CONTRA COSTA CLEAN WATER PROGRAM

Urban Creeks Monitoring Report:

Water Year 2021

(October 2020 – September 2021)

   

Submitted to the San Francisco Bay and Central Valley Regional Water Quality Control Boards in Compliance with NPDES Permit Provision C.8.h.iii

NPDES Permit Nos. CAS612008 and CAS083313

March 31, 2022

A Program of Contra Costa County, its Incorporated Cities and Towns, and the Contra Costa Flood Control & Water Conservation District

Contra Costa Clean Water Program

Urban Creeks Monitoring Report: Water Year 2021

(October 2020 – September 2021)

March 31, 2022

Prepared for

Contra Costa Clean Water Program
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Contra Costa Clean Water Program Participants

- Cities of Antioch, Brentwood, Clayton, Concord, Danville (Town), El Cerrito, Hercules, Lafayette, Martinez, Moraga (Town), Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, and Walnut Creek
- Unincorporated Contra Costa County
- Contra Costa County Flood Control & Water Conservation District

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List of Acronyms and Abbreviations

ACCWP	Alameda Countywide Clean Water Program
BAMSC	Bay Area Municipal Stormwater Collaborative
BASMAA	Bay Area Stormwater Management Agencies Association
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
CSCI	California Stream Condition Index
CVRWQCB	Central Valley Regional Water Quality Control Board
FSURMP	Fairfield-Suisun Urban Runoff Management Program
GIS	geographic information system
IMS	Information Management System
MRP	Municipal Regional NPDES Stormwater Permit
NPDES	National Pollutant Discharge Elimination System
POC	pollutants of concern
P/S Studies	Pilot and Special Studies
QAPP	quality assurance project plan
Region 2	San Francisco Bay Regional Water Quality Control Board
Region 5	Central Valley Regional Water Quality Control Board
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program for Water Quality in San Francisco Bay
RWQCB	Regional Water Quality Control Board
S&T Program	Status & Trends Monitoring Program
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	standard operating procedure(s)
SPoT	Stream Pollution Trends
SSID	Stressor/Source Identification
STLS	Small Tributaries Loading Strategy
SWAMP	California Surface Water Ambient Monitoring Program
UCMR	urban creeks monitoring report
USGS	United States Geological Survey

Table i. Summary of Water Year 2021 Creek Status and Pesticides/Toxicity Monitoring Stations

Site ID	Creek Name	Land Use	Latitude	Longitude	City/Town	Bioassessment PHab Chlorine Nutrients	Water Toxicity and Sediment Toxicity and Chemistry[1]	Continuous Water Temperature	Continuous Water Quality	Pathogen Indicator Bacteria
204R02068	South San Ramon Creek	Region 2, Urban	37.74719	-121.94256	San Ramon					X
204R02500	West Branch Alamo Creek	Region 2, Urban	37.77612	-121.92486	San Ramon	X				
204R02692	Alamo Creek	Region 2, Urban	37.74400	-121.91723	San Ramon	X				X
204SLE204	Moraga Creek	Region 2, Urban	37.83252	-122.13431	Moraga			X		
206R02816	Refugio Creek	Region 2, Urban	37.99454	-122.23909	Hercules	X				
206R02903	Wildcat Creek	Region 2, Urban	37.95198	-122.32170	Richmond	X				
206R02907	San Pablo Creek[2]	Region 2, Urban	37.89078	-122.19927	Orinda	X		X		
207R00700	San Ramon Creek	Region 2, Urban	37.80510	-121.97827	Danville					X
207R01307	Lafayette Creek	Region 2, Urban	37.88794	-122.13472	Lafayette			X		
207R02871	Walnut Creek	Region 2, Urban	37.96849	-122.05477	Concord	X				
207R03348	San Ramon Creek	Region 2, Urban	37.79917	-121.97747	Danville	X				X
207R03383	Tributary of Walnut Creek	Region 2, Urban	37.99285	-122.03022	Concord	X				
207R03403	Walnut Creek	Region 2, Urban	37.90342	-122.05906	Walnut Creek	X	X	X		
207ALH015	Alhambra Creek	Region 2, Urban	38.01674	-122.13587	Martinez					X
544R03353	Marsh Creek[3]	Region 5, Urban	37.95772	-121.69055	Brentwood	X				
544MSHM0	Marsh Creek[4]	Region 5, Urban	37.99046	-121.69599	Oakley				X	
544MSHM1	Marsh Creek[4]	Region 5, Urban	37.96389	-121.68374	Brentwood				X	

1 Dry weather sample
2 Upstream of San Pablo Reservoir
3 Site upstream of Brentwood wastewater treatment plant discharge
4 Monitoring station downstream of Brentwood wastewater treatment plant discharge

Preface

In 2010, several members of the Bay Area Stormwater Management Agencies Association (BASMAA) joined together to form the Regional Monitoring Coalition (RMC) to coordinate and oversee water quality monitoring required by the Municipal Regional Stormwater Permit (MRP). The RMC includes the following stormwater program participants:

- Alameda Countywide Clean Water Program
- Contra Costa Clean Water Program
- San Mateo Countywide Water Pollution Prevention Program
- Santa Clara Valley Urban Runoff Pollution Prevention Program
- Fairfield-Suisun Urban Runoff Management Program
- City of Vallejo and Vallejo Sanitation and Flood Control District

After more than 31 years of operation, including the last dozen years as a 501(c)(3) non-profit, BASMAA wound down its activities and dissolved. The State of California officially confirmed the dissolution of the non-profit organization on June 28, 2021. Information sharing and permittee advocacy functions of BASMAA have continued informally under a new moniker, Bay Area Municipal Stormwater Collaborative (BAMSC), via a Steering Committee and Subcommittees. CCCWP continues to perform creek status monitoring and report results in accordance with RMC standards like prior years.

In accordance with the BASMAA RMC multi-year work plan (Work Plan) (BASMAA, 2011) and the creek status and long-term trends monitoring plan (BASMAA, 2012), monitoring data were collected in accordance with the BASMAA RMC quality assurance project plan (QAPP) (BASMAA, 2020) and the BASMAA RMC standard operating procedures (SOPs) (BASMAA, 2016). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP. Data presented in this report were also submitted in electronic SWAMP-comparable formats to Moss Landing Marine Laboratory for transmittal to the Regional Water Quality Control Board on behalf of the Contra Costa Clean Water Program (CCCWP) permittees and pursuant to the MRP Provision C.8.h.ii requirements for electronic data reporting.

This Urban Creeks Monitoring Report complies with MRP Provision C.8.h.iii for reporting of all data in water year 2021 (Oct. 1, 2020-Sept. 30, 2021). Data were collected pursuant to Provision C.8 of the MRP. Data presented in this report were produced under the direction of the RMC and CCCWP using regional/probabilistic and local/targeted monitoring designs as described herein.

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1 Introduction

This Urban Creeks Monitoring Report (UCMR) was prepared by the Contra Costa Clean Water Program (CCCWP) on behalf of its 21 member agencies (19 cities/towns, County of Contra Costa, and Contra Costa County Flood Control and Water Conservation District). CCCWP gathers and reports monitoring data to help its program members comply with the Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit (MRP). This UCMR and its appendices present monitoring data through statistical and graphical analysis and summarizes results to understand creek health in Contra Costa County.

As Contra Costa County lies within both the Region 2 and Region 5 jurisdictions of the State Water Resources Control Board (Figure 1), the countywide stormwater program is subject to permit requirements of each jurisdiction. Municipal stormwater discharges in Contra Costa County are regulated by the requirements of the MRP in Region 2 (Order R2-2015-0049)[1] and the East Contra Costa County MRP (Central Valley Permit) in Region 5 (Order R5-2010-0102)[2]. Prior to the reissuance of MRP Order R2-2015-0049, the requirements of the two permits were effectively identical. With the reissued MRP in 2015, some differences between the permits led to an agreement between the Central Valley and San Francisco Bay Regional Water Quality Control Boards, where sites in the Central Valley Region (Region 5) will continue to be sampled as part of the creek status monitoring provision required by both permits, with monitoring and reporting requirements prevailing under the jurisdiction of the Region 2 MRP (Order R2-2019-0004)[3].

This report, including all appendices and attachments, fulfills the requirements of MRP Provision C.8.h.iii for interpreting and reporting monitoring data collected during water year 2021 (Oct. 1, 2020-Sept. 30, 2021). All monitoring data presented in this report were submitted electronically to the Water Boards by CCCWP (Attachment A). Data collected from receiving waters may be obtained via the California Environmental Data Exchange Network (CEDEN) website. Information on how this data may be obtained is available at http://www.ceden.org/find_data_page.shtml. This site contains information related to data retrieval from the CEDEN Query Tool, the California State Open Data Portal, and the Tableau Public Visualization Tool.

This report is organized by the sub-provisions of MRP Provision C.8, as follows:

1. Compliance Options (MRP Provision C.8.a), Monitoring Protocols and Data Quality (MRP Provision C.8.b)
2. San Francisco Estuary Receiving Water Monitoring (MRP Provision C.8.c)
3. Creek Status Monitoring (MRP Provision C.8.d) and Pesticides and Toxicity Monitoring (MRP Provision C.8.g) (Appendices 1 and 2)
4. Pollutants of Concern Monitoring (MRP Provision C.8.f) (Appendix 3)

[1] The SFBRWQCB issued the five-year municipal regional permit for urban stormwater (MRP, Order R2-2015-0049) to 76 cities, counties, and flood control districts (i.e., the Permittees) in the Bay Area on Nov. 19, 2015 (SFBRWQCB, 2015). The BASMAA programs supporting MRP regional projects include all MRP permittees, as well as the cities of Antioch, Brentwood, and Oakley, which are not named as permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

[2] The CVRWQCB issued the East Contra Costa County municipal NPDES permit (Central Valley Permit, Order R5-2010-0102) on Sept. 23, 2010 (CVRWQCB, 2010). This permit is now superseded by Order R2-2019-0004, incorporating the eastern portion of Contra Costa County within the requirements of the MRP (Order R2-2015-0049).

[3] The SFBRWQCB, per agreement with the CVRWQCB, adopted Order R2-2019-004 on Feb. 13, 2019.

Figure 1. **BASMAA Regional Monitoring Coalition Area, County Boundaries and Major Creeks**

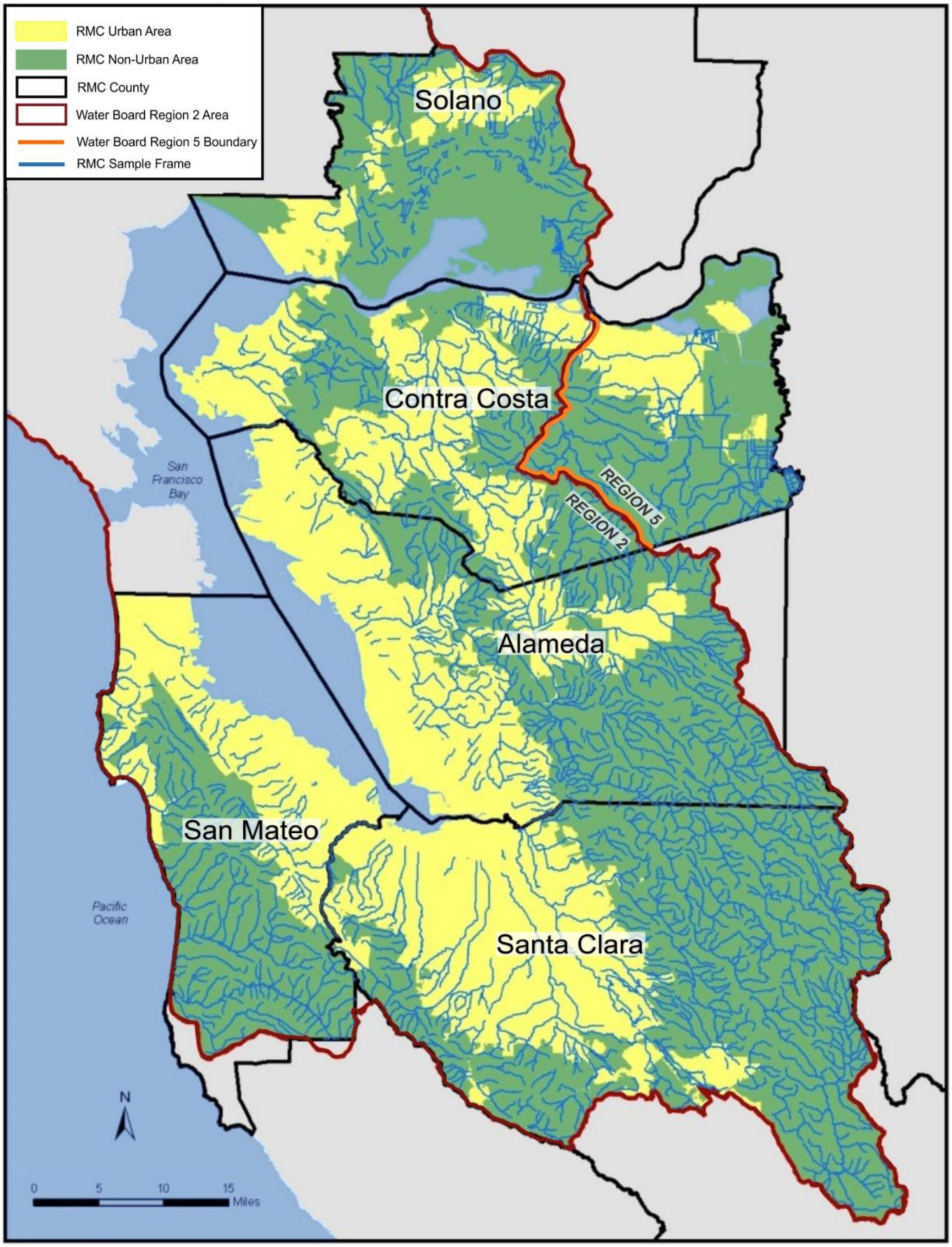


Figure 2 maps the locations of CCCWP monitoring stations associated with Provision C.8 compliance in water year 2021, including creek status, pesticides and toxicity, and pollutants of concern (POC) monitoring studies.

Monitoring discussed herein was performed in accordance with the requirements of the MRP. Key technical findings, detailed methods and results associated with these reports are summarized and provided in the respective appendices, as referenced within the applicable sections of the main body of this report.

1.1 Regional Monitoring Coalition (RMC) Overview

In 2010, CCCWP joined with several other members of the Bay Area Stormwater Management Agencies Association (BASMAA) to participate in a regional collaborative effort to coordinate water quality monitoring required by the MRP. The resulting regional monitoring collaborative is called the Regional Monitoring Coalition (RMC). Details of the respective RMC stormwater program participants and their co-permittees are presented in Table 1.

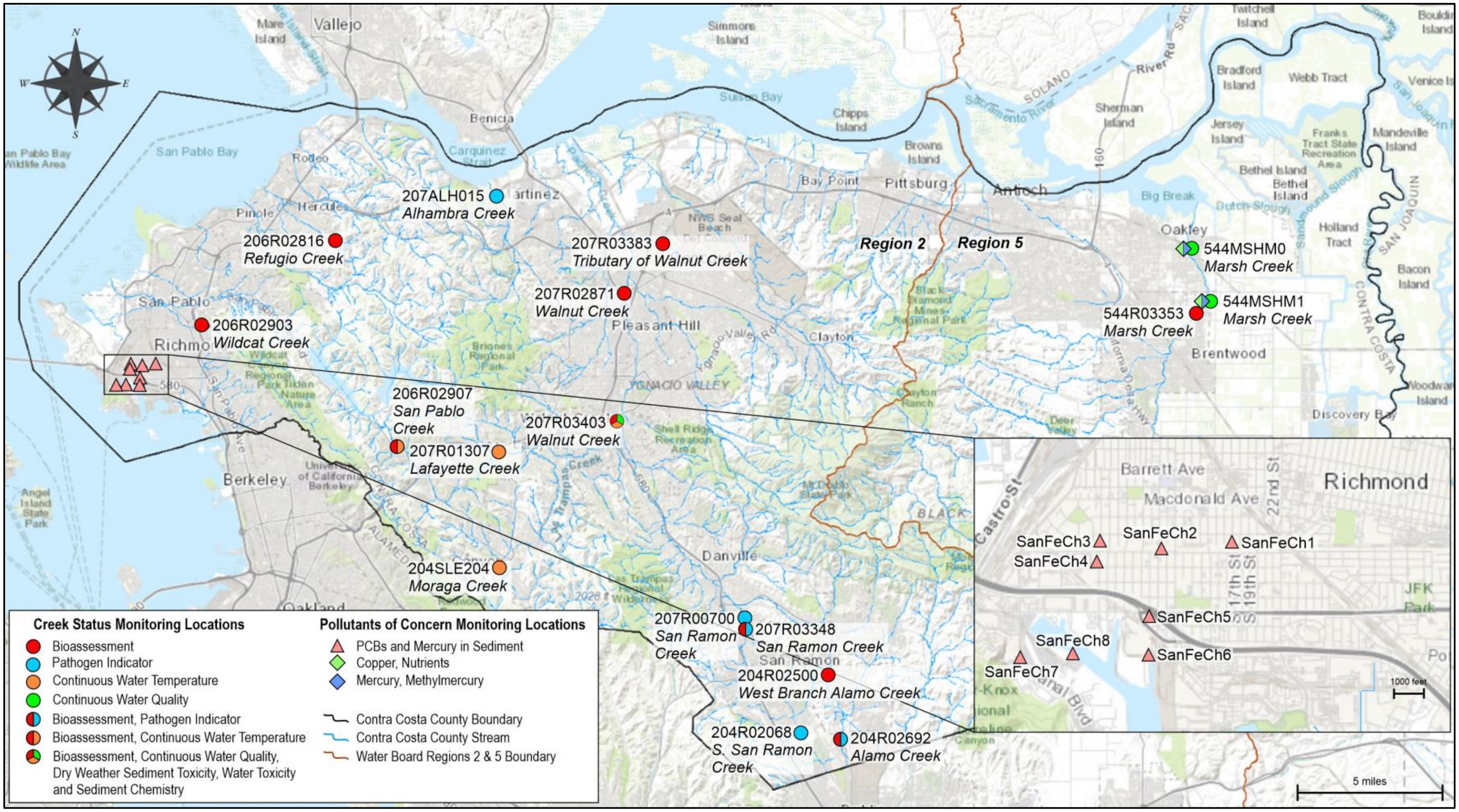
Table 1. Regional Monitoring Coalition Participants

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and Santa Clara County
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 Water Agency
Contra Costa Clean Water Program (CCCWP)	Cities/Towns 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 Countywide Water Pollution Prevention Program (SMCWPPP)	Cities and towns of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District

In June 2010, the permittees notified the Water Board in writing of their agreement to participate in the RMC to collaboratively address creek status and related monitoring requirements in MRP Provision C.8. The RMC's goals are to:

- Assist permittees in complying with the requirements of MRP Provision C.8 (Water Quality Monitoring)
- Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area through the improved coordination among RMC participants and other agencies, such as the Regional Water Quality Control Board (RWQCB), that share common goals

Figure 2. Creek Status and Pollutants of Concern Monitoring Stations in Water Year 2021



- Stabilize the costs of creek monitoring by reducing duplication of effort (e.g., development of quality assurance project plans)

In February 2011, the RMC developed a multi-year work plan (RMC Work Plan; BASMAA, 2011) to provide a framework for implementing regional monitoring and assessment activities required under MRP Provision C.8. The RMC Work Plan summarized RMC-related projects planned for implementation between fiscal years 2009-2010 and 2014-2015. Projects were collectively developed by RMC representatives to the BASMAA Monitoring and Pollutants of Concern Committee and were conceptually agreed to by the BASMAA Board of Directors.

Based on the requirements described in Provision C.8 of the original MRP (SFBRWQCB, 2009), a total of 27 regional projects were identified in the RMC Work Plan. Regionally implemented activities to provide standardization and coordination for the RMC Work Plan were conducted under the auspices of BASMAA. Scopes, budgets, and contracting implementation mechanisms for BASMAA regional projects follow BASMAA's Operational Policies and Procedures, approved by the BASMAA Board of Directors. MRP permittees, through their stormwater program representatives on the Board of Directors and its subcommittees, collaboratively authorized and participated in BASMAA regional projects or tasks. Regional project costs were shared by either all BASMAA members or among those Phase I municipal stormwater programs that are subject to the MRP. CCCWP and other RMC participants coordinate their monitoring activities through meetings and communications of the RMC workgroups and the BAMSC Monitoring and Pollutants of Concern Committee.

1.2 Compliance Options (C.8.a)

Provision C.8.a (Compliance Options) of the MRP allows the Permittees to comply with all monitoring requirements by contributing to their countywide stormwater program, through regional collaboration or by using data collected by a third party. The primary means for regional collaboration on creek status monitoring is the RMC, which coordinates member programs on monitoring needs, including:

- Shared standard operating procedures
- Shared quality assurance project plans (QAPPs)
- Site selection and number of sites per program
- Timing of sampling events
- Data quality assurance and quality control procedures
- Database management

The main benefit of the RMC to the CCCWP Permittees is assurance that the final results meet Water Board expectations for data content and quality. The MRP defines the type, amount, and frequency of monitoring; however, many details of execution require operator judgements (e.g., how to screen bioassessment sites or what are acceptable data quality objectives). Discussion at the RMC provides a single point of communication and common documentation to align the details across programs and allow the Water Board to comment on approach. The RMC is likely cost-neutral, in that the staff time and consultant support necessary to collaborate is offset by the cost efficiencies achieved by sharing methods and documents.

CCCWP works with third-party water quality monitoring partners to benefit local, regional, and statewide monitoring efforts. Provision C.8.a.iii allows permittees to work with third-party organizations such as the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), Central Valley Regional Water Quality Control Board (CVRWQCB), State Water Resources Control Board, or California Department of

Pesticide Regulation to fulfill monitoring requirements if data meets water quality objectives described in Provision C.8.b. Monitoring locations in Contra Costa County are sampled in a manner to be comparable to the protocols of the state's Surface Water Ambient Monitoring Program (SWAMP) and assessed for pesticide pollution and toxicity through the Stream Pollution Trends (SPoT) Program (Phillips et al., 2016). SPoT monitors status and trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California and relates contaminant concentrations and toxicity test results to watershed land uses.

CCCWP staff and other designated representatives participate with the Small Tributaries Loading Strategy (STLS) program (SFEI, 2013) of the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) to conduct pollutants of concern monitoring at Contra Costa sites, as further described in Section 4.

In addition, CCCWP supports efforts by local creek groups to monitor San Pablo, Wildcat, Walnut, and Marsh Creek Watersheds.

1.3 Monitoring Protocols and Data Quality (C.8.b)

Provision C.8.b of the MRP requires water quality data collected by the Permittees to comply with and be of a quality consistent with the State of California's SWAMP standards, set forth in the SWAMP QAPP and standard operating procedures (SOPs). RMC protocols and procedures were developed to assist permittees with meeting SWAMP data quality standards and to develop data management systems which allow for easy access to water quality monitoring data by Permittees.

1.3.1 Standard Operating and Data Quality Assurance Procedures

For creek status monitoring, the RMC adapted existing SOPs and the QAPP developed by SWAMP to document the field procedures necessary to produce SWAMP-comparable, high-quality data among RMC participants[4]. The RMC creek status monitoring program SOP and QAPPs were updated to accommodate MRP 2.0 requirements in March 2016 (Version 3) (BASMAA, 2016) and January 2020 (Version 4) (BASMAA, 2020), respectively.

For POC monitoring, a sampling analysis plan (ADH and AMS, 2020a) and QAPP (ADH and AMS, 2020b) were developed in 2016 and finalized in 2020 to guide the monitoring efforts for each POC task.

1.3.2 Information Management System Development/Adaptation

Permittees are required to report annually on water quality data collected in compliance with the MRP. To facilitate data management and transmittal, the RMC participants developed an Information Management System (IMS) to provide SWAMP-compatible storage and import/export of data for all RMC programs, with data formatted in a manner suitable for uploading to CEDEN.

BASMAA subsequently supplemented the IMS to accommodate management of POC data collected by the RMC programs. The expanded IMS provides standardized data storage formats which allow RMC participants to share data among themselves and to submit data electronically to the SFBRWQCB and CVRWQCB.

[4] Further details on SWAMP comparability are available at https://www.waterboards.ca.gov/water_issues/programs/quality_assurance/comparability.html

2 San Francisco Estuary Receiving Water Monitoring (C.8.c)

CCCWP contributes to the RMP, specifically the Status & Trends Monitoring Program (S&T Program) and the Pilot and Special Studies (P/S Studies). These efforts provide useful tools for CCCWP. Brief descriptions of the S&T Program and P/S Studies are provided below.

As described in MRP Provision C.8.c, Permittees are required to conduct or cause to be conducted receiving water monitoring in the Bay. Permittees comply with this provision by making financial contributions through the CCCWP to the San Francisco Bay RMP. Additionally, Permittees actively participate in RMP committees and work groups through Permittee and/or stormwater program representatives.

The Sacramento-San Joaquin River Delta (Delta) RMP serves a similar function in fulfilling receiving water monitoring requirements for dischargers located within the jurisdiction of the CVRWQCB. Some CCCWP Permittees (the cities of Brentwood, Antioch, and Oakley, and portions of unincorporated Contra Costa County and the Contra Costa County Flood Control District) are located within the CVRWQCB's jurisdiction; however, by agreement with the SFRWQCB and the CVRWQCB, those Permittees also meet receiving water monitoring requirements through funding of the San Francisco Bay RMP. This is consistent with the historic approach of managing the entire countywide program as a single, integrated program.

The RMP is a long-term, discharger-funded monitoring program directed by a steering committee and represented by regulatory agencies and the regulated community. In addition to regulators and the regulated community, the RMP Technical Committee includes participation by a local, non-governmental organization that specializes in water quality in the Bay. The goal of the RMP is to assess water quality in San Francisco Bay. The regulated community includes Permittees, publicly owned treatment works, dredgers, and industrial dischargers.

The RMP is intended to answer the following core management questions:

1. Are chemical concentrations in the estuary potentially at levels of concern and are associated impacts likely?
2. What are the concentrations and masses of contaminants in the estuary and its segments?
3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the estuary?
4. Have the concentrations, masses, and associated impacts of contaminants in the estuary increased or decreased?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the estuary?

The RMP budget is generally broken into two major program elements: status and trends monitoring and Pilot/Special Studies. The RMP publishes reports and study results on their website at www.sfei.org/rmp.

2.1 RMP Status and Trends Monitoring Program

The S&T Program is the long-term contaminant monitoring component of the RMP. The S&T Program was initiated as a pilot study in 1989 and was redesigned in 2007 based on a more rigorous statistical design aimed at enabling the detection of trends. The S&T Program is comprised of the following program elements:

- Long-term water, sediment, and bivalve monitoring
- Episodic toxicity monitoring
- Sport fishing monitoring
- U.S. Geological Survey (USGS) hydrographic and sediment transport studies
- Factors controlling suspended sediment in San Francisco Bay
- USGS monthly water quality data
- Triennial bird egg monitoring (cormorant and tern)

Additional information on the S&T Program and associated monitoring data are available for download via the RMP website at www.sfei.org/content/status-trends-monitoring.

2.2 RMP Pilot and Special Studies

The RMP conducts pilot and special studies on an annual basis through committees, workgroups, and strategy teams. Usually, studies are designed to investigate and develop new monitoring measures related to anthropogenic contamination or contaminant effects on biota in the estuary. Special studies address specific scientific issues that RMP committees and standing workgroups identify as priority for further study. These studies are developed through an open selection process at the workgroup level and are selected for further funding through RMP committees. Results and summaries of the most pertinent pilot and special studies can be found on the RMP web site (http://www.sfei.org/rmp).

2.3 Participation in Committees, Workgroups and Strategy Teams

CCCWP and/or other BAMSC representatives participate in the following RMP committees and workgroups:

- Steering Committee
- Technical Review Committee
- Sources, Pathways and Loadings Workgroup
- Emergent Contaminant Workgroup
- Nutrient Technical Workgroup
- Strategy teams (e.g., Small Tributaries, PCBs)

Committee and workgroup representation are provided by CCCWP, other stormwater program staff, and/or individuals designated by RMC participants. Representation includes participation in meetings, review of technical reports and work products, co-authoring or review of articles included in the RMP's annual publication, *Pulse of the Estuary*, and general program direction to RMP staff. Representatives of the RMP also provide timely summaries and updates to and receive input from BAMSC stormwater program representatives (on behalf of the Permittees) during workgroup meetings to ensure the Permittees' interests are represented.

3 Creek Status Monitoring (C.8.d and C.8.g)

Creek status monitoring and pesticides and toxicity monitoring are conducted in compliance with Provision C.8.d and C.8.g of the MRP. Monitoring management questions, strategy, and regional collaboration are presented below, while Section 3.1 describes the approach to regional/probabilistic creek status monitoring, Section 3.2 describes the approach to local/targeted creek status monitoring, and section 3.3 presents the approach to pesticide and toxicity monitoring.

The MRP requires Permittees to conduct creek status and pesticides and toxicity monitoring to assess the chemical, physical, and biological impacts of urban runoff on receiving waters, and 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 waters supportive of or likely supportive of beneficial uses?

Creek status monitoring parameters, methods, occurrences, duration, and minimum number of sampling sites for each stormwater program are described in Provision C.8.d of the MRP. Coordinated through the RMC, creek status monitoring began in October 2011 and continues annually in non-tidally influenced, flowing water bodies (i.e., creeks, streams, and rivers).

The RMC's strategy for creek status monitoring is described in the Creek Status and Long-Term Trends Monitoring Plan (BASMAA, 2011). The monitoring methods follow the protocols described in the updated BASMAA RMC QAPP (Version 4) (BASMAA, 2020) and SOPs for creek status and pesticides and toxicity monitoring (Version 3) (BASMAA, 2016). The purpose of these documents is to provide RMC participants with a common basis for application of consistent monitoring protocols across jurisdictional boundaries. These protocols form part of the RMC's quality assurance program to help ensure validity of resulting data and comparability with SWAMP protocols.

Creek status monitoring parameters required by MRP Provisions C.8.d and C.8.g are divided into two types: those conducted under a regional/probabilistic design, and those conducted under a local/targeted design (Table 2). The combination of these monitoring designs allows each RMC-participating program to assess the status of beneficial uses in local creeks within its program (jurisdictional) area, while also contributing data to answer management questions at the regional scale (e.g., differences between aquatic life conditions in urban and non-urban creeks).

The RMC monitoring strategy for complying with MRP 2.0 requirements includes continuing a regional ambient/probabilistic monitoring component, and a component based on local/targeted monitoring, as in the previous permit term. The analysis of results from the two creek status monitoring components conducted in water year 2021 is presented in Appendix 1 and Appendix 2, respectively, and a summary of the monitoring stations is shown in Table i.

Creek status monitoring data for each water year are submitted annually by CCCWP to SFBRWQCB and CVRWQCB by March 31 of the following year.

Table 2. Creek Status Monitoring Elements per MRP Provisions C.8.d. and C.8.g., Monitored as Either Regional/Probabilistic or Local/Targeted Parameters

Biological Response and Stressor Indicators	Monitoring Design	
	Regional (Probabilistic)	Local (Targeted)
Bioassessment, physical habitat assessment, CSCI	X	X[1]
Nutrients (and other water chemistry associated with bioassessment)	X	X[1]
Chlorine	X	X[2]
Water toxicity (wet and dry weather)	NA	NA
Water chemistry (pesticides, wet weather)	NA	NA
Sediment toxicity (dry weather)	NA	NA
Sediment chemistry (dry weather)	NA	NA
Continuous water quality (sondes data: temperature, dissolved oxygen, pH, specific conductance)		X
Continuous water temperature (data loggers)		X
Pathogen indicators (bacteria)		X

1 Provision C.8.d.i.(6) allows for up to 20% of sample locations to be selected under a targeted monitoring design. This design change was made under MRP Order R2-2015-0049.
2 Provision C.8.d.ii.(2) provides options for probabilistic or targeted site selection. In water year 2020, chlorine was measured at probabilistic sites.
CSCI California Stream Condition Index
NA Monitoring parameter not specific to either monitoring design

3.1 Regional/Probabilistic Monitoring

The regional/probabilistic creek status monitoring report (Appendix 1) documents the results of monitoring performed by CCCWP during water year 2021 under the regional/probabilistic monitoring design developed by the RMC. During each water year, 10 sites are monitored by CCCWP for bioassessment, physical habitat, and related water chemistry parameters. To date, 100 sites have been sampled since the inception of the program in water year 2012.

RMC probabilistic monitoring sites are drawn from a sample frame consisting of a creek network geographic information system (GIS) data set within the RMC boundary[5] (BASMAA, 2011), including stream segments from all perennial and non-perennial creeks and rivers running through urban and non-urban areas within the portions of the five RMC participating counties within the SFBRWQCB boundary, and the eastern portion of Contra Costa County which drains to the CVRWQCB region. A map of the BASMAA RMC area, equivalent to the area covered by the regional/probabilistic design "sample frame," is shown in Figure 1. The sites selected from the regional/probabilistic design master sample draw and monitored in water year 2021 are shown graphically in Figure 2.

The probabilistic design required several years to produce sufficient data to develop a statistically robust characterization of regional creek conditions. BASMAA conducted a regional project to analyze bioassessment monitoring data collected during a five-year period (2012-2016) (BASMAA, 2019). That analysis can be used to help inform recommendations for potential changes to the monitoring program. The project has also developed a fact sheet presenting the report findings in a format accessible to a broad audience.

[5] Based on discussion during RMC meetings, with SFBRWQCB staff present, the sample frame was extended to include the portion of Eastern Contra Costa County that ultimately drains to San Francisco Bay to address parallel provisions in CCCWP's Central Valley Permit for Eastern Contra Costa County.

Per MRP 2.0 Provisions C.8.d. and C.8.g., the creek status monitoring results are subject to potential follow-up actions if they meet certain specified threshold triggers. If monitoring results meet the requirements for follow-up actions, the results are compiled on a list for consideration as potential SSID projects, per MRP 2.0 Provision C.8.e. The results are compared to other regulatory standards, including the Basin Plan (SFBRWQCB, 2019) water quality objectives where available and applicable.

3.2 Local/Targeted Monitoring

The Local/Targeted Creek Status Monitoring Report (Appendix 2) documents the results of targeted monitoring performed by CCCWP during water year 2021. Within Contra Costa County, targeted monitoring is conducted annually at:

- Four continuous water temperature monitoring locations
- Two general water quality monitoring locations
- Five pathogen indicator bacteria monitoring locations

Site locations are identified using a targeted monitoring design based on the directed principle to address the following management questions:

1. What is the range of general water quality measurements at targeted sites of interest?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. What are the pathogen indicator concentrations at creek sites where recreational water contact may occur?

Targeted monitoring data are evaluated against MRP threshold triggers, to assess the potential need for follow-up. The results of water year 2021 monitoring are summarized in Appendix 2.

3.3 Toxicity, Pesticides and Other Pollutants in Sediment – Dry Weather (C.8.g)

Once per year during the dry season (July 1-Sept. 30), sediment samples are collected and tested for toxicity to several different aquatic species, as required by MRP 2.0. Sampling is conducted at a site selected from the probabilistic design for bioassessment monitoring, or at a site targeted to address management questions.

Concurrent with the sediment toxicity sampling described above, sediment chemistry samples are collected for analysis of a select list of pesticides, polycyclic aromatic hydrocarbons, trace elements, total organic carbon, and grain size. All sediment analytical chemistry (pesticides and other pollutants), grain size analysis and toxicity test results are presented in Appendix 1.

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4 Pollutants of Concern Monitoring (C.8.f)

POC monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, assess progress toward achieving waste load allocations and total maximum daily loads, and to help resolve uncertainties associated with loading estimates for these pollutants.

POC monitoring addresses five priority information management needs:

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

Monitoring in water year 2021 continued the effort toward addressing these information needs as discussed below. Table 3 presents a summary of water year 2021 POCs monitoring locations.

Table 3. Summary of Water Year 2021 Pollutants of Concern Monitoring Stations

Station ID	Receiving Water Body	Land Use	Latitude	Longitude	City/Town	Street Dirt Sediment	Methyl Mercury, Copper, and Nutrients
544MSHM0	Marsh Creek	Region 5, Urban	37.99035	-121.69591	Oakley		X
544MSHM1	Marsh Creek	Region 5, Urban	37.96448	-121.68392	Brentwood		X
SanFeCh1	Santa Fe Channel	Region 2, Urban	37.93154	-122.35327	Richmond	X	
SanFeCh2	Santa Fe Channel	Region 2, Urban	37.93088	-122.36159	Richmond	X	
SanFeCh3	Santa Fe Channel	Region 2, Urban	37.93161	-122.36878	Richmond	X	
SanFeCh4	Santa Fe Channel	Region 2, Urban	37.92969	-122.36912	Richmond	X	
SanFeCh5	Santa Fe Channel	Region 2, Urban	37.92465	-122.36301	Richmond	X	
SanFeCh6	Santa Fe Channel	Region 2, Urban	37.92118	-122.36304	Richmond	X	
SanFeCh7	Santa Fe Channel	Region 2, Urban	37.92089	-122.37810	Richmond	X	
SanFeCh8	Santa Fe Channel	Region 2, Urban	37.92120	-122.37191	Richmond	X	

4.1 Source Identification and Contribution to Bay Impairment

In water year 2021, CCCWP conducted source area assessments to investigate high interest parcels and areas for consideration of property referrals and focused implementation planning for PCBs and mercury load reductions. Street dirt and drop inlet sediments were sampled for POCs at eight locations within the Santa Fe Channel watershed in the City of Richmond, as shown in Figure 2. These sediment monitoring activities address source identification, contributions to Bay impairment, and management action effectiveness. Additionally, dry weather stream sampling was conducted in targeted locations for copper, nutrients, mercury, and methylmercury (see Figure 2). These water monitoring activities address source identification, contributions to Bay impairment, loads, and trends. A summary report of these data is presented in the Pollutants of Concern Monitoring Report: Water Year 2021 (Appendix 3).

4.2 Loads, Status and Trends

MRP 2.0 places an increased focus on finding watersheds, source areas, and source properties that are potentially more polluted and upstream from sensitive Bay margin areas (high leverage sites). To support this focus, a stormwater reconnaissance monitoring program was developed and implemented beginning in water year 2015 by the RMP through the STLS workgroup. However, in water year 2021, no stormwater sampling activities were located within Contra Costa County, due to COVID-19 restrictions.

