Alameda Countywide
Clean Water Program

Contra Costa
Clean Water Program

Fairfield-Suisun
Urban Runoff
Management Program

Marin County
Stormwater Pollution
Prevention Program

Napa County
Stormwater Pollution
Prevention Program

San Mateo Countywide
Water Pollution
Prevention Program

Santa Clara Valley
Urban Runoff Pollution
Prevention Program

Sonoma County
Water Agency

Vallejo Sanitation
and Flood
Control District

B A S M A A

Regional Monitoring Coalition
Urban Creeks Monitoring Report
Water Year 2012

Submitted pursuant to
Provision C.8.g.iii of Order R2-2009-0074
on behalf of all Permittees

March 15, 2013

Bay Area
Stormwater Management
Agencies Association
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BASMA A

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To Whom It May Concern:

We certify under penalty of law that this document was prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our 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 our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

James Scanlin, Alameda Countywide Clean Water Program

Tom Dalziel, Contra Costa Clean Water Program

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Certification statement

"Local" reports

Please note that portions of this regional document were not prepared for all of the above signatories collectively but were instead prepared for individual signatories listed above. Therefore, for each of the following sections, the certification statement above applies solely to the corresponding, individual signatory listed above:

Appendix B Local Urban Creeks Status Monitoring Reports (Pursuant to Provision C.8.c)
B1 Alameda Countywide Clean Water Program
B2 Contra Costa Clean Water Program
B3 San Mateo Countywide Water Pollution Prevention Program
B4 Santa Clara Valley Urban Runoff Pollution Prevention Program

Third party monitoring

Please note that consistent with provision C.8.a.iv of the MRP, two water quality monitoring requirements were fulfilled or partially fulfilled by third party monitoring in Water Year 2012.

- As described in Section 5A of the main body of the attached Urban Creeks Monitoring Report, the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) conducted a portion of the data collection in Water Year 2012 on behalf of Permittees, pursuant to provision C.8.e – Pollutants of Concern Loads Monitoring (i.e., Table 8.4, Categories 1 and 2). The results of that monitoring are reported in Section 5A and Appendix D-2 of the attached Urban Creeks Monitoring Report. The electronic data submittal to the Water Board (and the California Environmental Data Exchange Network) of all data collected from all stations monitored by both Permittees and the RMP in Water Year 2012 pursuant this provision is planned for April 2013 following completion of final quality assurance review.

- Additionally, as noted in Section 5B of the main body of the attached Urban Creeks Monitoring Report, data collected pursuant to provision C.8.e.iii (Long Term Monitoring - Table 8.4 - Category 3) was initiated by the State of California's Surface Water Ambient Monitoring Program (SWAMP) through its Stream Pollutant Trend Monitoring Program at locations identified in Table 8.3 of the MRP. As stated in provision C.8.e.iii Permittees may use these data to comply with the monitoring requirements included in this provision. The schedule for SWAMP's review and reporting of data collected pursuant to this provision, however, differs from the schedule described in the MRP.

Per MRP provision C.8.a.iv, the Permittees request that the Executive Officer adjust the MRP due dates for these reporting deliverables to synchronize with the third-party reporting schedules of SWAMP and the RMP for Water Year 2012 and future years covered under the MRP.

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SECTION 1 - INTRODUCTION

This *Urban Creeks Monitoring Report* was prepared by the Bay Area Stormwater Management Agencies Association (BASMAA), on behalf of all towns, cities, counties and flood control agencies (i.e., Permittees) subject to the Municipal Regional Stormwater NPDES Permit (MRP, Order R2-2009-0074) issued by the San Francisco Regional Water Quality Control Board (Water Board) on October 14, 2009. This report (including all appendices and attachments) fulfills the requirements of MRP Provision C.8.g.iii for interpreting and reporting monitoring data collected during Water Year 2012 (October 1, 2011 - September 30, 2012), the first year of water quality monitoring conducted under the MRP. Monitoring data presented in this report were submitted electronically to the Water Board by RMC participants and may be obtained via the San Francisco Bay Area Regional Data Center (http://water100.waterboards.ca.gov/ceden/sfei.shtml).

This report is organized into two main parts – the main body and appendices. The main body provides brief summaries of accomplishments made in Water Year 2012 in compliance with MRP provision C.8. Summaries are organized by sub-provisions of the MRP and grouped into the following sections:

1. Introduction (C.8.a)
2. San Francisco Estuary Receiving Water Monitoring (C.8.b)
3. Creek Status Monitoring (C.8.c)
4. Monitoring Projects (C.8.d)
5. Pollutants of Concern and Long-Term Trends Monitoring (C.8.e)
6. Citizen Monitoring and Participation (C.8.f)
7. Reporting (C.8.g), Monitoring Protocols and Data Quality (C.8.h)

Appendices include interpretive reports focused on specific types of water quality monitoring required by the MRP. Appendices are also grouped together by sub-provision and referenced within the applicable sections of the main body.

The following MRP reporting requirements (Provision C.8.g.iv) are addressed within the main body of this report and associated appendices:

- Descriptions of monitoring purpose and study design rationale
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data;
- Descriptions of sampling protocols and analytical methods;
- Tables and figures describing: sample location descriptions (including waterbody names, and latitudes/longitudes); sample ID, collection date (and time where relevant), media (e.g., water, filtered water, bed sediment, tissue); concentrations detected, measurement units, and detection limits;
- Data assessment, analysis, and interpretation for Provision C.8.c.;
- Pollutant load and concentration at each mass emissions station;
- A listing of volunteer and other non-Permittee entities whose data are included in the report;
- Assessment of compliance with applicable water quality standards; and,
- A signed certification statement.

REGIONAL COLLABORATIVE MONITORING (BASMAA RMC)

Provision C.8.a (Compliance Options) of the MRP allows Permittees to address monitoring requirements through a "regional collaborative effort" (e.g., RMC), their Stormwater Program, and/or individually. In June 2010, Permittees notified the Water Board in writing of their agreement to participate in a regional monitoring collaborative to address requirements in Provision C.8.[1] The regional monitoring collaborative is referred to as the BASMAA Regional Monitoring Coalition (RMC). With notification of participation in the RMC, Permittees were required to commence water quality data collection by October 2011. In a November 2, 2010 letter to the Permittees, the Water Board's Assistant Executive Officer (Dr. Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through a regional monitoring collaborative, the Bay Area Stormwater Management Agencies (BASMAA) Regional Monitoring Coalition (RMC).

In February 2011, the RMC developed a Multi-Year Work Plan (RMC Work Plan) to provide a framework for implementing regional monitoring and assessment activities required under MRP provision C.8. The RMC Work Plan summarizes RMC projects planned for implementation between Fiscal Years 2009-10 and 2014-15. Projects were collectively developed by RMC representatives to the BASMAA Monitoring and Pollutants of Concern Committee (MPC), and were conceptually agreed to by the BASMAA BOD. A total of 27 regional projects are identified in the RMC Work Plan, based on the requirements described in provision C.8 of the MRP.

Regionally implemented activities in the RMC Work Plan are conducted under the auspices of the Bay Area Stormwater Management Agencies Association (BASMAA), a 501(c)(3) non-profit organization comprised of the municipal stormwater programs in the San Francisco Bay Area. Scopes, budgets, and contracting or in-kind project implementation mechanisms for BASMAA regional projects follow BASMAA's *Operational Policies and Procedures,* approved by the BASMAA Board of Directors (BOD). MRP Permittees, through their stormwater program representatives on the BOD and its subcommittees, collaboratively authorize and participate in BASMAA regional projects or tasks. Regional project costs are shared by either all BASMAA members or among those Phase I municipal stormwater programs that are subject to the MRP.

[1] The Cities of Antioch, Brentwood and Oakley, and portions of Contra Costa County are not subject to the MRP, but have similar requirements and are therefore participating in the RMC.

SECTION 2 - SAN FRANCISCO ESTUARY RECEIVING WATER MONITORING (C.8.b)

As described in MRP provision C.8.b, Permittees are required to provide financial contributions towards implementing an Estuary receiving water monitoring program on an annual basis that at a minimum is equivalent to the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP). Since the adoption of the MRP, Permittees have complied with this provision by making financial contributions to the RMP directly or through stormwater programs (Table 1). Additionally, Permittees actively participated in RMP committees and work groups through Permittee and/or stormwater program staff as described in the following sections, which also provide a brief description of the RMP and associated monitoring activities conducted during this reporting period.

The RMP is a long-term monitoring program that is discharger funded and shares direction and participation by regulatory agencies and the regulated community with the goal of assessing water quality in the San Francisco Bay.[2] The regulated community includes Permittees, publicly owned treatment works (POTWs), 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?