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Appendix 1

Regional/Probabilistic Creek Status Monitoring Report:

Water Year 2021

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Contra Costa Clean Water Program

Regional/Probabilistic Creek Status Monitoring Report: Water Year 2021

(October 2020-September 2021)

March 31, 2022

Prepared for

Contra Costa Clean Water Program
255 Glacier Drive
Martinez, California 94553

Prepared by

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Contra Costa Clean Water Program

Regional/Probabilistic Creek Status Monitoring Report: Water Year 2021

(October 2020-September 2021)

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List of Acronyms and Abbreviations

ACCWP	Alameda Countywide Clean Water Program
AFDM	ash-free dry mass
A-IBI	algal index of biological integrity
ASCI	Algae Stream Condition Index
Basin Plan	common term for the Regional Water Quality Control plan
BAMSC	Bay Area Municipal Stormwater Collaborative
BASMAA	Bay Area Stormwater Management Agencies Association
B-IBI	benthic index of biological integrity
BMI	benthic macroinvertebrate
CCCWP	Contra Costa Clean Water Program
Central Valley Permit	East Contra Costa County Municipal NPDES Permit
cm	centimeter
CSCI	California Stream Condition Index
CVRWQCB	Central Valley Regional Water Quality Control Board
FSURMP	Fairfield-Suisun Urban Runoff Management Program
GIS	geographic information system
GRTS	Generalized Random Tessellated Stratified
IBI	Index of Biological Integrity
Kinnetic	Kinnetic Environmental, Inc.
LC_{50}	lethal concentration to 50% of test organisms
LCS	laboratory control standard
LCSD	laboratory control standard duplicate
m	meter
MCL	maximum contaminant level
MDL	method detection limit
MMI	multi-metric index
MQO	measurement quality objective
MRP	Municipal Regional Permit
MS/MSD	matrix spike/matrix spike supplicate
MUN	municipal and domestic water supply
ND	not detected
NPDES	National Pollutant Discharge Elimination System
NT	non-target
NZMS	New Zealand Mudsnail
PAH	polycyclic aromatic hydrocarbon
PEC	probable effect concentration
PHab	physical habitat assessment
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
PSA	perennial streams assessment
RL	reporting limit
RMC	Regional Monitoring Coalition
RPD	relative percent difference
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 procedure
SSID	stress/source identification
STE	Standard Taxonomic Effort
SWAMP	Surface Water Ambient Monitoring Program
TEC	threshold effect concentration
TNS	target not sampled (or sampleable)
TOC	total organic carbon
TS	target sampled
TST	Test of Significant Toxicity
TU	toxic unit
U	unknown
UCMR	Urban Creeks Monitoring Report
USEPA	U.S. Environmental Protection Agency
WY	water year

Acknowledgements

This report was prepared by Armand Ruby Consulting, in association with Kinnetic Environmental, Inc., under contract to and supervision of the Contra Costa Clean Water Program (CCCWP). The report format and organization are in part derived from the original region-wide Regional Monitoring Coalition (RMC) monitoring report for water year 2012 (Regional Urban Creeks Status Monitoring Report, Appendix A to the Water Year 2012 Urban Creeks Monitoring Report), prepared jointly by EOA, Inc. and Armand Ruby Consulting as a regional project for the RMC participants (BASMAA, 2013).

In addition to the RMC participants, San Francisco Bay Regional Water Quality Control Board staff members Kevin Lunde and Jan O'Hara participated in the RMC work group meetings, which contributed to the design and implementation of the RMC Monitoring Plan. These staff members also provided input on the outline of the initial regional urban creek status monitoring report and threshold trigger analyses conducted herein.

The CCCWP Monitoring Committee, facilitated by Karin Graves of CCCWP and Lisa Austin and Lisa Welsh of Geosyntec Consultants, provided project supervision and review of draft documents. Christian Kocher served as project manager for Kinnetic Environmental and lead consultant to CCCWP. The staff of Kinnetic Environmental also contributed to both the content and production of this report, with respect to data compilation and extraction, organization of metadata, and graphics production. Marco Sigala, Director of Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories provided algae data analysis and interpretation, and assistance with preparation of watershed GIS information and other metrics used in the computation of CSCI and IPI scores.

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Preface

The Regional Monitoring Coalition (RMC) was formed in early 2010 as a collaboration among several Bay Area Stormwater Management Agencies Association (BASMAA) members to implement the creek status monitoring requirements of the original Municipal Regional Stormwater Permit (MRP) through a regionally coordinated effort. The RMC developed a probabilistic design for regional characterization of selected creek status monitoring parameters.

While BASMAA dissolved on June 28, 2021, the Contra Costa Clean Water Program and other RMC participants continue to coordinate their monitoring activities through the Bay Area Municipal Stormwater Collaborative (BAMSC) to perform creek status monitoring and report results in accordance with the RMC regional/probabilistic study design as in prior years.

This report fulfills MRP reporting requirements for regional/probabilistic creek status monitoring data generated within Contra Costa County during water year 2021 (Oct. 1, 2020-Sept. 30, 2021) for certain parameters monitored per MRP provisions C.8.d and C.8.g. This report is an appendix to the Contra Costa Clean Water Program's Urban Creeks Monitoring Report for water year 2021, and complements similar reports submitted by each of the other former RMC programs on behalf of their respective permittees.

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Executive Summary

This report documents the results of monitoring performed by Contra Costa Clean Water Program (CCCWP) during water year 2021 (Oct. 1, 2020-Sept. 30, 2021), for parameters originally covered under the regional/probabilistic monitoring design developed by the Regional Monitoring Coalition (RMC).

Other creek status monitoring parameters were addressed using a targeted design, with regional coordination and common methodologies. Together with the creek status monitoring data reported in the local/targeted creek status monitoring report for water year 2021 (Kinnetic, 2022), this submittal fulfills reporting requirements for creek status monitoring specified in provisions C.8.d and C.8.g of the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board per Order No. R2-2015-0049, as amended by Order No. R2-2019-0004, incorporating the eastern portion of Contra Costa County within the requirements of the MRP.

Summary of Water Year 2021 Creek Status Monitoring: Regional/Probabilistic Parameters

During water year 2021, 10 sites were monitored by CCCWP under the RMC regional/probabilistic design for bioassessment, physical habitat, and water chemistry parameters. One site also was monitored for water and sediment toxicity and sediment chemistry.

The bioassessment and related data are used to develop a preliminary condition assessment for the monitored sites. The water and sediment chemistry and toxicity data are used in conjunction with physical habitat data to evaluate potential stressors which may affect aquatic habitat quality and beneficial uses. Various metrics and indices are also computed to aid in the condition assessment and stressor analysis.

Biological Conditions

Calculation of the California Stream Condition Index (CSCI) is the primary means by which benthic macroinvertebrate (BMI) taxonomic data are interpreted for bioassessment in California streams. CSCI scores have been calculated from the CCCWP bioassessment data since water year 2016. The CSCI uses location-specific GIS data to compare the observed BMI taxonomic data to expected BMI assemblage characteristics from reference sites with similar geographical characteristics.

Every CCCWP bioassessment site monitored in water year 2021 produced a CSCI score below the MRP threshold of 0.795, indicating a degraded biological community relative to reference conditions.

The water year 2021 CSCI scores range from a low of 0.286 at Refugio Creek (site 206R02816) to a high of 0.513 at Walnut Creek (site 207R02871).

The invasive New Zealand Mudsnail (NZMS) was found in eight of the 10 benthic samples. Only Wildcat Creek (site 206R02903) and Marsh Creek (site 544R03353) were found to be free of NZMS.

NZMS was the dominant taxon in five of the 10 benthic samples, each containing more than 20% NZMS individuals, ranging as high as 78.2% NZMS at the upper Walnut Creek site (207R03403) and 81.9% at the tributary to Walnut Creek (site 207R03383), in the lower Walnut Creek watershed. A Walnut Creek site (site 207R02871) situated intermediate between those two sites was relatively free of NZMS, with only 5 individuals (0.8%) identified.

Calculation of Algal Stream Condition Index (ASCI) scores is the primary means used to assess algal biological community status in California streams. ASCI scores were calculated for CCCWP bioassessment sites again in water year 2021 and assigned to status categories based on Surface Water Ambient Monitoring Program (SWAMP) guidance. Nine of the 10 sites scored in the Very Likely Altered category for both the diatoms and hybrid multi-metric indices. The Refugio Creek (site 206R02816) sample produced the highest score (0.79) for the diatoms multi-metric index (MMI), in the Likely Altered category, and second highest score (0.68) for the hybrid MMI, in the Very Likely Altered category.

Based on both the BMI and algal community indices, the biological community conditions of all CCCWP sites monitored in 2021 are characterized as impacted.

Physical Habitat (PHab) Conditions

Index of Physical Integrity (IPI) scores were calculated from the PHab data compiled during the spring 2021 bioassessment monitoring, and the IPI scores were related to condition categories as recommended by SWAMP guidance. Five of the water year 2021 sites are rated as Likely Intact, three are ranked as Possibly Altered, and two are ranked as Likely Altered.

Given that the water year 2021 CSCI scores and ASCI MMI scores indicate "degraded" benthic macroinvertebrate communities and Very Likely Altered algal biological communities relative to reference conditions, physical habitat does not appear to be a principal stressor, with half of the corresponding IPI score categories indicating Likely Intact physical habitat and only two indicating Likely Altered habitat.

The influence of physical habitat as a potential stressor on biological community health may be complicated by the widespread occurrence of the New Zealand Mudsnail. The apparently detrimental effect of the heightened presence of this invasive species, which surprisingly correlated well with the IPI physical habitat indicator scores in the CCCWP water year 2021 data, presents a complicating factor in the current analysis.

Water Quality

Of 12 water quality parameters required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate+nitrite (for sites with MUN beneficial use only). None of the results generated at the 10 sites monitored during water year 2021 exceeded the applicable water quality standards.

Water Toxicity

The water samples collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined to be toxic to *Ceriodaphnia dubia* (chronic/reproduction test) and *Hyalella azteca* (acute/survival test), according to the Test of Significant Toxicity (TST) test protocol required by the MRP.

Sediment Toxicity

The sediment samples also collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined not to be toxic to either of the test species.

Sediment Chemistry

Several of the common urban pyrethroid pesticides were detected at the water year 2021 sediment monitoring site (Walnut Creek, site 207R03403); as is typical, bifenthrin was detected at the highest concentration. The calculated toxic unit (TU) equivalent of 0.84 for the combined pyrethroid concentrations is less than that normally presumed to cause toxicity to either *Chironomus dilutus* or *Hyalella azteca* in the sediment toxicity testing.

Sediment Triad Analyses

Bioassessment, sediment toxicity, and sediment chemistry results from water year 2021 were evaluated as the three lines of evidence used in the triad approach for assessing overall stream condition and added to the compiled results for water years 2012-2021. Good correlation is observed throughout that period in the triad analysis between pyrethroid concentrations with TU ≥1 and sediment toxicity.

Pyrethroid pesticide sediment concentrations appear to be effective predictors of sediment toxicity, as samples with calculated pyrethroid TU equivalents greater than 1.0 exhibited significant sediment toxicity. The samples with TU equivalents less than 1.0 generally did not exhibit sediment toxicity.

Based on the results of the past 10 years, chemical stressors, particularly pesticides, may be contributing to the degraded biological conditions indicated by the low B-IBI scores in many of the monitored streams.

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1 Introduction

This report documents the results of monitoring performed by Contra Costa Clean Water Program (CCCWP) during water year 2021 (Oct. 1, 2020-Sept. 30, 2021), for parameters originally covered under the regional/probabilistic monitoring design developed by the Regional Monitoring Coalition (RMC). Other creek status monitoring parameters were addressed using a targeted design, with regional coordination and common methodologies. Together with the creek status monitoring data reported in the local/targeted creek status monitoring report for water year 2021 (Kinnetic, 2022), this submittal fulfills reporting requirements for creek status monitoring specified in provisions C.8.d and C.8.g of the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) per Order No. R2-2015-0049, as amended by Order No. R2-2019-0004, incorporating the eastern portion of Contra Costa County within the requirements of the MRP.

1.1 Regulatory Context

Contra Costa County lies within the jurisdictions of both the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB; Region 2) and the Central Valley Regional Water Quality Control Board (CVRWQCB; Region 5). Municipal stormwater discharges in Contra Costa County previously were regulated by the requirements of two National Pollutant Discharge Elimination System (NPDES) stormwater permits: the MRP in Region 2 (Order No. R2-2015-0049[1]), and the East Contra Costa County Municipal NPDES Permit (Central Valley Permit) in Region 5 (Order No. R5-2010-0102[2]).

Prior to the reissuance of the MRP in 2015, the requirements of the two permits were effectively identical. With the reissued MRP, there were some differences between the MRP and the Central Valley Permit, although in most respects the creek status monitoring and reporting requirements remained similar. For this report, the creek status monitoring and reporting requirements specified in the reissued MRP are considered the prevailing requirements. Sites in the Central Valley Region have been monitored as part of the creek status monitoring required by both permits. Per agreement between the Central Valley and San Francisco Regional Water Quality Control Boards on Feb. 13, 2019, the SFBRWQCB adopted Order No. R2-2019-0004, to include the eastern portion of Contra Costa County under the jurisdiction of the MRP, rendering the Central Valley Permit obsolete for the purposes of this report.

CCCWP conducted extensive bioassessment monitoring prior to the adoption of the original MRP (SFBRWQCB, 2009). Summaries of those findings can be found in *Preliminary Assessment of Aquatic Life Use Condition in Contra Costa Creeks, Summary of Benthic Macroinvertebrate Bioassessment Results (2001-2006)* (CCCWP, 2007), and *Contra Costa Monitoring and Assessment Program, Summary of Benthic Macroinvertebrate Bioassessment Results (2011)* (ARC, 2012).

[1] The San Francisco Bay Regional Water Quality Control Board adopted the reissued Municipal Regional Stormwater NPDES Permit (Order No. R2-2015-0049) to 76 cities, counties and flood control districts (i.e., permittees) in the Bay Area on Nov. 19, 2015 (SFBRWQCB, 2015), effective Jan. 1, 2016. The BASMAA programs supporting MRP regional projects include all MRP permittees, plus the eastern Contra Costa County cities of Antioch, Brentwood, and Oakley, which have voluntarily elected to participate in the RMC. The RMC regional monitoring design was expanded to include the eastern portion of Contra Costa County, which is within the Central Valley Region (Region 5), to assist CCCWP in fulfilling parallel provisions in the Central Valley Permit.

[2] The Central Valley Regional Water Quality Control Board issued the East Contra Costa County Municipal NPDES Permit (Order No. R5-2010-0102) on Sept. 23, 2010 (CVRWQCB, 2010). This Order was superseded by Order No. R2-2019-0004, incorporating the eastern portion of Contra Costa County within the requirements of the MRP, Order No. R2-2015-0049, on Feb. 13, 2019.

1.2 Regional Monitoring Coalition

The regional/probabilistic design was developed and implemented by the Regional Monitoring Coalition of the Bay Area Stormwater Management Agencies Association (BASMAA). This monitoring design allows each RMC participating program to assess stream ecosystem conditions within its program area (e.g., county boundary), while contributing data to answer regional management questions about water quality and beneficial use conditions in the creeks of the San Francisco Bay Area.

The RMC was formed in early 2010 as a collaboration among several BASMAA members representing MRP permittees (Table 1.1), to implement the creek status monitoring requirements of the MRP through a regionally coordinated effort. While BASMAA dissolved in 2021, RMC participants continue to meet on an ongoing basis through the Bay Area Municipal Stormwater Collaborative (BAMSC) to plan and coordinate monitoring, data management, and reporting activities, among others.

Table 1.1 Regional Monitoring Coalition (RMC) Participants

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and Santa Clara County
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 Water Agency
Contra Costa Clean Water Program (CCCWP)	Cities/Towns 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 Countywide Water Pollution Prevention Program (SMCWPPP)	Cities and towns of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District

The goals established by the RMC were to:

- Assist RMC permittees in complying with requirements in MRP provision C.8 (water quality monitoring)
- Develop and implement regionally consistent creek monitoring approaches and designs in the San Francisco Bay Area through improved coordination among RMC participants and other agencies sharing common goals (e.g., regional water quality control boards, Regions 2 and 5, and the Surface Water Ambient Monitoring Program [SWAMP])
- Stabilize the costs of creek status monitoring by reducing duplication of effort and streamlining monitoring and reporting

The RMC Work Group was a subgroup of the BASMAA Monitoring and Pollutants of Concern Committee, which met and communicated regularly to coordinate planning and implementation of monitoring-related activities. The RMC Work Group meetings were coordinated by an RMC coordinator and funded by the RMC's participating county stormwater programs. This work group included staff from the SFBRWQCB at two levels: those generally engaged with the MRP, as well as those working regionally with the State of California's Surface Water Ambient Monitoring Program (SWAMP). Through the RMC Work Group, the BASMAA RMC developed a quality assurance project plan (QAPP) (BASMAA, 2020), standard operating procedures (SOPs) (BASMAA, 2016), data management tools, and reporting templates and guidelines. Costs for these activities were shared among RMC members.

The RMC divided the creek status monitoring requirements required by MRP provisions C.8.d and C.8.g into those parameters which could reasonably be included within a regional/probabilistic design and those which, for logistical and jurisdictional reasons, should be implemented locally using a targeted (non-probabilistic) design. The assignments of the various activities have adapted over time; the monitoring elements currently included in each category are specified in Table 1.2. Creek status monitoring data collected by CCCWP at local/targeted sites (and not included in the regional/probabilistic design) are reported separately in Appendix 2 of the Water Year 2021 Urban Creeks Monitoring Report (UCMR) (Kinnetic, 2022).

Table 1.2 Creek Status Monitoring Elements per MRP Provisions C.8.d. and C.8.g., Monitored as Either Regional/Probabilistic or Local/Targeted Parameters

Biological Response and Stressor Indicators	Monitoring Design	
	Regional (Probabilistic)	Local (Targeted)
Bioassessment, physical habitat assessment, CSCI	X	X[1]
Nutrients (and other water chemistry associated with bioassessment)	X	X[1]
Chlorine	X	X[2]
Water toxicity (wet and dry weather)	NA	NA
Water chemistry (pesticides, wet weather)	NA	NA
Sediment toxicity (dry weather)	NA	NA
Sediment chemistry (dry weather)	NA	NA
Continuous water quality (sondes data: temperature, dissolved oxygen, pH, specific conductance)		X
Continuous water temperature (data loggers)		X
Pathogen indicators (bacteria)		X

CSCI California Stream Condition Index

1 Provision C.8.d.i.(6) allows for up to 20% of sample locations to be selected under a targeted monitoring design. This design change was made under MRP Order No. R2-2015-0049.

2 Provision C.8.d.ii.(2) provides options for probabilistic or targeted site selection. In water year 2021, chlorine was measured at probabilistic sites.

NA Monitoring parameter not specific to either monitoring design

1.3 Report Organization

The remainder of this report addresses study area and monitoring design (Section 2), data collection and analysis methods (Section 3), results and data interpretation (Section 4), and conclusions and next steps (Section 5). Additional information on other aspects of permit-required monitoring is found elsewhere in the CCCWP water year 2021 UCMR and its appendices.

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2 Study Area and Monitoring Design

2.1 Regional Monitoring Coalition Area

For the purposes of the regional/probabilistic monitoring design, the study area was defined as equal to the RMC area, encompassing the political boundaries of the five former RMC participating counties, including the eastern portion of Contra Costa County which drains to the Central Valley region. A map of the BASMAA RMC area, equivalent to the area covered by the regional/probabilistic design sample frame, is shown in Figure 2.1.

2.2 Regional Monitoring Design

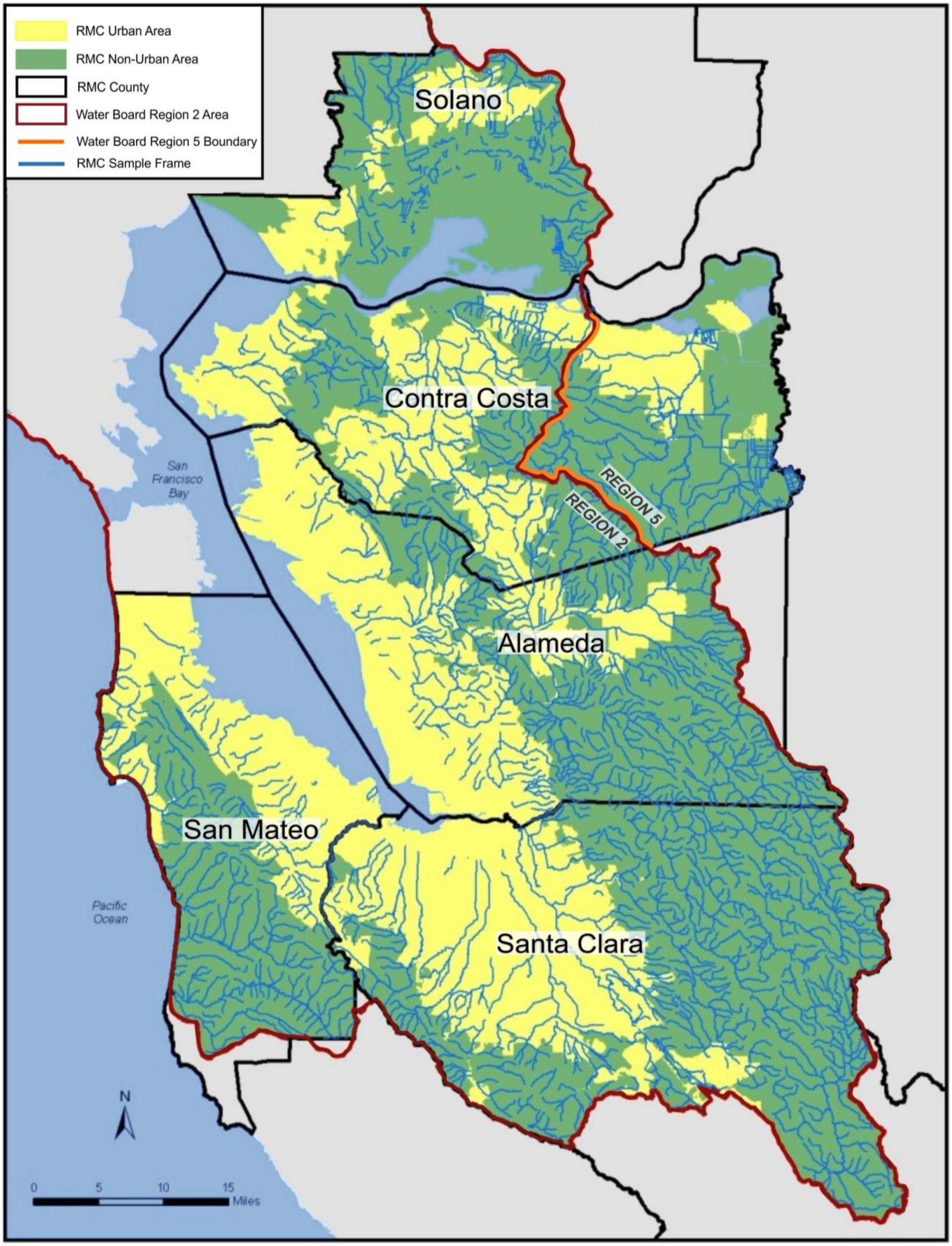
In 2011, the RMC developed a regional/probabilistic monitoring design to identify ambient conditions of creeks in the five main counties subject to the requirements of the MRP. The regional design was developed using the Generalized Random Tessellation Stratified (GRTS) approach developed by the U.S. Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olson, 2004). The GRTS approach has been implemented in California by several agencies, including the statewide Perennial Streams Assessment (PSA) conducted by SWAMP (Ode et al., 2011) and the regional monitoring conducted by the Southern California Stormwater Monitoring Coalition (SMC) (see SMC, 2007, updated by Mazor, 2015). The RMC area is considered to define the sample frame and represent the sample universe from which the regional "sample draw" (the randomized list of potential monitoring sites) is produced.

2.2.1 Management Questions

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

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

Figure 2.1 Map of BASMAA RMC Area, County Boundaries and Major Creeks



The regional design includes bioassessment monitoring to address the first set of questions regarding aquatic life condition. Assemblages of freshwater organisms are commonly used to assess the biological integrity of water bodies because they provide direct measures of ecological condition (Karr and Chu, 1999).

Benthic macroinvertebrates (BMIs) are an essential link in the aquatic food web, providing food for fish and consuming algae and aquatic vegetation (Karr and Chu, 1999). The presence and distribution of BMIs can vary across geographic locations based on elevation, creek gradient, and substrate (Barbour et al., 1999). These organisms are sensitive to disturbances in water and sediment chemistry, as well as to physical habitat, both in the stream channel and along the riparian zone. Due to their relatively long lifecycles (approximately one year) and limited migration, BMIs are particularly susceptible to site-specific stressors (Barbour et al., 1999).

Algae also are increasingly used as indicators of water quality, as they form the autotrophic base of aquatic food webs and exhibit relatively short life cycles which respond quickly to chemical and physical changes. Diatoms are found to be particularly useful for interpreting some causes of environmental degradation (Hill et al., 2000); therefore, both BMI and algae taxonomic data are used in the aquatic life assessments.

Additional water quality parameters, including water and sediment toxicity testing and chemical analysis, along with physical habitat characteristics, are then used to assess potential stressors to aquatic life.

2.2.2 Site Selection

Creek status monitoring was conducted in non-tidally influenced, flowing water bodies (i.e., creeks, streams, and rivers). The water bodies monitored were drawn from a master list which included all perennial and non-perennial creeks and rivers running through urban and non-urban areas within the RMC area. Sample sites were selected and attributed using the GRTS approach from a sample frame consisting of a creek network geographic information system (GIS) data set within the RMC boundary (BASMAA, 2011), within five management units corresponding to the five participating RMC counties. The National Hydrography Dataset Plus (1:100,000) was selected as the creek network data layer to provide consistency with both the statewide PSA and the SMC, and the opportunity for future data coordination with these programs.

The RMC sample frame was stratified by county and land use (i.e., urban and non-urban) to allow for comparisons within those strata. Urban areas were delineated by combining urban area boundaries and city boundaries defined by the U.S. Census Bureau of 2000. Non-urban areas were defined as the remainder of the areas within the sample universe (RMC area).

Based on discussions during RMC meetings with SFBRWQCB staff present, RMC participants weight their sampling to ensure at least 80% of monitored sites are in urban areas and not more than 20% are in non-urban areas. RMC participants coordinated with SWAMP and Regional Water Quality Control Board staff by identifying additional non-urban sites from their respective counties for SWAMP monitoring. For Contra Costa County, SWAMP monitoring included non-urban bioassessment sites chosen from the probabilistic sample draw in the Region 2 (San Francisco Bay) area of Contra Costa County, with the regional focus varying annually.

2.3 Monitoring Design Implementation

The number of probabilistic sites monitored annually in water years 2012-2021 by CCCWP are shown by land use category in Table 2.1. This tally includes non-urban sites monitored by SWAMP personnel.

In 2021 monitoring, all monitored sites were in areas of urban land use.

Table 2.1 Number of Urban and Non-Urban Bioassessment Sites Sampled by CCCWP and SWAMP in Contra Costa County During Water Years 2012-2021

	Contra Costa County	
	Land Use	
Monitoring Year	Urban Sites	Non-Urban Sites [1]
WY 2012	8	2/2
WY 2013	10	0/3
WY 2014	10	0/1
WY 2015	10	0/1
WY 2016	10	0/0
WY 2017	10	0/0
WY 2018	9	1/0
WY 2019	9	1/0
WY 2020	9	1/0
WY 2021	10	0/0
Total	**95**	**12**

1 Non-urban sites are shown as sampled by CCCWP/SWAMP for each year. The total represents combined non-urban sites, including those monitored by SWAMP in Contra Costa County.

3 Monitoring Methods

3.1 Site Evaluation

Sites identified in the regional sample draw are evaluated by CCCWP in numerical order using the process defined in the RMC SOPs (BASMAA, 2016). Each site is evaluated to determine if it meets the following RMC sampling location criteria:

1. The location (latitude/longitude) provided for a site is located on or is within 300 meters (m) of a non-impounded receiving water body
2. The site is not tidally influenced
3. The site is wadable during the sampling index period
4. The site has sufficient flow during the sampling index period to support SOPs for biological and nutrient sampling
5. The site is physically accessible and can be entered safely at the time of sampling
6. The site may be physically accessed and sampled within a single day
7. Landowner(s) grants permission to access the site[3]

In the first step, these criteria were evaluated for the current water year to the extent possible using desktop analysis.

For sites which successfully passed the initial desktop analysis, site evaluations were completed during the second step via field reconnaissance visits. Based on the outcome of the site evaluations, sites were classified into one of four categories:

Target Sampleable (TS): sites meeting all seven criteria were classified as target sampleable (TS)

Target Non-Sampleable (TNS): sites meeting criteria 1 through 4, but not meeting at least one of criteria 5 through 7, were classified as target non-sampleable (TNS)

Non-Target (NT): sites not meeting at least one of criteria 1 through 4 were classified as non-target (NT) status and were not sampled

Unknown (U): sites were classified with unknown (U) status and not sampled when it could be reasonably inferred, either via desktop analysis or a field visit, the site was a valid receiving water body and information for any of the seven criteria was unconfirmed

The outcomes of these site evaluations for CCCWP sites for water year 2021 are illustrated in Figure 3.1. Typically, a relatively small fraction of sites evaluated each year are classified as target sampleable sites, but over half of the sites evaluated for 2021 were determined to be target sampleable.

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

During the site evaluation field visits, flow status was recorded as one of five categories:

Wet Flowing: continuously wet or nearly so; flowing water

Wet Trickle: continuously wet or nearly so; very low flow; trickle less than 0.1 L/second

Majority Wet: discontinuously wet; greater than 25% by length of stream bed covered with water; isolated pools

Minority Wet: discontinuously wet; less than 25% of stream bed by length covered with water; isolated pools

No Water: no surface water present

Observations of flow status during pre-wet-weather, fall site reconnaissance events and during post-wet-weather, spring sampling were combined to classify sites as perennial or nonperennial as follows:

Perennial: fall flow status is either Wet Flowing or Wet Trickle, and spring flow is sufficient to sample

Non-Perennial: fall flow status is Majority Wet, Minority Wet, or No Water, and spring flow is sufficient to sample

The probabilistic sites selected for monitoring in water year 2021, following site evaluation, are shown graphically in Figure 3.2 as the bioassessment sites, and are listed with additional site information in Table 3.1. As shown in Table 3.1, one additional site (Walnut Creek, site 207R03403) was selected for dry weather water toxicity, sediment toxicity and sediment chemistry testing. Wet weather (stormwater) chemistry and toxicity testing was not conducted in water years 2019, 2020 or 2021, as the relevant MRP requirements had previously been met.

Figure 3.1 Results of CCCWP Site Evaluations for Water Year 2021

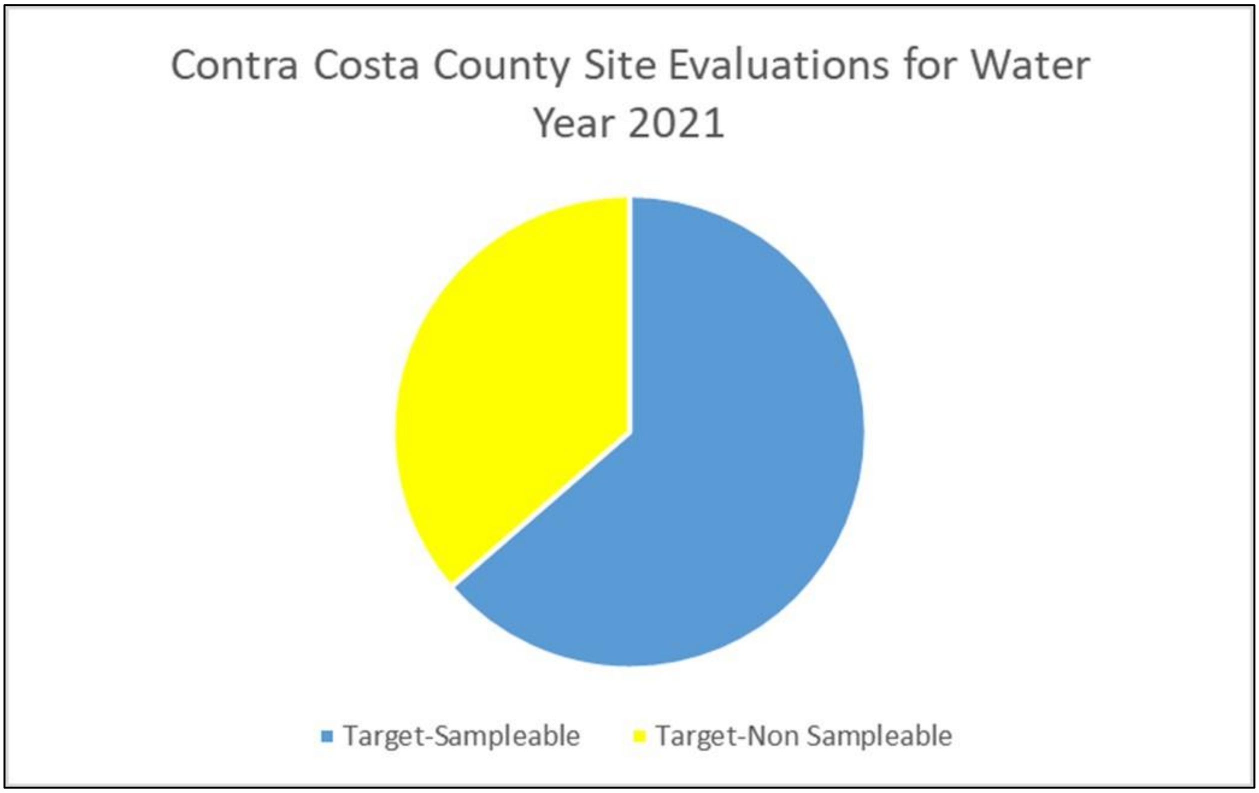


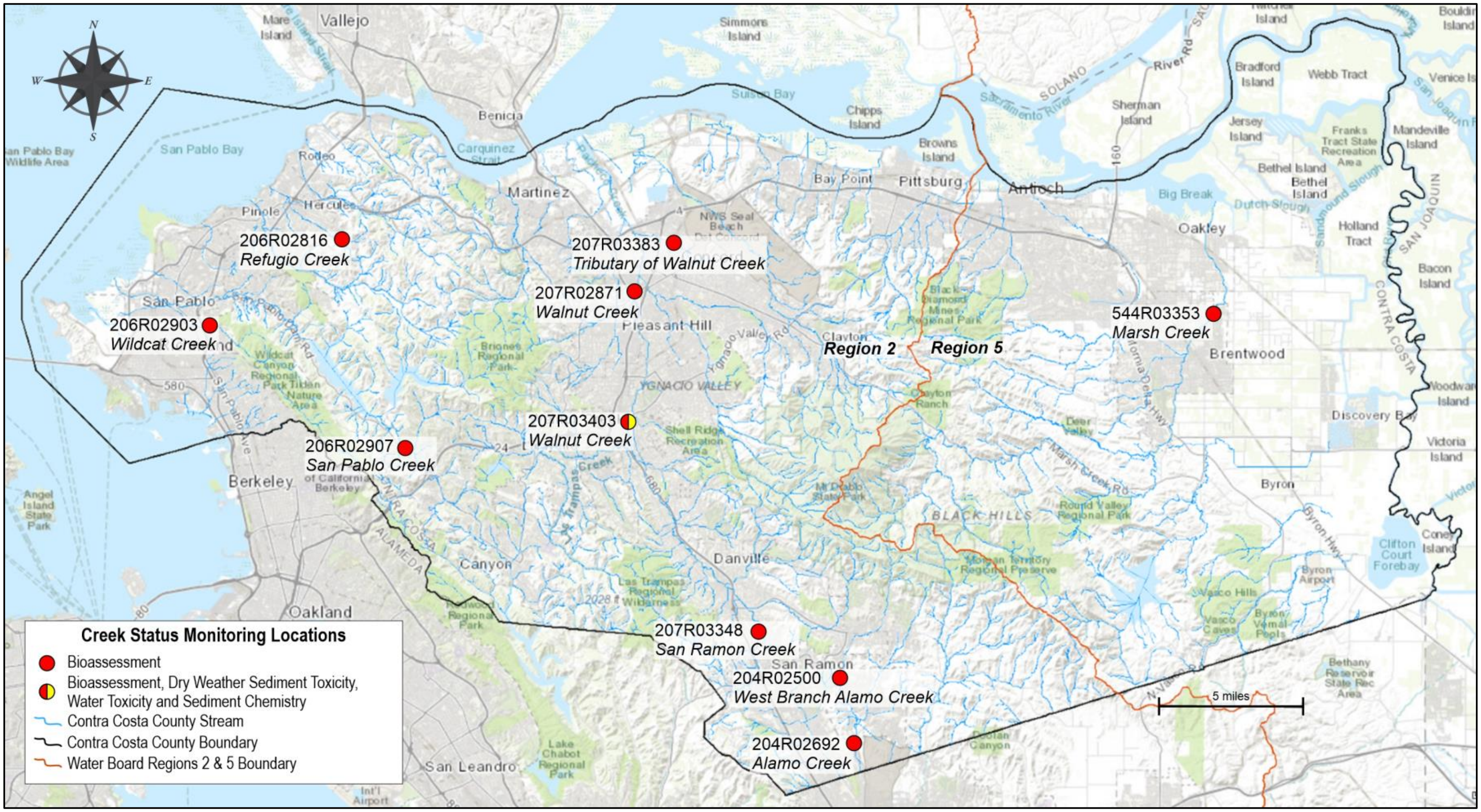
Table 3.1 Site Locations, Monitoring Parameters and Dates Sampled at CCCWP Sites from the RMC Probabilistic Monitoring Design in Water Year 2021

Site ID	Creek Name	Land Use	Latitude	Longitude	Bioassessment, PHab, Chlorine, Nutrients	Stormwater Toxicity and Chemistry[1] (Wet Weather)	Water Toxicity and Sediment Toxicity and Chemistry (Dry Weather)
204R02500	West Branch Alamo	U	37.77612	-121.92486	04/28/21		
204R02692	Alamo	U	37.74400	-121.91723	04/28/21		
206R02816	Refugio	U	37.99454	-122.23909	04/29/21		
206R02903	Wildcat	U	37.95198	-122.32170	05/11/21		
206R02907	San Pablo	U	37.89078	-122.19927	05/12/21		
207R02871	Walnut	U	37.96849	-122.05477	05/10/21		
207R03348	San Ramon	U	37.79917	-121.97747	05/10/21		
207R03383	Tributary of Walnut	U	37.99285	-122.03022	05/12/21		
207R03403	Walnut	U	37.90379	-122.05925	04/27/21		06/23/21
544R03353	Marsh	U	37.95772	-121.69055	05/13/21		

1 Wet weather monitoring was not conducted in water year 2019, 2020, or 2021.

Note: 'U' means urban land use; 'NU' means non-urban land use

Figure 3.2 Contra Costa County Creek Status Sites Monitored in Water Year 2021



Note: Bioassessment sites are those selected from the RMC Probabilistic Monitoring Design

3.2 Field Sampling and Data Collection Methods

Field data and samples were collected in accordance with existing SWAMP-comparable methods and procedures, as described in the RMC QAPP (BASMAA, 2020) and the associated SOPs (BASMAA, 2016). The SOPs were developed using a standard format describing health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures. Sampling methods and procedures include pre-fieldwork mobilization activities to prepare equipment, field collection of samples, and demobilization activities to preserve and transport samples, including procedures to prevent transporting invasive species between creeks. The SOPs relevant to the monitoring discussed in this report are listed in Table 3.2.

Table 3.2 RMC Standard Operating Procedures Pertaining to Regional Creek Status Monitoring

SOP	Procedure
FS-1	BMI and algae bioassessments and physical habitat assessments
FS-2	Water quality sampling for chemical analysis, pathogen indicators, and toxicity testing
FS-3	Field measurements, manual
FS-6	Collection of bedded sediment samples
FS-7	Field equipment cleaning procedures
FS-8	Field equipment decontamination procedures
FS-9	Sample container, handling, and chain-of-custody procedures
FS-10	Completion and processing of field data sheets
FS-11	Site and sample naming convention
FS-12	Ambient creek status monitoring site evaluation
FS-13	Quality assurance and quality control (QA/QC) data review

Procedures for sample container size and type, preservative type, and associated holding times for each regional/probabilistic analyte are described in RMC SOP FS-9 (BASMAA, 2016). Procedures for completion of field data sheets are provided in RMC SOP FS-10, and procedures for sample bottle labeling are described in RMC SOP FS-11 (BASMAA, 2016).