Table 1. Stormwater Program annual contributions to the Regional Monitoring Program for Water Quality in the San Francisco Bay Estuary in 2012 by MRP-related Programs

RMC Participant	2012 Contribution
Santa Clara Valley Urban Runoff Pollution Prevention Program	$174,994
Alameda Countywide Clean Water Program	$167,975
Contra Costa Clean Water Program	$137,317
San Mateo Countywide Water Pollution Prevention Program	$83,086
Vallejo Sanitation and Flood Control District	$12,717
Fairfield-Suisun Urban Runoff Management Program	$14,798
Total	**$590,887**

The RMP budget is generally broken into two major program elements: Status and Trends, and Pilot/Special Studies. The following paragraphs provide a brief overview of these programs.

[2] The 2012 and future RMP Annual Work Plans can be found at www.sfei.org/rmp/what.

RMP Status and Trends Monitoring Program

The Status and Trends Monitoring Program (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 redesigned in 2007 based on a more rigorous statistical design that enables the detection of trends. In Water Year 2012, the S&T Program was comprised of the following program elements that collect data to address RMP management questions described above:

- Water/Sediment/Biota Chemistry and Toxicity Monitoring
- Sediment Benthos Monitoring
- Small and Large Tributary Loading Studies
- Small Fish and Sport Fish Contamination Studies
- Studies to Determine the Causes of Sediment Toxicity
- Suspended Sediment, Hydrography and Phytoplankton Monitoring
- Bird Egg Monitoring

In fall 2011, the RMP Steering Committee, as part of a 5-year Master Planning process, reviewed the S&T Program and agreed to reduce the frequency of some data collection activities or elements in future years so that more funding will be available for pilot and special studies. Additional information on the S&T Program and associated monitoring data are available for downloading via the RMP website using the Status and Trends Monitoring Data Access Tool at www.sfei.org/rmp/data.htm.

RMP Pilot and Special Studies

The RMP also conducts Pilot and Special Studies (P/S Studies) on an annual basis. Studies usually 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 selected for funding through RMP committees. Results and summaries of the most pertinent P/S Studies can be found on the RMP website (www.sfei.org/rmp/).

In Water Year 2012, a considerable amount of RMP and Stormwater Program staff time was spent overseeing and implementing special studies associated with the RMP's Small Tributary Loading Strategy (STLS) and the STLS Multi-Year Monitoring Plan (MYP). Pilot and special studies associated with the STLS are intended to fill data gaps associated with loadings of Pollutants of Concern (POC) from relatively small tributaries to the San Francisco Bay. Additional information is provided on STLS-related studies under section 5 (POC and Long-Term Trends Monitoring) of this report.

Participation in Committees, Workgroups and Strategy Teams

In Water Year 2012, Permittees actively participated in the following RMP Committees and workgroups:

- Steering Committee (SC)
- Technical Review Committee (TRC)
- Sources, Pathways and Loadings Workgroup (SPLWG)
- Contaminant Fate Workgroup (CFWG)
- Exposure and Effects Workgroup (EEWG)
- Emerging Contaminant Workgroup (ECWG)
- Sport Fish Monitoring Workgroup

- Toxicity Workgroup
- Strategy Teams (e.g., PCBs, Mercury, Dioxins, Small Tributaries, Nutrients)

Committee and workgroup representation was provided by Permittee, stormwater program staff and/or individuals designated by RMC participants and the BASMAA BOD. Representation included participating in meetings, reviewing technical reports and work products, co-authoring or reviewing articles included in the RMP's *Pulse of the Estuary*, and providing general program direction to RMP staff. Representatives of the RMC also provided timely summaries and updates to, and received input from stormwater program representatives (on behalf of Permittees) during MPC and/or BOD meetings to ensure Permittees' interests were represented.

SECTION 3 - CREEK STATUS MONITORING (C.8.c)

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

1. Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers and tributaries?
2. Are conditions in local receiving waters supportive of or likely supportive of beneficial uses?

Creek status monitoring parameters, methods, occurrences, durations and minimum number of sampling sites for each stormwater program are described in Table 8.1 of the MRP. Based on the implementation schedule described in MRP Provision C.8.a.ii, creek status monitoring coordinated through the RMC began in October 2011.

Regional and Local Monitoring Designs

The RMC's regional monitoring strategy for complying with MRP provision C.8.c - creek status monitoring is described in the *RMC Creek Status and Long-Term Trends Monitoring Plan* (BASMAA 2011). The strategy includes a regional ambient/probabilistic monitoring component and a component based on local "targeted" monitoring. The combination of these monitoring designs allows each individual 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 condition in urban and non-urban creeks).

Creek status monitoring data from Water Year 2012 were submitted to the Water Board by January 15, 2013 by each applicable RMC participating program. The analyses of results from creek status monitoring conducted by RMC participants in Water Year 2012 are presented in **Appendix A** (Regional Urban Creeks Status Monitoring Report) and **Appendices B1 through B4** (Local Urban Creeks Status Monitoring Reports). Table 2 provides a list of which parameters are included in regional and local reports. Schedules for next steps are also included in Appendices A and B.

Table 2. Location of monitoring result analyses for each parameter in MRP Table 8.1.

Biological Response and Stressor Indicators	Interpretive Report	
	Appendix A Regional Urban Creeks Status Monitoring Report	**Appendix B** Local Urban Creeks Status Monitoring Reports
Bioassessment (Benthic Macroinvertebrates and Algae) & Physical Habitat Assessments	X	
Chlorine	X	
Nutrients	X	
Water Toxicity	X	
Sediment Toxicity	X	
Sediment Chemistry	X	
General Water Quality (Continuous)		X
Temperature (Continuous)		X
Pathogen Indicators		X
Stream Survey (USA or CRAM)		X

SECTION 4 - MONITORING PROJECTS (C.8.d)

Three types of monitoring projects are required by provision C.8.d of the MRP:

1) Stressor/Source Identification Projects (C.8.d.i);
2) BMP Effectiveness Investigations (C.8.d.ii); and,
3) Geomorphic Projects (C.8.d.iii).

The overall scopes of these projects are generally described in the MRP and the RMC Work Plan. Based on MRP compliance schedules for these provisions, Permittees were generally focused on conducting and scoping stressor/source identification projects and collaborative decision-making processes during Water Year 2012. The results of projects conducted by RMC participants in compliance with provisions C.8.d.ii (BMP Effectiveness) and C.8.d.iii (Geomorphic Project) will be presented in the Integrated Monitoring Report scheduled for submittal to the Water Board in March 2014.

The following sections provide brief summaries of RMC participant progress made in Water Year 2012 towards selecting and conducting stressor/source identification projects required by the MRP. As described, two of the required ten RMC stressor/source identification projects are currently underway.

Stressor/Source Identification Project Regional Guidance

To ensure consistency in interpretation of the Stressor/Source ID requirements (C.8.d.i) and a coordinated approach to compliance with that provision, the RMC initiated a regional project to develop Stressor/Source Identification Guidance. The guidance is being organized to assist RMC participants in responding to creek status data that exceed threshold triggers listed in MRP Table 8.1 and follow-up actions as required by provision C.8.d.i. Components of the guidance include identifying the geographical and temporal extent of data that exceed the trigger thresholds; compiling all available data and information on the trigger(s) threshold that was exceeded; investigating whether a known source or stressor is implicated; and determining whether a Toxicity Identification Evaluation, Toxicity Reduction Evaluation or other follow-up investigation is warranted. The guidance will be completed in 2013 and utilized by RMC participants in selecting and conducting projects triggered by creek status data that are reported in Appendices A and B.

Santa Clara Valley Stressor/Source Identification Projects

Based on creek status monitoring data collected by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) in previous fiscal years, SCVURPPP initiated three stressor identification projects in Stevens Creek, Coyote Creek, and the Guadalupe River. In Water Year 2012, SCVURPPP continued conducting stressor identification projects in Coyote Creek and the Guadalupe River. Summaries of each project are provided below. The stressor identification project in Stevens Creek was placed on hold until additional information could be gathered regarding the implementation of management actions associated reducing the impacts of pyrethroid pesticides in the creek.

- **Coyote Creek Stressor Identification Project**
  The stressor/source identification project that continued in Coyote Creek in Water Year 2012 was designed to identify the stressors associated with relatively low benthic macroinvertebrate index scores and low dissolved oxygen observed in the Coyote Creek mainstem prior to the MRP adoption. Water quality monitoring conducted in

Coyote Creek as part of this project during the late summer and fall 2010 included continuous water quality monitoring of:

- pH,
- dissolved oxygen,
- conductivity,
- temperature and
- turbidity.

The monitoring project was designed to answer the following monitoring questions:

1. What is the diurnal variability in dissolved oxygen concentrations?
2. What is the spatial variability of dissolved oxygen and turbidity concentrations?
3. How does water quality change during and following the first runoff event of the season?
4. To what extent do monitoring results provide information to identify and prioritize potential stressors or sources?

The project focused on dissolved oxygen and turbidity concentrations during the late summer season and the first runoff event of the wet weather season. The project was implemented by SCVURPPP, the City of San Jose and the Santa Clara Valley Water District (SCVWD). Each program/agency deployed and retrieved continuous monitoring equipment at three stream locations for a total of nine monitoring sites (six in urban areas and three in non-urban areas). Monitoring equipment was deployed for two dry weather sampling events (August 11-24, 2010 and September 8-22, 2010) and one wet weather event (October 20, 2010 through November 5, 2010).

An interim stressor/source identification report is included as **Appendix C1**. The report describes all water quality data collected as part of the project through Water Year 2011. The report also includes a description of planned next steps. As a follow up to correspondence with Water Board staff regarding the scope and timeframe of this project (and the Guadalupe Project described below) a memorandum further describing next steps and a schedule are included as **Appendix C2**. The actions described in the memorandum are consistent with the process described in MRP provision C.8.d.i and recent correspondence with Water Board staff.

- **Guadalupe River Stressor Identification Project**
  During the seasonal first flush events in FY 08-09, FY 09-10 and FY 10-11, fish kills were observed in various reaches of the Guadalupe River, including its confluence with the Bay (i.e., Alviso Slough). In FY 11-12, the Program, in collaboration with the City of San Jose and SCVWD, began conducting a stressor/source identification study designed to identify stressors that may be contributing to the observed fish kills.

  The monitoring project was intended to answer the following monitoring questions, with a focus on dissolved oxygen during the first runoff event of the wet weather season and subsequent rainfall/runoff events:

  1) What is the spatial and temporal variability in water quality conditions during the late dry weather and early/mid wet weather seasons?
  2) Are water quality impacts observed in Alviso Slough and Guadalupe River during and following the first rainfall event of the season?
  3) To what extent do monitoring results provide information to identify and prioritize potential water quality stressors or sources that may cause or contribute to fish kills?

4) Are potentially toxic algal species observed in Alviso Slough?
5) Do algal toxins represent a potential stressor in Alviso Slough after the first rainfall event of the wet weather season?

Continuous monitoring was conducted from September through November 2011 at six locations in Guadalupe River and two locations in Alviso Slough during the fall and winter 2011. Monitoring parameters included:

- pH,
- dissolved oxygen,
- conductivity, and
- temperature

Additionally, Solid Phase Adsorption Toxin Tracking (SPATT) passive samplers were deployed at the Alvisio Slough sites in conjunction with continuous water quality monitoring to assess the magnitude and extent of potentially toxic algae. Phytoplankton samples were also collected at the slough sites and taxonomic identification was conducted. In collaboration with the stressor identification project, the City of San Jose conducted additional monitoring in the side channel that receives discharge from the Rincon II stormwater pump station.

An interim stressor/source identification report is included in **Appendix C3** of this report. The report describes all water quality data collected as part of the project through Water Year 2011. The report also includes a description of planned next steps. As a follow up to correspondence with Water Board staff regarding the scope and timeframe of this project (and the Coyote Creek Project described above), a memorandum further describing next steps and a schedule are included as **Appendix C2**. The actions described in the memorandum are consistent with the process described in MRP provision C.8.d(i) and recent correspondence with Water Board staff.

Schedule for Identifying and Implementing Additional Stressor/Source Identification Projects

In addition to the stressor/source identification projects discussed above, in Water Year 2013 RMC participants will consider potentially suitable sites for projects. Evaluation of potential stressor/source ID projects is a high priority for the RMC following completion of analysis of creeks status data collected in Water Year 2012. Per MRP Provision C.8.d.i, the first follow-up stressor/source ID project shall be initiated as soon as possible and must begin no later than the second fiscal year following the sampling event that triggered the project. Table 3 provides a tentative schedule for prioritizing and selecting additional stressor/source identification projects. Discussions regarding projects will occur at both MPC and RMC Work Group meetings in 2013.

Table 3. Tentative 2013 schedule for prioritization and selection of additional stressor/source identification projects.

Month	Planned RMC Activity
January	Develop process for inventorying sites that exceeded threshold triggers and prioritizing project selection. Include Water Board staff in discussion.
February	Finalize template for inventorying sites exceeding threshold triggers. Discuss regional guidance. Include Water Board staff in discussion.
March	Review draft regional guidance. Develop candidate list of high priority projects. Develop initial project scopes and budgets. Include Water Board staff in discussion.
April	Finalize list of high priority projects. Update BOD on finalized list. Include Water Board staff in discussion.
May	Finalize project scopes and budgets. Prepare for project implementation. Coordinate with Water Board staff as needed.
June	
July	Initiate stressor/source identification projects. Coordinate with Water Board staff as needed.
August	Project implementation. Provide periodic project updates to RMC participants. Coordinate with Water Board staff as needed.
September	
October	
November	
December	

SECTION 5 - POC AND LONG-TERM TRENDS MONITORING (C.8.e)

A. POC Loads Monitoring

Pollutants of Concern (POC) loads monitoring is required by provision C.8.e.i of the MRP. Loads monitoring is intended to assess inputs of POCs to the Bay from local tributaries and urban runoff, assess progress toward achieving wasteload allocations (WLAs) for TMDLs, and help resolve uncertainties associated with loading estimates for these pollutants. In particular, there are four priority management questions that need to be addressed though POC loads monitoring:

1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs?
2. What are the annual loads or concentrations of POCs from tributaries to the Bay?
3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay?
4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact?

To assist participants in effectively and efficiently conducting POC loads monitoring required by the MRP and answer the POC loads management questions listed above, an RMP Small Tributaries Loading Strategy (STLS) was developed in 2009 by the STLS Team, which included representatives from BASMAA, Water Board staff, RMP staff and technical advisors. The objective of the STLS is to develop a comprehensive planning framework to coordinate POC loads monitoring/modeling between the RMP and RMC participants. This framework and a summary of activities and products to date are provided in the STLS Multi-Year Plan (version 2013), which is included as **Appendix D1**. With concurrence of participating Water Board Staff, the MYP presents an alternative approach to the POC loads monitoring requirements described in MRP Provision C.8.e.i, as allowed by Provision C.8.e. Previous versions of the STLS Multi-Year Plan, along with various appendices, were appended to the RMC's semi-annual Monitoring Status Reports in 2011 and 2012. The Multi-Year Plan included as Appendix D1 describes the major STLS elements, including recent activities that are summarized below. RMC participant activities associated with POC loads monitoring during Water Year 2012 focused on the first year of POC (bottom-of-watershed) monitoring and the continued development of a watershed pollutant load estimation model, both of which were coordinated through the STLS Team and the associated RMP Sources, Pathways and Loadings Work Group (SPLWG).

STLS Multi-Year Plan Activities

Based on the consensus of the STLS Team, RMC representatives in coordination with SFEI staff created the STLS Multi-Year Plan to assist Permittees in complying with provision C.8.e (POC Monitoring). The Multi-Year Plan is an alternative POC monitoring program to the one described in the MRP and equally addresses the management information needs described in the MRP. The alternative approach addresses the four core POC loads monitoring management questions, while integrating activities funded by RMC participants with those funded through the RMP. The Multi-Year Plan provides a more comprehensive description and work plan for STLS activities over the next 5 to10 years, including a detailed rationale for the methods and locations of proposed activities (e.g., POC loads monitoring in small tributaries).

The MYP includes four main elements that collectively address the four priority management questions for POC monitoring:

1. Watershed modeling (Regional Watershed Spreadsheet Model);
2. Bay Margins Modeling;
3. Source Area Runoff Monitoring; and,
4. Small Tributaries Monitoring

Previous MYP updates regarding STLS activities were provided in the Monitoring Status Report submitted to the Water Board in September 2012. The following are brief summaries of each of the STLS elements and activities conducted during the period from September 2012 through January 2013:

- **Watershed Modeling** –The STLS Team and RMP SPLWG continued to provide oversight in Water Year 2012 to the construction and initial testing of the Regional Watershed Spreadsheet Model, which is the primary tool for estimation of overall POC loads from small tributaries to San Francisco Bay. Initial modeling efforts focused on developing load estimates for sediment, mercury and PCBs. For each POC, a submodel architecture will be developed specific to its runoff characteristics and source areas in the Bay Area landscape. An initial test model was constructed for copper for which the submodel is similar to the basic hydrologic version and inputs from other efforts that were readily available. In the second half of 2012, a graphic user interface was also developed that allows for customization and running of submodels by users who are not GIS software experts. A report summarizing modeling results will be developed in 2013 and submitted to the Water Board by March 15, 2014 as part of the Integrated Monitoring Report (IMR).