3.2.1 Bioassessments

In accordance with the RMC QAPP (BASMAA, 2020), bioassessments were conducted during the spring index period (approximately April 15 to July 15) and at a minimum of 30 days after any significant storm (roughly defined as at least 0.5 inch of rainfall within a 24-hour period).

Each bioassessment monitoring site consisted of an approximately 150-meter stream reach divided into 11 equidistant transects placed perpendicular to the direction of flow. The sampling position within each transect alternated between 25, 50 and 75 percent distance of the wetted width of the stream (see SOP FS-1, BASMAA, 2016).

3.2.1.1 Benthic Macroinvertebrates (BMI)

BMIs were collected via kick net sampling using the reach-wide benthos method described in RMC SOP FS-1 (BASMAA, 2016), based on the SWAMP bioassessment procedures (Ode et al., 2016a and 2016b). Samples were collected from a 1 square foot area approximately 1 m downstream of each transect. The benthos was disturbed by manually rubbing areas of coarse substrate, followed by disturbing the upper layers of finer substrate to a depth of 4 to 6 inches to dislodge any remaining invertebrates into the net. Slack water habitat procedures were used at transects with deep and/or slow-moving water. Material collected from the 11 subsamples was composited in the field by transferring the entire sample into one to two 1,000 mL wide-mouth jar(s), and the samples were preserved with 95% ethanol.

3.2.1.2 Algae

Filamentous ("soft") algae and diatom samples also were collected at the 10 bioassessment sites using the reach-wide benthos method per SOP FS-1 (BASMAA, 2016), based on the SWAMP bioassessment procedures (Ode et al., 2016a and 2016b). Algae samples were collected synoptically with BMI samples. The sampling position within each transect was the same as used for BMI sampling, except algae samples were collected 6 inches upstream of the BMI sampling position and following BMI collection from that location. The algae were collected using a range of methods and equipment, depending on the substrate occurring at the site (e.g., erosional, depositional, large and/or immobile), per RMC SOP FS-1. Erosional substrates included any material (substrate or organics) small enough to be removed from the stream bed but large enough to isolate an area equal to a rubber delimiter (12.6 cm^2 in area).

When a sample location along a transect was too deep to sample, a more suitable location was selected, either on the same transect or from one further upstream. Algae samples were collected at each transect prior to moving on to the next transect. Sample material (substrate and water) from all 11 transects was combined in a sample bucket, agitated, and a suspended algae sample was then poured into a 500 mL cylinder, creating a composite sample for the site. A 45 mL subsample was taken from the algae composite sample and combined with 5 mL glutaraldehyde into a 50 mL sample tube for taxonomic identification of soft algae. Similarly, a 40 mL subsample was taken from the algae composite sample and combined with 10 mL of 10% formalin into a 50 mL sample tube for taxonomic identification of diatoms.

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

3.2.1.3 Physical Habitat (PHab)

PHab assessments were conducted during each BMI bioassessment monitoring event using the SWAMP PHab protocols (Ode et al., 2016a and 2016b) and RMC SOP FS-1 (BASMAA, 2016). PHab data were collected at each of the 11 transects and 10 additional inter-transects (located between each main transect) by implementing the "Full" SWAMP level of effort (as prescribed in the MRP). At algae sampling locations, additional assessment of the presence of micro- and macroalgae was conducted during the pebble counts. In addition, water velocities were measured per SWAMP protocols at a single location in the sample reach (when possible).

3.2.2 Physicochemical Measurements

Dissolved oxygen, temperature, conductivity, and pH were measured during bioassessment monitoring using a multi-parameter probe (see SOP FS-3, BASMAA, 2016). Dissolved oxygen, specific conductivity, water temperature, and pH measurements were made either by direct submersion of the instrument probe into the sample stream or by collection and immediate analysis of grab sample in the field. Water quality measurements were taken approximately 0.1 m below the water surface at locations of the stream appearing to be completely mixed, ideally at the centroid of the stream. Measurements should occur upstream of sampling personnel and equipment and upstream of areas where bed sediments have been disturbed or prior to such bed disturbance.

3.2.3 Chlorine

Water samples were collected and analyzed for free and total chlorine using CHEMetrics™ test kits (K-2511 for low range and K-2504 for high range). Chlorine measurements in water were conducted during late spring bioassessment monitoring.

3.2.4 Nutrients and Conventional Analytes (Water Chemistry)

Water samples were collected during bioassessment monitoring for nutrient analyses using the standard grab sample collection method, as described in SOP FS-2 (BASMAA, 2016). Sample containers were rinsed using ambient water and filled and recapped below the water surface whenever possible. An intermediate container was used to collect water for all sample containers containing preservative added in advance by the laboratory. Sample container size and type, preservative type, and associated holding times for each analyte are described in Table 1 of SOP FS-9 (BASMAA, 2016). The syringe filtration method was used to collect samples for analyses of dissolved orthophosphate and dissolved organic carbon. All sample containers were labeled and stored on ice for transport to the analytical laboratory, except for analysis of AFDM and chlorophyll-*a* samples, which were field-frozen on dry ice by sampling teams, where appropriate.

3.2.5 Water Toxicity

Samples were collected for water toxicity using the standard grab sample collection method described above, filling the required number of labeled 2.25-liter amber glass bottles with ambient water, putting them on ice to cool to 4° C ± 2° C, and delivered to the laboratory within the required hold time. The laboratory was notified of the impending sample delivery to ensure meeting the 24-hour sample delivery time requirement. Procedures used for sample collection and transport are described in SOP FS-2 (BASMAA, 2016).

3.2.6 Sediment Chemistry and Sediment Toxicity

In the case where sediment samples and water samples and measurements were collected at the same event, sediment samples were collected after water samples were collected. Before conducting sediment sampling, field personnel surveyed the proposed sampling area to identify appropriate fine-sediment depositional areas and to avoid disturbing possible sediment collection sub-sites. Personnel carefully entered the stream and began sampling at the closest appropriate reach, continuing upstream. Sediment samples were collected from the top 2 cm of sediment in a compositing container, thoroughly homogenized, and then aliquoted into separate jars for chemical and toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA, 2016). Sample jars were submitted to the respective laboratories per SOP FS-9 (BASMAA, 2016).

3.3 Laboratory Analysis Methods

RMC participants agreed to use the same set of analytical laboratories for regional/probabilistic parameters, developed standards for contracting with the labs, and coordinated quality assurance issues. All samples collected by RMC participants sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods, as described in the RMC QAPP (BASMAA, 2020). The following analytical laboratory contractors were used for biological, chemical, and toxicological analysis:

BioAssessment Services, Inc. – BMI taxonomic identification

The laboratory performed taxonomic identification nominally on a minimum of 600 BMI individuals for each sample, per standard taxonomic effort Level 1, as established by the Southwest Association of Freshwater Invertebrate Taxonomists, with additional identification of chironomids to subfamily/tribe level (corresponding to a Level 1a standard taxonomic effort).

EcoAnalysts, Inc. – Algae taxonomic identification

Samples were processed in the laboratory following draft SWAMP protocols to provide count (diatom and soft algae), biovolume (soft algae), and presence (diatom and soft algae) data. Laboratory processing included identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level. Diatom and soft algae identifications were not fully harmonized with the California Algae and Diatom Taxonomic Working Group's Master Taxa List, and 12 taxa were not included in the data analysis.

Caltest Analytical Laboratory, Inc. – Water chemistry (nutrients, etc.), sediment chemistry, chlorophyll-a, AFDM

Upon receipt at the laboratory, samples were immediately logged and preserved as necessary. USEPA-approved testing protocols were then applied for analysis of water and sediment samples.

Pacific EcoRisk, Inc. – Water and sediment toxicity

Testing of water and sediment samples was performed per species-specific protocols published by USEPA.

3.4 Data Analysis – Water Year 2021 Data

Only data collected by CCCWP during water year 2021 for regional/probabilistic parameters are presented and analyzed in this report. This includes data collected during bioassessment monitoring (BMI and algae taxonomy, water chemistry, and physical habitat evaluations at 10 sites), as well as dry weather water and sediment toxicity and sediment chemistry data from one additional site. The bioassessment data are used to evaluate stream conditions, and the associated physical, chemical and toxicity testing data are then analyzed to identify potential stressors which may impact water quality and biological conditions.

For the comprehensive, multi-year analysis required for the 2020 Integrated Monitoring Report (Armand Ruby Consulting, 2020), the accumulated data from water years 2012-2019 were used to develop a statistically representative data set for the RMC region to address management questions related to condition of aquatic life.

Creek status monitoring data generated by CCCWP for local/targeted parameters (not included in the probabilistic design), per MRP provision C.8.d, are reported in Local/Targeted Creek Status Monitoring Report: Water year 2021, found in Appendix 2 of the CCCWP water year 2021 UCMR (Kinnetic, 2022).

The creek status monitoring results are subject to potential follow-up actions, per MRP provisions C.8.d and C.8.g, if they meet certain specified threshold triggers, as shown in Table 3.3 for the regional/ probabilistic parameters. During MRP 2.0, if monitoring results met the requirements for follow-up actions as shown in Table 3.3, the results were compiled in a list for consideration as potential stress/source identification (SSID) projects, per MRP 2.0 provision C.8.e, and used by RMC programs to help inform the MRP 2.0 SSID project selection process.

As part of the stressor assessment for this report, water and sediment chemistry and toxicity data generated during water year 2021 also were analyzed and evaluated against the relevant threshold triggers to identify potential stressors which might contribute to degraded or diminished biological conditions.

In addition to those threshold triggers for potential MRP 2.0 SSID projects, the results were compared to other regulatory standards, including the San Francisco Bay Basin Plan (Basin Plan) water quality objectives, where available and applicable.

Table 3.3 Requirements for Follow-up for Regional/Probabilistic Creek Status Monitoring Results Per MRP 2.0 Provisions C.8.d and C.8.g

Constituent	Threshold Trigger Level	MRP Provision	Provision Text
CSCI Score	< 0.795 (plus see provision text =>)	C.8.d.i.(8)	Sites scoring less than 0.795 per CSCI are appropriate for an MRP 2.0 SSID project, as defined in provision C.8.e. Such a score indicates a substantially degraded biological community relative to reference conditions. Sites where there is a substantial difference in CSCI score observed at a location relative to upstream or downstream sites are also appropriate for an MRP 2.0 SSID project. If many samples show a degraded biological condition, sites where water quality is most likely to cause and contribute to this degradation may be prioritized by the permittee for an MRP 2.0 SSID project.
Chlorine	> 0.1 mg/L	C.8.d.ii.(4)	The permittees shall immediately resample if the chlorine concentration is greater than 0.1 mg/L. If the resample is still greater than 0.1 mg/L, then permittees shall report the observation to the appropriate permittee central contact point for illicit discharges, so the illicit discharge staff can investigate and abate the associated discharge in accordance with provision C.5.e (Spill and Dumping Complaint Response Program).
Toxicity	TST "fail" on initial and follow-up sample test; both results have > 50% effect	C.8.g.iv	The permittees shall identify a site as a candidate MRP 2.0 SSID project when analytical results indicate any of the following: (1) a toxicity test of growth, reproduction, or survival of any test organism is reported as "fail" in both the initial sampling, and (2) a second, follow up sampling, and both have ≥ 50% effect. Note: Applies to dry and wet weather, water column and sediment tests.
Pesticides (Water)[1]	> Basin Plan water quality objectives	C.8.g.iv	The permittees shall identify a site as a candidate MRP 2.0 SSID project when analytical results indicate a pollutant is present at a concentration exceeding its water quality objective in the Basin Plan.
Pesticides and Other Pollutants (Sediment)	Result exceeds PEC or TEC (per MacDonald et al., 2000)	C.8.g.iv	The permittees shall identify a site as a candidate MRP 2.0 SSID project when analytical results indicate any of the following: (1) A pollutant is present at a concentration exceeding its water quality objective in the Basin Plan, and (2) for pollutants without water quality objectives, results exceed PEC or TEC.

PEC probable effects concentrations

TEC threshold effects concentrations

Notes: Per RMC decision, with Water Board staff concurrence, in accordance with MRP provision C.8.g.iii.(3), this monitoring commenced in water year 2017.
Per MRP 2.0 provision C.8.d. and C.8.g., these are the data thresholds which trigger listings as candidate SSID projects.

3.4.1 Biological Data

The biological condition of each probabilistic site monitored by CCCWP in water year 2021 was evaluated principally through analysis of BMI and algal taxonomic metrics, and calculation of associated index of biological integrity (IBI) scores. An IBI is an analytical tool involving calculation of a site condition score based on a compendium of biological metrics.

3.4.1.1 Benthic Macroinvertebrate (BMI) Data Analysis

Under the MRP, the BMI taxonomic data are evaluated principally through calculation of the California Stream Condition Index (CSCI), a bioassessment index developed by California SWAMP for statewide use (Rehn et al., 2015; Rehn, 2016; Mazor et al., 2016); methods updated in 2020 (Boyle et al., 2020). CSCI scores evaluate stream health based on comparison of metric characteristics of the observed benthic macroinvertebrate (BMI) taxonomy (as reported by the lab), versus the expected BMI community characteristics that would, in theory, be present in a reference stream with similar geographic characteristics as the monitored stream, based on a specific set of watershed (GIS) parameters.

The CSCI score is computed as the average of two other indices: O/E, the observed (O) taxonomic diversity at the monitoring site divided by the taxonomic composition expected (E) at a reference site with similar geographical characteristics, and MMI, a multi-metric index incorporating several metrics reflective of BMI community attributes (such as measures of assemblage richness, composition, and diversity), as predicted for a site with similar physical characteristics. The six metrics selected for inclusion in the MMI calculations were taxonomic richness, number of shredder taxa, percent clinger taxa, percent Coleoptera taxa, percent EPT (Ephemeroptera, Plecopter, and Trichoptera) taxa, and percent intolerant taxa (Rehn et al., 2015; Rehn, 2016).

CSCI scores were calculated using ‘R’ statistical software (per Boyle et al., 2020). The CSCI is calculated from empirical data organized into two input files: the “stations” data, derived from the GIS characteristics associated with each monitoring site, and “bugs” data, the taxonomic data derived from laboratory analysis of the BMI samples.

CSCI scores run from a minimum of 0 (indicating no correspondence to modeled reference site conditions) to a maximum of 1 (perfect correspondence with modeled reference site conditions). A CSCI score below 0.795 indicates biological degradation and a potential candidate site for an MRP 2.0 SSID project. This index produces conservative values relative to urban creeks.

The various taxonomic metrics derived from the BMI taxonomic data, as produced by Tom King of Bioassessment Services, also are presented in this report. For consistency and comparison with the water year 2012 regional UCMR (BASMAA, 2013), subsequent urban creeks monitoring reports, and other RMC programs, the Southern California Benthic Index of Biological Integrity (B-IBI) score (per Ode et al., 2005) is also computed and presented in this report.

3.4.1.2 Algae Data Analysis

Algae taxonomic data can be evaluated through a variety of metrics and indices. The MRP does not specify analytical metrics or threshold trigger levels for algae data.

In accordance with general practice among Bay Area municipal stormwater programs, algal biological stream condition is assessed for this report via a set of algae indices developed for statewide use by California SWAMP. Three Algae Stream Condition Index (ASCI) multi-metric indices (MMIs) were developed (for diatoms, soft algae, and a diatom/soft algae hybrid), for use in assessing biointegrity in wadable streams in California, and the methods were published in 2020 (Boyle et al., 2020). These statewide ASCI MMIs are expected to be more robust across a wider range of environmental conditions than the former standard algal indices of biotic integrity (A-IBIs).

As with the CSCI score calculations, ASCI scores are computed using the watershed characteristics of each monitored site, and comparisons of the observed algal taxonomic characteristics to those which may be expected from healthy sites with similar watershed characteristics. The ASCI MMIs are calculated from empirical data organized into two input files: the “stations” data, derived from the GIS characteristics associated with each monitoring site, and “algae_tax” data, the taxonomic data derived from laboratory analysis of the algae samples.

The watersheds were delineated for the water year 2021 sites using the Watershed Conversion Tool (Geographic Information Center; Boyle et al., 2020). Delineations were checked against catchment borders and topography for accuracy using ArcGIS and no adjustments were necessary. GIS metrics were then calculated for input into the ASCI computational routine using the Indices Processor toolbox version 4.7.2 (Boyle et al., 2020).

ASCI scores were calculated using ‘R’ statistical software running ASCI R scripts version 2.3.3, per Boyle et al., (2020). ASCI score categories were applied to diatom (D_ASCI) and hybrid (H_ASCI) results as defined in Theroux et al., (2020). The soft algae (S_ASCI) output is not recommended for use at this time, as it did not perform well in development. H_ASCI includes soft algae and diatom data and performed as well or slightly less than D_ASCI. However, D_ASCI is likely to be the most frequently reported index statewide, and is the preferred index for assessment (Marco Sigala, personal communication).

3.4.1.3 Biological Condition Categories

During development of the CSCI and ASCI indices, the developers divided the range of possible scores for each index into categories representing the relative likelihood that the biota observed at monitored sites were intact or altered, when compared to conditions prevailing in similar creeks under unimpacted conditions (Rehn et al., 2015; Theroux et al., 2020). Those condition categories are defined in Table 3.4 for the CSCI and the three ASCI MMIs.

Table 3.4 CSCI and ASCI Multi-metric Scoring Ranges by Condition Category

	Likely Intact	Possibly Altered	Likely Altered	Very Likely Altered
B-IBI (BMI) Index				
CSCI	≥ 0.92	≥ 0.79 and < 0.92	≥ 0.63 and < 0.79	< 0.63
ASCI (Algae) Indices				
Diatom MMI	≥ 0.94	≥ 0.86 and < 0.94	≥ 0.76 and < 0.86	< 0.76
Soft Algae MMI	≥ 0.86	≥ 0.65 and < 0.86	≥ 0.38 and < 0.65	< 0.38
Hybrid MMI	≥ 0.94	≥ 0.86 and < 0.94	≥ 0.76 and < 0.86	< 0.76

3.4.2 Physical Habitat (PHab) Condition

The MRP does not define analytical metrics or threshold trigger levels for interpretation of PHab data. PHab condition was assessed for the CCCWP bioassessment monitoring sites principally using the Index of Physical Habitat Integrity (IPI), a multi-metric index developed by California SWAMP to characterize physical habitat condition for streams in California (Rehn et al., 2018a). The IPI is based on the concept that physical habitat characteristics have a profound effect on stream health, and that high-quality physical habitat is essential for maintaining beneficial uses. Interim instructions for calculating IPI using GIS and the analytical software platform "R" were published by SWAMP in 2018 (Rehn et al., 2018b), and updated in 2020 (Boyle et al., 2020).

During method development, the IPI model was calibrated such that:

- the mean score of reference sites is 1
- scores near 0 indicate substantial departure from reference condition and serious degradation of physical condition
- scores greater than 1 indicate greater physical complexity than predicted for a site, given its natural environmental setting

IPI scores were calculated for the water year 2021 CCCWP bioassessment sites according to SWAMP IPI protocols (Rehn et al., 2018b) using 'R' statistical software (per Boyle et al., 2020). As with the CSCI and ASCI, the IPI is calculated from empirical data organized into two input files: the "stations" data, derived from the GIS characteristics associated with each monitoring site, and "PHab" data, which include about a dozen physical habitat characteristics derived from metrics present in the bioassessment EDD produced from the bioassessment fieldwork.

The SWAMP IPI protocols provide guidance on IPI score condition categories that can be used in interpretation of the calculated IPI scores, based on the 30th, 10th, and 1st percentiles of IPI scores at reference sites (Rehn et al., 2018a). The IPI scoring ranges so derived fall into four categories of physical condition, as follows:

- IPI $\geq$ 0.94 = likely intact condition
- IPI $\geq$ 0.84 and < 0.94 = possibly altered condition
- IPI $\geq$ 0.71 and < 0.84 = likely altered condition
- IPI < 0.71 = very likely altered condition

The IPI scores computed from the water year 2021 PHab data are assigned to condition categories according to those ranges.

3.4.3 Water and Sediment Chemistry and Toxicity

As part of the stressor assessment for this report, water and sediment chemistry and toxicity data generated during water year 2021 were analyzed and evaluated to identify potential stressors that may contribute to degraded or diminished biological conditions. Results were evaluated in relation to MRP threshold triggers, and water chemistry results were evaluated with respect to applicable water quality objectives, where feasible.

For sediment chemistry trigger criteria, comparisons to threshold effects concentrations (TECs) and probable effects concentrations (PECs) are calculated as defined in MacDonald et al., (2000), as specified in the MRP. For each constituent for which there is a published TEC or PEC value, the ratio of the measured concentration to the respective TEC or PEC value was computed as the TEC or PEC quotient, respectively. All results where a TEC quotient was equal to or greater than 1.0 were identified. For each site, the mean PEC quotient was then computed, and any sites where mean PEC quotient was equal to or greater than 0.5 were identified.

Toxic unit equivalents also were computed for pyrethroid pesticides in sediment, based on available literature LC_{50} values (LC_{50} is the concentration of a chemical which is lethal on average to 50% of test organisms). Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC_{50} values were derived based on organic carbon-normalized pyrethroid concentrations. Therefore, the RMC pyrethroid concentrations reported by the lab also were divided by the measured total organic compound (TOC) concentration at each site (as a percentage), and the TOC-normalized concentrations were then used to compute toxic unit (TU) equivalents for each pyrethroid. For each site, the TU equivalents for the individual pyrethroids were summed, and sites where the summed TU equivalents were equal to or greater than 1.0 were identified.

3.5 Quality Assurance/Quality Control (QA/QC)

The RMC established a set of guidance and tools to help ensure data quality and consistency. Key BASMAA functions are now coordinated through BASMC, and the RMC QAPP (BASMAA, 2020) and SOPs (BASMAA, 2016) are still considered to be the applicable references for implementation of monitoring required by the MRP.

Data quality assurance and quality control (QA/QC) procedures are described in detail in the BASMAA RMC QAPP (BASMAA, 2020) and in RMC SOP FS13, QA/QC Data Review (BASMAA, 2016).

Data quality objectives were established to ensure the data collected were of sufficient quality for the intended use. Data quality objectives include both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include completeness, sensitivity (detection and quantitation limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-monitoring field training and *in situ* field assessments were conducted.

Data were collected per the procedures described in the relevant SOPs (BASMAA, 2016), including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on demonstrated capability to adhere to specified protocols.

All data were thoroughly reviewed by the programs responsible for collecting them, for conformance with QAPP requirements, and review of field procedures for compliance with the methods specified in the relevant SOPs. Data review was performed per protocols defined in RMC SOP FS13, QA/QC Data Review (BASMAA, 2016). Data quality was assessed, and qualifiers were assigned, as necessary, in accordance with SWAMP requirements.

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4 Results and Discussion

4.1 Statement of Data Quality

A comprehensive QA/QC program was implemented by CCCWP, following protocols as required by the MRP and as defined in the RMC QAPP (BASMAA, 2020) and SOPs (BASMAA, 2016), covering all aspects of the regional/probabilistic monitoring. In general, QA/QC procedures were implemented as specified in the RMC QAPP (BASMAA, 2020), and monitoring was performed per protocols specified in the RMC SOPs (BASMAA, 2016) and in conformity with SWAMP protocols. QA/QC issues noted by the laboratories and/or RMC field crews are summarized below.

4.1.1 Bioassessment

Taxonomic procedures for BMI identification and enumeration included components identified in the RMC QAPP (BASMAA, 2020):

- Minimum 600 organism subsample when possible
- Sorting measurement quality objective: a check of remnants for organisms missed by original subsampler
- Interlaboratory quality control: submission of 10% of processed samples (one sample for this project) to an independent lab for review of taxonomic accuracy/precision and conformance to standard taxonomic level

All water year 2021 samples met the minimum sample count threshold of 600 individuals specified in the QAPP.

An interlaboratory quality control review was completed for BMI taxonomy on one of the CCCWP samples. The consulting laboratory reported that there were no taxonomic discrepancies and two minor counting errors. One of the minor counting errors involved quality control rejection of empty shells of *Potamopyrgus antipodarum* (New Zealand Mudsnail). SWAMP assessment measurement quality objectives (MQOs) all were well below the threshold error rates.

A field duplicate sample was collected at Walnut Creek (site 207R03403) and each sample was analyzed separately for BMI taxonomy and algal taxonomy, with subsequent calculation of taxonomic metrics. Analysis of the comparative results from the field duplicate samples produced the following:

- The average relative percent difference (RPD) between the duplicate samples for 23 individual BMI taxonomic metrics was 24.7%, ranging from 0% for several of the richness metrics, to over 50% for the Collector-Filterers (%) and Collectors (%) functional feeding groups
- The RPD for the CSCI scores computed from this duplicate data set is 8.0%
- The RPD computed for the three ASCI scores is 5.0% for the diatoms MMI, 19.3% for the hybrid MMI, and 39.7% for the soft algae MMI; these results provide further evidence of the enhanced reliability of the diatoms MMI as a measure of algal community health

The RPD results for the BMI, CSCI and ASCI metrics overall are considered to represent an acceptable level of variation between duplicate sets of taxonomic data.

In the course of performing the data analysis for computation of the ASCI multi-matric indices, nine algae taxonomic classifications (“FinalIDs” in the CEDEN database format) did not match the current Algal

Stream Condition Index (ASCI) Standard Taxonomic Effort (STE) list and were labeled as Unrecognized Taxa, and were not included in the ASCI calculations (Marco Sigala, personal communication).

The presence of the New Zealand mudsnail (*Potamopyrgus antipodarum*), a non-native invasive species, was identified at eight of the 10 bioassessment sites (see results in Table 4.2, below). The presence of this invasive species, especially at sites where it was found in very high numbers, is a confounding factor in the stressor analysis, as presented below.

4.1.2 Water Chemistry

Caltest reported the following qualifier, which affects the Nitrogen-Nitrate results for four of the 10 water quality samples: "Reporting Limit raised due to failing 0.05 mg/L calibration standard. Re-analysis within holding time was not possible." The four affected samples have nitrate concentrations between the method detection limit (MDL) and reporting limit (RL) and were J-flagged as estimated concentrations. The data are considered reliable.

Caltest also reported the following qualifier for one sample (site 207R03348) for the ammonia analysis: "RPD exceeds acceptance criteria due to low native concentration in the sample analyzed as a Laboratory Duplicate." This is considered a minor issue.

Several CCCWP samples were selected by Caltest for batch matrix spike/matrix spike duplicate quality control analyses. All of the associated results are within acceptable quality control limits for percent recovery and RPD.

All other laboratory-initiated quality control results are within acceptable ranges.

Field duplicate samples were collected for water quality analysis as part of the bioassessment field work from Walnut Creek (site 207R03403) on April 27, 2021. The average relative percent difference (RPD) between the duplicate samples for the 10 water quality analytes is 20.3%, which is generally acceptable from a quality assurance standpoint. However, there is a striking divergence in the RPD results. For six of the analytical constituents (chloride, nitrate, nitrite, orthophosphate, total phosphorous and silica), field duplicate RPD is less than or equal to 5%. For the other constituents the field duplicate RPD is much higher, as follows:

- 76.7% Ash-free Dry Mass (AFDM_Algae)
- 27.5% Chlorophyll-*a*
- 55.3% TKN (Nitrogen, Total Kjeldahl)
- 30.3% Ammonia as N via SM 4500-NH3 G-11

All four of these constituents exceed the relevant measurement quality objective (RPD <25%) specified in the RMC QAPP (BASMAA, 2020). These water quality RPD results represent higher than normal levels of variation between duplicates. Given the acceptable quality control results obtained by the laboratory for laboratory duplicate and matrix spike duplicate sample analyses, these results imply some variation in field sample collection that may have caused elevated RPDs in the affected samples.

4.1.3 Sediment Chemistry

The sediment sample was collected from Walnut Creek (site 207R03403) on June 23, 2021. This sample was not selected by the laboratory (Caltest) for the batch matrix spike/matrix spike duplicate quality control sample; the Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses were performed on other samples in their respective analytical batches.

Caltest reported the following qualifiers for the sediment analyses, involving results of laboratory control standard (LCS) and LCS duplicate (LCSD) quality control analyses, as well as MS/MSD analyses:

- Affecting acenapthene and bifenthrin: “Sample diluted prior to analysis in an effort to reduce matrix interferences resulting in higher reporting limit(s).” This did not appear to have a significant effect on the analytical results.
- Affecting cyfluthrin, cypermethrin, permethrin and carbaryl: “High Matrix Spike recovery(ies) due to possible matrix interferences in the QC sample. QC batch accepted based on LCS and RPD results.” The high spike recoveries are a bit puzzling, especially given that some are substantially higher than the acceptable range, but given the acceptability of the other QC criteria, this is not expected to have a significant effect on the reliability of the reported concentrations. The sample used for the batch MS/MSD quality control analysis may not have been similar to the Walnut Creek sample matrix; the three pyrethroids were detected at low levels in the Walnut Creek sample, but all three were reported as “ND” in the sample used for the batch MS/MSD analysis.
- Affecting chromium, nickel and zinc: “Recovery Not Calculated. Matrix Spike/Matrix Spike Duplicate (MS/MSD) recoveries were not calculated due to the high native concentration in the sample selected for MS/MSD versus the laboratory spike concentration.” These three metals were detected in the Walnut Creek sample at concentrations that were 2-3 orders of magnitude above their respective MDLs; the lack of matrix spike recovery data for these constituents is not considered significantly detrimental.
- Affecting copper: “Low Matrix Spike recovery(ies) due to possible matrix interferences in the QC sample. QC batch accepted based on LCS and RPD results.” At 62%, the matrix spike percent recovery was below the acceptable range (75-125%), but the matrix spike duplicate percent recovery (76%) was within range. No significant effect on results.
- Affecting benzo(g,h,i)perylene: “LCSD recovery and LCS/LCSD RPD outside control limit for this compound. Sample result accepted based on LCS recovery, MS/MSD recovery and RPD. Meets all pertinent method criteria.” This constituent was not detected in the Walnut Creek sample. No significant effect on results.

Otherwise, no significant quality control issues were reported for the sediment sample analyses.

4.1.4 Sediment Toxicity

For the sediment sample collected from Walnut Creek (site 207R03403) on June 23, 2021, the *Chironomus* and *Hyalella* tests were initiated within the required holding times. No quality control issues were noted by the laboratory.

4.1.5 Water Toxicity

No significant quality control issues were reported in the laboratory toxicity testing of the water sample collected from Walnut Creek (site 207R03403) on June 23, 2021. The water toxicity tests were initiated within required holding times. Pathogen-related mortality was not observed in any sample replicates tested for water year 2021.

4.2 Biological Condition Assessment

Biological condition assessment addresses the RMC's core management question: what is the condition of aquatic life in creeks in the RMC area and are aquatic life beneficial uses supported? The designated beneficial uses listed in the San Francisco Bay Region Basin Plan (SFBRWQCB, 2019) for RMC creeks monitored by CCCWP for bioassessment in water year 2021 are shown in Table 4.1.

The BASMAA Five-Year Bioassessment Report (BASMAA, 2019) provides additional analysis of bioassessment data to assess benthic community health at the countywide program and regional levels, and includes comparisons between urban and non-urban land use sites.

Table 4.1 Designated Beneficial Uses Listed in the San Francisco Bay Region Basin Plan or CCCWP Bioassessment Sites Monitored in Water Year 2021

		Human Consumptive Uses							Aquatic Life Uses									Recreational Uses		
Site Code	Creek Name	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
204R02500	West Branch Alamo				E					P			E	E	E	E	E	E	E	
204R02692	Alamo				E					P			E	E	E	E	E	E	E	
206R02816	Refugio															E	E	E	E	
206R02903	Wildcat			E						E			E	E	E	E	E	E	E	
206R02907	San Pablo			E						E			E	E	E	E	E	E	E	
207R02871	Walnut									E			E	E	E	E	E	E	E	
207R03348	San Ramon															E	E	E	E	
207R03383	Tributary of Walnut									E			E	E	E	E	E	E	E	
207R03403	Walnut									E			E	E	E	E	E	E	E	
544R03353	Marsh							E						E		E	E	P	P	

E existing beneficial use

P potential beneficial use

Note: Per Basin Plan Ch. 2 (SFBRWQCB, 2019), beneficial uses for freshwater creeks include municipal and domestic supply (MUN), agricultural supply (AGR), industrial process supply (PRO), groundwater recharge (GWR), water contact recreation (REC1), noncontact water recreation (REC2), wildlife habitat (WILD), cold freshwater habitat (COLD), warm freshwater habitat (WARM), fish migration (MIGR), and fish spawning (SPWN). The San Francisco Bay Estuary supports estuarine habitat (EST), industrial service supply (IND), and navigation (NAV) in addition to all the uses supported by streams. Coastal waters' beneficial uses include water contact recreation (REC1); noncontact water recreation (REC2); industrial service supply (IND); navigation (NAV); marine habitat (MAR); shellfish harvesting (SHELL); ocean, commercial and sport fishing (COMM); and preservation of rare and endangered species (RARE). Where creek is not named in Basin Plan, designated uses for nearest named downstream tributary are shown above.

4.2.1 Benthic Macroinvertebrate (BMI) Metrics

Detailed BMI taxonomic metrics are shown in Table 4.2 for the CCCWP creek status sites monitored in the spring index period of water year 2021. For consistency with the 2012 regional UCMR (BASMAA, 2013), subsequent CCCWP urban creeks monitoring reports, and other RMC programs, the SoCal B-IBI score is computed from the BMI taxonomic data and included in the results shown in Table 4.2, but then is not included further in the condition assessment analysis in this report. The principal metric used by Bay Area municipal stormwater programs to evaluate benthic biotic community health is the CSCI score.

CSCI scores were computed from the BMI taxonomy data and site-specific watershed characteristics for each bioassessment monitoring site. CSCI scores run from a minimum of 0 (indicating no correspondence to modeled reference site conditions) to a maximum of 1 (perfect correspondence with modeled reference site conditions). Per MRP 2.0, a CSCI score of less than 0.795 is degraded, and should be evaluated for consideration as a possible MRP 2.0 SSID study location.

The essential results of the CSCI calculations are presented in Table 4.3. Every CCCWP bioassessment site monitored in water year 2021 produced a CSCI score below the MRP 2.0 threshold of 0.795, indicating a degraded biological community relative to reference conditions.

The water year 2021 CSCI scores range from a low of 0.286 at Refugio Creek (site 206R02816) to a high of 0.513 at Walnut Creek (site 207R02871), as shown in Table 4.3.

The invasive New Zealand Mudsnail (NZMS) was found in eight of the 10 benthic samples. The relevant results also are shown in Table 4.3. Only Wildcat Creek (site 206R02903) and Marsh Creek (site 544R03353) were found to be free of the invasive snails.

NZMS was the dominant taxon in five of the 10 samples, each with more than 20% NZMS, ranging as high as 78.2% NZMS at the upper Walnut Creek site (site 207R03403) and 81.9% at the tributary to Walnut Creek (site 207R03383), in the lower Walnut Creek watershed. Curiously, a Walnut Creek site (site 207R02871) situated intermediate between those two sites was relatively free of NZMS, with only 5 individuals (0.8%) identified.

Table 4.2 Benthic Macroinvertebrate Metrics for CCCWP Bioassessment Sites Monitored in Water Year 2021

BMI Metrics for CCCWP Bioassessment Sites, Spring 2021										
Creek Name:	WB Alamo	Alamo	Refugio	Wildcat	San Pablo	Walnut	San Ramon	Tributary to Walnut	Walnut	Marsh
Site Code:	204R02500	204R02692	206R02816	206R02903	206R02907	207R02871	207R03348	207R03383	207R03403	544R03353
Richness										
Taxonomic	12	16	15	13	19	30	20	9	15	16
EPT	1	1	0	2	4	6	3	1	1	1
Ephemeroptera	1	1	0	2	1	4	1	1	1	0
Plecoptera	0	0	0	0	0	0	0	0	0	0
Trichoptera	0	0	0	0	3	2	2	0	0	1
Coleoptera	0	0	1	0	0	1	1	0	0	0
Predator	2	5	3	3	6	11	5	1	4	5
Diptera	5	8	7	5	7	7	5	3	5	4
Composition										
EPT Index (%)	1.6	0.2	0.0	1.3	14	18	11	1.5	3.5	0.5
Sensitive EPT Index (%)	0.0	0.0	0.0	0.0	0.5	5.2	0.3	0.0	0.0	0.5
Shannon Diversity	1.3	1.5	1.8	1.6	1.4	2.6	1.8	0.8	1.0	1.7
Dominant Taxon (%)	54	49	32	43	58	26	47	82	78	49
Non-insect Taxa (%)	50	38	47	46	37	47	45	44	53	63
Tolerance										
Tolerance Value	5.2	6.3	6.4	5.7	7.0	6.0	6.8	7.5	7.5	7.5
Intolerant Organisms (%)	0.0	0.0	0.0	0.2	0.5	0.0	0.0	0.0	0.0	0.0
Intolerant Taxa (%)	0.0	0.0	0.0	7.7	5.3	0.0	0.0	0.0	0.0	0.0
Tolerant Organisms (%)	3.8	24	35	19	61	35	53	82	82	80
Tolerant Taxa (%)	33	31	47	31	26	40	40	33	47	44
Functional Feeding Groups										
Collector-Gatherers (%)	91	26	85	81	23	66	41	15	15	74
Collector-Filterers (%)	8.0	49	1.2	0.2	16	6.0	10	2.5	4.7	0.3
Collectors (%)	99	75	86	81	39	72	50	18	20	74
Scrapers (%)	0.5	23	13	19	58	5.2	48	82	78	18
Predators (%)	0.3	2.1	0.8	0.5	2.0	17	1.1	0.2	2.2	7.8

Table 4.2 Benthic Macroinvertebrate Metrics for CCCWP Bioassessment Sites Monitored in Water Year 2021

BMI Metrics for CCCWP Bioassessment Sites, Spring 2021										
Creek Name:	WB Alamo	Alamo	Refugio	Wildcat	San Pablo	Walnut	San Ramon	Tributary to Walnut	Walnut	Marsh
Site Code:	204R02500	204R02692	206R02816	206R02903	206R02907	207R02871	207R03348	207R03383	207R03403	544R03353
Shredders (%)	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
Other (%)	0.3	0.0	0.2	0.0	0.2	5.7	0.5	0.0	0.0	0.5
Estimated Abundance										
Composite Sample (11 ft^2)	11,154	10,016	2,420	8,325	19,552	6,560	6,190	29,136	10,192	11,558
#/ft^2	1,014	911	220	757	1,777	596	563	2,649	927	1,051
#/m^2	10,829	9,724	2,350	8,082	18,983	6,369	6,010	28,287	9,895	11,222
Supplemental Metrics										
Collectors (%)	99	75	86	81	39	72	50	18	20	74
Non-Gastropoda Scrapers (%)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Shredder Taxa (%)	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0
Diptera Taxa[a]	3	5	5	2	4	4	2	2	3	1
IBI Scores										
SoCal IBI Score	3	16	4	11	31	21	20	19	16	11
New Zealand Mudsnail Abundance										
NZMS Individuals	3	145	55	0	356	5	288	497	498	0
% NZMS	0.5	23.2	9.1	0.0	58.3	0.8	46.5	81.9	78.2	0.0

a Calculated based on Chironomids identified to family level

Notes: Metrics are calculated from standard classifications, based on level I standard taxonomic effort, except Chironomids, which are identified to subfamily/ tribe.
Standard taxonomic effort source: Southwest Association of Freshwater Invertebrate Taxonomists (http://www.waterboards.ca.gov/swamp/docs/safit/ste_list.pdf)

Table 4.3 Results of CSCI Calculations for Water Year 2021 CCCWP Bioassessment Sites

Site Code	Creek Name	Sample Date	BMI Count	O/E	MMI	CSCI
204R02500	West Branch Alamo	04/28/21	610	0.518	0.275	0.397
204R02692	Alamo	04/28/21	626	0.498	0.220	0.359
206R02816	Refugio	04/29/21	605	0.357	0.216	0.286
206R02903	Wildcat	05/11/21	607	0.464	0.182	0.323
206R02907	San Pablo	05/12/21	608	0.540	0.306	0.423
207R02871	Walnut	05/10/21	615	0.644	0.382	0.513
207R03348	San Ramon	05/10/21	619	0.443	0.374	0.409
207R03383	Tributary of Walnut	05/12/21	607	0.378	0.243	0.310
207R03403	Walnut	04/27/21	637	0.510	0.210	0.360
544R03353	Marsh	05/13/21	602	0.552	0.207	0.380

Note: CSCI scores less than 0.795 indicate a substantially degraded biological community relative to reference conditions, and such sites are candidates for MRP 2.0 SSID projects.

4.2.2 Algae Metrics

CCCWP sampled soft algae and diatoms at 10 sites during bioassessment monitoring in April and May 2021, following the SWAMP Reach-Wide Benthos collection method (Ode et al., 2016a and 2016b). Samples were processed in the laboratory by EcoAnalysts following SWAMP protocols (Stancheva et al., 2015) to provide count (diatom and soft algae), biovolume (soft algae), and “presence” (diatom and soft algae) data. Nine taxonomic classifications (“FinalIDs” in the CEDEN database format) did not match the current Algal Stream Condition Index (ASCI) Standard Taxonomic Effort (STE) list, were labeled as Unrecognized Taxa, and were not included in the ASCI calculations.

ASCI MMI Scores

Following the SWAMP ASCI computational protocols (Boyle et al., 2020), diatom, soft algae, and hybrid multi-metric indices (MMIs) were calculated for the water year 2021 CCCWP bioassessment sites (Table 4.4). Because of questions regarding the reliability of the soft algae MMI, only the diatoms MMI and hybrid MMI are reported here (Marco Sigala, personal communication).

The ASCI MMI scores for the water year 2021 samples were assigned to condition categories as described above (see Table 3.4); these results also are shown in Table 4.4.

Refugio Creek (site 206R02816) produced the highest score for the diatoms MMI (0.79) and second highest score for the hybrid MMI (0.68), but these values fell into the Likely Altered and Very Likely Altered Status categories, respectively. The nine other sites scored as Very Likely Altered for both the diatoms and hybrid indices.

Table 4.4 ASCI MMI Scores

Site Code	Creek Name	Sample Date	Diatoms MMI	Diatoms Status	Hybrid MMI	Hybrid Status
204R02500	West Branch Alamo	04/28/21	0.74	Very Likely Altered	0.56	Very Likely Altered
204R02692	Alamo	04/28/21	0.57	Very Likely Altered	0.53	Very Likely Altered
206R02816	Refugio	04/29/21	0.79	Likely Altered	0.68	Very Likely Altered
206R02903	Wildcat	05/11/21	0.60	Very Likely Altered	0.63	Very Likely Altered
206R02907	San Pablo	05/12/21	0.65	Very Likely Altered	0.65	Very Likely Altered
207R02871	Walnut	05/10/21	0.59	Very Likely Altered	0.59	Very Likely Altered
207R03348	San Ramon	05/10/21	0.70	Very Likely Altered	0.69	Very Likely Altered
207R03383	Tributary of Walnut	05/12/21	0.58	Very Likely Altered	0.51	Very Likely Altered
207R03403	Walnut	04/27/21	0.58	Very Likely Altered	0.51	Very Likely Altered
544R03353	Marsh	05/13/21	0.63	Very Likely Altered	0.53	Very Likely Altered

4.3 Stressor Assessment

This section addresses the question: what are the major stressors to aquatic life in the RMC area? The biological, physical, chemical, and toxicity testing data produced by CCCWP during water year 2021 were compiled, evaluated, and analyzed against the threshold trigger criteria shown in Table 3.3. When the data analysis indicated the associated trigger criteria were exceeded, those sites and results were identified as potentially warranting further investigation.

When interpreting analytical chemistry results, it is important to account for laboratory data reported as either below method detection limits or between detection and reporting limits. Dealing with data in this range of the analytical spectrum introduces some level of uncertainty, especially when attempting to generate summary statistics for a data set. In the following compilation of statistics for analytical chemistry, in some cases non-detect data (ND) were substituted with a concentration equal to half of the respective MDL, as reported by the laboratory.

4.3.1 Physical Habitat (PHab) Parameters

Field crews recorded an array of physical habitat characteristics on the SWAMP field data sheets during bioassessment monitoring at the 10 CCCWP bioassessment sites in 2021. These field-measured parameters, along with an array of watershed parameters generated through GIS analysis, were used to compute IPI scores, following SWAMP protocols (Boyle et al., 2020).

The IPI scores calculated from the PHab data compiled during bioassessment monitoring conducted in spring 2021 are shown in Table 4.5. Five sites are rated as Likely Intact, three are ranked as Possibly Altered, and two are ranked as Likely Altered.

Given that the water year 2021 CSCI scores and ASCI MMI scores indicate “degraded” benthic macroinvertebrate communities and Very Likely Altered algal biological communities relative to reference conditions, physical habitat does not appear to be a principal stressor, with half of the corresponding IPI score categories indicating Likely Intact physical habitat and only two indicating Likely Altered habitat.

The influence of physical habitat as a potential stressor on biological community health may be complicated by the widespread occurrence of the New Zealand Mudsnail, as discussed further below.

Table 4.5 Index of Physical Habitat Integrity (IPI) Scores for CCCWP Bioassessment Sites Monitored in Water Year 2021

Site Code	Creek Name	Sample Date	IPI Score	IPI Category
204R02500	West Branch Alamo	04/28/21	0.80	Likely Altered
204R02692	Alamo	04/28/21	1.10	Likely Intact
206R02816	Refugio	04/29/21	0.86	Possibly Altered
206R02903	Wildcat	05/11/21	0.87	Possibly Altered
206R02907	San Pablo	05/12/21	1.08	Likely Intact
207R02871	Walnut	05/10/21	0.90	Possibly Altered
207R03348	San Ramon	05/10/21	1.01	Likely Intact
207R03383	Tributary of Walnut	05/12/21	0.98	Likely Intact
207R03403	Walnut	04/27/21	1.06	Likely Intact
544R03353	Marsh	05/13/21	0.75	Likely Altered

4.3.2 Correlations of Biological and Physical Habitat Parameters

The principal biological and physical habitat condition scores are shown together in Table 4.6, and correlations among the key biological and physical habitat condition scores are shown in Table 4.7.

For the 2021 analysis, there is generally poor correlation among the various biological and physical habitat indices, with the exception of the two algal indices, which correlate moderately well with each other. The CSCI scores are very poorly correlated with scores from the two algal indices and the physical habitat index.

Because of the abundance of New Zealand Mudsnail identified in many of the water year 2021 samples (see results, Table 4.2), correlations also were computed for percent New Zealand Mudsnail (%NZMS) versus CSCI, ASCI Diatoms MMI, ASCI Hybrid MMI, and IPI scores; those results also are shown in Table 4.7.

The CSCI scores and ASCI MMI scores are all negatively correlated with %NZMS, as expected, although fairly weakly. The somewhat surprising result is the relatively strong *positive* correlation between %NZMS and the IPI scores ($R = 0.723$; $R^2 = 0.523$), which could imply that NZMS colonizes and propagates more effectively in creeks with better physical habitat quality. However, based upon a review of IPI scores and %NZMS results from the most recent three years of CCCWP bioassessment monitoring (water years 2019-2021), it appears that this result may be an artifact peculiar to the 2021 data.

Regression analysis of IPI scores and %NZMS incorporating the water year 2019-2021 results (n=30) produced a much lower correlation coefficient (R) of 0.256 ($R^2 = 0.065$), and the regression equation was not statistically significant ($F = 0.173$). The fuller range of both IPI scores and %NZMS results associated with the larger sample size (30 samples) over the course of the three-year period provides a more reliable picture, indicating a relatively weak relationship between IPI score and %NZMS.

Furthermore, there are some questions regarding the accuracy of IPI scores and their reliability in characterizing physical habitat quality. In particular, the IPI may not accurately reflect altered or degraded physical habitat conditions where there has been significant human disturbance of the natural channel, especially relating to hydromodification. An example from the 2021 CCCWP data is Walnut Creek site 207R02871, which is in an engineered channel in an urbanized area with effectively no riparian zone, and yet received a moderate IPI score of 0.90. The state's developers of the IPI program may be investigating this situation, to evaluate the IPI's response under such conditions (Rehn, personal communication, 2022).

Table 4.6 Summary of PHab and Biological Condition Scores for CCCWP Bioassessment Sites Monitored in Water Year 2021

Site Code	Creek Name	Sample Date	CSCI Score	Diatoms MMI ASCI Score	Hybrid MMI ASCI Score	IPI Score
204R02500	West Branch Alamo	04/28/21	0.397	0.74	0.56	0.80
204R02692	Alamo	04/28/21	0.359	0.57	0.53	1.10
206R02816	Refugio	04/29/21	0.286	0.79	0.68	0.86
206R02903	Wildcat	05/11/21	0.323	0.60	0.63	0.87
206R02907	San Pablo	05/12/21	0.423	0.65	0.65	1.08
207R02871	Walnut	05/10/21	0.513	0.59	0.59	0.90
207R03348	San Ramon	05/10/21	0.409	0.70	0.69	1.01
207R03383	Tributary of Walnut	05/12/21	0.310	0.58	0.51	0.98
207R03403	Walnut	04/27/21	0.360	0.58	0.51	1.06
544R03353	Marsh	05/13/21	0.380	0.63	0.53	0.75

Table 4.7 Correlations for PHab and Biological Condition Scores for CCCWP Sites Monitored in Water Year 2021

Comparison	Correlation Coefficient (R)	R Squared
CSCI:DiatomsMMI	-0.170	0.029
CSCI:HybridMMI	0.063	0.004
CSCI:IPI	0.046	0.002
DiatomsMMI:HybridMMI	0.623	0.388
DiatomsMMI:IPI	-0.411	0.169
HybridMMI:IPI	-0.018	0.000
Correlations with % New Zealand Mudsnail:		
CSCI:%NZMS	-0.176	0.031
DiatomsMMI:%NZMS	-0.321	0.103
HybridMMI:%NZMS	-0.220	0.048
IPI:%NZMS	0.723	0.523

Note: Correlations are based on scores shown in Table 4.8 and %NZMS provided by Tom King, invertebrate taxonomist, as part of the Water Year 2021 lab data report submitted by BioAssessment Services. Well correlated results (R^2 greater than 0.50) are highlighted in green.

4.3.3 Water Chemistry Parameters

At all 10 bioassessment sites, water samples were collected for nutrient and other conventional analyses using the standard grab sample collection method, as described in SOP FS-2 (BASMAA, 2016). Standard field parameters (water temperature, dissolved oxygen, pH, and specific conductance) also were measured in the field using a portable multi-meter and YSI sonde.

Of the 12 water quality constituents monitored in association with the bioassessment monitoring, water quality standards or established thresholds are available only for ammonia (un-ionized form[4]), chloride[5], and nitrate + nitrite[6] – the latter for waters with MUN beneficial use only, as indicated in Table 4.8.

Table 4.8 Water Quality Thresholds Available for Comparison to Water Year 2021 Water Chemistry Constituents

Sample Parameter	Threshold	Units	Frequency/Period	Application	Source
Ammonia	0.025	mg/L	Annual Median	Un-ionized ammonia, as N (maxima also apply to Central Bay and u/s [0.16] and Lower Bay [0.4])	SF Bay Basin Plan (Ch. 3)
Chloride	230	mg/L	Criterion Continuous Concentration	Freshwater aquatic life	USEPA National Recreation Water Quality Criteria, Aquatic Life Criteria Table
Chloride	860	mg/L	Criteria Maximum Concentration	Freshwater aquatic life	USEPA National Recreation Water Quality Criteria, Aquatic Life Criteria Table
Chloride	250	mg/L	Secondary Maximum Contaminant Level	Alameda Creek watershed above Niles and MUN waters; Title 22 drinking waters	SF Bay Basin Plan (Ch. 3); California Title 22; USEPA Drinking Water Standards Secondary MCL
Nitrate + Nitrite (as N)	10	mg/L	Maximum Contaminant Level	Areas designated as MUN	Basin Plan (Ch. 3)

The comparisons of the measured nutrients concentrations to the thresholds listed in Table 4.8 are shown in Table 4.9. There were no exceedances of the applicable criteria for un-ionized ammonia, chloride, or nitrate+nitrite at any of the 10 sites monitored in water year 2021.

In follow-up to occasional observed un-ionized ammonia threshold exceedances and analytical anomalies involving ammonia and TKN in recent years, CCCWP analyzed the water year 2021 ammonia samples using both the previously standard distillation method (SM 4500-NH3 B,C-11) and the newer low-level method (SM 4500-NH3 G-11), which has been employed in recent years to achieve the lower ammonia analytical MDL required by the MRP. Some laboratory testing of bioassessment water quality samples using the low-level method had resulted in ammonia concentrations greater than corresponding TKN concentrations, which is technically impossible, as Total Kjeldahl Nitrogen is defined analytically as the sum of ammonia and organic nitrogen.

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[4] For ammonia, the standard provided in the Basin Plan (SFBRWQCB, 2019, section 3.3.20) applies to the un-ionized fraction, as the underlying criterion is based on un-ionized ammonia, which is the more toxic form. Conversion of RMC monitoring data from the measured total ammonia to un-ionized ammonia was based on a formula provided by the American Fisheries Society, which calculates un-ionized ammonia in freshwater systems from analytical results for total ammonia and field-measured pH, temperature, and electrical conductivity (see: http://fisheries.org/hatchery).

[5] For chloride, a Secondary Maximum Contaminant Level (MCL) of 250 mg/L applies to those waters with MUN beneficial use, per the Basin Plan (Table 3-5), Title 22 of the California Code of Regulations, and the USEPA drinking water quality standards, and per the Basin Plan (Table 3-7) applies to waters in the Alameda Creek watershed above Niles. Per RMC decision as noted in the UCMR for water year 2012 (BASMAA, 2013), for all other waters, the Criterion Continuous Concentration (CCC) of 230 mg/L (USEPA Water Quality Criteria*) for the protection of aquatic life is used as a conservative benchmark for comparison for all locations not specifically identified within the Basin Plan (i.e., sites not within the Alameda Creek watershed above Niles nor identified as MUN).

*See: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

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

With one minor exception, the low-level method results are in fact lower than the results produced by the older method for the water year 2021 samples. In accordance with longstanding practice, it is generally assumed that results derived from analytical methods with lower MDLs are more accurate and therefore preferred over methods with higher MDLs.

Furthermore, when the low-level method results are compared with their corresponding TKN concentrations, two samples produced ammonia results just slightly higher than their TKN results. For the results obtained using the older method, four samples exhibited ammonia concentrations that were substantially higher than the corresponding TKN results.

For these reasons, the low-level method results (converted to un-ionized ammonia) are reported in Table 4.9. (Un-ionized ammonia also was calculated for the ammonia results obtained via the older method, and none of those results exceeded the 25 µg/L water quality threshold, with a maximum value of 15.89 µg/L.)

Water samples also were collected and analyzed for free and total chlorine in the field using CHEMetrics™ test kits during bioassessment monitoring. As shown in Table 4.10, no water year 2021 water samples produced measurable levels of free or total chlorine.

Table 4.9 Comparison of Water Quality (Nutrient) Data to Associated Water Quality Thresholds for Water Year 2021 Water Chemistry Results

Site Code	Creek Name	MUN?	Parameter and Threshold			Number of Parameters > Threshold/ Water Body
			Un-ionized Ammonia (as N)	Chloride	Nitrate + Nitrite (as N)	
			25 µg/L	230/250 mg/L[1]	10 mg/L[2]	
204R02500	West Branch Alamo	No	1.16	52	0.055	0
204R02692	Alamo	No	5.25	110	0.134	0
206R02816	Refugio	No	0.57	59	0.139	0
206R02903	Wildcat	No	0.14	41	0.061	0
206R02907	San Pablo	No	3.34	85	0.098	0
207R02871	Walnut	No	4.58	85	0.007	0
207R03348	San Ramon	No	2.10	48	0.121	0
207R03383	Tributary of Walnut	No	0.54	100	2.32	0
207R03403	Walnut	No	4.27	49	0.077	0
544R03353	Marsh	No	3.85	160	0.007	0
Number of Values > Threshold			0	0	0	0
Percent of Values > Threshold			0%	0%	0%	

1 250 mg/L threshold applies for sites with MUN beneficial use and Alameda Creek above Niles per Basin Plan.

2 Nitrate + nitrite threshold applies only to sites with MUN beneficial use. No water year 2021 sites have MUN beneficial use.

Bolded values indicate results above applicable thresholds

Table 4.10 Summary of Chlorine Testing Results for Samples Collected in Water Year 2021 in Comparison to Municipal Regional Permit Trigger Criteria

Site Code	Creek Name	Sample Date	Chlorine, Free	Chlorine, Total	Exceeds Trigger Threshold?
204R02500	West Branch Alamo	04/28/21	0.0	0.0	No
204R02692	Alamo	04/28/21	0.0	0.0	No
206R02816	Refugio	04/29/21	0.0	0.0	No
206R02903	Wildcat	05/11/21	0.0	0.0	No
206R02907	San Pablo	05/12/21	0.0	0.0	No
207R02871	Walnut	05/10/21	0.0	0.0	No
207R03348	San Ramon	05/10/21	0.0	0.0	No
207R03383	Tributary of Walnut	05/12/21	0.0	0.0	No
207R03403	Walnut	04/27/21	0.0	0.0	No
544R03353	Marsh	05/13/21	0.0	0.0	No
Number of Samples Exceeding 0.08 mg/L			0	0	
Percentage of Samples Exceeding 0.08 mg/L			0%	0%	

4.3.4 Water Column Toxicity and Chemistry (Wet Weather)

Wet weather samples were not collected during water year 2021, as the relevant MRP monitoring requirement had been fulfilled in previous monitoring years.

4.3.5 Water Column Toxicity (Dry Weather)

Water samples were collected on June 23, 2021, from one site on Walnut Creek (site 207R03403) and tested for acute and chronic toxicity to several different aquatic species, as required by the MRP. Water chemistry testing was not required for the dry season sample. The dry weather water toxicity test results are shown in Table 4.11.

Both the *Ceriodaphnia dubia* chronic (reproduction) and *Hyalella azteca* acute (survival) toxicity test results were determined to be toxic, according to the Test of Significant Toxicity (TST) test protocol required by the MRP. Survival also was reduced in the Walnut Creek sample for the *Chironomus dilutus* test, but the difference was not statistically significant according to the TST method.

Resampling of this Walnut Creek site and retesting of the statistically significant toxic results was not required because the % effect was less than 50% in both cases.

Table 4.11 Summary of CCCWP Water Year 2021 Dry Season Water Toxicity Results

Dry Season Water Samples			Toxicity Test Results						
			S. capricornutum	*C. dubia*		*C. dilutus*	*H. azteca*	*P. promelas*	
Site Code	Creek Name	Sample Collection Date	Growth (cells/mL x 10^6)	Survival (%)	Reproduction (No. of neonates/ female)	Survival (%)	Survival (%)	Survival (%)	Growth (mg)
Lab Control			2.09	100	46.6	100	100	95.0	0.53
207R03403	Walnut Creek	06/23/2021	7.90	100	**31.2 ***	92.5	**66.0 ***	100	0.88

* Test treatment was determined to be significantly less than the lab control treatment response at $p < 0.05$

4.3.6 Sediment Toxicity and Sediment Chemistry

Sediment samples were collected on June 23, 2021, after water samples were collected at the same site sampled for water column toxicity (Walnut Creek, site 207R03403), and tested for acute toxicity (survival) to *Hyalella azteca* and *Chironomus dilutus*. The sediment toxicity test results are shown in Table 4.12.

The June 23, 2021, Walnut Creek sediment sample was determined not to be toxic to *Chironomus dilutus* or *Hyalella azteca*. Survival was reduced in the Walnut Creek sample for both tests, but in each case the difference was not statistically significant according to the TST method.

The sediment sample also was analyzed for a suite of potential sediment pollutants, as required by the MRP, and the results were compared to the trigger threshold levels specified for follow-up in MRP provision C.8.g.iv. (see Table 3.3). The complete sediment chemistry results are shown in Table 4.13, and the results are shown in comparison to the applicable MRP threshold triggers in Table 4.14.

Sediment chemistry results (Tables 4.13 and 4.14) are summarized as follows:

- No metal constituents had a TEC ratio $\geq$1.0, except nickel at 1.15
- Only three PAH compounds were detected; none of those had a TEC ratio $\geq$1.0
- The monitored site did not produce a mean PEC ratio $\geq$0.5
- Five of the seven pyrethroid pesticides were detected; the highest was bifenthrin at 3.7 ng/g
- The other pesticides tested (carbaryl and the fipronil compounds) were not detected

Sediment toxic unit (TU) equivalents were calculated for the pyrethroid pesticides for which there are published LC_{50} levels, and a sum of the calculated TU equivalents was computed for the dry season sediment chemistry results from the monitored site (Walnut Creek, site 207R03403); see Table 4.15. Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC_{50} values are based on organic carbon-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration (as a percentage) at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid (Table 4.15).

Several of the common urban pyrethroid pesticides were detected at the water year 2021 sediment monitoring site, with bifenthrin at the highest concentration, as is typical in urban creeks in California. The calculated TU equivalent of 0.84 for the sum of the pyrethroids in sediment is less than 1.0, so while survival of the test species was reduced, it is not surprising that this sample did not cause statistically significant toxicity to *Chironomus dilutus* or *Hyalella azteca* in the sediment toxicity testing.

Table 4.12 Summary of CCCWP Water Year 2021 Dry Season Sediment Toxicity Results

Dry Season Sediment Samples			Toxicity Test Results	
			Hyalella azteca	*Chironomus dilutus*
Site Code	Creek Name	Sample Collection Date	Survival (%)	Survival (%)
Lab Control			100	96.2
207R03403	Walnut Creek	06/23/2021	92.5	86.2

Note: No test treatment was determined to be significantly less than the lab control treatment response at $p < 0.05$

Table 4.13 CCCWP Water Year 2021 Sediment Chemistry Results

Analyte	Units[1]	Site 207R03403 Walnut Creek		
		Result	MDL	RL
Metals				
Arsenic	mg/Kg	3.4	0.21	0.52
Cadmium	mg/Kg	0.29	0.01	0.04
Chromium	mg/Kg	24	0.51	0.52
Copper	mg/Kg	30	0.077	0.21
Lead	mg/Kg	14	0.041	0.041
Nickel	mg/Kg	26	0.031	0.031
Zinc	mg/Kg	91	0.82	0.82
Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthene	ng/g	ND	16	18
Acenaphthylene	ng/g	ND	16	18
Anthracene	ng/g	ND	16	18
Benz(a)anthracene	ng/g	ND	16	18
Benzo(a)pyrene	ng/g	ND	16	18
Benzo(b)fluoranthene	ng/g	ND	16	18
Benzo(e)pyrene	ng/g	ND	16	18
Benzo(g,h,i)perylene	ng/g	ND	16	18
Benzo(k)fluoranthene	ng/g	ND	16	18
Biphenyl	ng/g	ND	17	18
Chrysene	ng/g	ND	16	18
Dibenz(a,h)anthracene	ng/g	ND	16	18
Dibenzothiophene	ng/g	ND	17	18
Dimethylnaphthalene, 2,6-	ng/g	ND	16	18
Fluoranthene	ng/g	83	16	18
Fluorene	ng/g	ND	16	18
Indeno(1,2,3-c,d)pyrene	ng/g	ND	16	18
Methylnaphthalene, 1-	ng/g	ND	16	18
Methylnaphthalene, 2-	ng/g	ND	16	18
Methylphenanthrene, 1-	ng/g	ND	16	18
Naphthalene	ng/g	ND	16	18
Perylene	ng/g	ND	16	18
Phenanthrene	ng/g	31	16	18
Pyrene	ng/g	83	16	18

Table 4.13 CCCWP Water Year 2021 Sediment Chemistry Results

Analyte	Units[1]	Site 207R03403 Walnut Creek		
		Result	MDL	RL
Pyrethroid Pesticides				
Bifenthrin	ng/g	3.7	0.41	1
Cyfluthrin, total	ng/g	0.75	0.46	1
Cyhalothrin, Total lambda-	ng/g	ND	0.25	1
Cypermethrin, total	ng/g	0.79	0.41	1
Deltamethrin/Tralomethrin	ng/g	0.64	0.5	1
Esfenvalerate/Fenvalerate, total	ng/g	ND	0.54	1
Permethrin	ng/g	1.8	0.46	1
Other Pesticides				
Carbaryl	ng/g	ND	0.021	0.021
Fipronil	ng/g	ND	0.41	1
Fipronil Desulfinyl	ng/g	ND	0.41	1
Fipronil Sulfide	ng/g	ND	0.41	1
Fipronil Sulfone	ng/g	ND	0.41	1
Organic Carbon				
Total Organic Carbon	%	1.3	0.02	0.05

1 All measurements reported as dry weight
MDL method detection limit
ND not detected
RL reporting limit

Table 4.14 Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Quotients for Water Year 2021 Sediment Chemistry Constituents

		Site 207R01547		
		Grayson Creek		
	Sample Units[1]	Sample	TEC Ratio	PEC Ratio
Metals				
Arsenic	mg/Kg	3.4	0.35	0.10
Cadmium	mg/Kg	0.29	0.29	0.06
Chromium	mg/Kg	24	0.55	0.22
Copper	mg/Kg	30	0.95	0.20
Lead	mg/Kg	14	0.39	0.11
Nickel	mg/Kg	26	**1.15**	0.53
Zinc	mg/Kg	91	0.75	0.20
Polycyclic Aromatic Hydrocarbons (PAHs)				
Anthracene	ng/g	ND		
Fluorene	ng/g	ND		
Naphthalene	ng/g	ND		
Phenanthrene	ng/g	31	0.152	0.0265
Benz(a)anthracene	ng/g	ND		
Benzo(a)pyrene	ng/g	ND		
Chrysene	ng/g	ND		
Fluoranthene	ng/g	83	0.196	0.0372
Pyrene	ng/g	83	0.426	0.0546
Total PAHs[a]	ng/g	258	0.160	0.0113
		Number with TEC > 1.0	1	
		Combined TEC Ratio	5.37	
		Average TEC Ratio	0.49	
		Combined PEC Ratio		1.55
		Average PEC Ratio		0.14

a Total PAHs include 24 individual PAH compounds; NDs were substituted at 1/2 MDL to compute total PAHs

Bold TEC or PEC ratio indicates ratio 1.0

ND not detected

Note: All measurements reported as dry weight. TECs and PECs per MacDonald et al. (2000).

Table 4.15 Calculated Pyrethroid Toxic Unit Equivalents, Water Year 2021 Sediment Chemistry Data

Pyrethroid Pesticides	LC_{50} (µg/g organic carbon)	Site 207R03403 Walnut Creek Sample (ng/g)	Sample (µg/g organic carbon)	TU Equivalents[1]
Bifenthrin	0.52	3.7	0.28	0.55
Cyfluthrin	1.08	0.75	0.06	0.05
Cyhalothrin, lambda	0.45	ND		
Cypermethrin	0.38	0.79	0.06	0.16
Deltamethrin/Tralomethrin	0.79	0.64	0.05	0.06
Esfenvalerate/Fenvalerate	1.54	ND		
Permethrin	10.8	1.8	0.14	0.01
			Sum (Pyrethroid TUs)	0.83

1 Toxic unit equivalents (TU) are calculated as ratios of organic carbon-normalized pyrethroid sample concentrations to published *H. azteca* LC_{50} values. See http://www.tdcenvironmental.com/resources/Pyrethroids-Aquatic-Tox-Summary.pdf for associated references.

ND Not detected

Note: All sample measurements reported as dry weight.

4.3.7 Analysis of Condition Indicators and Stressors – Water Year 2021

During water year 2021, 10 sites were monitored by CCCWP under the RMC regional/probabilistic design for bioassessment, physical habitat, and water chemistry parameters. One site also was monitored for water and sediment toxicity and sediment chemistry.

The bioassessment and related data are used to develop a preliminary condition assessment for the monitored sites. The water and sediment chemistry and toxicity data are used in conjunction with physical habitat data to evaluate potential stressors which may affect aquatic habitat quality and beneficial uses. Various metrics and indices are also computed to aid in the condition assessment and stressor analysis.

Biological Conditions

CSCI scores have been calculated from the CCCWP bioassessment data since water year 2016. The CSCI uses location-specific GIS data to compare the observed BMI taxonomic data to expected BMI assemblage characteristics from reference sites with similar geographical characteristics.

Every CCCWP bioassessment site monitored in water year 2021 produced a CSCI score below the MRP threshold of 0.795, indicating a degraded biological community relative to reference conditions.

The water year 2021 CSCI scores range from a low of 0.286 at Refugio Creek (site 206R02816) to a high of 0.513 at Walnut Creek (site 207R02871).

The invasive New Zealand Mudsnail (NZMS) was found in eight of the 10 benthic samples. Only Wildcat Creek (site 206R02903) and Marsh Creek (site 544R03353) were found to be free of NZMS.

NZMS was the dominant taxon in five of the 10 benthic samples, each containing more than 20% NZMS individuals, ranging as high as 78.2% NZMS at the upper Walnut Creek site (207R03403) and 81.9% at the tributary to Walnut Creek (site 207R03383), in the lower Walnut Creek watershed. A Walnut Creek site (site 207R02871) situated intermediate between those two sites was relatively free of NZMS, with only five individuals (0.8%) identified.

ASCI scores were calculated for CCCWP bioassessment sites again in water year 2021 and assigned to status categories based on SWAMP guidance. Nine of the 10 sites scored in the Very Likely Altered category for both the diatoms and hybrid multi-metric indices. The Refugio Creek (site 206R02816) sample produced the highest score for the diatoms MMI (0.79), in the Likely Altered category, and second highest score for the hybrid MMI (0.68), in the Very Likely Altered category.

Based on both the BMI and algal community indices, the biological community conditions of all CCCWP sites monitored in 2021 are characterized as impacted.

Physical Habitat (PHab) Conditions

IPI scores were again calculated from the PHab data compiled during the spring 2021 bioassessment monitoring, and the IPI scores were related to condition categories as recommended by SWAMP guidance. Five of the water year 2021 sites are rated as Likely Intact, three are ranked as Possibly Altered, and two are ranked as Likely Altered.

Given that the water year 2021 CSCI scores and ASCI MMI scores indicate “degraded” benthic macroinvertebrate communities and Very Likely Altered algal biological communities relative to reference conditions, physical habitat does not appear to be a principal stressor, with half of the corresponding IPI score categories indicating Likely Intact physical habitat and only two indicating Likely Altered habitat.

The influence of physical habitat as a potential stressor on biological community health may be complicated by the widespread occurrence of the New Zealand Mudsnail.

Water Quality

Of 12 water quality parameters required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate+nitrite (for sites with MUN beneficial use only). None of the results generated at the 10 sites monitored during water year 2021 exceeded the applicable water quality standards.

Water Toxicity

The water samples collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined to be toxic to *Ceriodaphnia dubia* (chronic/reproduction test) and *Hyalella azteca* (acute/survival test), according to the TST test protocol required by the MRP.

Sediment Toxicity

The sediment samples also collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined not to be toxic to either of the test species.

Sediment Chemistry

Several of the common urban pyrethroid pesticides were detected at the water year 2021 sediment monitoring site (Walnut Creek, site 207R03403); as is typical, bifenthrin was detected at the highest concentration. The calculated toxic unit equivalent of 0.84 for the combined pyrethroid concentrations is less than that normally presumed to cause toxicity to either *Chironomus dilutus* or *Hyalella azteca* in the sediment toxicity testing.

Sediment Triad Analyses

Bioassessment, sediment toxicity, and sediment chemistry results from water year 2021 were evaluated as the three lines of evidence used in the triad approach for assessing overall stream condition and added to the compiled results for water years 2012-2021. Good correlation is observed throughout that period in the triad analysis between pyrethroid concentrations with TU $\geq$1 and sediment toxicity.

Pyrethroid pesticide sediment concentrations appear to be effective predictors of sediment toxicity, as samples with calculated pyrethroid TU equivalents greater than 1.0 exhibited significant sediment toxicity. The samples with TU equivalents less than 1.0 generally did not exhibit sediment toxicity, as shown in Table 4.16 (the 2018 sample being the exception, as the calculated TU equivalent was 0.95, and toxicity was observed to *Hyalella azteca* in the sediment sample).

Based on the results of the past 10 years, chemical stressors, particularly pesticides, may be contributing to the degraded biological conditions indicated by the low B-IBI scores in many of the monitored streams.

Comparisons to Conclusions of the Comprehensive Multi-Year Analysis

The multi-year analysis of regional/probabilistic parameters included within the water year 2019 Integrated Monitoring Report (ARC, 2020) produced the following conclusions:

- Biological conditions in Contra Costa County urban creeks are generally impacted, as indicated by analysis of bioassessment results from 76 monitoring sites over the course of eight years (2012-2019). Physical habitat factors play a significant role in degradation of in-stream biota, with water quality factors and antecedent rainfall also contributing to in-stream conditions.
- Factors that have a positive influence on in-stream biological conditions for BMI and algae include higher percentages of fast water within the reach, higher percentages of coarse gravel, and higher diversity of natural substrate types.
- Factors that tend to negatively impact in-stream biota include higher percentages of fines or substrate smaller than sand, higher percentages of slow water in the reach, and elevated chloride or conductivity.
- Algae assemblages tend to benefit from higher antecedent rainfall in the 60- to 90-day range and are negatively impacted by elevated temperatures.
- Throughout the study period, sediment toxicity and occasional water toxicity are chronic occurrences, with toxicity typically attributable to the presence of pyrethroid and sometimes other pesticides, including the recent presence of fipronil and imidacloprid.

These findings are supported in the water year 2021 analysis with respect to biological conditions, although sediment toxicity was not observed in the water year 2021 dry weather monitoring.

The apparently detrimental effect of the heightened presence of the invasive New Zealand Mudsnail, which surprisingly correlated well with the IPI physical habitat indicator scores in the CCCWP water year 2021 data, presents a complicating factor in the current analysis.

Sediment chemistry and toxicity clearly are linked to "very poor" IBI scores and "degraded" CSCI scores, but those factors don't always completely explain very poor biological conditions as indicated from the bioassessment results. Where the sum of TUs exceeds 1, sediment toxicity consistently occurs. Where sediment toxicity occurs, IBI and CSCI scores consistently indicate "very poor" and "degraded" conditions. In contrast, "very poor" and "degraded" conditions are often but not always associated with sediment toxicity and TUs exceeding 1.

Table 4.16 Summary of Sediment Quality Triad Evaluation Results – Water Years 2012-2021 Data

Water Year	Water Body	Site ID	B-IBI Condition Category	Sediment Toxicity	No. of TEC Quotients > 1.0	Mean PEC Quotient	Sum of TU Equivalents
2012	Grayson Creek	207R00011	Very Poor	Yes	10	0.14	2.17
2012	Dry Creek	544R00025	Very Poor	Yes	11	0.51	3.62
2013	Sycamore Creek	207R00271	Very Poor	Yes	0	0.04	10.5
2013	Marsh Creek	544R00281	Very Poor	Yes	4	0.13	1.03
2014	San Pablo Creek	206R00551	Very Poor	No	1	0.09	.016
2014	Grizzly Creek	207R00843	Very Poor	No	1	0.12	.11
2015	Rodeo Creek	206R01024	Poor	No	1	0.11	0.32
2015	Green Valley Creek	207R00891	Very Poor	Yes	3	0.12	1.11
2016	Rimer Creek	204R01519	Degraded (CSCI)	No	1	0.12	0.89
2017	West Branch Alamo Creek	204R01412	Degraded (CSCI)[1]	No	3	0.21	0.255
2018	Marsh Creek	544R01737	Degraded (CSCI)	Yes	1	0.09	0.95
2019	Marsh Creek	544R02505	Degraded (CSCI)	Yes	3	0.25	1.84
2020	Grayson Creek	207R01547	[not tested]	No	1	0.11	0.55
2021	Walnut Creek	207R03403	Degraded (CSCI)	No	1	0.14	0.84

1 Based on water year 2016 bioassessment data

Note: Yellow-highlighted cells indicate results exceed permit trigger threshold.

5 Conclusions and Next Steps

5.1 Water Year 2021 Results

The water year 2021 data were fairly consistent with the results of previous creek status monitoring performed by CCCWP under the MRP.

Every CCCWP bioassessment site monitored in water year 2021 produced a CSCI score below the MRP 2.0 threshold of 0.795, indicating a degraded benthic biological community relative to reference conditions.

The algae metrics (ASCI scores) produced similar results in water year 2021. With the exception of the Refugio Creek (site 206R02816) sample, which scored Likely Altered on the diatoms MMI, all sites scored Very Likely Altered on the diatoms MMI and hybrid MMI ASCI metrics.

Based on both the BMI and algal community indices, the biological community conditions of all CCCWP sites monitored in 2021 are characterized as impacted.

IPI scores were again calculated from the PHab data compiled during the spring 2021 bioassessment monitoring, and the IPI scores were related to condition categories as recommended by SWAMP guidance. Five of the water year 2021 sites are rated as Likely Intact, three are ranked as Possibly Altered, and two are ranked as Likely Altered with respect to physical habitat quality.

Given that the water year 2021 CSCI scores and ASCI MMI scores indicate “degraded” benthic macroinvertebrate communities and Very Likely Altered algal biological communities relative to reference conditions, physical habitat does not appear to be a principal stressor, with half of the corresponding IPI score categories indicating Likely Intact physical habitat and only two indicating Likely Altered habitat.

The influence of physical habitat as a potential stressor on biological community health may be complicated by the widespread occurrence of the New Zealand Mudsnail, as the presence of this invasive species correlated surprisingly well with the IPI physical habitat indicator scores in the CCCWP water year 2021 data.

Of the 12 water quality parameters required in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate+nitrite (for sites with MUN beneficial use only). None of the results generated from the 10 sites monitored during water year 2021 exceeded the applicable water quality standards.

The water samples collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined to be toxic to *Ceriodaphnia dubia* (chronic/reproduction test) and *Hyalella azteca* (acute/survival test), according to the TST test protocol required by the MRP.

The sediment samples also collected from Walnut Creek (site 207R03403) on June 23, 2021, were determined not to be toxic to either of the test species.

Several of the common urban pyrethroid pesticides were detected at the water year 2021 sediment monitoring site (Walnut Creek, site 207R03403). As is typical of urban streams, bifenthrin was detected at the highest concentration. The calculated toxic unit equivalent of 0.84 for the combined pyrethroid concentrations is less than that normally presumed to cause toxicity to either *Chironomus dilutus* or *Hyalella azteca* in the sediment toxicity testing.

5.2 Next Steps

The analysis presented in this report identifies a number of potentially impacted sites which might deserve further evaluation and/or investigation to provide better understanding of the sources/stressors which contribute to reduced water quality and lower biological conditions.