- **Bay Margins Modeling** – In 2012, The RMP released a second draft Bay Margins Conceptual Model report incorporating extensive review comments by the RMP's Contaminant Fate Work Group, which includes representatives from BASMAA. The RMP Steering Committee also authorized the development of a multi-year plan to develop a modeling framework with multiple objectives regarding nutrients and other contaminants of interest, which may be used to answer management questions regarding contaminant processes in the Bay Margins. The goals of the modeling strategy pertinent to the STLS include identification of high-leverage watersheds whose POC loadings contribute disproportionately to Bay impacts. Further development of the Bay Modeling Strategy planned in 2013 will include convening technical experts, stakeholders and RMP work groups to produce an initial draft work plan for Bay modeling-related activities.

- **Source Area Runoff Monitoring** – This element of the STLS is intended as a placeholder for studies to develop Event Mean Concentrations (EMCs) of POCs to parameterize the Regional Watershed Model. On the advice of the SPLWG, initial RMP studies used alternative approaches to "back-calculate" EMCs from available data as a cost-effective way to support the first iteration of the watershed model. The STLS Work Group will review initial modeling results in 2013 and determine priorities for source area runoff field-data collection in Water Year 2014.

- **Small Tributaries Watershed Monitoring** – For this STLS element, the approach outlined in the Multi-Year Plan consists of intensively monitoring a total of six "bottom-of-watershed" stations, over several years to accumulate data needed to calibrate the watershed model and assist in developing loading estimates from small tributaries for priority POCs. Monitoring is also intended to provide a more limited characterization of additional lower priority analytes. Water Year 2013 is the second year of monitoring activities at four stations that were set up and mobilized beginning in October 2011. Two additional stations were established in October 2012 to begin monitoring and complete the phasing in of all watershed stations:

1. Lower Marsh Creek(Contra Costa County)
2. Guadalupe River (Santa Clara County)
3. Lower San Leandro Creek (Alameda County)
4. Sunnyvale East Channel (Santa Clara County)
5. North Richmond Pump Station (Contra Costa County)
6. Pulgas Pump Station (San Mateo County)

The stations in Lower Marsh Creek, Guadalupe River and Pulgas Pump Station are operated by the Contra Costa Clean Water Program, the Santa Clara Valley Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, respectively, on behalf of RMC participants. The stations in the Sunnyvale East Channel and North Richmond Pump Station are operated by SFEI on behalf of the RMP, as was the Lower San Leandro Creek Station in its first year before operation was transferred to the Alameda Countywide Clean Water Program in summer 2012.

Monitoring methods and laboratory analyses according to the descriptions in the STLS Multi-Year Plan are documented in a Field Manual and Quality Assurance Project Plan, currently under development as a BASMAA regional project. These documents are expected to be completed in Water Year 2013.

For Water Year 2012, BASMAA (on behalf of all RMC participants) contracted with SFEI to coordinate laboratory analyses, data management and data quality assurance. The goal was to ensure data consistency among all watershed monitoring stations. BASMAA again recently approved a contract with SFEI to continue to support these activities in Water Year 2013.

Water Year 2012 Results

During Water Year 2012 storms, discrete and composite samples were collected at four POC loads (bottom-of-watershed) monitoring stations over the rising, peak and falling stages of the hydrographs. Samples collected were analyzed for multiple analytes (Table 4) consistent with MRP provision C.8.e. Receiving water samples were collected and analyzed from a total of:

- 2 storms at the Sunnyvale East Channel Station
- 3 storms at the Guadalupe River Station
- 2 storms at the Lower Marsh Creek Station
- 4 storms at the San Leandro Creek Station

The turbidity of the water flowing through each station was recorded during the entire 2012 wet weather season. Suspended sediment concentration samples were also collected during sampling of the analytes listed in Table 4. Preliminary results of Water Year 2012 POC Monitoring conducted by the STLS team are presented in **Appendix D2**.

Table 4. Laboratory analysis methods used by the STLS team for POC (loads) monitoring in Water Year 2012.

Analyte	Analytical Method	Analytical Laboratory
Carbaryl	EPA 632M	DFG WPCL
Fipronil	EPA 619M	DFG WPCL
Suspended Sediment Concentration	ASTM D3977	EBMUD
Total Phosphorus	EBMUD 488 Phosphorus	EBMUD
Nitrate	EPA 300.1	EBMUD
Dissolved OrthoPhosphate	EPA 300.1	EBMUD
PAHs	AXYS MLA-021 Rev 10	AXYS Analytical Services Ltd.
PBDEs	AXYS MLA-033 Rev 06	AXYS Analytical Services Ltd.
PCBs	AXYS MLA-010 Rev 11	AXYS Analytical Services Ltd.
Pyrethroids	AXYS MLA-046 Rev 04	AXYS Analytical Services Ltd.
Total Methylmercury	EPA 1630M	Moss Landing Marine Laboratories
Total Mercury	EPA 1631EM	Moss Landing Marine Laboratories
Copper	EPA 1638M	Brooks Rand Labs LLC
Selenium	EPA 1638M	Brooks Rand Labs LLC
Total Hardness	EPA 1638M Really?	Brooks Rand Labs LLC
Total Organic Carbon	SM 5310 C	Delta Environmental Lab LLC

Comparisons to Numeric Water Quality Objectives/Criteria for Specific Analtyes

Provision C.8.g.iii requires RMC participants to assess all data collected pursuant to provision C.8 for compliance with applicable water quality standards. In compliance with this requirement, an assessment of data collected at POC monitoring stations in Water Year 2012 is provided in the following section.[3]

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

- Freshwater vs. Saltwater - POC monitoring data were collected in freshwater receiving water bodies above tidal influence and therefore comparisons were made to freshwater water quality objectives/criteria.
- Aquatic Life vs. Human Health - Comparisons were primarily made to objectives/criteria for the protection of aquatic life, not objectives/criteria for the protection of human health to support the consumption of water or organisms. This decision was based on the assumption that water and organisms are not likely being consumed from the creeks monitored.
- Acute vs. Chronic Objectives/Criteria - For POC monitoring required by provision C.8.e, data were collected in an attempt to develop more robust loading estimates

[3] An assessment of data collected in compliance with provision C.8.c (Creek Status Monitoring) is provided in Appendix A – Regional Urban Creeks Status Monitoring Report.

from small tributaries. Therefore, detecting the concentration of a constituent in any single sample was not the primary driver of POC monitoring. Monitoring was conducted during episodic storm events and results do not likely represent long-term (chronic) concentrations of monitored constituents. POC monitoring data collected in Water Year 2012 were therefore compared to “acute” water quality objectives/criteria for aquatic life that represent the highest concentrations of an analyte to which an aquatic community can be exposed briefly (e.g., 1-hour) without resulting in an unacceptable effect. For analytes for which no water quality objectives/criteria have been adopted, comparisons were not made.

It is important to note that acute water quality objectives or criteria have only been promulgated for a small set of analytes collected at POC monitoring stations. These include objectives for trace metals (i.e., copper, selenium and total mercury). Table 5 provides a comparison of data collected in Water Year 2012 to applicable numeric water quality objectives/criteria adopted by the San Francisco Bay Water Board or the State of California for these analytes.

All samples collected in Water Year 2012 were below applicable numeric water quality objectives (i.e., freshwater acute objective for aquatic life) for mercury and selenium. Stormwater management activities are currently underway for mercury (via MRP provision C.11) and selenium (via MRP provision C.14).

With respect to copper, a total of 46% of water samples collected in Water Year 2012 were above the applicable water quality objective (i.e., freshwater acute objective for aquatic life). Samples with copper concentrations above the objective were collected from the Sunnyvale East Channel and San Leandro Creek stations. All samples collected from Lower Marsh Creek and the Guadalupe River stations fell below the objective. Copper concentrations at all stations, however, were comparable. Because copper water quality objectives are hardness dependent, excursions of copper water quality objectives in the Sunnyvale East Channel and San Leandro Creek occurred due to lower hardness concentrations (>100 mg/L) in these watersheds. Management actions designed to reduce the impacts of copper on local receiving waters are currently underway via provision C.13 of the MRP.