Candidate probabilistic sites previously classified with “unknown" sampling status in the RMC probabilistic site evaluation process may continue to be evaluated for potential sampling in water year 2022.

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Appendix 2

Local/Targeted Creek Status Monitoring Report:

Water Year 2021

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Contra Costa Clean Water Program

Local/Targeted Creek Status Monitoring Report: Water Year 2021

(October 2020 – September 2021)

March 31, 2022

Prepared for

Contra Costa Clean Water Program
255 Glacier Drive
Martinez, California 94553

Prepared by

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Contra Costa Clean Water Program

Local/Targeted Creek Status Monitoring Report: Water Year 2021

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List of Acronyms and Abbreviations

ACCWP	Alameda Countywide Clean Water Program
ADH	ADH Environmental
ARC	Armand Ruby Consulting
BAMSC	Bay Area Municipal Stormwater Collaborative
BASMAA	Bay Area Stormwater Management Agencies Association
CCCDD	Contra Costa County Development Department
CCCWP	Contra Costa Clean Water Program
CFU	colony forming units
COLD	cold freshwater habitat (steelhead stream)
CVRWQCB	Central Valley Regional Water Quality Control Board
DO	dissolved oxygen
EBMUD	East Bay Municipal Utility District
FSURMP	Fairfield-Suisun Urban Runoff Management Program
GM	geometric mean
MPN	most probable number
MRP	municipal regional stormwater permit
MWAT	maximum weekly average temperature
NPDES	National Pollutant Discharge Elimination System
pH	hydrogen ion concentration
QAPP	quality assurance project plan
Region 2	San Francisco Bay Regional Water Quality Control Board
Region 5	Central Valley Regional Water Quality Control Board
RMC	Regional Monitoring Coalition
RPD	relative percent difference
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	standard operating procedure
SSID	stressor/source identification
STV	standard threshold value
SWAMP	Surface Water Ambient Monitoring Program
USEPA	U.S. Environmental Protection Agency
WARM	warm water habitat (non-steelhead streams)
WAT	weekly average temperature
WWTP	wastewater treatment plant
YSI	Yellow Springs Instrument Company

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Preface

In 2010, several members of the Bay Area Stormwater Management Agencies Association (BASMAA) joined to form the Regional Monitoring Coalition (RMC) to coordinate and oversee water quality monitoring required by the Municipal Regional Stormwater Permit (MRP). The RMC includes the following stormwater program participants:

- Alameda Countywide Clean Water Program
- Contra Costa Clean Water Program
- San Mateo Countywide Water Pollution Prevention Program
- Santa Clara Valley Urban Runoff Pollution Prevention Program
- Fairfield-Suisun Urban Runoff Management Program
- City of Vallejo and Vallejo Sanitation and Flood Control District

While BASMAA dissolved on June 28, 2021, CCCWP and other RMC participants continue to coordinate their monitoring activities through Bay Area Municipal Stormwater Collaborative (BAMSC) to perform creek status monitoring and report results in accordance with the RMC study designs as in prior years.

In accordance with the BASMAA RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA, 2011), monitoring data were collected following methods and protocols specified in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA, 2020) and BASMAA RMC Standard Operating Procedures (BASMAA, 2016). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP. Data presented in this report were also submitted to the Moss Landing Marine Laboratories Regional Data Center for submittal to the State Water Resources Control Board on behalf of the Contra Costa Clean Water Program's permittees and pursuant to MRP provision C.8.h.ii requirements for electronic data reporting.

This Local/Targeted Creek Status Monitoring Report documents the results of targeted (non-probabilistic) monitoring performed by the Contra Costa Clean Water Program in water year 2021 (Oct. 1, 2020-Sept. 30, 2021). Together with the creek status monitoring data reported in Regional/Probabilistic Creek Status Monitoring Report: Water Year 2021 (ARC, 2022), this submittal fulfills monitoring requirements specified in MRP provisions C.8.d and C.8.g and complies with reporting provision C.8.h.iii of the MRP (SFBRWQCB, 2015).

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Executive Summary

This Local/Targeted Creek Status Monitoring Report was prepared by the Contra Costa Clean Water Program (CCCWP) in compliance with the National Pollutant Discharge Elimination System (NPDES) Municipal Regional Stormwater Permit (MRP) issued by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), Order R2-2015-0049. This report documents the results of targeted (non-probabilistic) monitoring performed by CCCWP in water year 2021 (Oct. 1, 2020-Sept. 30, 2021). Together with the creek status monitoring data reported in Regional/Probabilistic Creek Status Monitoring Report: Water Year 2021 (ARC, 2022), this submittal fulfills monitoring requirements specified in MRP provisions C.8.d and C.8.g and complies with reporting provision C.8.h.iii of the MRP (SFBRWQCB, 2015).

Within Contra Costa County, targeted monitoring was conducted at:

- Four continuous water temperature monitoring locations
- Two continuous general water quality monitoring locations
- Five pathogen indicator monitoring locations

Continuous Water Temperature

Water temperature measurements were recorded at hourly intervals using Onset® HOBO® data loggers (HOBOs) deployed in four creeks on April 14, 2021. One device each was deployed in Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek. The HOBOs were retrieved on Oct. 8, 2021. As the permit term reporting requirements apply only to the extent of a given water year, data collected after Sept. 30, 2021, are not included in this report.

Pathogen Indicators

Samples were collected on June 29, 2021, at five stations along four separate creeks in Contra Costa County. Samples were analyzed for enterococci and *E. coli.* The five sampling locations were located at Alamo Creek, Alhambra Creek, South San Ramon Creek, and two locations along San Ramon Creek.

General (Continuous) Water Quality

Temperature, dissolved oxygen (DO), hydrogen ion concentration (pH), and specific conductance were continuously monitored at 10-minute intervals by sonde devices during two time periods (June 6-19, 2021, and Sept. 1-14, 2021) at two locations along Marsh Creek (stations 544MSHM1 and 544MSHM0).

Results of Targeted Monitoring Data

Targeted monitoring data were evaluated against numeric trigger thresholds, as described in MRP provision C.8.d. These thresholds, which include applicable numeric water quality objectives or other applicable criteria, indicate levels at which additional follow-up may be required under the MRP. Targeted monitoring locations for water year 2021 were located within both SFBRWQCB Region 2 and Central Valley Regional Water Quality Control Board (CVRWQCB) Region 5 boundaries. Numeric thresholds are discussed below as presented in MRP provision C.8.d.

Temperature – HOBOs and Sondes

For streams documented to support steelhead fisheries, or for streams maintaining a designated cold freshwater habitat per the Basin Plan, the trigger threshold for temperature is defined in the MRP as 20% or more of instantaneous results exceeding 24° C, or a maximum weekly average temperature (MWAT) of 17° C. Per the MRP, for the HOBO temperature data, a maximum of one weekly average temperature

(WAT) can exceed the threshold of 17° C during the deployment period. For temperature data recorded by sonde devices, which are deployed for a much briefer period (one to two weeks), all WATs must be below 17° C.

Creeks targeted in water year 2021 and their respective designated beneficial uses are listed in Table ES.1. For this report, creeks listed as cold freshwater habitat (COLD) are evaluated as steelhead streams, while creeks designated as warm freshwater habitat (WARM) are referred to as non-steelhead streams.

In water year 2021, streams designated as COLD freshwater habitat were targeted for temperature monitoring using HOBO devices, while Marsh Creek, which maintains a WARM freshwater habitat, was targeted for temperature monitoring using sonde devices. At the four locations with continuously recorded HOBO temperature data from April until September, all four creeks (Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek) are classified as steelhead streams.

As part of an ongoing flow augmentation pilot study and to investigate whether Marsh Creek could support Chinook salmon identified in the lower reaches of the watershed, COLD freshwater habitat temperature criterion was applied to the Marsh Creek monitoring locations for the purpose of this report.

No water year 2021 temperature monitoring location within steelhead streams recorded more than 20% instantaneous results above 24° C; therefore, there were no exceedances of this criterion. In Marsh Creek, which maintains a WARM beneficial use, the 24° C water temperature criterion was exceeded during both the June and September deployment periods at each monitoring location. As Marsh Creek is a non-steelhead stream, this does not constitute an exceedance under the MRP criterion.

Exceedances of the 17° C WAT threshold occurred for eight out of eight monitoring periods in water year 2021. This includes the four monitoring stations along Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek and both Marsh Creek stations during the June and September deployment periods for the sonde data. As Marsh Creek is a non-steelhead stream (i.e., does not maintain a designated COLD beneficial use), this does not constitute an exceedance under the MRP criterion.

Dissolved Oxygen (DO)

The MRP trigger threshold for dissolved oxygen in non-tidal waters is applied as follows: in waters designated as steelhead streams, no more than 20% of instantaneous dissolved oxygen results may drop below 7.0 mg/L; in waters designated as non-steelhead streams, per Basin Plan criteria (SFBRWQCB, 2019), no more than 20% of instantaneous dissolved oxygen results may drop below 5.0 mg/L.

During the June monitoring period, the 20% threshold for non-steelhead streams was not exceeded for dissolved oxygen measurements in Marsh Creek at either monitoring station. During the September deployment at Marsh Creek, dissolved oxygen measurements were not recorded below the MRP trigger threshold at the upstream monitoring station (544MSHM1), while 38% of instantaneous dissolved oxygen results were recorded below 5.0 mg/L at the downstream monitoring station (544MSHM0), exceeding the MRP criterion at this station.

pH

The MRP trigger threshold for pH in surface waters is applied as follows: no more than 20% of instantaneous pH results may fall outside the range of 6.5 to 8.5. This range was used to evaluate the pH data collected at targeted locations over water year 2021.

For Marsh Creek station 544MSHM1, the 20% threshold was not exceeded during either the June or September deployment periods, meeting the MRP criterion. During the June monitoring period at Marsh Creek station 544MSHM0, 25% of results failed to meet the pH criterion, exceeding the MRP threshold of 20% of instantaneous results. During the September monitoring period, the pH of Marsh Creek station 544MSHM0 did not exceed the MRP trigger threshold criterion.

Specific Conductance

The MRP trigger threshold for specific conductance in surface waters is applied as follows: no more than 20% of instantaneous specific conductance results may exceed 2,000 µS/cm, and readings should not indicate a spike in specific conductance with no obvious natural explanation.

During both the June and September monitoring periods, specific conductance measurements at Marsh Creek stations 544MSHM1 and 544MSHM0 did not exceed the 20% threshold for specific conductance results above 2,000 µS/cm and no spikes in the data were observed.

Pathogen Indicator Bacteria

A single-sample maximum concentrations of 130 CFU/100 ml for enterococci and 410 CFU/100 ml for *E. coli* were used as water contact recreation evaluation thresholds for the purposes of this evaluation, based on an adaptation of the recommended water quality criteria established by U.S. Environmental Protection Agency (USEPA) to protect recreational uses (USEPA, 2014).

For enterococci, five out of five single-sample concentrations (South San Ramon Creek, Alamo Creek, Alhambra Creek and two locations on San Ramon Creek) exceeded the single-sample threshold concentration. For *E. coli,* one of the five stations (Alhambra Creek) exceeded the threshold concentration for water contact recreation.

Exceedances for each of the above parameters are summarized in Table ES.2.

Table ES.1. Designated Beneficial Uses Listed in the Basin Plan for CCCWP Targeted Monitoring Sites – Water Year 2021

Water Year	Site ID	Water Body	Human Consumptive Uses							Aquatic Life Uses									Recreational Uses		
			AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
2021	204SLE204	Moraga Creek			E						E					E	E	E	E	E	
	206R02907	San Pablo Creek			E						E			E	E	E	E	E	E	E	
	207R01307	Lafayette Creek									E						E	E	E	E	
	207R03403	Walnut Creek									E			E	E	E	E	E	E	E	
	544MSHM1	Marsh Creek							E						E		E	E	P	P	
	544MSHM0	Marsh Creek							E						E		E	E	P	P	

E Existing beneficial use
P Potential beneficial use
Notes: Per Basin Plan Ch. 2 (SFBRWQCB, 2019), beneficial uses for freshwater creeks include municipal and domestic supply (MUN), agricultural supply (AGR), industrial process supply (PRO), groundwater recharge (GWR), water contact recreation (REC1), noncontact water recreation (REC2), wildlife habitat (WILD), cold freshwater habitat (COLD), warm freshwater habitat (WARM), fish migration (MIGR), and fish spawning (SPWN). The San Francisco Bay Estuary supports estuarine habitat (EST), industrial service supply (IND), and navigation (NAV) in addition to all uses supported by streams. Beneficial uses for coastal waters include water contact recreation (REC1); noncontact water recreation (REC2); industrial service supply (IND); navigation (NAV); marine habitat (MAR); shellfish harvesting (SHELL); ocean, commercial and sport fishing (COMM); and preservation of rare and endangered species (RARE).

Table ES.2 CCCWP Threshold Exceedances – Water Year 2021

Creek	Index Period	Parameter	Threshold Exceedance
Moraga Creek	06/17/21-09/15/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
San Pablo Creek	06/17/21-07/14/21 07/22/21-08/25/21 09/09/21-09/15/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Lafayette Creek	07/29/21-08/04/21 08/12/21-08/18/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Walnut Creek	05/06/21-05/12/21 05/27/21-09/29/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Marsh Creek (544MSHM0)	06/06/21-06/19/21	Continuous Water Quality – pH	20% of instantaneous results below 6.5 or above 8.5
Marsh Creek (544MSHM0)	09/01/21-09/14/21	Continuous Water Quality – DO	20% of instantaneous results below 5.0 mg/L
South San Ramon Creek	06/29/21	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alamo Creek	06/29/21	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
San Ramon Creek	06/29/21	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
San Ramon Creek	06/29/21	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alhambra Creek	06/29/21	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alhambra Creek	06/29/21	*E. coli*	Single grab sample exceeded USEPA criterion of 410 CFU/100 ml

CFU colony forming unit
DO dissolved oxygen
WAT weekly average temperature

1. Introduction

Contra Costa County lies within both the Region 2 and Region 5 jurisdictions of the State Water Resources Control Board. The countywide stormwater program is subject to both the Region 2 municipal regional stormwater National Pollutant Discharge Elimination System (NPDES) permit (MRP) and the Region 5 permit (Central Valley Permit). Municipal stormwater discharges in Contra Costa County are regulated by the requirements of both the municipal regional permit (MRP) for urban stormwater in Region 2 (Order R2-2015-0049)[1] and the Central Valley Permit in Region 5 (Order R5-2010-0102)[2]. Prior to the reissuance of MRP Order R2-2015-0049, the requirements of the two permits were effectively identical. With the reissued MRP in 2015, some differences between the permits led to an agreement between the Central Valley and San Francisco Bay Regional Water Quality Control Boards, where sites in the Central Valley Region (Region 5) will continue to be sampled as part of the creek status monitoring required by both permits, with monitoring and reporting requirements prevailing under the jurisdiction of the Region 2 MRP (Order R2-2019-0004)[3].

In 2010, members of the Bay Area Stormwater Management Agencies Association (BASMAA) formed the Regional Monitoring Coalition (RMC) to collaboratively implement the monitoring requirements found in provision C.8 of the MRP. The participants of the RMC are listed in Table 1.1. The BASMAA RMC developed a quality assurance project plan (QAPP) (BASMAA, 2020), standard operating procedures (SOPs) (BASMAA, 2016), data management tools, and reporting templates and guidelines. Costs for these activities were shared among RMC members on a population-weighted basis by direct contributions and provision of in-kind services by RMC members to complete required tasks. Participation in the RMC was facilitated through the BASMAA and is now coordinated through the BAMSC Monitoring and Pollutants of Concern Committee.

While BASMAA dissolved in June 2021, the Contra Costa Clean Water Program (CCCWP) continues to coordinate monitoring activities through BAMSC and perform creek status monitoring and report results in accordance with the RMC study designs.

The goals of the RMC are to:

1. Assisting RMC permittees in complying with requirements of MRP provision C.8 (water quality monitoring)
2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area through improved coordination among RMC participants and other agencies (e.g., regional water quality control boards, Regions 2 and 5, and the State Water Resources Control Water Board) which share common goals
3. Stabilize the costs of creek monitoring by reducing duplication of efforts and streamlining reporting

[1] The SFBRWQCB issued the five-year municipal regional permit for urban stormwater (MRP, Order R2-2015-0049) to 76 cities, counties, and flood control districts (i.e., permittees) in the Bay Area on Nov. 19, 2015 (SFBRWQCB, 2015). The BASMAA programs supporting MRP regional projects include all MRP permittees, as well as the cities of Antioch, Brentwood, and Oakley, which are not named as permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.

[2] The CVRWQCB issued the Central Valley Permit (Order R5-2010-0102) on Sept. 23, 2010 (CVRWQCB, 2010). This permit is now superseded by Order R2-2019-0004, incorporating the eastern portion of Contra Costa County within the requirements of the MRP (Order R2-2015-0049).

[3] The SFBRWQCB, per agreement with the CVRWQCB, adopted Order R2-2019-004 on Feb. 13, 2019.

The RMC divided the creek status monitoring requirements specified by permit provisions into those parameters which could reasonably be included within a regional/probabilistic design, and those which, for logistical and jurisdictional reasons, should be implemented locally using a targeted (non-probabilistic) design. The monitoring elements included in each design category are specified in Table 1.2.

This report focuses on the creek status and long-term trends monitoring activities conducted to comply with provision C.8.d using a targeted (non-probabilistic) monitoring design (Table 1.2). The report documents the results of targeted monitoring performed by CCCWP during water year 2021. Together with the creek status monitoring data reported in Regional/Probabilistic Creek Status Monitoring Report: Water Year 2021 (ARC, 2022), this submittal fulfills creek status monitoring requirements specified in MRP provisions C.8.d and C.8.g and complies with reporting provision C.8.h.iii of the MRP (SFBRWQCB, 2015). The remainder of the report describes the study area and design (Section 2), monitoring methods (Section 3), results and discussion (Section 4), and next steps (Section 5).

Table 1.1 Regional Monitoring Coalition Participants

Stormwater Programs	RMC Participants
Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)	Cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, Sunnyvale, Los Altos Hills, and Los Gatos; Santa Clara Valley Water District; and Santa Clara County
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, Town of Danville, El Cerrito, Hercules, Lafayette, Martinez, Town of Moraga, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek; Contra Costa County Flood Control and Water Conservation District; and Contra Costa County Watershed Program
San Mateo County Wide Water Pollution Prevention Program (SMCWPPP)	Cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and San Mateo County
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District

Table 1.2 Creek Status Monitoring Elements per MRP Provisions C.8.d. and C.8.g., Monitored as Either Regional/Probabilistic or Local/Targeted Parameters

Biological Response and Stressor Indicators	Monitoring Design	
	Regional (Probabilistic)	Local (Targeted)
Bioassessment, physical habitat assessment, CSCI	X	X[1]
Nutrients (and other water chemistry associated with bioassessment)	X	X[1]
Chlorine	X	X[2]
Water toxicity (wet and dry weather)	NA	NA
Water chemistry (pesticides, wet weather)	NA	NA
Sediment toxicity (dry weather)	NA	NA
Sediment chemistry (dry weather)	NA	NA
Continuous water quality (sondes data: temperature, dissolved oxygen, pH, specific conductance)		X
Continuous water temperature (data loggers)		X
Pathogen indicators (bacteria)		X

1 Provision C.8.d.i.(6) allows for up to 20% of sample locations to be selected under a targeted monitoring design. This design change was made under MRP Order R2-2015-0049.

2 Provision C.8.d.ii.(2) provides options for probabilistic or targeted site selection. In water year 2020, chlorine was measured at probabilistic sites.

CSCI California Stream Condition Index

NA Not applicable; the monitoring parameter is not specific to either monitoring design

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2. Study Area and Design

2.1. Regional Monitoring Coalition Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes portions of five participating counties which fall within the jurisdiction of the SFBRWQCB. Figure 2.1 displays the BASMAA RMC area and illustrates the boundary of the State Water Resources Control Board (Regions 2 and 5) within Contra Costa County. The eastern portion of Contra Costa County drains to the CVRWQCB region (Region 5), while the rest of the county drains into Region 2. Status and trends monitoring is conducted in flowing water bodies (i.e., creeks, streams, and rivers) interspersed among the RMC area, including perennial and non-perennial creeks and rivers running through both urban and non-urban areas.

Contra Costa County has 31 major watersheds and sub-watersheds containing more than 1,300 miles of creeks and drainages (CCCDD, 2003). The county's creeks discharge into the Sacramento-San Joaquin River Delta in the east, along the series of bays to the north (including Suisun and San Pablo bays), and to North San Francisco Bay in the west. In addition, two watersheds (Upper San Leandro and Upper Alameda Creek) originate in Contra Costa County and continue through Alameda County before reaching San Francisco Bay.

2.2. Contra Costa County Targeted Monitoring Areas and Siting Rationale

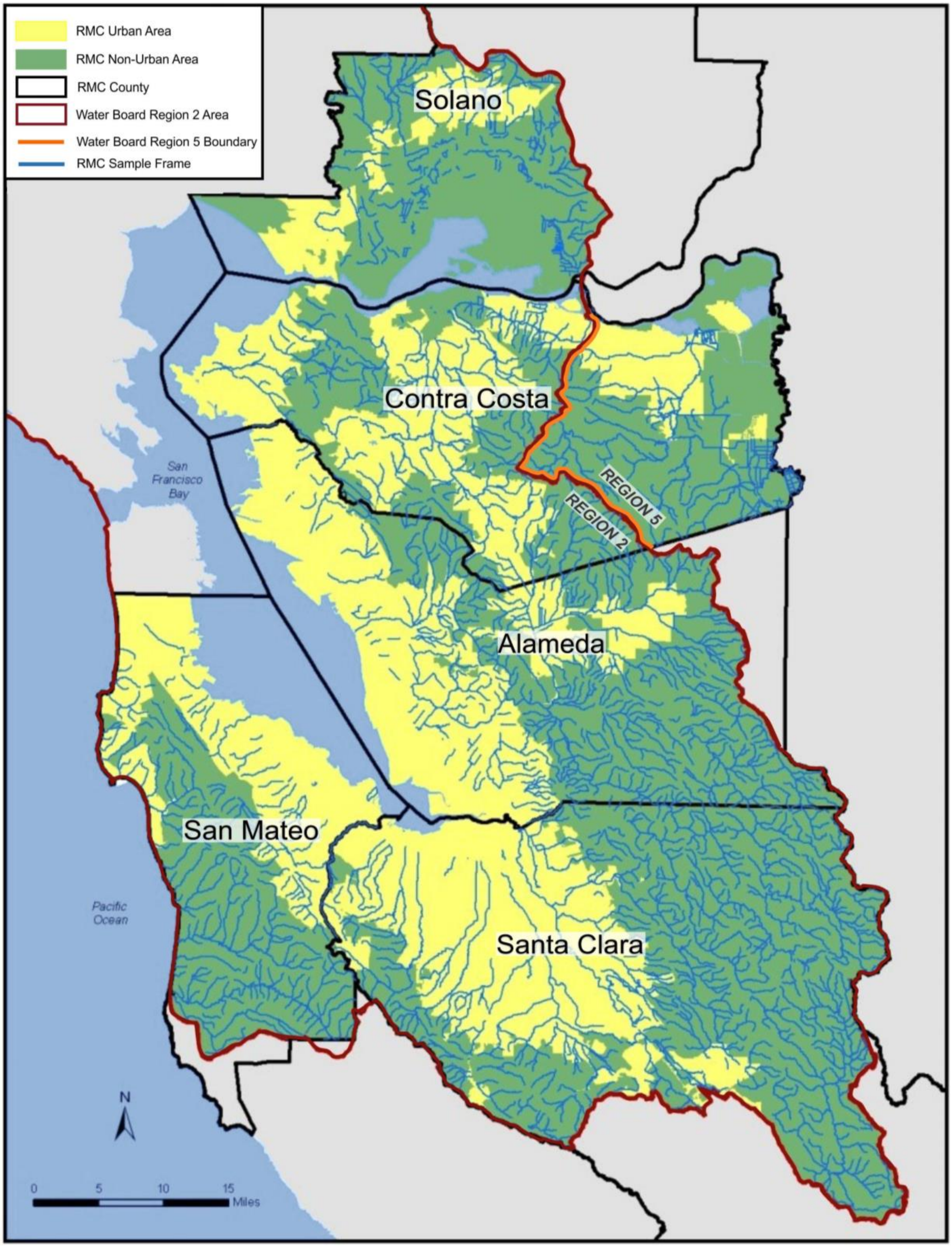
In water year 2021, four of the county's watersheds were the focus of targeted general water quality or water temperature monitoring, while five locations were selected for pathogen indicator sampling. In Region 2, the Upper San Leandro Creek, San Pablo Creek, and Walnut Creek watersheds were selected for continuous water temperature monitoring, while locations along Alamo Creek, Alhambra Creek, South San Ramon Creek and San Ramon Creek were sampled for pathogen indicators. In Region 5, the Marsh Creek watershed was targeted for continuous general water quality and water temperature monitoring. Details discussing the water year 2021 siting rationale and watershed overview are discussed below.

2.2.1. Upper San Leandro Creek Watershed – Moraga Creek Sub-watershed

Unlike most creeks in Contra Costa County, the 4.8-mile-long Moraga Creek is part of the Upper San Leandro Creek watershed that drains into Alameda County via the San Leandro Reservoir. Moraga Creek, Laguna Creek and Rimer Creek create the Moraga Creek sub-watershed coming together to flow into Upper San Leandro Creek and the northeast arm of the Upper San Leandro Reservoir. Managed by the East Bay Municipal Utility District (EBMUD), the reservoir spans the county line with its outlet in Alameda County. Water then flows through Alameda County to the San Francisco Bay (CCCDD, 2003).

The channels of the creeks throughout the area are relatively unmodified, with 93.8% of the 50.47 miles of stream channel containing no obvious reinforcements. Within Contra Costa County, the southern extent of Orinda and a major portion of Moraga make up the local jurisdictions in the 13,059-acre watershed. Portions of Moraga Creek are routed underground, to accommodate urbanization and infrastructure-based development (CCCDD, 2003).

Figure 2.1 Map of BASMAA RMC Area, County Boundaries and Major Creeks



In the Moraga Creek sub-watershed, unincorporated county lands, including portions of protected watershed managed by the EBMUD and East Bay Regional Parks District, keep the watershed area lightly developed at 25%. The developed area of the watershed consists mainly of small ranches and single-family homes, while impervious surface makes up only 15% of the total watershed area. Because of the rain shadow generated by the southern extent of the East Bay Hills, annual rainfall in this watershed is some of the highest in the county, ranging from 28 to 33 inches per year (CCCDD, 2003).

Targeted monitoring for water year 2021 took place in Moraga Creek, downstream of the Moraga Country Club below the confluence with Laguna Creek in the City of Moraga. Continuous water temperature monitoring was targeted in Moraga Creek to determine if the stream is meeting the designated beneficial use as a COLD freshwater habitat, following MRP 2 exceedances in water year 2020.

2.2.2. San Pablo Creek Watershed

The full watershed of San Pablo Creek is 27,640 acres, arising in the City of Orinda at a maximum elevation of 1,905 feet and flowing westerly 19.65 miles to San Pablo Bay. After leaving Orinda, San Pablo Creek flows across EBMUD land into San Pablo Reservoir. Water released from San Pablo Reservoir flows into lower San Pablo Creek, where it crosses first through rural and then through heavily urbanized residential and commercial property. Earthen or concrete channelized portions of San Pablo Creek amount to 10.6% of the entire channel and occur as it passes through the City of San Pablo. Impervious surface in the San Pablo Creek watershed is calculated at 20% (CCCDD, 2003).

Covering 43.5 square miles in west Contra Costa County, the San Pablo Creek watershed is characteristic of other west county watersheds, as the lower portions reflect years of occupation and industrialization in the Cities of San Pablo and Richmond, and the headwaters are occupied by semi-rural residential areas in the City of Orinda and unincorporated Contra Costa County. The San Pablo Reservoir, a major feature of the watershed, has a capacity of 38,600 acre-feet of water and is regulated by EBMUD. To the north of the San Pablo Reservoir, tributary headwaters enter the Briones Reservoir (a reserve to the San Pablo Reservoir), also regulated by EBMUD. The surrounding lands adjacent to these reservoirs currently maintain a protected watershed status, providing habitat for numerous species of plants and animals in the region. This habitat is further enhanced by the adjacent East Bay Regional Park lands of Briones and Tilden Regional Parks (CCCWP, 2004).

In water year 2021, one location was targeted for water temperature monitoring on San Pablo Creek. Located above the San Pablo Reservoir, continuous water temperature monitoring was targeted at station 206R02907 to determine if the stream is meeting the designated beneficial use as a COLD freshwater habitat, following MRP 2 exceedances in the upper reaches of San Pablo Creek above the reservoir in water year 2019.

2.2.3. Walnut Creek Watershed and Las Trampas Creek Sub-watershed

The Walnut Creek watershed is in central Contra Costa County, with boundaries demarcated by the west side of Mount Diablo and the east side of the East Bay Hills. At 93,556 acres, it is the largest watershed in the county. The watershed has eight major tributaries which flow into the generally south-north trending direction of Walnut Creek. These tributaries include San Ramon Creek, Bollinger Creek, Las Trampas Creek, Lafayette Creek, Grayson Creek, Murderers Creek, Pine Creek, and Galindo Creek.

Due to steep slopes and land protection efforts, the upper watersheds along the perimeter of the Walnut Creek watershed generally remain undeveloped open space. The valleys of the watershed are densely urbanized and populated by the cities of Walnut Creek, Lafayette, Pleasant Hill, and Danville. The cities of Concord, Martinez, and small areas of Moraga and San Ramon also are partly within the watershed (Walkling, 2013).

Walnut Creek has the second longest running stream length in the county at 28.74 miles. Its highest elevation lies at 3,849 feet, while the mouth joins sea level at Suisun Bay. An estimated 73% of its stream channel remains in a natural or earthen state, with the remaining portion containing hardened man-made reinforcements. Estimated impervious surfaces make up 30% of its watershed. Walnut Creek's estimated mean daily flow is 81.4 cubic feet per second (CCCDD, 2003).

There were two locations in the Walnut Creek watershed, one on Walnut Creek and one on Lafayette Creek, targeted for continuous water temperature monitoring in water year 2021. Lafayette Creek is a three-mile tributary to Las Trampas Creek, a 12.37-mile branch which eventually joins with San Ramon Creek to form Walnut Creek on the south side of the City of Walnut Creek. The 17,238-acre Las Trampas Creek sub-watershed is predominantly natural, with 79.1% of the 64.1 miles of channel containing no obvious reinforcements. Impervious surface in the Las Trampas Creek sub-watershed is calculated at 13.5% (CCCDD, 2003). CCCWP monitored Lafayette Creek in water year 2016 and discovered continuous water temperature exceedances. As data from previous years suggest water temperature in Lafayette Creek may be impacting its designated beneficial use, continuous water temperature was targeted again in water year 2021.

The second targeted location in the Walnut Creek watershed was located on Walnut Creek's main branch, downstream of the confluence with San Ramon Creek in the City of Walnut Creek at Civic Park. Continuous water temperature was targeted to determine if this reach of Walnut Creek maintains its designated beneficial use for COLD freshwater species.

2.2.4. Marsh Creek

The Marsh Creek watershed lies in the northeastern part of Contra Costa County. The headwaters flow from the eastern flank of Mount Diablo, across the Morgan Territory preserve and Mount Diablo foothills into Marsh Creek Reservoir. From its headwaters, Marsh Creek experiences a range of geologic, hydrologic, and topographic changes as it descends steep rocky terrain and enters the alluvial plain downstream of the Marsh Creek Reservoir. The second largest watershed in the county, it encompasses over 60,000 acres and flows 34.57 miles before exiting into the Sacramento-San Joaquin River Delta at Big Break Regional Shoreline (CCCWP, 2004).

Historically, Marsh Creek meandered through the alluvial plain area north of the Marsh Creek reservoir. After the turn of the century, however, farmers and flood control authorities altered the channel and surrounding landscape to protect agricultural resources which have served the area since the mid-1800s. This intended alteration of flow, including the building of levees, dams, detention basins and reservoirs, led to a severe reduction in riparian vegetation and habitat, lending to significant development within the City of Brentwood (CCCWP, 2004). The alteration from the creek's natural state in the lower watershed, along with active and historic agricultural use and growing urban development, make the Marsh Creek watershed a continued location for targeted monitoring by CCCWP when determining urban impacts on receiving waters to the Sacramento-San Joaquin River Delta.

CCCWP selected two locations for continuous monitoring in the Marsh Creek watershed during water year 2021, targeted for continuous general water quality. The upstream monitoring station (544MSHM1) is located roughly one mile north of Sunset Road in Brentwood, and the downstream monitoring station

(544MSHM0) is located just upstream of the East Cypress Road bridge in the City of Oakley. Both sites are located downstream of the Brentwood Wastewater Treatment Plant, which is located about 0.5 miles east of the junction of Lone Tree Way and Brentwood Boulevard in Brentwood. The upstream monitoring station (544MSH1) is 400 feet downstream of the Brentwood wastewater treatment plant effluent discharge. This station reflects Marsh Creek conditions after receiving flow augmentation from tertiary treated water discharged from the wastewater treatment plant. The downstream station (544MSHM0) is approximately two miles below the wastewater treatment plant effluent discharge and represents more ambient conditions in the lower watershed, while investigating if benefits from flow augmentation translate to this location in the watershed.

Flow augmentation in lower Marsh Creek from the Brentwood wastewater treatment plant is an ongoing pilot project that began in September 2019. The purpose of the pilot project is to determine if augmented effluent flows during periods of daily dissolved oxygen minima within the creek (nighttime hours) can improve water quality. Specifically, the goal is to demonstrate that holding back some effluent during the day, then releasing it during the night can eliminate or lessen the severity of quasi periodic fish kills which are linked to depleted dissolved oxygen (CCCWP, 2020).

2.3. Contra Costa Targeted Monitoring Design

In water year 2021, continuous water temperature, continuous water quality measurements and pathogen indicator bacteria were monitored at the targeted locations listed in Table 2.1 and illustrated in the overview map (Figure 2.2).

Site locations were identified using a targeted monitoring design based on a directed principle[4] to address the following management questions:

1. What is the range of continuous water quality measurements at targeted sites of interest?
2. Do continuous water quality measurements indicate potential impacts to aquatic life?
3. What are the pathogen indicator concentrations at creek sites where water contact recreation may occur?
4. Are conditions in local receiving waters supportive of or likely supportive of beneficial uses?

Within Contra Costa County, the following targeted monitoring was conducted in water year 2021:

- Four continuous water temperature monitoring locations
- Two continuous water quality monitoring locations
- Five pathogen indicator monitoring locations

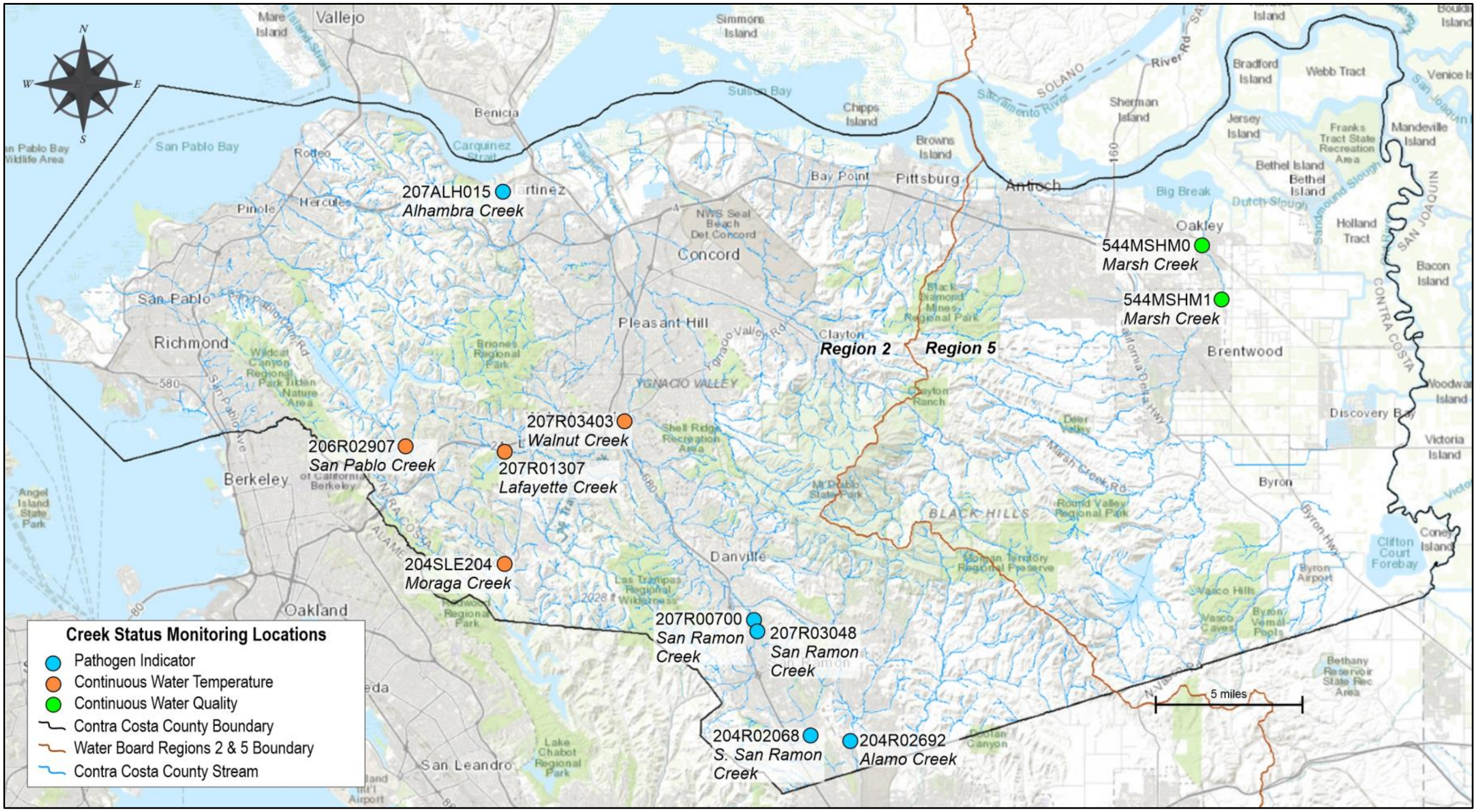
[4] Directed Monitoring Design Principle: A deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based."

Table 2.1 Targeted Sites and Local Reporting Parameters Monitored in Water Year 2021 in Contra Costa County

Site Code	Creek Name	Latitude	Longitude	Continuous Water Temperature	Continuous Water Quality	Pathogen Indicator Bacteria
204R02068	South San Ramon Creek	37.74719	-121.94256			X
204R02692	Alamo Creek	37.74420	-121.91743			X
204SLE204	Moraga Creek	37.83252	-122.13431	X		
206R02907	San Pablo Creek[1]	37.89041	-122.19711	X		
207R00700	San Ramon Creek	37.80510	-121.97827			X
207R01307	Lafayette Creek	37.88794	-122.13472	X		
207R03048	San Ramon	37.79875	-121.97607			X
207R03403	Walnut Creek	37.90342	-122.05906	X		
207ALH015	Alhambra Creek	38.01674	-122.13587			X
544MSHM1	Marsh Creek[2]	37.96389	-121.68374		X	
544MSHM0	Marsh Creek[2]	37.99046	-121.69599		X	

1 Monitoring station upstream of San Pablo Reservoir
2 Monitoring station downstream of Brentwood wastewater treatment plant

Figure 2.2 Overview of Targeted Sites Monitored by CCCWP in Water Year 2021



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3. Monitoring Methods

Targeted monitoring data were collected in accordance with the BASMAA RMC QAPP (BASMAA, 2020) and BASMAA RMC SOP (BASMAA, 2016). Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP (SWAMP, 2013) and were submitted in SWAMP-compatible format by CCCWP to the SFBRWQCB and the CVRWQCB on behalf of CCCWP permittees and pursuant to provision C.8.h.

3.1. Data Collection Methods

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). These documents are updated as needed to maintain current and optimal applicability. The SOPs were developed using a standard format which describes health and safety precautions and considerations, relevant training, site selection, and sampling methods and procedures, (including pre-fieldwork mobilization activities to prepare equipment), sample collection, and demobilization activities to preserve and transport samples.

Monitoring frequency, timeframe, and number of site details for data evaluated are discussed below.

3.1.1. Continuous Water Quality Measurements

Continuous water quality monitoring equipment (YSI EXO 3) were deployed at two targeted locations each water year. Continuous water quality parameters (dissolved oxygen, pH, specific conductance, and water temperature) were recorded every 10 minutes at two stations over two time periods. The equipment was deployed as follows:

- Once during the spring over one to two weeks concurrent with bioassessment sampling (April-early June)
- Once during the summer over one to two weeks at the same sites (late June-September)

Procedures used for calibrating, deploying, programming, and downloading data are described in RMC SOP FS-4 (BASMAA, 2016).

3.1.2. Continuous Water Temperature Monitoring

During each water year, continuous water temperature monitoring was conducted using digital temperature loggers (Onset® HOBO® Water Temp Pro V2) at four locations in the county. Locations were deployed at targeted sites from April-September in stream reaches that are documented to support cold water fisheries or where either past data or best professional judgment indicates that temperatures may negatively affect the designated beneficial use. Digital temperature loggers were set to record at 60-minute intervals over the course of the monitoring period.

Procedures used for calibrating, deploying, programming, and downloading data are described in RMC SOP FS-5 (BASMAA, 2016).

3.1.3. Pathogen Indicator Sampling

In compliance with permit requirements, a set of pathogen indicator samples was collected on July 29, 2021, at five locations. All five sampling locations were selected based upon their potential to detect anthropogenic sources of contamination or targeted due to site location within public parks, giving increased potential of public recreational contact with waterbodies. Pathogen indicator samples for enterococci and *E. coli* were analyzed at all sites.

Sampling techniques included direct filling of containers and immediate transfer of samples to analytical laboratories within specified holding time requirements. Procedures used for sampling and transporting samples are described in RMC SOP FS-2 (BASMAA, 2016).

3.2. Data Analysis and Interpretation Methods

Targeted monitoring data were evaluated against water quality objectives or other applicable thresholds, as described in provision C.8.d of the MRP. Table 3.1 defines thresholds used for selected targeted monitoring parameters as they apply to water year 2021. The following subsections provide details on MRP thresholds and the underlying rationale.

3.2.1. Dissolved Oxygen (DO)

The Basin Plan (SFBRWQCB, 2019) lists the applicable water quality objective for dissolved oxygen in non-tidal waters as follows: 7.0 mg/L minimum for waters designated as COLD (i.e., a steelhead stream) and 5.0 mg/L minimum for waters designated as WARM (i.e., a non-steelhead stream). Although this water quality objective is a suitable criterion for an initial evaluation of water quality impacts, further evaluation may be needed to determine the overall extent and degree to which cold or warm water beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a water body which may not support salmonid spawning or rearing habitat but may be important for upstream or downstream fish migration. In these cases, dissolved oxygen data will be evaluated for the salmonid life stage and/or fish community expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

To evaluate the results against the relevant threshold in MRP section C.8.d, dissolved oxygen data were evaluated against water quality objectives for both steelhead and non-steelhead streams to determine whether 20% or more of the measurements were below the 7.0 mg/L and 5.0 mg/L minimum for COLD and WARM designated beneficial uses, respectively.

3.2.2. Hydrogen Ion Concentration (pH)

The applicable water quality objective for pH in surface waters is stated in the Basin Plan (SFBRWQCB, 2019) as follows: the pH shall not be depressed below 6.5 nor raised above 8.5. This range was used in this report to evaluate the pH data collected from creeks.

To evaluate the results against the relevant threshold in MRP provision C.8.d, the pH data were evaluated to determine whether 20% or more of the measurements were outside of the water quality objectives.

Table 3.1 Requirements for Follow-up for Local/Targeted Creek Status Monitoring Results Per MRP 2.0 Provision C.8.d

Constituent	Threshold Level[1]	MRP 2 Provision	Provision Text
Water Temperature (continuous, HOBO)	≥2 weekly averages >17° C (steelhead streams); or 20% of results >24° C instantaneous maximum (per station)	C.8.d.iii.(4)	The temperature trigger is defined as when two or more weekly average temperatures exceed the MWAT of 17° C for a steelhead stream, or when 20% of the results at one sampling station exceed the instantaneous maximum of 24° C. Permittees shall calculate the WAT by breaking the measurements into non-overlapping, 7-day periods.
Water Temperature (continuous, sondes)	A weekly average >17° C (steelhead streams); or 20% of results >24° C instantaneous maximum (per station)	C.8.d.iv.(4)a.	The Permittees shall calculate the WAT by separating the measurements into non-overlapping, 7-day periods. The temperature trigger is defined as any of the following: MWAT exceeds 17° C for a steelhead stream, or 20% of the instantaneous results exceed 24° C.
pH (continuous, sondes)	≥20% results <6.5 or >8.5	C.8.d.iv.(4)b.	The pH trigger is defined as 20% of instantaneous pH results are <6.5 or >8.5.
Specific Conductance (continuous, sondes)	≥20% results >2000 µS	C.8.d.iv.(4)c.	The specific conductance trigger is defined as 20% of the instantaneous specific conductance results are >2000 µS, or there is a spike in readings with no obvious natural explanation.
Dissolved Oxygen (continuous, sondes)	≥20% results <7 mg/L (cold water fishery streams); or 20% of results <5 mg/L (warm-water fishery streams)	C.8.d.iv.(4)d.	The dissolved oxygen trigger is defined as 20% of instantaneous dissolved oxygen results are <7 mg/L in a cold-water fishery stream, or 20% of instantaneous dissolved oxygen results are < 5 mg/L in a warm-water fishery stream
Enterococci	>130 CFU/100 mL	C.8.d.v.(4)	If USEPA's statistical threshold value for 36 per 1000 primary contact recreators is exceeded, the water body reach shall be identified as a candidate MRP 2.0 SSID project. (Per RMC/SFBRWQCB staff agreement, CFU and MPN units are deemed to be comparable for this purpose.)
E. coli	>410 CFU/100 mL	C.8.d.v.(4)	If USEPA's statistical threshold value for 36 per 1000 primary contact recreators is exceeded, the water body reach shall be identified as a candidate MRP 2.0 SSID project. (Per RMC/SFBRWQCB staff agreement, CFU and MPN units are deemed to be comparable for this purpose.)

1 Per MRP 2.0 provision C.8.d., these are the data thresholds that trigger listings as candidate SSID projects per MRP 2.0 provision C.8.e.
CFU colony forming unit
MPN most probable number
MWAT maximum weekly average temperature
SSID stressor/source identification
WAT weekly average temperature

3.2.3. Specific Conductance

The applicable water quality objective for specific conductance in surface waters is stated in the MRP as follows: 20% of instantaneous specific conductance results should not exceed 2,000 µS/cm, or there should not be a spike in readings with no obvious natural explanation.

To evaluate the results against the relevant threshold in MRP provision C.8.d, the specific conductance data were evaluated to determine whether 20% or more of instantaneous measurements were outside of the water quality objectives, or if data was determined to have a spike in readings with no obvious natural explanation.

3.2.4. Temperature

Temperature is one indicator of the ability of a water body to support a salmonid fisheries habitat (e.g., a steelhead stream). In California, the beneficial use of a steelhead stream is generally associated with suitable spawning habitat and passage for anadromous fish.

In Section C.8.d.iii.(4) of MRP 2.0, the temperature trigger threshold specification is defined as follows:

> "The permittees shall identify a site for which results at one sampling station exceed the applicable temperature trigger or demonstrate a spike in temperature with no obvious natural explanation as a candidate SSID project. The temperature trigger is defined as when two or more weekly average temperatures exceed … 17° C for a steelhead stream, or when 20% of the results at one sampling station exceed the instantaneous maximum of 24° C."

In Section C.8.d.iv.(4).a of the MRP, which deals with continuous monitoring of dissolved oxygen, temperature and pH, the temperature trigger threshold specification is defined as follows:

> "…(the) maximum weekly average temperature (MWAT) exceeds 17° C for a steelhead stream, or 20% of the instantaneous results exceed 24° C."

The first cited section applies to temperature data recorded by the HOBO devices through the period of April-September. The second cited section applies to temperature data recorded by sonde devices during the two shorter deployment periods in spring and summer.

In either case, the weekly average temperature was calculated as the average of seven daily average temperatures in non-overlapping seven-day periods. The first day's data was not included in the weekly average temperature calculations to eliminate the probable high bias of the average daily temperature of that day, because the recording devices were deployed during daylight hours (the typically warmer part of a standard 24-hour day). As the weekly average temperatures were calculated over the disjunctive seven-day periods, the last periods not containing a full seven days of data were also excluded from the calculations.

In compliance with the cited sections of MRP 2.0, sites for which results exceeded the applicable temperature trigger can be identified as candidates for a stressor/source identification (SSID) project in the following three ways:

1. If a site had temperature recorded by a HOBO device and two or more weekly average temperatures calculated from the data were above 17° C
2. If a site had temperature recorded by a sonde device and one or more weekly average temperatures calculated from the data were above 17° C (equivalent to determining the MWAT at one of the sites was above 17° C for the period in question)
3. If a site had 20% of its instantaneous temperature results above 24° C, regardless of the recording device

3.2.5. Pathogen Indicator Bacteria

In 2012, the USEPA released its recreational water quality criteria recommendations for protecting human health in coastal and non-coastal waters designated for primary contact recreation use. The Recreational

Water Quality Criteria include two sets of recommendations (Table 3.2). Primary contact recreation is protected if either set of criteria recommendations are adopted into state water quality standards. However, these recommendations are intended as guidance to states, territories, and authorized tribes in developing water quality standards to protect swimmers from exposure to water containing organisms which indicate the presence of fecal contamination; they are not regulations themselves (USEPA, 2014), but are considered to represent established thresholds for the purpose of evaluating threshold triggers per the MRP.

Section C.8.d.v of the MRP requires use of the USEPA statistical threshold value for the 36/1000 illness rate (Recommendation 1; Table 3.2) for determining if a pathogen indicator collection sample site is a candidate for a stressor/source identification project. Because the geometric mean (GM) cannot be determined from the data collected, the MRP also requires use of the standard threshold values (STV) shown in Table 3.2. For data interpretive purposes, colony forming units (CFU) and most probable number (MPN) are considered equivalent.

Table 3.2 USEPA 2012 Recreational Water Quality Criteria

Criteria Elements	Recommendation 1 Estimated Illness Rate 36/1,000		Recommendation 2 Estimated Illness Rate 32/1,000	
Indicator	GM (CFU/100 mL)	STV[1] (CFU/100 mL)	GM (CFU/100 mL)	STV (CFU/100 mL)
Enterococci	35	130	30	110
E. coli (freshwater)	126	410	100	320

1 MRP thresholds
CFU colony forming unit
GM geometric mean
STV standard threshold values

3.3. Quality Assurance/Quality Control Procedures

Data quality assurance and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA, 2020). Data quality objectives were established to ensure data collected are of adequate quality and sufficient for the intended uses. Data quality objectives address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. Data were collected according to the procedures described in the relevant BASMAA RMC SOPs (BASMAA, 2016), including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on the demonstrated ability to adhere to specified protocols.

3.4. Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the local quality assurance officer and compared against the methods and protocols specified in the RMC SOPs and QAPP. The findings and results were then evaluated against the relevant data quality objectives to provide the basis for an assessment of programmatic data quality. A summary of data quality steps associated with water quality measurements is shown in Table 3.3. The data quality assessment consisted of the following elements:

- Conformance with field and laboratory methods, as specified in RMC SOPs and QAPP (including sample collection and analytical methods, sample preservation, sample holding times, etc.)
- Numbers of measurements/samples/analyses completed versus planned, and identification of reasons for any missed samples
- Temperature data were checked for accuracy by comparing measurements taken by HOBOs with National Institute of Standards Technology thermometer readings in room temperature water and ice water
- Continuous water quality data were checked for accuracy by comparing measurements taken before and after deployment with measurements taken in standard solutions to evaluate potential drift in readings
- Quality assessment laboratory procedures for accuracy, precision, and contamination (i.e., lab duplicates and lab blanks) were implemented for pathogen samples collected

Table 3.3 Data Quality Steps Implemented for Temperature and Continuous Water Quality Monitoring

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

4. Results

4.1. Statement of Data Quality

Field data sheets and laboratory reports were reviewed by the local quality assurance officer and results were evaluated against relevant data quality objectives. Results were compiled for qualitative metrics (representativeness and comparability) and quantitative metrics (completeness, precision, and accuracy) in accordance with the BASMAA RMC QAPP (BASMAA, 2020). Results summarizing the water year 2021 data quality assessment are discussed below:

- Hourly water temperature data were recorded at 60-minute intervals from digital data loggers deployed in four creeks: one location each in Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek. Data loggers were deployed on April 14, 2021, and remained deployed until the pickup date of Oct. 8, 2021. As the permit term reporting requirements apply only to the extent of a given water year, data collected after Sept. 30, 2021, were not included in this report. One hundred percent of the expected data were collected at all four locations.

- Continuous water quality data (water temperature, pH, dissolved oxygen, and specific conductance) were continuously monitored at 10-minute intervals by sonde devices during two time periods (June 6-19 and Sept. 1-14, 2021) in two locations along Marsh Creek. One hundred percent of the expected data were collected at both locations. Data logging intervals were increased in water year 2020, from 15 minutes to 10 minutes, as data collected were part of an ongoing flow augmentation pilot study. Logging intervals of 10 minutes continued in water year 2021.

- Quality assurance laboratory procedures were implemented for pathogen indicator analyses this year. One laboratory duplicate sample for pathogen analyses was performed and resulted in a relative percent difference that exceeded the measurement quality objective of 25%. The relative percent difference (RPD) calculated for enterococci and *E. coli* were 56% and 19%, respectively, indicating a measurement quality objective exceedance for enterococci. This result is not uncommon, as urban surface waters have relatively high RPDs due to nonuniform distribution of bacteria in suspension in water samples. All other quality assurance samples for pathogen indicator analyses successfully met data quality objectives.

- An assessment of the continuous water quality data related to data quality objectives for accuracy in water year 2021 is presented in Table 4.1. Accuracy measurements generally met the data quality objectives in water year 2021. Following the June deployment period, dissolved oxygen membrane caps on the YSI EXO3 dissolved oxygen sensors were replaced on both devices, resulting in less sensor drift during the September monitoring period on both instruments. Following the September deployment period, conductivity sensors on both devices returned a warning message during calibration that conductivity sensors should be considered for replacement as they were approaching the end of their optimal operating lifespan.

Table 4.1 Accuracy[1] Measurements Taken for Dissolved Oxygen, pH, and Specific Conductance

Parameter	Measurement Quality Objectives	544MSHM0 Marsh Creek		544MSHM1 Marsh Creek	
		June	September	June	September
Dissolved oxygen (mg/l)	± 0.5 or 10%	**-11%**	-1.5%	-1.9%	0.8%
pH 7.0	± 0.2	0.15	**0.26**	**0.4**	0.03
pH 10.0	± 0.2	0.15	**0.33**	**0.45**	-0.03
Specific conductance (µS/cm)	± 10%	**-11%**	**-12%**	**-11%**	**-23%**

1 Accuracy of the water quality measurements were determined by calculating the difference between sonde readings using a calibration standard versus the actual concentration of the calibration standard. The results displayed are those taken following measurements within the stream, defined as "post calibration", as opposed to the "pre calibration values", where all the sonde probes were offset to match the calibration standard prior to deployment.

Values in **bold** exceed the measurement quality objective.

4.2. Water Quality Monitoring Results

All targeted water quality monitoring data were evaluated against numeric trigger thresholds, as described in MRP provision C.8.d. These thresholds, which include applicable numeric water quality objectives or other criteria, indicate levels at which additional follow-up may be required under the MRP. Targeted monitoring locations for water year 2021 were located within both SFBRWQCB Region 2 and CVRWQCB Region 5 boundaries. The results are presented below.

4.2.1. Continuous Water Temperature (HOBO)

Summary statistics for continuous water temperature data collected at the four monitoring locations from April through September 2021 are shown in Table 4.2. At Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek, approximately 170 days of hourly temperature data were collected. All data were collected successfully with no device issues or equipment movement, resulting in 100% capture of targeted data.

The minimum and maximum temperature for all four stations was 9.73° C and 24.84° C, respectively. The median temperature range for all four stations was 15.53° C to 18.34° C, and the MWAT range was 17.37° C to 20.63° C.

Continuous water temperature data measured at each station are presented in Figure 4.1. The WAT data, WAT threshold of 17° C and acute threshold of 24° C for juvenile salmonid rearing (steelhead streams), are illustrated in Figures 4.2 and 4.3.

Over the course of the monitoring period, weekly average temperatures measured at Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek locations exceeded the threshold for steelhead streams (Table 4.3). The number of exceedances ranged from two to 19 instances. Therefore, all four stations exceeded the MRP trigger threshold for continuous (HOBO) water temperature (two or more weekly average temperatures over the 17° C threshold; Table 4.3).

Table 4.2 Descriptive Statistics for Continuous Water Temperature Measured at Four Sites in Contra Costa County (Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek) – April 14-Sept. 30, 2021

Site / Temperature	204SLE204 Moraga Creek (° C)	206R02907 San Pablo Creek (° C)	207R01307 Lafayette Creek (° C)	207R03403 Walnut Creek (° C)
Minimum	11.49	9.73	9.82	12.36
Median	17.24	16.60	15.53	18.34
Mean	16.92	16.22	15.11	18.42
Maximum	20.88	20.48	19.43	24.84
MWAT[1]	18.96	18.51	17.37	20.63
Number of Measurements	4,066	4,068	4,069	4,069

1 The maximum of the 7-day average of the daily average temperature

Figure 4.1 Hourly Water Temperature Data Collected at Four Sites in Contra Costa County (Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek) – April 14-Sept. 30, 2021

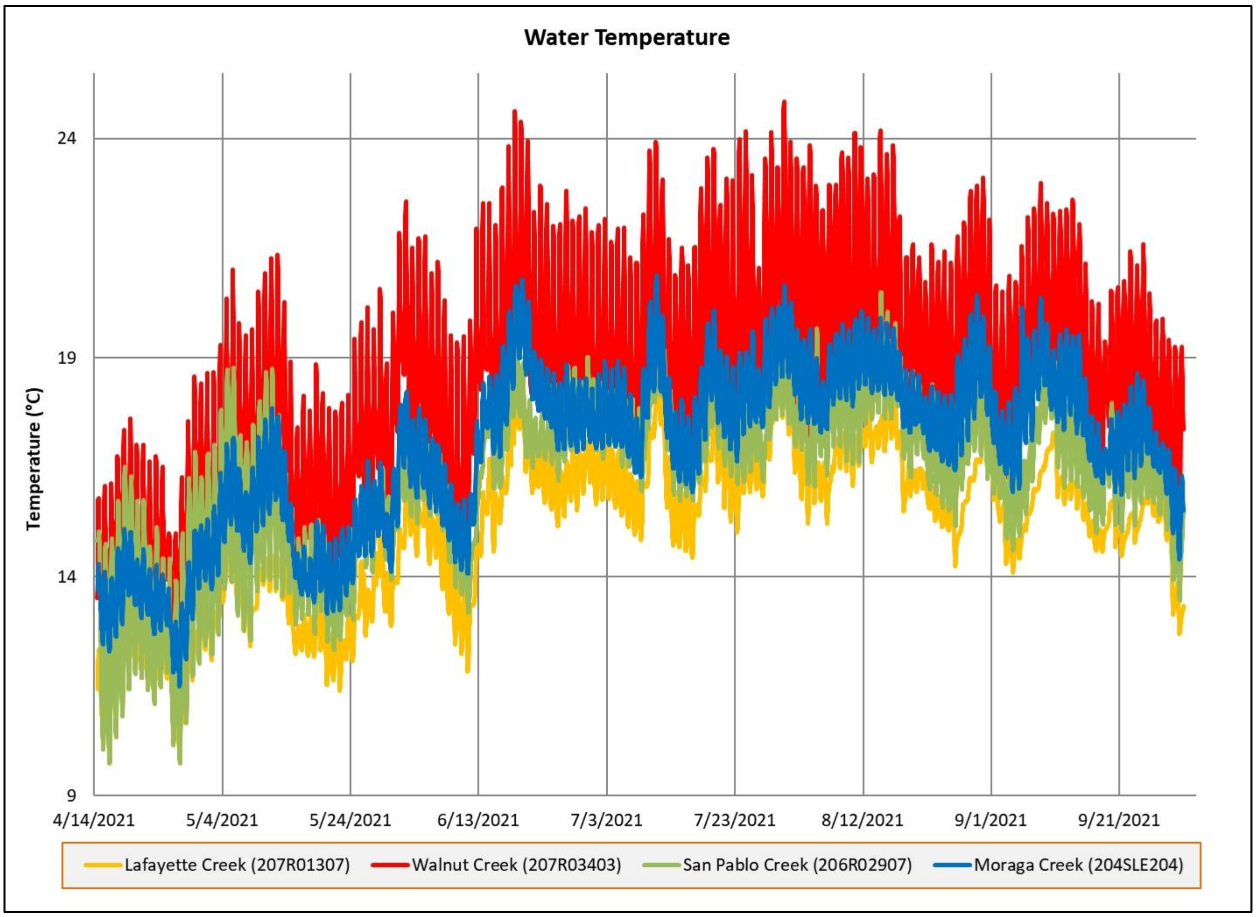


Figure 4.2 Weekly Average Water Temperature Data Collected at Four Sites (Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek) – April 14-Sept. 30, 2021

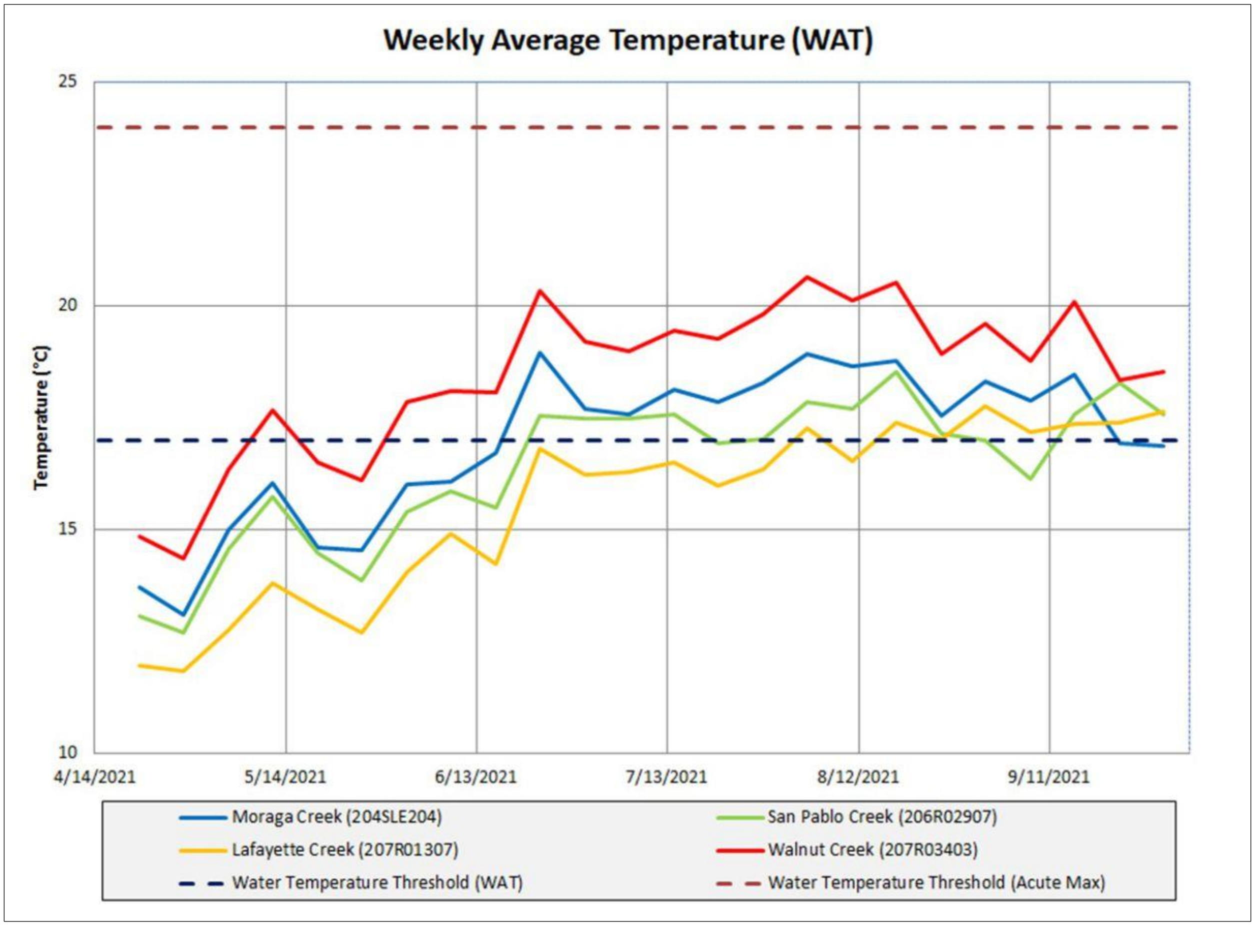


Figure 4.3 Box Plots of Weekly Average Water Temperature Data Collected at Four Sites in Contra Costa County (Moraga Creek, San Pablo Creek, Lafayette Creek, and Walnut Creek) – April 14-Sept. 30, 2021

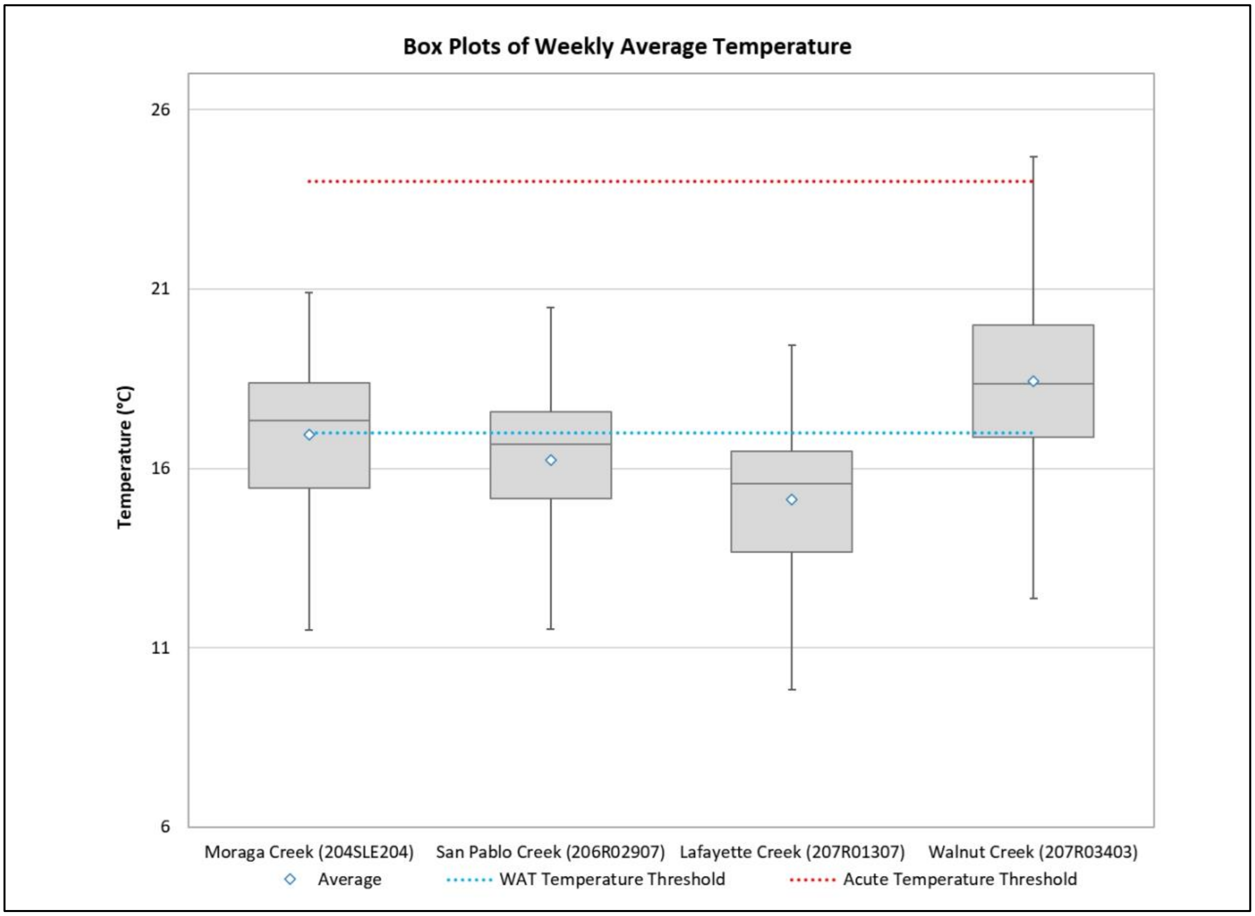


Table 4.3 Water Temperature Data Measured at Four Sites in Comparison to MRP WAT Trigger Threshold for Steelhead Streams

Site ID	Creek Name	Monitoring Period	Number of Results Where WAT > 17° C
204SLE204	Moraga Creek	04/14/2021-09/30/2021	**13**
206R02907	San Pablo Creek	04/14/2021-09/30/2021	**10**
207R01307	Lafayette Creek	04/14/2021-09/30/2021	**2**
207R03403	Walnut Creek	04/14/2021-09/30/2021	**19**

WAT weekly average temperature
Values in **bold** exceed MRP criterion

4.2.2. Continuous Water Quality

Summary statistics for continuous water quality measurements collected at both Marsh Creek locations during two separate deployment periods (once in June and once in September) are shown in Table 4.4. WAT and MWAT for both stations over the same monitoring period are displayed in Table 4.5. Data collected during both periods, along with the required thresholds, are plotted in Figures 4.4 through 4.7.

Table 4.4 Descriptive Statistics for Daily and Monthly Continuous Water Quality Parameters (Temperature, Dissolved Oxygen, pH, and Specific Conductance) Measured in Contra Costa County (Marsh Creek) – June 6-19 and Sept. 1-14, 2021

Parameter		544MSHM1 Marsh Creek[1]		544MSHM0 Marsh Creek[2]	
		June	September	June	September
Temperature (° C)	Minimum	20.50	22.58	19.78	21.42
	Median	23.42	24.98	24.11	24.41
	Mean	23.35	24.98	24.21	24.29
	Maximum	26.45	27.03	29.28	26.43
Dissolved oxygen (mg/l)	Minimum	4.93	3.86	2.84	2.44
	Median	7.11	6.95	9.08	6.05
	Mean	7.85	7.37	9.25	6.67
	Maximum	14.44	11.83	16.82	13.05
pH	Minimum	7.47	7.54	7.19	7.60
	Median	7.78	7.75	8.31	7.95
	Mean	7.81	7.78	8.24	8.00
	Maximum	8.37	8.22	8.72	8.59
Specific conductance (µS/cm)	Minimum	1197	1201	1344	1243
	Median	1699	1449	1658	1430
	Mean	1677	1437	1632	1418
	Maximum	1856	1569	1779	1519

1 Upstream monitoring station located 400 feet downstream of Brentwood Wastewater Treatment Plant
2 Downstream monitoring station located two miles downstream of Brentwood Wastewater Treatment Plant

Table 4.5 Weekly Average Temperatures and MWAT Measured at Two Sites Along Marsh Creek for Both Monitoring Periods

Site Name	Creek Name	Monitoring Period	WAT (° C)	MWAT (° C)
544MSHM1	Marsh Creek[1]	06/06/21-06/19/21	**22.77, 23.94**	**23.94**
		09/01/21-09/14/21	**24.60, 25.36**	**25.36**
544MSHM0	Marsh Creek[1]	06/06/21-06/19/21	**22.80, 25.71**	**25.71**
		09/01/21-09/14/21	**23.69, 24.87**	**24.87**

1 Monitoring Station downstream of Brentwood Wastewater Treatment Plant
MWAT maximum of recorded weekly average temperatures
WAT weekly average temperature
Values in **bold** exceed MRP criterion of 17° C for steelhead streams

Figure 4.4 Continuous Water Quality Data (Temperature) Measured in Marsh Creek – June 6-19 and Sept. 1-14, 2021

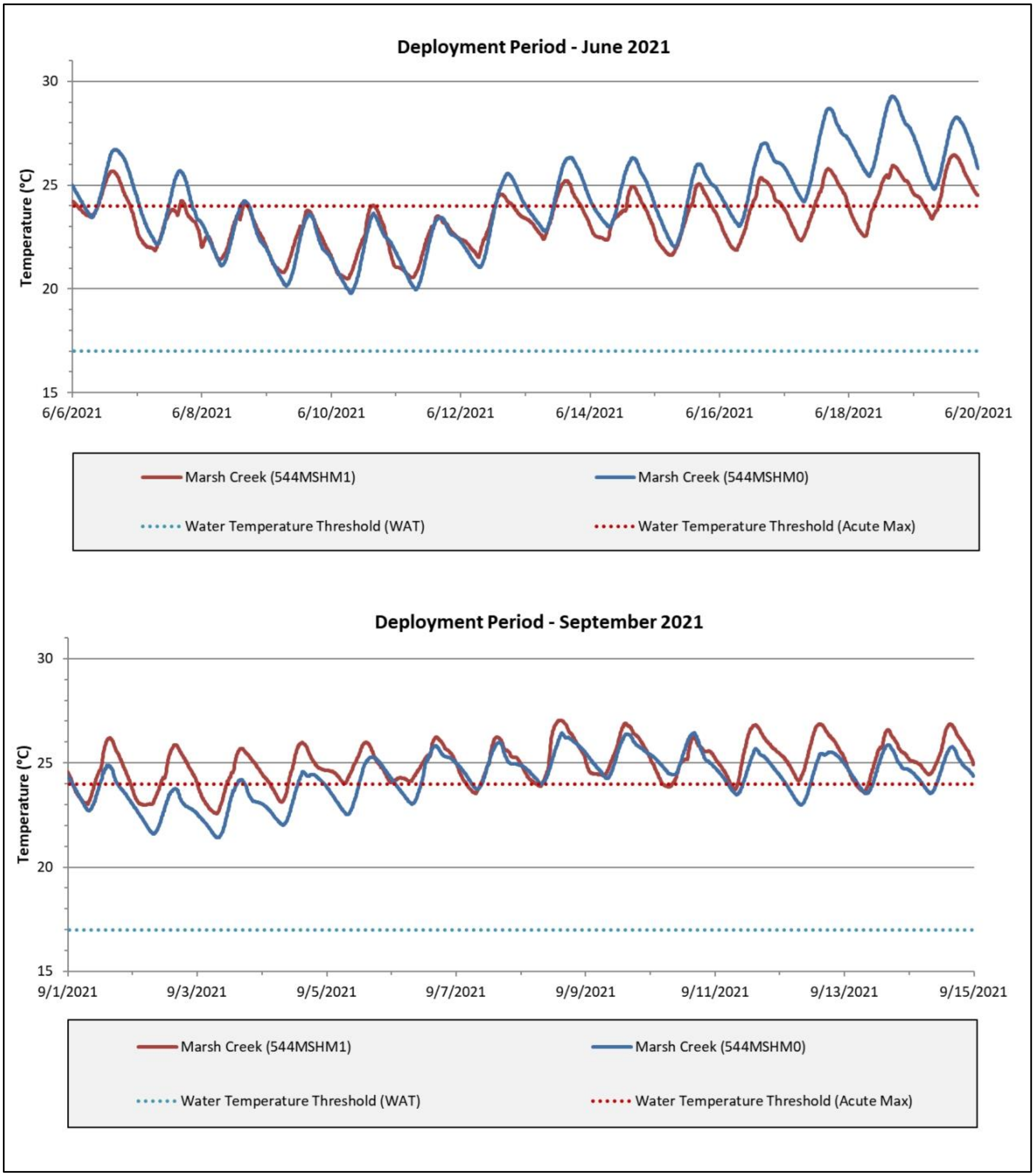


Figure 4.5 Continuous Water Quality Data (Dissolved Oxygen) Measured in Marsh Creek – June 6-19 and Sept. 1-14, 2021