For all other analytes measured via POC monitoring in Water Year 2012 (e.g., pyrethroid pesticides and polycyclic aromatic hydrocarbons), the State of California has yet to adopt numeric water quality objectives applicable to beneficial uses of interest. For these analytes, an assessment of compliance of applicable water quality standards cannot be conducted at this time.

Table 5. Comparison of Water Year 2012 POC (loads) monitoring data to applicable numeric water quality objectives.

Analyte	Fraction	Numeric Water Quality Objective/Criteria	Unit	Type of Objective	Source of Objective	# of Samples > Objective				
						Sunnyvale East Channel	Guadalupe River	Lower Marsh Creek	San Leandro Creek	Total
Copper	Dissolved	13[4]	µg/L	Freshwater Acute Water Quality Objective for Aquatic Life (1-hr Average)	San Francisco Bay Water Quality Control Plan (SFBRWQCB 2011)	1/2	0/3	0/2	4/4	5/11
Selenium	Total	20	µg/L			0/2	0/3	0/2	0/4	0/11
Mercury	Total	2.1	µg/L			0/10	0/12	0/8	0/16	0/46

[4] The copper water quality objective is hardness dependent and therefore comparisons were made based on hardness values of samples collected synoptically with samples analyzed for copper. The objective presented in the table is based on a hardness of 100 mg/L.

Summary of Toxicity Testing Results

In addition to comparisons of data for specific analytes, the results of toxicity testing conducted on water samples collected during storm events in Water Year 2012 were also evaluated in the context of adopted water quality objectives. Toxicity testing was conducted at each POC monitoring station using four different types of test organisms:

- *Pimephales promelas* (freshwater fish)
- *Hyalella azteca* (amphipod)
- *Ceriodaphnia dubia* (crustacean)
- *Selenastrum capricornutum* (algae)

Both acute and chronic endpoints were recorded. A summary of toxicity results is presented in Table 6.

Table 6. Summary of Water Year 2012 toxicity testing results for POC monitoring stations.

Receiving Water	*Pimephales promelas*		*Hyalella azteca*	*Ceriodaphnia dubia*		*Selenastrum capricornutum*
	Significant Reduction in Survival	Significant Reduction in Growth	Significant Reduction in Survival	Significant Reduction in Survival	Significant Reduction in Reproduction	Significant Reduction in Growth
Sunnyvale East Channel	0/2	0/2	**2/2**	0/2	0/2	0/2
San Leandro Creek	**1/4**	0/4	**3/4**	0/4	0/4	0/4
Lower Marsh Creek	0/2	0/2	**2/2**	0/2	0/2	0/2
Guadalupe River	0/3	0/3	**2/3**	0/3	0/3	0/3
Total	**1/11**	**0/11**	**9/11**	**0/11**	**0/11**	**0/11**

Of the organisms exposed to water collected from POC monitoring stations in Water Year 2012, consistent toxicity was only observed for the amphipod *Hyalella azteca* (9 of 11 samples). For all other organisms, a toxic endpoint was observed in only 1 of 55 endpoints (acute and chronic) calculated.

Observations of toxicity to *H. azteca* are similar to those from recent wet weather monitoring conducted in Southern California (Riverside County 2007, Weston Solutions 2006), the Imperial Valley (Phillips et al. 2007), the Central Valley (Weston and Lydy 2010a, b), and the Sacramento-San Joaquin Delta (Werner et al., 2010), where follow up toxicity identification evaluations indicated that pyrethroid pesticides were almost certainly the cause of the toxicity observed. Based on recent studies conducted in California receiving waters, pyrethroid pesticides have also been identified as the likely current causes of sediment toxicity in urban creeks (Amweg et al. 2005, Weston and Holmes 2005, Anderson et al. 2010). These results are not unexpected given that *H. azteca* is considerably more sensitive to pyrethroids than other species tested as part of the POC monitoring studies (Palmquist 2008).

To further explore the potential causes of toxicity to *H. azteca* in the nine samples, pyrethroid concentrations in samples collected at the same time as those exhibiting toxicity were compiled and compared to thresholds (i.e., LC50s) known to be lethal to *H. azteca*. LC50s were identified through a review of the scientific literature and are only available for a limited number of types of pyrethroids.[5] The results of these comparisons are provided in Table 7.

Table 7. Water quality samples with observed toxicity to *Hyalella azteca* AND concentrations of pesticides detected.

Location	Sample Date	Mean % Survival of test organism s (*Hyalella azteca*)	Bifenthrin	Cyfluthrin	Cypermethrin	Delta/Tralomethrin	Permethrin	Carbarlyl
	Effects Concentration (LC50s in ng/L)		*7.7[a]*	*2.3[a]*	*2.3[a]*	*10[b]*	*48.9[c]*	*2100[d]*
Sunnyvale East Channel	3/24/2012	**10%**	-	-	-	-	5.79	21
	4/12/2012	87.5%	8.0	-	-	1.42	20.9	11
Guadalupe River	1/21/2012	84%	12.8	-	-	2.11	20.2	-
	3/27/2012	87.5%	-	-	-	0.704	19.5	13
Lower Marsh Creek	1/21/2012	**0%**	272.0	-	81.8	6.78	18.6	16
	3/17/2012	**0%**	241.0	-	-	0.954	3.81	-
San Leandro Creek	2/29/2012	**16%**	-	-	-	1.41	13.1	10
	3/14/2012	**36%**	17.4	-	-	0.326	3.65	-
	3/16/2012	58%	32.4	-	-	1.74	7.49	-
Total # > Adverse Water Quality Threshold			6	0	1	0	0	

[a] As reported by D. Weston, University of California, Berkeley.
[b] LC50 values for *Hyalella azteca* unavailable. LC50 values listed are for *Daphnia magna* as reported by Xiu et al. (1989).
[c] Brander et al. (2009)
d USEPA (2012).
Bolded toxicity values represent those <50% of the control value, the threshold trigger applied to creek status toxicity results (see Appendix A)
Shaded cells represent concentrations >LC50 values
Dashes represent concentrations less than method detection limits

Results suggest that the concentration of one or more pyrethroid pesticides was consistently above levels known to cause significant reduction in the survival to *H. azteca*. Specifically, observed concentrations of bifenthrin were greater than LC50s in all but three of the nine samples collected at the same time that significant toxicity was observed.

Given the results of previous toxicity studies conducted in receiving waters throughout California, it appears highly likely that pyrethroids could have caused toxicity to *H. azteca* observed in Water Year 2012. Management actions designed to reduce the impacts of pesticide-related toxicity are outlined in the TMDL and Water Quality Attainment Strategy for Diazinon and Pesticide-related Toxicity in Urban Creeks TMDL, and are currently underway via provision C.9 of the MRP.

[5] Adverse effects concentrations for pyrethroids presented in Table 7 are not adopted water quality objectives and should not be used to draw conclusions about compliance with water quality standards. The comparison contained in this table is only intended to facilitate an evaluation of the potential need for further evaluation of the stressors causing the toxicity.

Water Year 2013 POC Monitoring Stations

The STLS team is sampling a total of six POC monitoring stations in Water Year 2013 (October 2012 – September 2013). In addition to the four POC monitoring stations monitored in Water Year 2012, the STLS selected an additional two stations and began conducting monitoring in October 2012. The two stations are located near two stormwater pump stations in the cities of San Carlos (San Mateo County) and Richmond (Contra Costa County). The San Carlos POC monitoring station is directly upstream of the Pulgas Pump Station and receives runoff from a watershed with PCB sources that are currently under investigation via studies being conducted as part of the Clean Watersheds for a Clean Bay (CW4CB) project. The station in Richmond is located at the North Richmond Pump Station, which drains an industrial area of the city.

Samples collected at Water Year 2013 stations are being analyzed for analytes listed in Table 4. Additional information on the sampling procedures and analytes is provided in the updated version of the STLS Multi-Year Plan, which is included as **Appendix D1**.

B. Long-Term Trends Monitoring (C.8.e)

In addition to POC loads monitoring, Provision C.8.e requires Permittees to conduct long-term trends monitoring to evaluate if stormwater discharges are causing or contributing to toxic impacts on aquatic life. Required long-term monitoring parameters, methods, intervals and occurrences are included as Category 3 parameters in Table 8.4 of the MRP, and prescribed long-term monitoring locations are included in Table 8.3. Similar to creek status and POC loads monitoring, long-term trends monitoring was scheduled to begin in October 2011 for RMC participants.

As described in the *RMC Creek Status and Trends Monitoring Plan* (BASMAA 2011), the State of California's Surface Water Ambient Monitoring Program (SWAMP) through its Statewide Stream Pollutant Trend Monitoring (SPoT) Program currently monitors the seven long-term monitoring sites required by Provision C.8.e.ii. Sampling via the SPoT program is currently conducted at the sampling interval described in Provision C.8.e.iii in the MRP. The SPoT program is generally conducted to answer the management question:

- What are the long-term trends in water quality in creeks?

Based on discussions with Region 2 Water Board (SWAMP) staff, RMC participants are complying with long-term trends monitoring requirements described in MRP provision C.8.e via monitoring conducted by the SPoT program. This manner of compliance is consistent with the MRP language in provisions C.8.e.ii and C.8.a.iv.[6] Based on discussions with staff coordinating the SPoT program, a technical report on 2009-2010 data is currently under review and will be released to the public in 2013. During 2013, RMC representatives will continue to coordinate with the SPoT program on long-term monitoring to ensure MRP monitoring and reporting requirements are addressed. Additional information on the SPoT program can be found at http://www.waterboards.ca.gov/water_issues/programs/swamp.

[6] MRP Provision C.8.a.iv "Third Party Monitoring" states that where an existing third-party organization has initiated plans to conduct monitoring that would fulfill one or more requirements of Provision C.8 but the monitoring would not meet MRP due date(s) by a year or less, the Permittees may request that the Executive Officer adjust the due date(s) to synchronize with such efforts.

C. Sediment Delivery Estimate/Budget (C.8.e.vi)

Provision C.8.e.(vi) of the MRP requires Permittees to develop a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages, and implement the study by July 1, 2012. The purpose of the sediment delivery estimate is to improve the Permittees' ability to estimate urban runoff contributions to loads of POCs, most of which are closely associated with sediment. To determine a strategy for a robust sediment estimate/budget, RMC representatives reviewed recent sediment delivery estimates developed by the RMP, and determined that these objectives will be met through sediment-specific modeling with the regional watershed model. The implementation of the sediment delivery/budget study is occurring in coordination with the STLS Multi-Year Plan. BASMAA-funded sediment work will also enhance the model development for PCBs and other sediment-bound POCs. A more detailed work plan and schedule for the integration of the sediment load estimation with other regional watershed modeling work is included as **Appendix D1**.

D. Emerging Pollutants Work Plan

In compliance with Provision C.8.e.v, Permittees are required by March 2014 to develop a work plan and schedule for initial loading estimates and source analyses for the following emerging pollutants:

1) Endocrine-disrupting compounds;
2) Perfluorooctane Sulfonates (PFOS);
3) Perfluoroalkyl Sulfonates (PFAS); and,
4) Nonylphenols/nonylphenol esters —estrogen-like compounds (NP/NPEs).

The intent of the work plan is to begin planning for implementation during the next permit term (i.e., post December 2014).

BASMAA representatives to the STLS Team will coordinate efforts with the Emerging Contaminants Strategy being developed by the RMP through the Master Planning process. The compliance date for completion of this work plan is in 2014. Initial discussions of the scope of this project were conducted by the RMC participants during this reporting period.

SECTION 6 - CITIZEN MONITORING AND PARTICIPATION (C.8.f)

Participants of the RMC, to varying degrees, currently coordinate with or support citizen monitors and watershed groups within their geographical areas. As a result, relationships have been developed between RMC participants and citizen monitors. In the first part of Water Year 2012, RMC participants began sharing information and ideas about varying approaches to encourage citizen monitoring and seek out stakeholder participation and comment at MPC meetings. The variety of potential or planned activities discussed by various Programs and Permittees include:

- encouraging citizen input via interactive website;
- funding volunteer monitoring through grants to groups;
- providing direct assistance to citizen monitoring efforts; and,
- compiling information on various citizen monitoring efforts for incorporation in annual reports.

The following sections provide brief overviews of activities conducted by RMC participants in compliance with provision C.8.f of the MRP in Water Year 2012.

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

During the period from October 2011 through September 2012, ACCWP staff communicated with members of two creek groups with interests in water quality monitoring:

- ACCWP coordinated its deployment of six continuous temperature loggers in the Sausal Creek watershed with the Friends of Sausal Creek (FOSC) to encourage the group's pilot effort at redesigning their volunteer-based water quality monitoring program. A member of the FOSC Board of Directors accompanied ACCWP's consultant team to determine deployment locations and presented the temperature monitoring results of the FOSC's annual membership meeting on the "State of the Creek." FOSC volunteers will continue temperature monitoring at selected sites during the summer of 2013. While FOSC volunteer monitoring data are not completely SWAMP-comparable, they will be used to assist in broader interpretation of Creek Status results in the Integrated Monitoring Report.

  The FOSC volunteer coordinator for Aquatic Insect Monitoring was invited as an observer to a training on SWAMP bioassessment protocols that was held at Sausal Creek in spring 2012 for RMC contractors. The FOSC volunteers use an educational Streamside Survey protocol as part of educational outreach to schoolchildren.

- ACCWP staff attended a meeting of Friends of San Leandro Creek in fall 2011 with a presentation on the Pollutants of Concern Loads Monitoring station, discussed future presentation of station monitoring results, and also provided preliminary summary of the turbidity results to the group's Watershed Awareness Coordinator in response to interest in learning more about sources and impacts of suspended sediment in the creek.

CONTRA COSTA CLEAN WATER PROGRAM

The Contra Costa Clean Water Program supports citizen and volunteer involvement with monitoring through partnering with Contra Costa County in support of the Community Watershed Stewardship Grant. This funding source was established to fund various creek restoration and education projects throughout unincorporated areas of the County. The grant process is administered by a non-profit watershed organization. Grants are awarded annually in the amount of $5,000 - $20,000 per project. Typical Projects include, but are not limited to:

- Pollution Prevention Projects
- Trash Mitigation & Removal
- Watershed Education
- Watershed Group Coordination
- Low-Impact Design Projects

Eighty percent of the funds are allocated to projects that demonstrate a benefit to the unincorporated regions of the County and 20% to projects in the incorporated cities of Contra Costa County.

Funding watershed coordinators establishes a nexus between the Community Watershed Grant program and citizen monitoring. Watershed coordinators are the first point of contact to organize citizen groups who are interested in participating in stream assessments, creek cleanups, and other volunteer activities.

FAIRFIELD-SUISUN URBAN RUNOFF MANAGEMENT PROGRAM

The Fairfield Suisun Urban Runoff Management Program contracts with Solano Resource Conservation District to implement the Watershed Explorers Program. The Watershed Explorers Program utilizes science and placed-based learning to build awareness and understanding of local creeks and watersheds, their unique ecosystems and ways in which we care for them. In-the-field discussions and activities teach children about the fragile habitats for fish and other wildlife. Students learn the importance of water quality in their watersheds and discover the impacts of runoff and its components: trash, oil, household chemicals and other human and domestic animal waste and discards. Concepts are directly linked to the California State Standards and the program offers local children, many of whom have little or no experience being in open space settings, a concrete, experiential introduction to their watershed and creatures that inhabit it.

The primary program goal is to help students develop an awareness of the outdoor, natural world. Participants leave the program:

- understanding the impact of stormwater on their watershed, particularly the impacts of oil, chemicals and human debris in stormwater;
- learning individual stewardship practices in their watershed, for example, how they can mitigate or eliminate the impacts of their own and their families' behavior around stormwater protection and water quality;
- flagging problem areas that might require further investigation.

Field trips are followed with a classroom session where students solidify what they have learned and talk about the ramifications of human behavior on creek, marine and marsh health. Students are provided with manuals that are aligned with the California Science Standards.

Measurements are made and explained in the field, by the instructor, using an array of monitoring tools including bioassessment tools, multimeters, colorimeters and pH paper. The location where the data was collected is high in the watershed on Union Creek in Fairfield.

The City of Fairfield recently obtained a grant for this location to construct a Nature Center along this portion of Union Creek to protect the creek and educate the public.

SAN MATEO WATER POLLUTION PREVENTION PROGRAM

In 2012, SMCWPPP staff reviewed multiple sources of water quality data collected by organizations that incorporate citizen monitoring data to identify areas most suitable for monitoring several C.8.c parameters: pathogen indicators, water temperature, and water quality. These organizations included the San Mateo County Resource Conservation District, Monterey Bay National Marine Sanctuary, Surfrider Foundation San Mateo County Chapter, San Pedro Creek Watershed Coalition, San Gregorio Environmental Resource Center, Pacifica Beach Coalition, Half Moon Bay Coastside Foundation, San Mateo County Department of Health Services, and Acterra. SMCWPPP staff focused on Pilarcitos Creek for monitoring temperature and water quality and coordinated with the Pilarcitos Creek Restoration Workgroup to identify appropriate monitoring locations. Water quality monitoring results were discussed with the Workgroup in the context of their watershed planning at a meeting held on December 10, 2012. Countywide Program staff coordinated with Acterra on several issues: 1) discussed water quality conditions at their restoration site in San Mateo County on Arroyo Ojo de Agua Creek – this site was selected as a pathogen indicator monitoring site; 2) discussed providing in-kind technical support for water quality methods including toxicity and pathogen indicator sampling; 3) encouraged them to submit a grant to USEPA to expand their Riparian Restoration/Water Quality Outreach and Monitoring Program; 4) provided contacts to other watershed groups conducting monitoring in San Mateo County and encouraged them to also contact these groups for technical advice and as potential collaborators in monitoring and grant applications.

SANTA CLARA VALLEY URBAN RUNOFF POLLUTION PREVENTION PROGRAM

In Water Year 2012, the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), City of Sunnyvale, City of Cupertino and City of Mountain View continued to assist the Stevens Permanente Creek Watershed Council (SPCWC) in implementing a grant that funds a volunteer monitoring program. The grant was received by the SPCWC for funding under the Santa Clara Valley Water District's (SCVWD) Watershed Stewardship Grant Program. The grant application was accepted by the SCVWD and the volunteer monitoring program was implemented in 2011 and 2012. In support of the volunteer monitoring program, SCVURPPP provided the following in□kind services (in addition to Co□permittee support): 1) technical support for the implementation of both field and laboratory methods and equipment used by volunteers; 2) reviewing and commenting on monitoring data results and summary reports; 3) participation in SPCWC meetings and events; and 4) promotion of SPCWC□sponsored activities through the SCVURPPP website and/or other electronic media.

In Water Year 2013, SCVURPPP intends to continue working with SPCWC, which is now coordinated through Acterra, a non-profit organization that assists in managing community-based environmental activities.

SECTION 7 – REPORTING, DATA QUALITY AND DATA MANAGEMENT (C.8.g&h)

Provision C.8.g requires Permittees to report annually on water quality data collected in compliance with the MRP. Annual reporting requirements include: 1) water quality standard exceedances; 2) creek status monitoring electronic reporting; and, 3) urban creeks monitoring reporting. For RMC participants, annual reporting requirements began with the initial creek status monitoring electronic data submittal to the Water Board that occurred on January 15, 2013. Preliminary evaluations of data compared to water quality objectives were included in these submittals. Additional evaluations of data collected pursuant to provision C.8 are included in this Urban Creeks Monitoring Report and associated appendices.

Provision C.8.h requires that water quality data collected by Permittees in compliance with the MRP should be of a quality that is consistent with the State of California's Surface Water Ambient Monitoring Program (SWAMP) standards, set forth in the SWAMP Quality Assurance Project Plan (QAPP). To assist Permittees in meeting SWAMP data quality standards and developing data management systems that allow for easy access of water quality monitoring data by Permittees, the RMC made significant progress on the following regional projects during the period of this report:

- Standard Operating and Data Quality Assurance Procedures – With regards to POC monitoring, a draft field manual and quality assurance project plan (QAPP) for POC loads monitoring are currently under development through the STLS Team and described in the Multi-Year Plan (**Appendix D1**). The Field Manual and QAPP will be completed in Water Year 2013. For creek status monitoring, the RMC adapted existing creek status monitoring SOPs and QAPP developed by SWAMP to document the field procedures necessary to maintain comparable, high quality data among RMC participants. Final draft deliverables were completed in Water Year 2012 prior to field work and will be updated later in Water Year 2013 after final coordination with the Creek Status Monitoring Information Management System described below.

- Information Management System Development/Adaptation – RMC participants would like to store and manage water quality data collected in compliance with Provision C.8 in a cost effective manner that provides data users easy access. Therefore, two regional projects occurred in Water Year 2012 that developed two Information Management Systems – one for POC Monitoring and one for Creek Status and Trends Monitoring. The systems provide standardized data storage formats, thus providing a mechanism for sharing data among RMC participants and efficient submittal of data electronically to the Water Board per provision C.8.g. Each data management system is being updated in Water Year 2013 to increase their efficiencies.

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Appendices

A **Regional Urban Creeks Status Monitoring Report (Provision C.8.c)**

B **Local Urban Creeks Status Monitoring Reports (Provision C.8.c)**

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Appendix A

Regional Urban Creeks Status Monitoring Report (Provision C.8.c)

BASMAA
Regional Monitoring Coalition

Regional Urban Creeks Status Monitoring Report
Water Year 2012 (October 1, 2011 – September 30, 2012)

Prepared for:

The Bay Area Stormwater Management Agencies Association

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March 15, 2013

Preface

This BASMAA Regional Monitoring Coalition (RMC) Regional Urban Creeks Status Monitoring Report was developed in compliance with the Municipal Regional Permit (MRP) Reporting Provision C.8.g for Status Monitoring data (Provision C.8.c) collected between in Water Year 2012 (October 1, 2011 and September 30, 2012) through the RMC's probabilistic design.

The following RMC participants[1] contributed data to this report:

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

As described in the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011), RMC participants collected data by implementing Standard Operating Procedures in accordance with the Quality Assurance Program Plan (QAPP). Analytical laboratory analyses were also conducted under the direction of RMC participants. The quality of all data presented in this report, therefore are assured by RMC participants, and not the authors.

In addition to the RMC participants, San Francisco Bay Regional Water Quality Control Board staff, Kevin Lunde and Jan O'Hara, also participated in RMC workgroup meetings that contributed to design and implementation of the RMC Monitoring Plan. Additionally, these staff also provided input to the outline of this report and threshold trigger analyses conducted herein.

[1] The cities of Fairfield, Suisun City and Vallejo are RMC participants but not required, under the MRP, to collect data until Water Year 2013.

List of Acronyms

ACCWP	Alameda Countywide Clean Water Program
AFDM	Ash Free Dry Mass
BASMAA	Bay Area Stormwater Management Agencies Association
B-IBI	Benthic Index of Biological Integrity
BMI	Benthic Macroinvertebrates
CCCWP	Contra Costa Clean Water Program
CDFG	California Department of Fish and Game
CTR	California Toxics Rule
DW	Dry Weight
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
FSURMP	Fairfield Suisun Urban Runoff Management Program
GIS	Geographic Information System
GRTS	Generalized Random Tesselated Stratified
IBI	Index of Biological Integrity
LC50	Lethal Concentration to 50% of test organisms
MCL	Maximum Contaminant Level
MPC	BASMAA Monitoring and Pollutants of Concern Committee
MQO	Measurement Quality Objective
MRP	Municipal Regional Permit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ND	Non-Detect
NorCal B-IBI	Northern California Benthic Index of Biological Integrity
NPDES	National Pollution Discharge Elimination System
NT	Non-Target
PAH	Polycyclic aromatic hydrocarbon
PEC	Probable Effects Concentration
PHab	Physical Habitat Assessment
POC	Pollutants of Concern
PRM	Pathogen-Related Mortality
PSA	Perennial Streams Assessment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RL	Reporting Limit
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RPD	Relative Percent Difference
RWB	Reach-Wide Benthos
RWQCB	Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Project
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFRWQCB	San Francisco Regional Water Quality Control Board
SMC	Southern California Stormwater Monitoring Coalition

SMCWPPP	San Mateo County Water Pollution Prevention Program
SoCal B-IBI	Southern California Benthic Index of Biological Integrity
SOP	Standard Operating Procedure
STLS	Small Tributaries Loading Strategy
SWAMP	Surface Water Ambient Monitoring Program
TEC	Threshold Effects Concentrations
TKN	Total Kjeldahl Nitrogen
TNS	Target Not Sampled
TOC	Total Organic Carbon
TS	Target Sampled
U	Unknown
USEPA	United States Environmental Protection Agency
TU	Toxicity Unit
WQ	Water Quality
WY	Water Year

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Executive Summary

This report presents the results of creek status monitoring conducted during Water Year (WY) 2012 (October 1, 2011 - September 30, 2012) by the Regional Monitoring Coalition (RMC), using a probabilistic monitoring design. The RMC was formed by members of the Bay Area Stormwater Management Agencies Association (BASMAA) to assist member agencies in fulfilling requirements of Provision C.8 of the Municipal Regional Stormwater National Pollutant Discharge Elimination System Permit (MRP; SFBRWQCB 2009). Certain creek status monitoring parameters were addressed on a regional basis using the probabilistic design and are included in this report. Other parameters were addressed using a targeted design, with regional coordination and common methodologies. These parameters are reported in separate “local” urban creeks status monitoring reports developed individually by each RMC participating program.

During WY 2012, 60 sites were monitored regionally under the probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Ten of the 60 sites were also monitored for water and sediment toxicity and sediment chemistry. The bioassessment and related data were used to develop a preliminary condition assessment for the monitored creeks, and the water and sediment chemistry and toxicity data were used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses. The probabilistic design requires at least three years to produce sufficient data to develop a statistically-robust characterization of regional creek conditions, so the analysis and interpretation that can be completed with the first year’s data are necessarily limited.

The following MRP reporting requirements (per Provision C.8.g.iv) are addressed within this report:

- Descriptions of monitoring purpose and study design rationale
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data;
- Descriptions of sampling protocols and analytical methods;
- Tables and Figures describing: Sample location descriptions (including waterbody names, and lat/longs); sample ID, collection date (and time where relevant), media (e.g., water, filtered water, bed sediment, tissue); concentrations detected, measurement units, and detection limits;
- Data assessment, analysis, and interpretation for Provision C.8.c.;
- Pollutant load and concentration at each mass emissions station;
- A listing of volunteer and other non-Permittee entities whose data are included in the report;
- Assessment of compliance with applicable water quality standards; and,
- A signed certification statement.

Principal findings of the limited, preliminary condition assessment that can be derived based on the WY 2012 RMC bioassessment data are as follows:

- Bioassessment metrics for the 60 sites sampled within the RMC area during the spring index period (April 15 – June 15, 2012) exhibited a wide range of community composition, based on the results of benthic macroinvertebrate (BMI) taxonomic analyses.
- Using the Southern California benthic index of biological integrity (SoCal B-IBI) as a multi-metric measure of BMI communities, 43% of the sites scored in the very poor condition category, 32%

in the poor category, 12% in the fair category, 10% in the good category, and 3% in the very good category. All nonurban sites scored in the top condition category achieved (either good or very good) for the respective County.

- Comparative analysis of the BMI metrics indicates that there are significant differences between the benthic communities in urban vs. non-urban sites.
- Pollutant tolerant diatom taxa comprised a total of 33% of the regional RMC sample, while pollutant intolerant diatom taxa comprised 27% of the sample.

The initial condition assessment for the urban portion of the RMC area, based on the WY 2012 RMC bioassessment data, is summarized as follows:

- Analyses of benthic macroinvertebrates sampled in the RMC area consistently indicated lower quality biological integrity in urban areas compared to nonurban areas of the RMC sample frame.
- Preliminary analyses of algae metrics sampled in the RMC area did not indicate significant differences between urban and nonurban areas of the RMC.

The stressor analysis revealed the following potential stressors, based on an analysis of the first year RMC data:

- **Nutrients (and Conventional Constituents):** The MRP Table 8.1 trigger criterion for "Nutrients" (20% of results in one waterbody exceed one or more water quality standards or applicable thresholds) was considered to be met at only one of the 60 monitoring sites.
- **Water Toxicity:** Of the 10 sites sampled, four water samples exhibited results "< 50% of Control" and therefore should be resampled and retested, per MRP Table 8.1. Following the retesting, a determination should be made as to whether the results meet the MRP Table 8.1 trigger criteria, and if the results should then be applied to the requirements specified in Provision C.8.d.i (stressor/source identification projects).
- **Sediment Toxicity:** At two sites, sediment toxicity results were more than 20% less than the control, meeting the MRP Table 8.1 trigger criterion.
- **Sediment Chemistry:** Sediment chemistry results produced evidence of potential stressors in three ways, based on the criteria from MRP Table H-1:
  - At nine of ten sites, three or more constituents had TEC quotients greater than or equal to 1.0.
  - At two of ten sites, the mean PEC quotient was greater than 0.5.
  - At seven of ten sites, the sum of TU equivalents for all measured pyrethroids was greater than 1.0.

The sediment chemistry and toxicity results were evaluated along with the bioassessment B-IBI scores per Appendix H-1 of the MRP. Eight of ten sites were identified as sites that should be considered for stressor/source identification projects.

The trigger analysis identified a number of sites that may deserve further investigation to provide better understanding of the sources/stressors likely contributing to reduce ecological condition in Bay Area creeks. RMC participants will consider these sites as potentially suitable for stressor/source identification projects in the near future. Evaluation of potential stressor/source identification projects is a high priority for the RMC following completion of this report. Per MRP Provision C.8.d.i, follow-up stressor/source identification projects shall be initiated as soon as possible and must begin no later than the second fiscal year following the sampling event that triggered the project.

1.0 Introduction

This report fulfills a portion of the reporting requirements of Provision C.8.g.iii of the Bay Area Municipal Regional Stormwater National Pollutant Discharge Elimination System Permit (MRP; SFBRWQCB 2009) for creek status monitoring data produced pursuant to MRP Provision C.8.c during Water Year 2012 (October 1, 2011 - September 30, 2012) under a regional probabilistic design. The regional probabilistic design was developed and implemented by the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC). Provision C.8.c data collected at targeted sites (not included in the probabilistic design) are reported in separate "local" reports developed by RMC participants and submitted as part of the larger Urban Creeks Monitoring Report.

The RMC was formed in early 2010 as a collaboration among several BASMAA members and all MRP Permittees (Table 1-1) to focus on development and implementation of a regionally-coordinated water quality monitoring program. The intent of the regional monitoring effort is to improve stormwater management in the region and address water quality monitoring required by the MRP[2]. Through its implementation, the RMC allows Permittees and the San Francisco Regional Water Quality Control Board (SF Bay RWQCB) to effectively modify their previously creek monitoring programs and improve their collective ability to answer core management questions in a cost-effective and scientifically rigorous way. Participation in the RMC is coordinated by county stormwater programs and or Permittee representatives (or equivalent), and facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC). The RMC Work Group is a subgroup of the MPC that meets and communicates regularly to coordinate planning and implementation of monitoring. This workgroup includes staff from the SF Bay RWQCB 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).

[2] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) issued the five-year MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFRWQCB 2009). 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. Note that the RMC regional monitoring design was expanded to include the portion of eastern Contra Costa County that drains to the San Francisco Bay in order to assist the CCCWP in fulfilling parallel provisions in their NPDES permit from the Region 5 SF Bay RWQCB.

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, 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 of the RMC are to:

1. Assist Permittees[3] in complying with requirements in MRP Provision C.8 (Water Quality Monitoring);
2. Develop and implement regionally consistent creek monitoring approaches and designs in the San Francisco Bay Area, through the improved coordination among RMC participants, SF Bay RWQCB[4] and other agencies with common goals; and
3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining reporting.

The RMC addresses the scope of subprovisions specified in MRP Provision C.8 (Table 1-2). This report presents and discusses results of Creek Status Monitoring conducted using a regional ambient (probabilistic) monitoring design to comply with Provision C.8.c (Table 1-3). The list of parameters in Table 1-3 derive from the MRP Table 8.1 (SFBRWQCB 2009, BASMAA 2012A, 2012B)[5].

[3] For the CCCWP this includes addressing the eastern portion of Contra Costa County that drains to the San Francisco Bay that is within the jurisdiction of the Region 5 Regional Water Quality Control Board.

[4] The intent is to coordinate with SF Bay RWQCB staff working regionally with the State of California's Surface Water Ambient Monitoring Program (SWAMP).

[5] MRP provision C.8.a.i states in reference to all subsections of C.8 that "provided these datatypes, quantities, and quality are obtained, a regional monitoring collaborative may develop its own sampling design".

Table 1-2. Municipal Regional Permit Provisions addressed by the Regional Monitoring Coalition.

Subprovision	Subprovision Title	Reporting Document
C.8.a	Compliance Options	• Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan (BASMAA 2011)
C.8.b	San Francisco Bay Estuary Monitoring	• Regional Monitoring Program Annual Monitoring Results (www.sfei/rmp.org)
C.8.c	**Creek Status Monitoring**	• **Regional Urban Creeks Status Monitoring Report** • Local Urban Creeks Status Monitoring Reports (Appendix B)
C.8.d	Monitoring Projects	
	• Stressor/Source Identification	• Stressor/Source Identification Reports
	• BMP Effectiveness Investigation	• BMP Effectiveness Reports
	• Geomorphic Project.	• Integrated Monitoring Report (2014)
C.8.e	Pollutants of Concern (Loads) and Long-Term Trends Monitoring	• Small Tributaries Loading Strategy (STLS) Multi-Year Monitoring Plan (Version 2012) • Pollutants of concern (POC) loads monitoring data progress report (Water Year 2012) (Appendix D)
C.8.f	Citizen Monitoring and Participation	• Urban Creeks Monitoring Report (Main Body)
C.8.g	Data Analysis and Reporting	• Urban Creeks Monitoring Report (Main Body) • Individual Monitoring Reports

Table 1-3. Creek