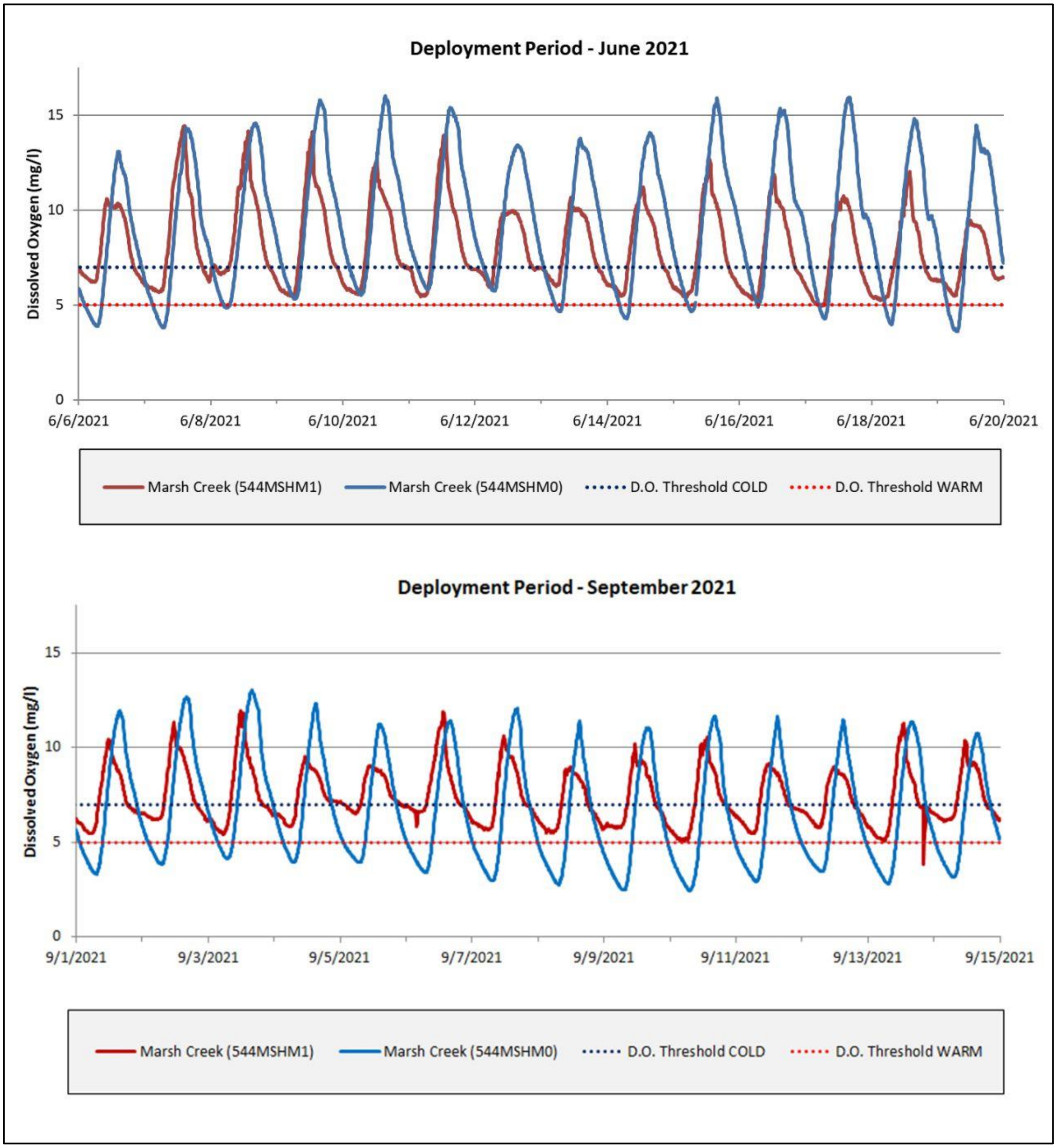
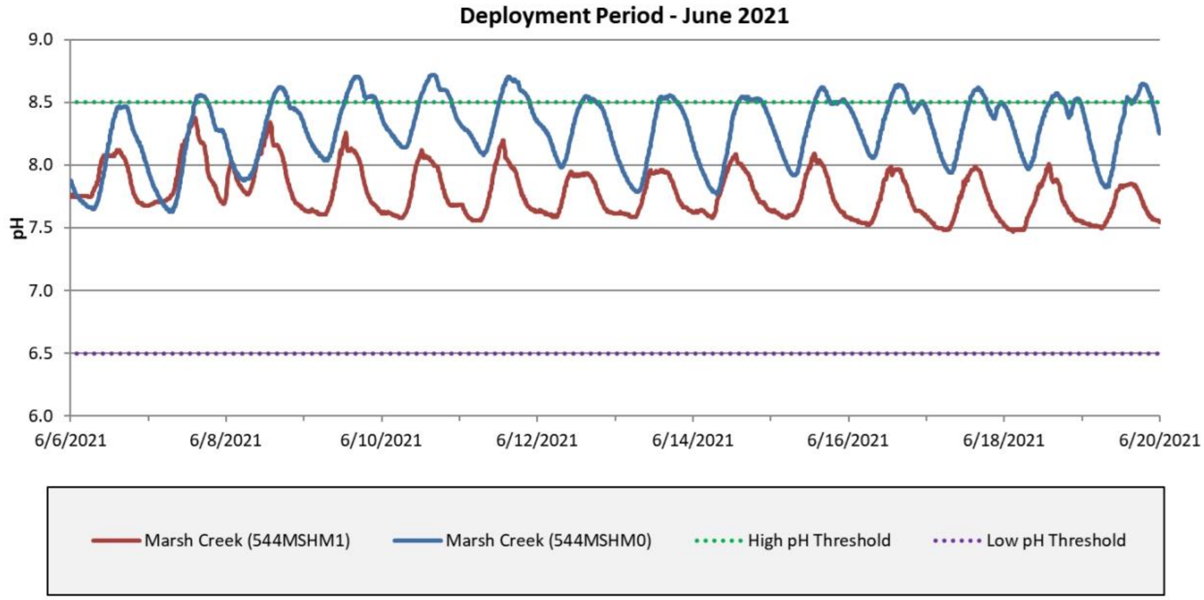


Figure 4.6 Continuous Water Quality Data (pH) Measured in Marsh Creek – June 6-19 and Sept. 1-14, 2021



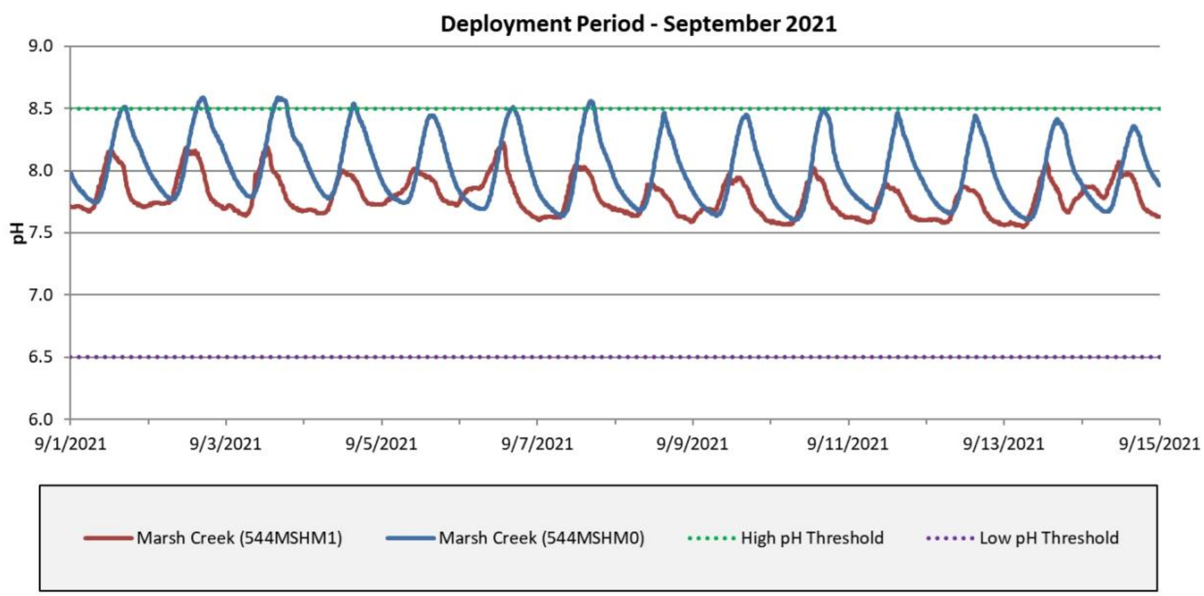
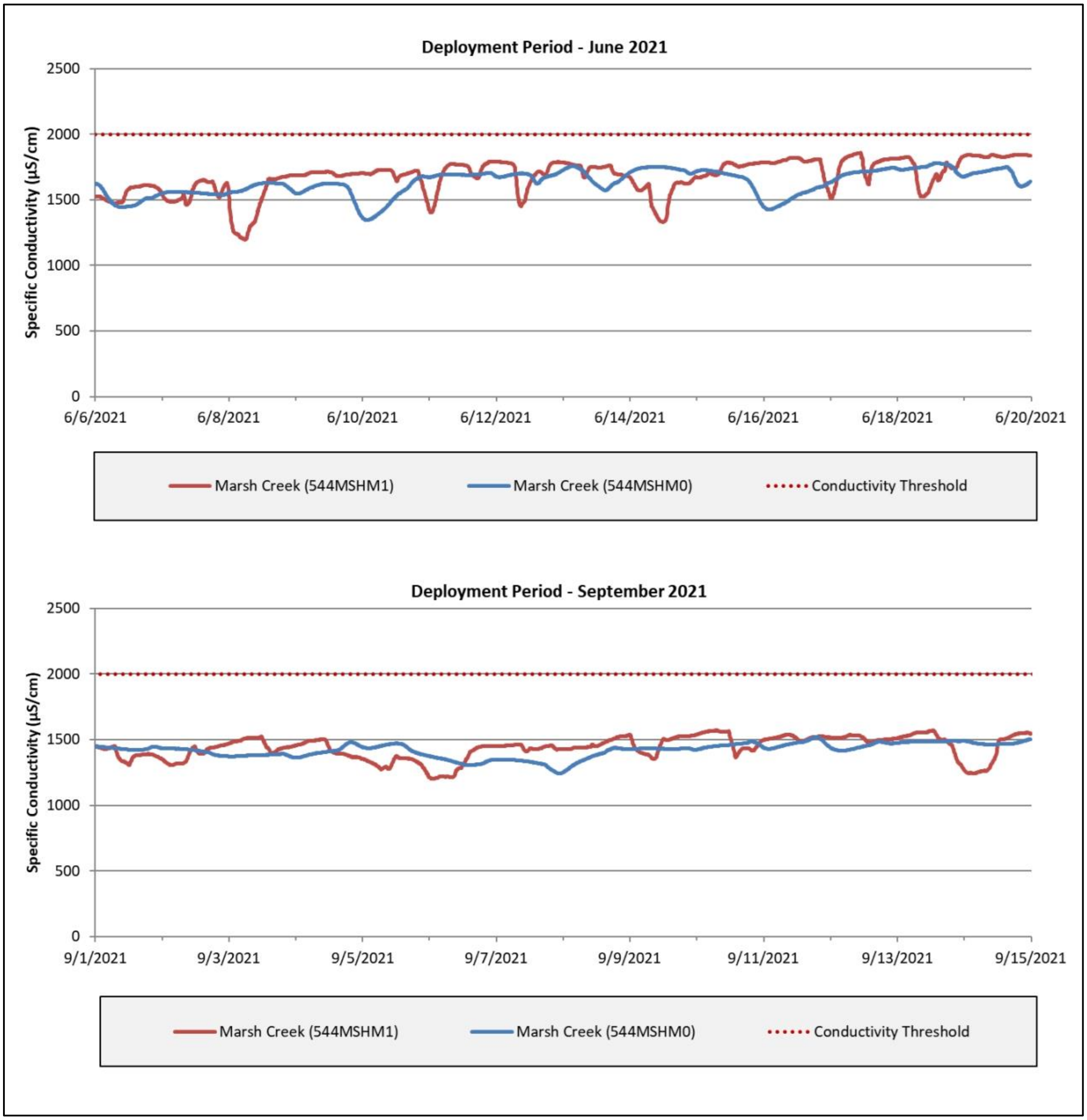


Figure 4.7 Continuous Water Quality Data (Specific Conductance) Measured in Marsh Creek – June 6-19 and Sept. 1-14, 2021



At both the upstream and downstream Marsh Creek monitoring stations, continuous water temperature data during the June and September deployment periods display a diurnal cycle typical of the region. (Figure 4.4). During both the June and September deployment periods, weekly average temperatures measured at both stations were recorded above the MRP threshold criterion for steelhead streams (see Table 4.5). As the Sacramento River Basin and San Joaquin River Basin Plan does not designate Marsh Creek to maintain COLD beneficial uses, and the MRP does not specify a temperature criterion for WARM designated beneficial uses, these results do not constitute an exceedance.

The lowest dissolved oxygen concentration (3.86 mg/l) at the upstream (544MSHM1) Marsh Creek monitoring station occurred in September 2021. The lowest dissolved oxygen concentration (2.44 mg/l) at the downstream (544MSHM0) Marsh Creek monitoring station occurred in September 2021 as well. The minimum and maximum pH measurements for the upstream Marsh Creek monitoring station during both deployment periods were 7.47 and 8.37, respectively. The minimum and maximum pH measurements at the downstream Marsh Creek monitoring station during both periods was 7.19 and 8.72, respectively (see Table 4.4).

During both the June and September deployment periods, the upstream and downstream Marsh Creek stations show diurnal fluctuations of dissolved oxygen and pH (Figures 4.5 and 4.6). This cycle is slightly more pronounced during the June deployment than in September, as seen with dissolved oxygen in Figure 4.5. The seasonal exaggeration is typically a result of instream primary production, as during the late spring and early summer month monitoring periods, longer periods of daylight increase algae production, thus increasing the production and concentration of dissolved oxygen during the day. As the sun sets and during night hours, algae and aquatic plants switch from sunlight-induced photosynthesis to respiration and the consumption of dissolved oxygen. The consumption of dissolved oxygen in the stream through plant respiration and by decomposing plants and algae biomass display a more exaggerated diurnal curve. In low gradient sections of stream, where pool habitats do not encounter dry season flow turbulence, conditions of dissolved oxygen in water can reach supersaturated levels, as lack of wind or turbulence does not create a mixing of surface water with atmospheric oxygen, creating conditions where instream primary production can generate dissolved oxygen levels of 14-17 mg/l (ADH, 2021).

Continuous conductivity data at both Marsh Creek monitoring stations display readings typical of the region (Figure 4.7). The median concentration of specific conductance in the upstream Marsh Creek station ranged from 1,699 µS/cm in June to 1,449 µS/cm in September. The median concentration of specific conductance in the downstream Marsh Creek station ranged from 1,658 µS/cm in June to 1,430 µS/cm in September. During both the June and September deployment periods, neither the upstream nor downstream Marsh Creek station exceeded the MRP specific conductance threshold of 2,000 µS/cm.

Table 4.6 presents the percentages of continuous water quality data exceeding the water quality evaluation criteria specified in provision C.8.d of the MRP (see Table 3.1) for dissolved oxygen, pH, and specific conductance, as measured at the two Marsh Creek stations during both monitoring periods.

Table 4.6 Percent of Dissolved Oxygen, pH, and Specific Conductance Data Measured at Two Sites along Marsh Creek for Both Monitoring Periods Exceeding Water Quality Evaluation Criteria Identified in Table 3.1

Site Name	Creek Name	Monitoring Period	Dissolved Oxygen Percent Results < 5.0 mg/L	pH Percent Results < 6.5 or > 8.5	Specific Conductance Percent Results >2,000 µS/cm
544MSHM1	Marsh Creek[1]	06/06/21-06/19/21	0%	0%	0%
		09/01/21-09/14/21	0%	0%	0%
544MSHM0	Marsh Creek[2]	06/06/21-06/19/21	10%	**25%**	0%
		09/01/21-09/14/21	**38%**	3%	0%

Values in **bold** exceed MRP criterion
1 Upstream most monitoring station located below Brentwood Wastewater Treatment Plant
2 Downstream most monitoring station located below Brentwood Wastewater Treatment Plant

Following is a summary of water quality evaluation criteria exceedances occurring at either creek location.

4.2.2.1. Marsh Creek (Station 544MSHM1)

During the June and September 2021 deployments, no water quality parameter exceeded MRP trigger thresholds at Marsh Creek station 544MSHM1.

4.2.2.2. Marsh Creek (Station 544MSHM0)

During the June 2021 deployment, pH levels in Marsh Creek station 544MSHM0 exceeded the MRP threshold criterion 25% of the time, exceeding MRP trigger thresholds for pH. During the September deployment, dissolved oxygen measurements exceeded the MRP criterion 38% of the time, exceeding MRP trigger thresholds for dissolved oxygen.

4.2.3. Continuous Water Quality Data Evaluation for Steelhead Suitability

The potential responsive action to the analysis of continuous water temperature and water quality data as it relates to fish habitat in Moraga Creek, San Pablo Creek, Lafayette Creek, Walnut Creek, and Marsh Creek is discussed below.

4.2.3.1. Moraga Creek – 204SLE204

Water Temperature

The 2021 continuous water temperature monitoring station at Moraga Creek recorded a median temperature of 17.24° C and an MWAT of 18.96° C (see Table. 4.2). The 17° C WAT criterion was exceeded on 13 occasions, with all occurrences during the monitoring period of June 17-Sept. 15, 2021. There were no exceedances of the acute instantaneous water temperature criterion of 24° C, as the maximum recorded temperature was 20.88° C.

Steelhead Suitability

There are presently three reservoirs on San Leandro Creek located between Moraga Creek and the San Francisco Bay: Upper San Leandro Reservoir, Lower San Leandro Reservoir, and Lake Chabot, located 6.2 miles above San Francisco Bay (ADH, 2021). The construction of Chabot Reservoir in 1875 blocked the historical run of steelhead to the upstream portions of San Leandro Creek and its tributaries, but a remnant population of anadromous steelhead still spawn downstream of Lake Chabot when rains and runoff are suitable (Leidy et al., 2005).

Moraga Creek, part of the Upper San Leandro Creek watershed, flows into the Upper San Leandro Reservoir. Moraga Creek and most all of Upper San Leandro Creek's tributaries support populations of resident rainbow trout. Nearby Redwood Creek has one of the largest populations of rainbow trout in the watershed. In the 1980s and 1990s, the East Bay Regional Parks District obtained 53 yearling rainbow trout from Redwood Creek and had genetic analysis performed on them. The results showed that these fish were non-hybridized descendants of the coastal anadromous steelhead that once spawned throughout the San Leandro Creek watershed and were trapped in the upper watershed when the dams were built. So, although the upper watershed's rainbow trout are presently resident fish, their genetic stock appears to be that of San Leandro Creek's original population of anadromous steelhead un-hybridized with stocked rainbow trout from hatcheries (Leidy et al., 2005).

Leidy et al. (2005) reports that Moraga Creek is depicted as having a definite run or population of rainbow trout. More recently, fishery biologist Bert Mulchaey of EBMUD confirmed that rainbow trout from Upper San Leandro Reservoir migrate up the tributary streams to spawn and the resulting juvenile fish rear in these streams (personal communication between Bert Mulchaey and Scott Cressey, December 2017). Based on this information, it is assumed that Moraga Creek continues to support a resident rainbow trout population.

In water year 2021, Moraga Creek did not experience any acute instantaneous temperature exceedances of 24° C. However, the failure to meet the 17° C WAT criterion during 13 weeks of the 24-week deployment period suggest Moraga Creek in the area immediately downstream of the Laguna Creek confluence may not be suitable for rearing habitat or juvenile resident rainbow trout during the summer months.

4.2.3.2. San Pablo Creek – 206R02907

Water Temperature

At the San Pablo Creek continuous water temperature monitoring station, the median water temperature was 16.60° C and the MWAT was 18.51° C (see Table 4.2). The WAT failed to meet the 17° C threshold criterion on 10 occasions, four times during the monitoring period of June 17-July 14, five times during the monitoring period of July 22-Aug. 25, and one time during the monitoring period of Sept. 9-Sept. 15, 2021. There were no exceedances of the acute instantaneous water temperature criterion of 24° C, as the maximum recorded temperature was 20.48° C.

Steelhead Suitability

Currently, there are three barriers present in Lower San Pablo Creek that prevent upstream steelhead migration. The first barrier is located where San Pablo Creek flows under Giant Road in North Richmond, followed by the Interstate 80 culvert barrier, and finally the barrier at El Portal Drive in San Pablo. Although Lower San Pablo Creek does not currently support steelhead/rainbow trout, the Basin Plan designates San Pablo Creek's existing beneficial uses as both COLD and WARM habitat, showing awareness that the upper end of San Pablo Creek could serve as habitat to resident rainbow trout, while the lower end of San Pablo Creek could serve as a winter and spring migration corridor should steelhead return to San Pablo Creek.

The lower section of San Pablo Creek below the San Pablo Reservoir dam had runs of steelhead in the 1950s; however, EBMUD currently reports San Pablo Creek below San Pablo Reservoir no longer supports steelhead/rainbow trout. From 2006-2018, EBMUD conducted annual fish sampling of three sites on San Pablo Creek below the reservoir and found no steelhead/rainbow trout other than a few hatchery rainbow trout that appear to have come from San Pablo Reservoir (Cressey, 2018).

Above the San Pablo Reservoir, rainbow trout from the reservoir can migrate only a short distance (0.5 miles) up San Pablo Creek due to a vertical drop structure near the EBMUD Orinda water treatment plant. The water year 2021 monitoring station on San Pablo Creek is about 1,300 feet upstream of the EBMUD Orinda Water Treatment Plant and a little over a mile downstream of Highway 24. While this reach of San Pablo Creek once supported a run of steelhead prior to the construction of San Pablo Dam and Reservoir, the station on San Pablo Creek is upstream of the Orinda Water Treatment Plant drop structure; therefore, the creek at this location may contain resident rainbow trout, but not migratory trout from the San Pablo Reservoir.

In water year 2021, San Pablo Creek did not experience any acute instantaneous temperature exceedances of 24° C. However, the failure to meet the 17° C WAT criterion during 10 weeks of the 24-week deployment period suggest Upper San Pablo Creek water temperatures may be too warm in the area downstream of Highway 24 and upstream of the Orinda Water Treatment Plant drop structure for juvenile resident rainbow trout and for rearing habitat during the summer months.

4.2.3.3. Lafayette Creek – 207R01307

Water Temperature

At the Lafayette Creek water temperature monitoring station (207R1307), the median water temperature was 15.53° C and the MWAT was 17.37° C (see Table 4.2). The 17° C WAT criterion was exceeded on two occasions, once during the monitoring period of July 29-Aug. 4 and once more during the monitoring period of Aug. 12-Aug. 18, 2021. The 24° C acute water temperature threshold was not exceeded on any occasion at the Lafayette Creek monitoring station.

Steelhead Suitability

Historically, Lafayette Creek likely had a population of steelhead, but steelhead are not present in this creek today (Leidy et al., 2005). Leidy found no salmonids in Lafayette Creek in 1980 and 1999, but states rainbow trout were reported in Lafayette Creek as recently as 2002. However, those fish are believed to come from Lafayette Reservoir and transported into the creek by storm flows and spill events. The 2015 Basin Plan designates Lafayette Creek as having both COLD and WARM beneficial uses. This indicates the upstream portion of this creek has year-round water temperatures suitably cold to support salmonids, but the lower portions of the creek are too warm to support salmonids through the summer (ADH, 2018). The location of targeted water temperature monitoring for water year 2021 within Lafayette Creek was selected along the upper portion of the stream to monitor the potential to support cold water fisheries.

In water year 2021, Lafayette Creek did not experience any acute instantaneous temperature exceedances of 24° C. The 17° C WAT criterion was exceeded during two weeks of the 24-week deployment period, constituting an exceedance per the MRP criterion. Although this exceedance suggests this location of Lafayette Creek above the Lafayette Reservoir may be too warm to support juvenile rainbow trout and rearing habitat during the summer months, it does not prohibit a rainbow trout fishery.

4.2.3.4. Walnut Creek – 207R03403

Water Temperature

At the Walnut Creek continuous water temperature monitoring station (207R03403), the median water temperature was 18.34° C and the MWAT was 20.63° C (see Table 4.2). The WAT failed to meet the 17° C threshold criterion on 19 occasions, once during the monitoring period of May 6-May 12, and 18 times during the monitoring period spanning May 27-Sept. 29, 2021. The acute instantaneous water temperature criterion of 24° C was exceeded on 18 occasions; however, as this constitutes less than 1% of the instantaneous measurements, this does not qualify as an exceedance according to MRP criteria (see Table 3.1).

Steelhead Suitability

The Walnut Creek watershed supported a population of steelhead and coho salmon until the mid-1960s; however, the construction of drop structures on Walnut Creek downstream of the City of Walnut Creek prevent steelhead access to the watershed at present. Historically, steelhead and coho salmon formerly occupied the Walnut Creek watershed, migrating up Walnut Creek to enter the San Ramon Creek and Las Trampas Creek drainage systems to access spawning and rearing habitat. Recent studies on Walnut Creek (Leidy et al., 2005) determined that no steelhead or rainbow trout reside in the lower Walnut Creek watershed at present, and it is likely the extensive modification of streams within the basin for flood control purposes has eliminated suitable salmonid habitat. Should the construction of effective fish ladders allow steelhead and other anadromous fish to pass over these two drop structures on Walnut Creek, the fish could use Walnut Creek as passage habitat to reach spawning and rearing habitat higher in the San Ramon and Las Trampas Creek sub-watersheds.

In water year 2021, the Walnut Creek location at Civic Park (monitoring station 207R03403) experienced acute instantaneous temperature exceedances of 24° C, for less than 1% of instantaneous measurements. The 17° C WAT criterion was exceeded during 19 weeks of the 24-week deployment period, indicating this section of Walnut Creek is not suitable for juvenile steelhead or rearing habitat, and may only act as a corridor for upstream migration to more suitable spawning and rearing habitat in the upper watershed.

4.2.3.5. Marsh Creek – downstream of wastewater treatment plant (544MSHM1)

Water Temperature

The 2018 edition of the Basin Plan for the Sacramento River Basin and San Joaquin River Basin designates Marsh Creek as having a WARM beneficial use. Because the Basin Plan does not list Marsh Creek as having a COLD designated beneficial use, steelhead stream exceedance criteria do not apply here. However, due to adult Chinook salmon having been observed in recent years in this portion of Marsh Creek, steelhead stream criteria will be applied to Marsh Creek in this analysis, as it was in water year 2020.

The sonde monitoring location at Marsh Creek immediately below the Brentwood Wastewater Treatment Plant recorded median temperatures of 23.42° C and 24.98° C for the June and September deployments, respectively (see Table 4.4). The temperature at the sonde monitoring location during both the June and September deployments exceeded the 17° C WAT threshold criterion during both weeks of each respective deployment (see Table 4.5). The 24° C acute threshold was also exceeded for 32% and 83% of the recorded June and September monitoring periods, respectively. As Marsh Creek does not maintain a COLD beneficial use, these results do not constitute an exceedance according to MRP criteria.

The MWAT over the two deployment periods was 23.94° C and 25.36° C (see Table 4.5).

Dissolved Oxygen

During the June and September deployment periods in Marsh Creek, dissolved oxygen levels at station 544MSHM1 dropped below the minimum steelhead stream criterion during 46% and 51% of the recorded monitoring periods, respectively. As Marsh Creek does not maintain a designated beneficial use of a steelhead stream, these results do not constitute an exceedance in accordance with the MRP criterion (see Table 3.1). The steelhead stream criterion for dissolved oxygen were applied to Marsh Creek to investigate the suitability of providing habitat for Chinook salmon identified in the stream during recent years. As Marsh Creek currently maintains a WARM beneficial use, dissolved oxygen criteria for non-steelhead streams were also applied (20% of instantaneous results shall not be depressed below 5.0 mg/L) to determine water quality exceedances in accordance to Basin Plan criteria.

During the June and September deployment period, dissolved oxygen levels met Basin Plan criteria for non-steelhead streams (see Table 4.6).

pH

The pH of Marsh Creek at station 544MSHM1 met Basin Plan criteria during the June and September deployment periods (see Table 3.1).

Specific Conductance

The median specific conductance in Marsh Creek station 544MSHM1 during the June and September deployment periods was 1,699 µS/cm and 1,449 µS/cm, respectively (see Table 4.4). Therefore, the specific conductance in Marsh Creek during the spring and summer monitoring periods met the MRP criterion (<20% of results >2,000 µS/cm).

Steelhead Suitability

From the eastern side of Mount Diablo, Marsh Creek flows 30 miles through Clayton, Brentwood, and Oakley before draining into the Sacramento-San Joaquin River Delta at Big Break northeast of Oakley. The Marsh Creek Reservoir, approximately 11 miles upstream from the mouth of Marsh Creek, was constructed in the 1960s to regulate flow and provide floodwater protection through the developed areas along lower reaches of the creek. Most of the lower portion of Marsh Creek below the reservoir was channelized between the 1930s and 1970s to help control flooding in the downstream agricultural area. Immediately below the reservoir, there remains a 3-mile section of Marsh Creek that was never channelized, located roughly from Creekside Park up to the toe of the reservoir dam. This 3-mile section of Marsh Creek still has a relatively natural channel with mature riparian trees (Levine and Stewart, 2004).

Historical use of Marsh Creek for rearing and spawning by steelhead is probable, and Marsh Creek is likely to have also historically supported anadromous Chinook salmon in its lower reaches (Leidy et al., 2005). However, the construction of the Marsh Creek Reservoir as well as a 6-foot-high grade control structure on lower Marsh Creek just upstream of the Brentwood Wastewater Treatment Plant created barriers to anadromous fish ascending the creek to spawn. In 2010, a fish ladder was built to allow anadromous fish passage over the grade control structure and access to seven miles of potential upstream spawning habitat up to the Marsh Creek Reservoir. The construction of the fish ladder was driven largely by the arrival of adult Chinook salmon in Marsh Creek below the grade control barrier, as they have been spotted during the past several decades since the California Department of Fish and Wildlife began releasing hatchery-reared Chinook salmon smolt at Benicia and in the San Francisco Bay to allow them to bypass the Delta (ADH, 2021). These smolt are apparently less imprinted to home waters, as there has since been notably more straying of adult Chinook salmon into the small creeks draining into San Francisco Bay and the Sacramento-San Joaquin River Delta (Leidy et al., 2005).

Above the Marsh Creek Reservoir, several surveys by the California Department of Fish and Wildlife and East Bay Regional Parks District have concluded there are no steelhead or rainbow trout present in the Upper Marsh Creek area. Marginal summer temperatures and non-perennial flow, coupled with historic mining activities, have created contamination problems in the upper reaches of Marsh Creek, not lending to a suitable habitat for steelhead or rainbow trout restoration (Levine and Stewart, 2004).

In water year 2021, continuous water temperature and dissolved oxygen measurements exceeded MRP and Basin Plan criteria, respectfully, for a steelhead stream at the upstream Marsh Creek monitoring station. Water temperature recordings for both WAT and acute instantaneous thresholds exceeded MRP criteria. As Marsh Creek does not maintain a COLD designated beneficial use, this does not constitute an exceedance; however, this indicates that steelhead or Chinook salmon would not find suitable habitat in Marsh Creek during the spring and summer months, agreeing with the results from water year 2020.

4.2.3.6. Marsh Creek – downstream of wastewater treatment plant (544MSHM0)

Water Temperature

As discussed in section 4.2.3.5, the Sacramento River Basin and San Joaquin River Basin Plan designate Marsh Creek as having a WARM beneficial use. To determine the suitability of Marsh Creek to support Chinook salmon observed in its lower reaches, COLD water temperature criteria have been applied to Marsh Creek for the purpose of this analysis.

The sonde monitoring location at Marsh Creek two miles below the Brentwood Wastewater Treatment Plant recorded median temperatures of 24.11° C and 24.41° C for the June and September deployments, respectively (see Table 4.4). The temperature at the sonde monitoring location during both the June and September deployments exceeded the 17° C WAT threshold criterion (see Table 4.5) and exceeded the 24° C acute threshold for 51% and 62% of the recorded June and September monitoring periods, respectively. As Marsh Creek does not maintain a COLD beneficial use, these results do not constitute an exceedance according to MRP criteria.

The MWAT over the two deployment periods was 23.94° C and 25.36° C (see Table 4.5).

Dissolved Oxygen (DO)

Dissolved oxygen levels during the June deployment dropped below the minimum steelhead stream criterion of 7.0 mg/L for 32% of the recorded monitoring period. During the September deployment period, dissolved oxygen levels fell below the steelhead stream criterion of 7.0 mg/l for 59% of the recorded monitoring period. As Marsh Creek does not maintain a designated beneficial use of a steelhead stream, these results do not constitute an exceedance in accordance with the MRP criterion (see Table 3.1).

As Marsh Creek does maintain a WARM designated beneficial use, dissolved oxygen criteria for non-steelhead streams were also applied (20% of instantaneous results shall not be depressed below 5.0 mg/L).

During the June deployment period, dissolved oxygen levels failed to meet Basin Plan criteria for 10% of the recorded monitoring period (see Table 4.6). As this is below the 20% threshold, these measurements do not exceed the MRP criterion for follow-up. During the September deployment period, dissolved oxygen levels for a non-steelhead stream dropped below Basin Plan criteria for 38% of recorded measurements, indicating an exceedance per Basin Plan criteria.

pH

During the June monitoring period, 25% of results failed to meet pH criteria, exceeding the MRP threshold of 20% of instantaneous results. During the September monitoring period, the pH of Marsh Creek did not exceed the MRP criterion, with 3% of results exceeding Basin Plan criteria (see Table 4.6).

Specific Conductance

The specific conductance of Marsh Creek met the MRP criterion (<20% of results >2,000 µS/cm) during both June and September monitoring periods (see Table 4.6).

Steelhead Suitability

General steelhead suitability of the Marsh Creek Watershed is discussed in section 4.2.3.5. For site-specific steelhead suitability at the downstream Marsh Creek monitoring station, continuous water temperature and dissolved oxygen measurements exceeded MRP and Basin Plan criteria, respectfully. Water temperature recordings for both WAT and acute instantaneous thresholds exceeded MRP criteria. As Marsh Creek does not maintain a COLD designated beneficial use, this does not constitute an exceedance; however, this indicates that steelhead or Chinook salmon would not find suitable habitat in Marsh Creek during the spring and summer months, agreeing with the results from water year 2020.

4.2.3.7. Marsh Creek – ongoing Permittee evaluation of pilot flow augmentation

Continuous water quality monitoring sondes deployed in Marsh Creek to satisfy MRP monitoring requirements also supported voluntary actions by Permittees assessing the potential for flow augmentation to mitigate lethally low dissolved oxygen conditions in Marsh Creek. The City of Brentwood, at the request of CCCWP, consciously augmented effluent discharge from their wastewater treatment plant during critical nighttime periods of low dissolved oxygen beginning in September 2020 and again in September 2021. This action is a repeat of a similar pilot in water year 2019 and documented in CCCWP's Marsh Creek SSID Study (CCCWP, 2020). The Contra Costa Flood Control and Water Conservation District funded continuous water quality monitoring for an extended period, allowing data collection of pH, conductivity, turbidity, water temperature and dissolved oxygen throughout summer and fall periods to better characterize the relationship between flow augmentation and dissolved oxygen minima in Marsh Creek. Detailed data analysis and reporting of flow augmentation monitoring is outside the scope and schedule for this Urban Creeks Monitoring Report. Recorded time series data from July-November 2020 and June-December 2021 are archived and are available upon request.

No fish kills were reported in water year 2021. Water quality sonde monitoring at three locations on lower Marsh Creek indicate that conditions consistent with fish kills did not take place in water year 2021. Dissolved oxygen levels did not dip to lethal levels during the deployment from late spring 2021 through the first flush storm event of the fall. Historically, first flush storms appear to pose a fish-kill threat, potentially by mobilizing sources of biochemical oxygen demand from the watershed or stream bed. In water year 2021, the first flush of the 2021-2022 storm season occurred on Oct. 23, 2021, as part of water year 2022.

On Sept. 17, 2019, a first flush storm led to a fish kill upstream of augmented flows from the Brentwood wastewater treatment plant where dissolved oxygen levels were greatly depressed during daily minima for five days (<1.0 mg/L). This fish kill event is chronicled in the report for the Marsh Creek SSID Study for Year 2 (CCCWP, 2020). The recent first flush storm of the 2021-2022 season (Oct. 23, 2021) did not lead to lethally low dissolved oxygen levels and no fish kill was reported. During this event, and in the days following it, dissolved oxygen values did not fall below 3.0 mg/L. This information helps bound the “critical condition” for fish kills in the late season. Historic data shows that no fish kills have occurred later than November, consistent with water year 2020 and water year 2021 observations.

4.3. Pathogen Indicator Bacteria

In compliance with MRP provision C.8.d, a set of pathogen indicator samples were collected on June 29, 2021, at five stations on creeks in Contra Costa County (Table 4.7). The samples were analyzed for enterococci and *E. coli*. The sites were located along Alhambra Creek, Alamo Creek, South San Ramon Creek and at two locations along San Ramon Creek. Due to their proximity to either a public park or an encampment, sites were targeted to investigate whether water quality could be impacted by human activity, such as off-leash dog parks or other activities associated with encampments. Sites were chosen based upon the likelihood of recreational water contact or to investigate areas of possible anthropogenically-induced contamination.

As described previously (Section 3.2.5), single-sample maximum concentrations of 130 CFU/100ml enterococci and 410 CFU/100ml *E. coli* were used for evaluation, based on the most recently published recreational water quality criteria statistical threshold values for water contact recreation (USEPA, 2012). Enterococci concentrations ranged from 187 to 12,898 CFU/100 ml and *E. coli* concentrations ranged from 155 to 6,271 CFU/100 ml. All five enterococci samples exceeded the applicable criterion, while one sample collected for *E. coli* also exceeded the applicable USEPA criterion. The sample collected at 207ALH015 (Alhambra Creek) exceeded criteria for both enterococci and *E. coli* for the second water year in a row. The location along Alhambra Creek was targeted in water year 2021, as results in water year 2020 indicated enterococci and *E. coli* levels may negatively affect designated beneficial uses for water contact recreation.

Table 4.7 Enterococci and *E. coli* Levels Measured from Water Samples Collected at Five Locations in Creeks in Contra Costa County (June 29, 2021)

Site ID	Creek Name	Enterococci (CFU/100 ml)	*E. coli* (CFU/100 ml)
204R02068	South San Ramon Creek	**788**[1]	187
204R02692	Alamo Creek	**3,175**[1]	310
207R00700	San Ramon Creek	**335**[1]	155
207R03348	San Ramon Creek	**187**[1]	155
207ALH015	Alhambra Creek	**12,898**[1]	**6,271**[2]

1 Exceeded USEPA criterion of 130 CFU/100ml enterococci
2 Exceeded USEPA criterion of 410 CFU/100ml *E. coli*
Values in **bold** exceed the measurement quality objective.

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5. Next Steps

Under the requirements of provision C.8 in the MRP 2.0, the following next steps will be taken:

1. CCCWP will continue to conduct monitoring for local/targeted parameters in water year 2022.

2. All permit-related water quality threshold exceedances will be included in a compilation of water quality triggers for consideration as potential SSID projects, as well as other potential follow-up investigations and/or monitoring. Based on the analysis of the local targeted data, the results exceeding the MRP 2.0 trigger thresholds and water quality objectives (Table 5.1) are and will continue to be added to a list of candidate SSID projects maintained throughout the permit term.

Table 5.1 Summary of CCCWP MRP 2.0 Threshold Exceedances for Water Year 2021

Creek	Index Period	Parameter	Threshold Exceedance
Moraga Creek	06/17/21-09/15/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
San Pablo Creek	06/17/21-07/14/21 07/22/21-08/25/21 09/09/21-09/15/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Lafayette Creek	07/29/21-08/04/21 08/12/21-08/18/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Walnut Creek	05/06/21-05/12/21 05/27/21-09/29/21	Continuous Water Temperature (HOBO)	Two or more WATs exceed 17° C
Marsh Creek (544MSHM0) downstream of WWTP	06/06/21-06/19/21	Continuous Water Quality – pH	20% of instantaneous results below 6.5 or above 8.5
Marsh Creek (544MSHM0) downstream of WWTP	09/01/21-09/14/21	Continuous Water Quality – DO	20% of instantaneous results below 5.0 mg/L
South San Ramon Creek	06/29/2021	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alamo Creek	06/29/2021	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
San Ramon Creek	06/29/2021	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
San Ramon Creek	06/29/2021	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alhambra Creek	06/29/2021	Enterococci	Single grab sample exceeded USEPA criterion of 130 CFU/100 ml
Alhambra Creek	06/29/2021	*E. coli*	Single grab sample exceeded USEPA criterion of 410 CFU/100 ml

CFU colony forming unit
DO dissolved oxygen
WAT weekly average temperature
WWTP wastewater treatment plant

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Appendix 3

Pollutants of Concern Monitoring Report:

Water Year 2021

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Contra Costa Clean Water Program

Pollutants of Concern Monitoring Report: Water Year 2021

March 31, 2022

Prepared for

Contra Costa Clean Water Program
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Contra Costa Clean Water Program

Pollutants of Concern Monitoring Report:
Water Year 2021

March 31, 2022

Prepared for

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Contra Costa Clean Water Program Participants

- Cities of: Antioch, Brentwood, Clayton, Concord, Danville (Town), El Cerrito, Hercules, Lafayette, Martinez, Moraga (Town), Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, and Walnut Creek
- Contra Costa County
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Acronyms and Abbreviations

Bay	San Francisco Bay
CCCWP	Contra Costa Clean Water Program
CVRWQCB	Central Valley Regional Water Quality Control Board
MeHg	methylmercury
MRP	municipal regional stormwater permit
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyl congeners
POC	pollutants of concern
ppb	parts per billion
PSD	particle size distribution
RL	reporting limit
RMP	Regional Monitoring Program for Water Quality in San Francisco Bay
RPD	relative percent difference
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SSC	suspended sediment concentration
TMDL	total maximum daily load
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency
WWTP	wastewater treatment plant
WY	water year

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1. Introduction

This report summarizes pollutants of concern (POC) monitoring conducted by Contra Costa Clean Water Program (CCCWP) during water year 2021 (Oct. 1, 2020-Sept. 30, 2021). This report fulfills Provision C.8.h.iv of the Municipal Regional Stormwater Permit (MRP 2.0), Order R2-2015-0049, issued in 2015 by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB, 2015).

CCCWP Permittees prioritize monitoring pollutants of concern with the goal of identifying reasonable and foreseeable means of achieving load reductions of pollutants required by total maximum daily loads (TMDLs). TMDLs are watershed plans to attain water quality goals developed and established by the San Francisco Bay Regional Water Quality Control Board. The two most prominent TMDLs in driving stormwater monitoring, source control, and treatment projects under MRP 2.0 are the mercury TMDL and the polychlorinated biphenyl congeners (PCBs) TMDL. In the interest of protecting the beneficial uses of the surface waters for people and wildlife dependent on San Francisco Bay (the Bay) for food, these regulatory plans are intended to reduce concentrations of mercury and PCBs in fish within the Bay.

Mercury and PCBs tend to bind to sediments. The principal means of transport from watersheds is via sediments washed into the Municipal Separate Storm Sewer System (MS4); therefore, an important focus of POC monitoring is identifying the most significant sources of contaminated sediments to the MS4. An additional focus is quantifying the effectiveness of control measures. The highest POC monitoring priorities for Permittees are answering these two basic TMDL implementation questions: where are the most significant sources of pollutants of concern, and what can be done to control them?

During water year 2021, the following monitoring activities were completed:

- PCBs and mercury sediment screening – sampling of street dirt and/or storm drain drop inlet sediment at eight locations adjacent to suspected source properties in old industrial areas of the Santa Fe Channel watershed in Richmond
- Copper and nutrients water sampling in lower Marsh Creek
- Mercury and methylmercury water sampling in lower Marsh Creek (specific to East County monitoring requirements).

Monitoring activities were performed in accordance with CCCWP's Pollutants of Concern Sampling and Analysis Plan and Quality Assurance Project Plan (ADH and AMS, 2020a; ADH and AMS, 2020b). Each of these monitoring efforts is described in the following sections.

Additional monitoring information, background, and context, including a discussion of permit-driven goals, can be found in the pollutants of concern report for water year 2021 (CCCWP, 2021).

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2. PCBs and Mercury Sediment Screening – Street Dirt and Storm Drain Drop Inlet Sampling

Eight composite samples of street dirt and/or storm drain drop inlet sediment in the public right of way were collected in September 2021. Sampling sites were selected from a GIS layer prepared by CCCWP's C.11/C.12 contractor, Geosyntec Consultants. The GIS layer identifies remaining old industrial properties throughout the county that may not have been thoroughly investigated in the past, and that may have the potential to contribute PCBs to the public right-of-way and the MS4. In generating the old industrial property database, careful consideration was given to the historic land use of each property and to results of previous monitoring efforts.

Table 1 provides site IDs, sampling dates, position coordinates and sampling notes for each location. Table 2 provides analytical test methods, reporting limits and holding times. Table 3 provides results of PCBs, mercury, total organic carbon (TOC), and particle size distribution (PSD) testing. Refer to Figure 1 for the general locations of street dirt sampling sites.

The concentration of PCBs was elevated above the high opportunity threshold in one sample, SanFeCh2 (1,084 µg/Kg versus threshold value of 500 µg/Kg). PCB concentration in the remaining samples ranged from 11 µg/Kg (SanFeCh8) to 359 µg/Kg (SanFeCh5).

The concentration of mercury was elevated above the high opportunity threshold in one sample, SanFeCh3 (1,150 µg/Kg versus threshold value of 750 µg/Kg). Mercury concentration in the remaining samples ranged from 73 µg/Kg (SanFeCh8) to 640 µg/Kg (SanFeCh2).

Table 1. Sediment Screening Sampling Locations and Sampling Notes (Water Year 2021)

Site ID [1]	Date Sampled	Latitude (decimal degrees)	Longitude (decimal degrees)	Sampling Notes
SanFeCh1	09/22/2021	37.93154	-122.35327	Sampled curb and gutter sediment; evidence of recent small brush fire along curb
SanFeCh2	09/22/2021	37.93088	-122.36159	Sampled curb and gutter sediment and along fence line on Ohio Ave. near S 8th St.
SanFeCh3	09/22/2021	37.93161	-122.36878	Sampled curb sediment adjacent to wrecking yard and near railroad property
SanFeCh4	09/22/2021	37.92969	-122.36912	Sampled sediment along curb, attempted sampling in 2015 but not enough sediment was available
SanFeCh5	09/22/2021	37.92465	-122.36301	Sampled gutter sediment on S 7th St. near Hoffman Blvd., elevated PCBs across Hoffman near Sims Metals
SanFeCh6	09/22/2021	37.92118	-122.36304	Sediment sample from drop inlet and curb/gutter on Wright Ave next to railroad tracks near Parr Canal
SanFeCh7	09/22/2021	37.92089	-122.37810	Sampled drop inlet sediment on Canal Blvd near wastewater treatment plant entrance
SanFeCh8	09/22/2021	37.92120	-122.37191	Sampled gutter area on Wharf St. cul-de-sac, discharges directly to Santa Fe Channel

1 Site ID Key:
SanFeCh Santa Fe Channel Watershed

Table 2. Sediment Screening Analytical Tests, Methods, Reporting Limits, and Holding Times

Sediment Analytical Test	Method	Target Reporting Limit	Holding Time
Total PCBs (RMP 40 congeners)[1]	USEPA 8082A	0.5 µg/kg	1 year
Total Mercury	USEPA 7471B	5 µg/kg	1 year
Total Organic Carbon	ASTM D4129-05M	0.05%	28 days
Particle Size Distribution[2]	ASTM D422M	0.01%	28 days

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

2 Particle size distribution by the Wentworth scale; percent fines (slit and clay) are less than 62.5 microns.

Table 3. Sediment Screening Sampling Results (Water Year 2021)

Sample ID	Total PCBs (µg/Kg or ppb)[1,2]	Total Hg (µg/Kg or ppb)[3]	TOC (%)	Particle Size Distribution[4]			
				Clay (%)	Silt (%)	Sand (%)	Gravel (%)
SanFeCh1	58	498	7.48	1.96	11.52	46.54	39.98
SanFeCh2	1,084	640	4.15	3.14	19.87	51.12	25.88
SanFeCh3	81	1,150	2.99	2.21	11.88	33.50	52.40
SanFeCh4	17	404	3.73	0.00	9.28	29.08	61.64
SanFeCh5	359	527	8.70	1.13	15.84	61.09	21.94
SanFeCh6	116	395	18.4	3.64	26.03	44.99	25.34
SanFeCh7	192	225	5.90	0.56	7.76	82.18	9.50
SanFeCh8	11	73	3.05	1.26	11.67	57.37	29.69

1 Sum of RMP 40 congeners

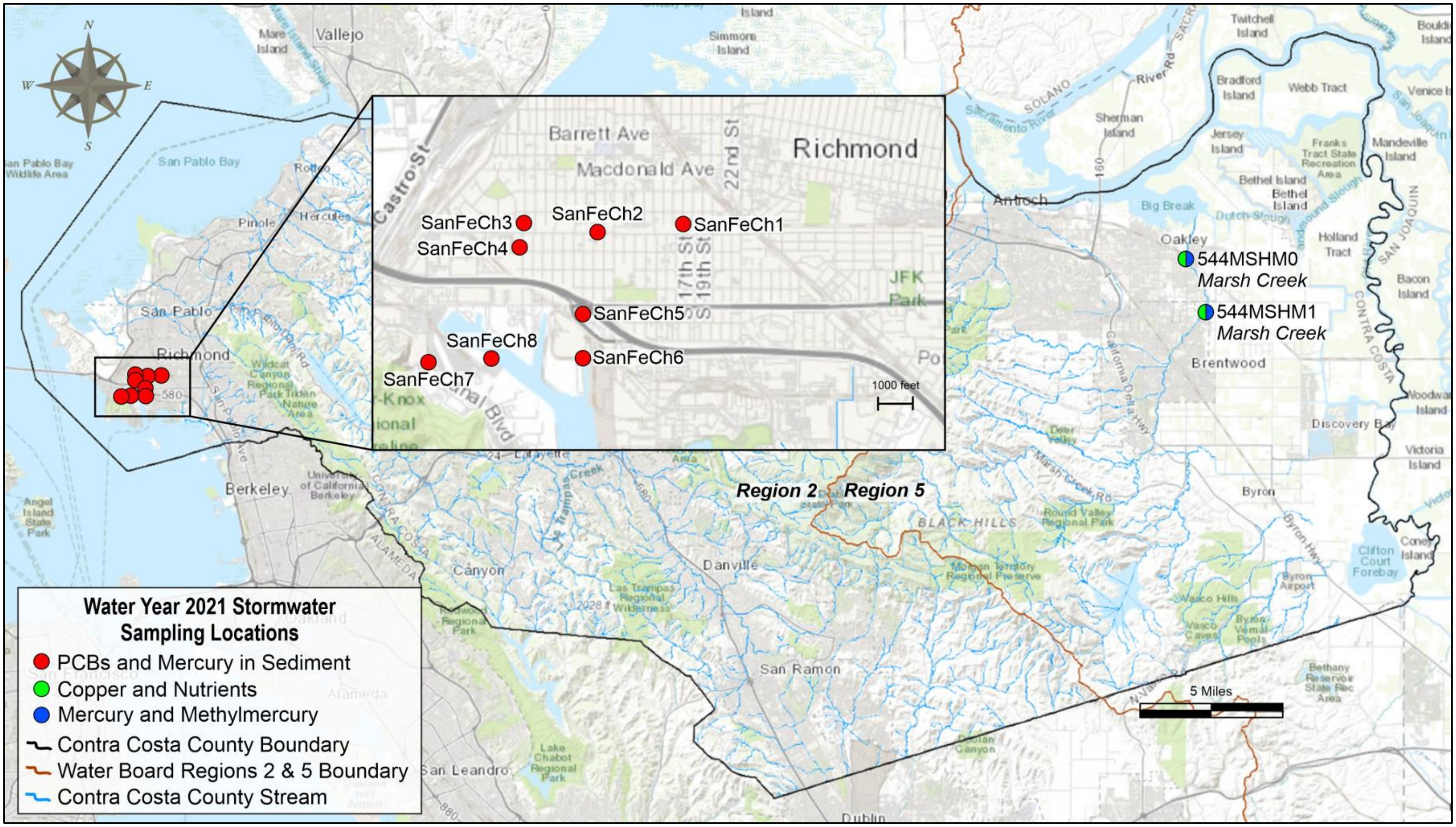
2 Values in ***bold italics*** indicate a likely high source area for PCBs (>500 ppb)

3 Values in ***bold italics*** indicate a likely high source area for mercury (>750 ppb)

ppb parts per billion

Normalized to 100 percent

Figure 1. Location of Water Year 2021 Monitoring Activities – County Overview



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3. Copper and Nutrients Monitoring

Sampling for copper and nutrients was conducted in lower Marsh Creek during dry weather at Stations 544MSHM1 and 544MSHM0. Station 544MSHM1 is located immediately downstream of the Brentwood wastewater treatment plant (WWTP) outfall and Station 544MSHM0 is located just upstream of tidal influence, approximately 2.25 river miles downstream of the Brentwood WWTP outfall (Figure 1). Two samples were collected: the first was collected at 544MSHM1 at 08:00 on Sept. 29, 2021, and the second sample was collected at 544MSHM0 at 08:30 the same day.

Sample collection was timed to coincide with the elevated creek stage that commonly occurs throughout the dry season in Marsh Creek. There was only a slight increase in stage throughout the waiting period, likely due to the drought during water year 2021 and a corresponding decrease in irrigation return water to the creek. Sampling during periods of elevated stage may help to identify variations in dry weather water quality which may exist in lower Marsh Creek where WWTP outflow is a major source of flow to the creek. Due to the very low flow in Marsh Creek upstream of the WWTP, which consisted of isolated pools and very little positive flow, even during elevated flow events, sampling efforts were abandoned at Station 544MSHM2 (immediately upstream of the WWTP outfall). Instead, sampling was conducted at Stations 544MSHM1 and 544MSHM0, as both locations are downstream of the WWTP.

Samples were filtered in the field within 15 minutes of collection for dissolved copper, ammonia, nitrate, nitrite, and orthophosphate. Refer to Table 4 for test methods and reporting limits. Refer to Table 5 for the analytical results.

Copper and nutrients concentrations were generally low. Except for orthophosphate and phosphorus, concentration of copper and nutrients fell below the maximum permissible contaminant levels and water quality objectives. As found in prior years in Marsh Creek, concentration of orthophosphate and phosphorus were elevated above the U.S. Environmental Protection Agency's Quality Criteria for Water.

Table 4. Watershed Characterization Analytical Tests, Methods, and Reporting Limits – Copper and Nutrients

Analytical Test	Method	Target Reporting Limit
Suspended Sediment Concentration (SSC)	ASTM D 3977-97B	3 mg/L
Copper, total recoverable and dissolved	USEPA 200.8	0.5 µg/L
Hardness	SM 2340C (titration)	5 mg/L
Ammonia as N	SM 4500-NH3 C v20	0.1 mg/L
Nitrate	USEPA 300.0	0.05 mg/L
Nitrite	USEPA 300.0	0.05 mg/L
Total Kjeldahl Nitrogen	SM 4500 NH3-C	0.1 mg/L
Dissolved Orthophosphate	SM 4500P-E	0.01 mg/L
Total Phosphorus	SM 4500P-E	0.01 mg/L

Table 5. Copper and Nutrients Monitoring Results – Lower Marsh Creek (Water Year 2021)

Site ID	544MSHM1	544MSHM0	Maximum Contaminant Level / Water Quality Objective
Sample Date	09/29/2021	09/29/2021	-
Sample Time	08:00	08:30	-
Latitude (decimal degrees)	37.96448	37.99035	-
Longitude (decimal degrees)	-121.68392	-121.69591	-
Copper, Dissolved (µg/L)	2.1	2.0	10-67[a]
Copper, Total (µg/L)	3.0	2.6	None
Hardness (mg/L)	280	310	None
Ammonia as N (mg/L)	0.16	0.21	None
Nitrate (mg/L)	6.8	6.0	9.0[b]
Nitrite (mg/L)	0.008 J	0.029 J	1.0[c]
Total Kjeldahl Nitrogen (mg/L)	0.28	0.11	None
Dissolved Orthophosphate (mg/L)	1.3	2.6	0.03[d]
Phosphorus (mg/L)	1.4	2.9	0.1[d]

Values presented in ***bold italics*** exceed the listed maximum contaminant level/water quality objective

a Range of maximum acceptable values for dissolved copper calculated from hardness as specified in the San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan), May 2017, Table 3–4: Freshwater Water Quality Objectives for Toxic Pollutants for Surface Waters, 1-hour average for copper. The objectives for copper are based on hardness. The table values in the source assume a hardness of 100 mg/l CaCO3. At other hardnesses, the objectives are calculated using the following formula where H = ln (hardness): The 1-hour average for copper is e(0.9422H-1.700).

b San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan), May 2017, contains maximum contaminant levels for un-ionized ammonia, but not for ammonium (ionized ammonia).

c San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan), May 2017, Table 3-5: Water Quality Objectives for Municipal Supply. The table specifies water quality objectives of 10 mg/L for Nitrate+Nitrite as N and 1 mg/L for Nitrite as N.

d Quality Criteria for Water, U.S. Environmental Protection Agency, USEPA#440/5-86-001, 1986. The recommended criterion for total phosphorus is for streams which do not empty into reservoirs.

J Analyte detected below the reporting limit; result should be considered an estimated value

4. Mercury and Methylmercury Monitoring

Mercury and methylmercury sampling was conducted on lower Marsh Creek during dry weather at Stations 544MSHM1 and 544MSHM0, concurrent with copper and nutrient sampling. This work builds on results of the Methylmercury Control Study Final Report (CCCWP, 2018), and should help to better understand mercury concentrations and methylation occurrences within lower Marsh Creek.

This monitoring effort satisfies Central Valley Regional Water Quality Control Board (CVRWQCB) requirements of the MRP Amendment Provision C.16.5.g for eight samples within lower Marsh Creek each year (SFBRWQCB, 2019). Refer to Table 6 for test methods and reporting limits. Refer to Table 7 for analytical results. See Figure 1 for general sampling locations.

Dry weather methylmercury (MeHg) monitoring was conducted at various times during the day on Sept. 28 and Sept. 29 to coincide with high and low periods of flow from the Brentwood WWTP. Samples were collected during the early morning and late afternoon, when flows from the WWTP are at a minimum, and at mid-morning when WWTP flows reach a daily maximum. The data in Table 7 indicate that the MeHg concentrations were consistently very low (<0.02 ng/L) no matter the time of day.

Since MeHg is strongly associated with suspended particles, this finding of low MeHg is very likely due to the fact that suspended sediment concentrations were also very low (ranging from <2.0 to approximately 2.6 mg/L). MeHg concentrations in all samples were well below the Sacramento-San Joaquin River Delta TMDL of 0.06 ng/L.

Table 6. Mercury and Methylmercury in Water - Analytical Tests, Methods, Reporting Limits, and Holding Times

Sediment Analytical Test	Method	Target Reporting Limit	Holding Time
Total Mercury	USEPA 1631E	0.5 ng/L	90 days
Total Methylmercury	USEPA 1631	0.05 ng/L	90 days
Suspended Sediment Concentration	ASTM D 3977-97	2.0 mg/L	7 days

Table 7. Methylmercury Analytical Results

Site ID	Sample Date	Sample Time	Latitude	Longitude	SSC (mg/L)	Total Hg (ng/L)	Total MeHg (ng/L)
544MSHM1-01	09/28/2021	11:05	37.96448	-121.68392	<2.0	1.5	<0.02
544MSHM0-01	09/28/2021	11:50	37.99035	-121.69591	<2.0	0.62	<0.02
544MSHM1-02	09/28/2021	16:20	37.96448	-121.68392	<2.0	0.68	<0.02
544MSHM0-02	09/28/2021	16:45	37.99035	-121.69591	2.1 J	0.67	<0.02
544MSHM1-03	09/29/2021	08:00	37.96448	-121.68392	2.6 J	0.98	<0.02
544MSHM0-03	09/29/2021	08:30	37.99035	-121.69591	2.2 J	0.72	<0.02
544MSHM1-04	09/29/2021	12:00	37.96448	-121.68392	2.2 J	2.8	<0.02
544MSHM0-04	09/29/2021	12:30	37.99035	-121.69591	<2.0	0.96	<0.02

MeHg methylmercury
< Analyte not detected at or above the MDL; numeric value following the "<" symbol is the associated MDL value
J Analyte detected below the reporting limit; result should be considered as an estimated value

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5. Summary of Monitoring Completed in Water Year 2021

Water year 2021 monitoring is summarized in Table 8. The table lists the total number of tests completed for each pollutant class, and the corresponding targets outlined in MRP 2.0.

The number of samples collected and analyzed in water year 2021 met the minimum annual requirements of the MRP in all pollutant categories.

Table 8. Summary of Monitoring Completed in Water Year 2021 by Pollutant Class, Analyte, Management Information Need, and MRP Targets

Pollutant Class / Type of Monitoring	Analyte									Management Information Need					Agency or Organization Performing the Monitoring	Samples Collected and Analyzed in WY 2021	Cumulative Samples Collected and Analyzed In WYs 2016 through 2021	Total Samples Required By the MRP for 5-Year Term, Plus 1 Additional Year
	PCBs	Mercury	Methylmercury	SSC	PSD	TOC	Copper [1]	Hardness	Nutrients [2]	Source ID	Bay Impairment	Management Action	Loads & Status	Trends				
PCBs - sediment	✓				✓	✓				X	X	X			CCCWP	8[a]	101	88
Mercury & MeHg - water		✓	✓	✓						X	X	X	X	X	CCCWP	8[b]	151	88
Mercury - sediment		✓			✓					X	X	X			CCCWP	8[a]		
Copper - water							✓	✓		X	X		X	X	CCCWP	2	22	22
Nutrients - water									✓	X	X		X	X	CCCWP	2	22	22

1 Total and dissolved fractions of copper
2 Nutrients include ammonia, nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate, and total phosphorus
a Sediment screening adjacent to remaining old industrial source properties in high opportunity areas of Santa Fe Channel watershed
b Mercury and methylmercury water sampled were collected in lower Marsh Creek per CVRWQCB requirement
SSC suspended sediment concentration
PSD particle size distribution
TOC total organic carbon
MeHg total methylmercury

6. Quality Assurance / Quality Control Analysis

Project staff performed verification and validation of laboratory data per the project quality assurance project plan (QAPP) and consistent with 2013 California Surface Water Ambient Monitoring Program (SWAMP) measurement quality objectives.

Samples for all analyses met laboratory quality control objectives, except for minor instances detailed in Table 9 below. Given that the quality control issues described in Table 9 show the issues were of relatively minor consequence, 100% of the data from these samples are of acceptable quality and are included in the dataset for this annual report.

Table 9. Quality Control Issues and Analysis in the Water Year 2021 Project Data Set

Sample ID / Type	Issue	Analysis
SanFeCh2, SanFeCh3, SanFeCh4, SanFeCh5, SanFeCh6, SanFeCh7 SanFeCh8 / Total PCB congeners	Several of the PCB congers from Method 8082A were "P" qualified, indicating the GC or HPLC confirmation criteria was exceeded. The RPD was greater than 40% between the two results.	Exceedance of this type are common with results that are only slightly above the RL. Since the "P" qualified data represent very low detections, the sum of the RMP 40 congeners is acceptable for use.
SanFeCh1, SanFeCh2, SanFeCh3, SanFeCh4, SanFeCh5, SanFeCh6, SanFeCh7, SanFeCh8 / Total PCB congeners	The upper control criterion was exceeded for PCB 97, 194 and Tetrachloro-m-xylene in CCV. The field samples analyzed in this sequence did not contain the analytes in question above the MRL or were reran with passing CCV.	Since the apparent problem indicated a potential high bias and the analytical results were below the MRL, the data quality was not affected. No further corrective action was required.
SanFeCh1, SanFeCh2, SanFeCh3, SanFeCh4, SanFeCh5, SanFeCh6, SanFeCh7, SanFeCh8 / Total PCB congeners	The surrogate recovery of Tetrachloro-m-xylene for LCS was outside the lower control criterion. The spiked analytes were in control, the error associated with reduced recovery indicated a potential low bias for the surrogate.	The LCS data was flagged to indicate the problem. No further corrective action was required.
SanFeCh6 / Total Mercury	Method 7471B, the RPD (28%) for the replicate analysis of mercury was slightly outside the normal control limit (20%). The variability in the results was attributed to the heterogeneous character of the sample. Standard mixing techniques were used but were not sufficient for complete homogenization of this sample.	Variability of this degree (28% RPD) between laboratory replicates in street dirt samples is fairly common due to sample heterogeneity. The sample result is acceptable.

CCV Continuing Calibration Verification
LCS laboratory control sample
GC gas chromatography
HPLC high pressure liquid chromatography
MRL mean reporting limit
RL reporting limit
RMP regional monitoring program
RPD relative percent difference

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.

7. References

ADH Environmental and Applied Marine Sciences (ADH and AMS). 2020a. Contra Costa County Clean Water Program, Sampling and Analysis Plan, Pollutants of Concern Monitoring; Pesticides and Toxicity Monitoring. Feb. 14, 2020.

ADH Environmental and Applied Marine Sciences (ADH and AMS). 2020b. Contra Costa County Clean Water Program, Quality Assurance Project Plan, Pollutants of Concern Monitoring; Pesticides and Toxicity Monitoring. Feb. 14, 2020.

Contra Costa Clean Water Program (CCCWP). 2021. Contra Costa Clean Water Program, Pollutants of Concern Report: Accomplishments in Water Year 2021 and Allocation of Effort for Water Year 2022. Prepared by ADH Environmental. October 2021.

Contra Costa Clean Water Program (CCCWP). 2018. Contra Costa Clean Water Program, Methylmercury Control Study Final Report. Prepared by ADH Environmental. October 2018.

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB). 2015. California Regional Water Quality Control Board, San Francisco Bay Region, Municipal Regional Stormwater NPDES Permit, Order R2-2015-0049, NPDES Permit CAS612008. Nov. 19, 2015.

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB). 2019. California Regional Water Quality Control Board, San Francisco Bay Region, Municipal Regional Stormwater NPDES Permit, Order R2-2019-0004 Amendment Revising Order R2-2015-0049, NPDES Permit CAS612008. Feb. 13, 2019

Attachment A

Electronic Data Transmittal Letter dated March 31, 2022, with attached file list

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CONTRA COSTA
CLEAN WATER
PROGRAM

March 31, 2022

Thomas Mumley, Interim Executive Officer
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Oakland, CA 94612

Patrick Pulupa, Esq., Executive Officer
California Regional Water Quality Control Board, Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

SUBJECT: Submittal of Electronic Status Monitoring Data Report in Accordance with MRP 2.0 Permit Provision C.8.h.ii and C.8.g.ii

Dear Mr. Mumley and Mr. Pulupa:

Provision C.8.h.ii of the Municipal Regional Permit (MRP) for urban stormwater issued by the San Francisco Bay Regional Water Quality Control Board (Order No. R2-2015-049, as amended by Order No. R2-2019-004) requires submittal of an "Electronic Status Monitoring Data Report" (Data Report) providing all monitoring data collected during the forgoing October 1 – September 30 period (Water Year 2021). Enclosed please find documentation that all monitoring data were uploaded to California Environmental Data Exchange Network (CEDEN) in a Surface Water Ambient Monitoring Program compatible format on behalf of all Contra Costa County Permittees.

Per historic practice, the Contra Costa Clean Water Program has also transmitted electronic monitoring data to CVRWQCB staff (Elizabeth Lee) and Mr. Zach Rokeach (SFRWQCB) electronically by share site.

With the approval and direction from each duly authorized representative of each Permittee, I have been authorized to submit and certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Regards,

Karin Graves
Acting Program Manager
Contra Costa Clean Water Program

Cc: Zach Rokeach, SFRWQCB
Elizabeth Lee, CVRWQCB

File Name	Data Contents
CCCWP 2021 POC Results.pdf	Combine Pollutants of Concern Stations Chemistry – Water Year 2021
CCCWP_UCMR_WY2021_final.pdf	Urban Creeks Monitoring Report – Water Year 2021
CM_CCCWP_HOBO_204SLE204_2021.xlsx	Creek Status Monitoring Station 204SLE204 HOBO© temperature time series – Water Year 2021
CM_CCCWP_HOBO_206R02907_2021.xlsx	Creek Status Monitoring Station 206R02907 HOBO© temperature time series – Water Year 2021
CM_CCCWP_HOBO_207R01307_2021.xlsx	Creek Status Monitoring Station 207R01307 HOBO© temperature time series – Water Year 2021
CM_CCCWP_HOBO_207R03403_2021.xlsx	Creek Status Monitoring Station 207R03403 HOBO© temperature time series – Water Year 2021
CM_CCCWP_Sonde_M0_2021_Fall.xlsx	Creek Status Monitoring Station M0 Sonde Water Quality Parameter time series – Water Year 2021, Fall
CM_CCCWP_Sonde_M0_2021_Spring.xlsx	Creek Status Monitoring Station M0 Sonde Water Quality Parameter time series – Water Year 2021, Spring
CM_CCCWP_Sonde_M1_2021_Fall.xlsx	Creek Status Monitoring Station M1 Sonde Water Quality Parameter time series – Water Year 2021, Fall
CM_CCCWP_Sonde_M1_2021_Spring.xlsx	Creek Status Monitoring Station M1 Sonde Water Quality Parameter time series – Water Year 2021, Spring
CSM_CCCWP_Bioassessment_204R02500_WY2021.xls	Creek Status Monitoring station 204R02500 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_204R02692_WY2021.xls	Creek Status Monitoring station 204R02692 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_206R02816_WY2021.xls	Creek Status Monitoring station 206R02816 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_206R02903_WY2021.xls	Creek Status Monitoring station 206R02903 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_206R02907_WY2021.xls	Creek Status Monitoring station 206R02907 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_207R02871_WY2021.xls	Creek Status Monitoring station 207R02871 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_207R03348_WY2021.xls	Creek Status Monitoring station 207R03348 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_207R03383_WY2021.xls	Creek Status Monitoring station 207R03383 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_207R03403_WY2021.xls	Creek Status Monitoring station 207R03403 bioassessment – water year 2021
CSM_CCCWP_Bioassessment_544R03353_WY2021.xls	Creek Status Monitoring station 544R03353 bioassessment – water year 2021
CSM_CCCWP_Indicator_Bacteria_WY2021.xlsx	Combined Creek Status Monitoring stations indicator bacteria – water year 2021
CSM_CCCWP_Sediment_Chemistry_207R03403_WY2021.xls	Creek Status Monitoring station 207R03403 sediment chemistry – water year 2021
CSM_CCCWP_Toxicity_207R03403_WY2021.xls	Creek Status Monitoring station 207R03403 toxicity – water year 2021
CSM_CCCWP_Water_Quality_Chemistry_WY2021.xls	Combined Creek Status Monitoring stations water quality chemistry – water year 2021

Attachment B

BASMAA Regional Monitoring Coalition: Status of Regional Stressor/Source Identification (SSID) Projects (updated February 17, 2022)

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SSID Project ID	Date Updated	County/ Program	Creek/ Channel Name	Site Code(s) or Other Site ID	Project Title	Primary Indicator(s) Triggering Stressor/Source ID Project									Indicator Result Summary	Rationale for Proposing/Selecting Project	Current Status of SSID Project or Date Completed	EO Concurrence of project completion (per C.8.e.iii.(b))
						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Bacteria	Other				
AL-1	2/4/21	ACCWP	Palo Seco Creek		Exploring Unexpected CSCI Results and the Impacts of Restoration Activities	X									Sites where there is a substantial difference in CSCI score observed at a location relative to upstream or downstream sites, including sites on Palo Seco Creek upstream of the Sausal Creek restoration-related sites, that had substantial and unexpected differences in CSCI scores.	The project will provide additional data to aid consideration of unexpected and unexplained CSCI results from previous water year sampling on Palo Seco Creek, enable a more focused study of monitoring data collected over many years in a single watershed, and allow analysis of before and after data at sites upstream and downstream of previously completed restoration activities.	In WY 2019, nutrient sampling, bioassessment, and additional DO and temperature monitoring were conducted. The final SSID progress report was included in ACCWP's March 2020 IMR, recommending project completion.	Final report submitted. Waiting for EO concurrence.
AL-2	2/4/21	ACCWP	Arroyo Las Positas		Arroyo Las Positas Stressor Source Identification Project	X	X							X	Creek Status Monitoring has identified multiple instances of benthic macroinvertebrate assemblages within the "Very Likely Altered" condition category, exceedances of the Basin Plan objective for pH, and multiple instances of nitrate concentrations above guidelines for nuisance algal growth and nitrate toxicity.	The Water Board is conducting sampling in the watershed as part of their TMDL development efforts and an SSID project will supplement those efforts and generate a better overall picture of stressors impacting the waterbody.	In WY 2019, ACCWP conducted bioassessments, nutrient sampling, and continuous monitoring at multiple locations within the watershed over the course of spring and summer months. The first SSID progress report was included in ACCWP's March 2020 IMR. The planned second year's efforts were mostly precluded by the Covid-19 pandemic restrictions. ACCWP will investigate alternative monitoring techniques in WY 2021 to better understand causal factors and included a progress report with its March 2021 UCMR submittal. The final MRP2 progress report, which requests project completion coinciding with transition to MRP3, contains information on novel monitoring tools employed and may further investigations in this or other County watersheds with similar concerns.	

SSID Project ID	Date Updated	County/ Program	Creek/ Channel Name	Site Code(s) or Other Site ID	Project Title	Primary Indicator(s) Triggering Stressor/Source ID Project: Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Bacteria	Other	Indicator Result Summary	Rationale for Proposing/Selecting Project	Current Status of SSID Project or Date Completed	EO Concurrence of project completion (per C.8.e.iii.(b))
CC-1	2/4/21	CCCWP	Lower Marsh Creek		Marsh Creek Stressor Source Identification Study									X	10 fish kills have been documented in Marsh Creek between September 2005 and September 2019. Low dissolved oxygen was proved to be the cause in the most recent (9/17/19) event; circumstances indicate low DO was a likely cause in many if not all of the prior events.	This SSID study addresses the root causes of fish kills in Marsh Creek. Monitoring data collected by CCCWP and other parties are being used to investigate multiple potential causes, including low dissolved oxygen, warm temperatures, daily pH swings, fluctuating flows, physical stranding, and pesticide exposure. During year 2 a pilot test of water storage and night-time flow augmentation was conducted by the City of Brentwood Wastewater Treatment Plant (WWTP).	The CCCWP SSID work plan was submitted in 2018. The Year 2 Status Report is included in CCCWP's March 2020 IMR. The study successfully concluded in Year 2. The final report recommended project completion. Flow augmentation appears to be a viable means of avoiding lethally low DO in portions of the creek downstream of the WWTP. Permittees are voluntarily implementing flow augmentation and monitoring during WY2021 and WY 2022.	SSID Comment Letter received 1/3/22.
FSV-1	2/20/21	City of Vallejo in assoc. with FSURMP	Rindler Creek	207R03504	Rindler Creek Bacteria and Nitrogen Study								X		E. coli result of 2800 MPN/100mL in Sept. 2017.	A source identification study is warranted in Rindler Creek due to the elevated FIB result, other (non-RMC) monitoring indicating elevated ammonia levels, and the presence of a suspected pollutant source upstream of the data collection point. Rindler Creek is a highly urbanized and modified creek that originates in open space northeast of the City of Vallejo. Monitoring is conducted just downstream of the creek crossing under Columbus Parkway; upstream of this site there is City-owned land that is grazed by cattle roughly from December-June.	A Project Outline was submitted with the IMR in March 2020. The project has been approved by RB staff. Fencing to exclude cattle from Rindler Creek will be installed in Spring 2022 and subsequent monitoring will commence in Spring 2022 to monitor project efficacy.	

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						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Bacteria	Other				
SC-1	1/13/22	SCVURPPP	Coyote Creek	NA	Coyote Creek Toxicity SSID Project						X				The SWRCB recently added Coyote Creek to the 303(d) list for toxicity.	This SSID study investigated the extent and magnitude of toxicity in an urban reach of Coyote Creek. Sediment samples (n=8) were collected during the dry season of 2018 and 2019. Samples were generally not toxic, with the exception of one sample that had low levels of toxicity (subsequent re-test of sample was not toxic). Sediment chemistry results were inconclusive (i.e., pesticide concentrations were not at levels suspected of causing toxicity). SSID Project results support similar findings from long term monitoring conducted by the SWAMP SPoT Program of reduced acute toxicity in Coyote Creek over the past 10 years.	The work plan was submitted with SCVURPPP's WY 2017 UCMR. A project report describing the results of the WY 2018 and WY 2019 monitoring and recommending project completion was submitted with the WY 2019 IMR. On Dec 31, 2021, RWQCB staff requested revisions to the conclusions in the Final Report, and indicated that the SSID project would be considered complete upon incorporation of the revisions. The revised report will be submitted with this WY 2021 UCMR (Mar 31, 2022).	Yes (upon incorporation of RWQCB requested revisions per letter dated 12/31/21)
SC-2	1/13/22	SCVURPPP	Lower Silver-Thompson Creek	NA	Lower Silver SSID Project	X								X	Low CSCI scores and high nutrient concentrations at a majority of bioassessment locations.	Evaluate potential causes of reduced biological conditions in Lower Silver-Thompson Creek. The SSID Project is investigating sources of nutrients and assessing the range and extent of eutrophic conditions (if present). The Project will evaluate association between stressor data (e.g., water chemistry, dissolved oxygen and physical habitat) and biological condition indicators (i.e., CSCI and ASCI scores).	The work plan was submitted with SCVURPPP's FY 18-19 Annual Report and the WY 2019 IMR. A project report describing the results of the WY 2019 and WY 2020 monitoring and recommending project completion is planned for submission with this WY 2021 UCMR. Although there was no obvious relationship between nutrients and CSCI scores, two catchments with high nutrients were investigated. In one, groundwater discharge to the stormdrain was the source of nitrogen. In the other, dry weather flows suggesting an illicit connection are being tracked by City of San José staff.	

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						Bioassess	General WQ	Chlorine	Temp	Water Tox	Sed Tox	Sed Chem	Bacteria	Other				
SM-1	2/4/21	SMCWPPP	Pillar Point / Deer Creek / Denniston Creek	NA	Pillar Point Harbor Bacteria SSID Project								X		FIB samples from 2008 and 2011-2012 exceeded WQOs.	A grant-funded Pillar Point Harbor MST study conducted by the RCD and UC Davis in 2008, 2011-2012 pointed to urban runoff as a primary contributor to bacteria at Capistrano Beach and Pillar Point Harbor. The study, however, did not identify the specific urban locations or types of bacteria. This SSID project investigated bacteria contributions from the urban areas within the watershed. In WY 2018, Pathogen indicator and MST monitoring was conducted at 14 freshwater sites during 2 wet and 2 dry events. Very few samples contained "controllable" source markers (i.e., human and dog). Additional field studies were conducted in WY 2019 to understand hydrology and specific source areas.	The work plan was submitted with SMCWPPP's WY 2017 UCMR. A project report describing the results of the WY 2018 and WY 2019 investigations was submitted on Oct 28, 2019. On Feb 7, 2020, RWQCB staff requested minor report changes prior to Executive Officer concurrence regarding project completion. The Revised Final Report was submitted Jun 30, 2020. A TMDL addressing bacteria in Pillar Point Harbor is currently under development.	Yes (per letter dated 2/7/20)
RMC-1	2/17/21	RMC/ Regional	NA (entire RMC area)	NA	Regional SSID Project: Electrical Utilities as a Potential PCBs Source to Stormwater in the San Francisco Bay Area									X	Fish tissue monitoring in San Francisco Bay led to the Bay being designated as impaired on the CWA 303(d) list and the adoption of a TMDL for PCBs in 2008. POC monitoring suggests diffuse PCBs sources throughout region.	PCBs were historically used in electrical utility equipment, some of which still contain PCBs. Although much of the equipment has been removed from services, ongoing releases and spills may be occurring at levels approaching the TMDL waste load allocation. This regional SSID project is investigating opportunities for BASMAA RMC partners to work with RWQCB staff to: 1) improve knowledge about the extent and magnitude of PCB releases and spills, 2) improve the flow of information from utility companies, and 3) compel cooperation from utility companies to implement improved control measures.	The work plan was submitted with each Program's WY 2018 UCMR and implementation began in WY 2019. The work plan outlined a process for BASMAA RMC partners to work with RWQCB staff to better understand PCB releases from electrical utility equipment owned by PG&E and to propose a source control framework. Ongoing bankruptcy proceedings at PG&E stalled the process. Therefore, BASMAA, with RWQCB staff concurrence, developed a revised approach to implement the work plan but with a focus on municipally-owned utilities. The SSID project was completed in June 2020.	Final report submitted. Waiting for EO concurrence.

AC = Clean Water Program of Alameda County (ACCWP)
CC = Contra Costa Clean Water Program (CCCWP)
SC = Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)
SM = San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)
FSV = Solano County Permittees
RMC = Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC)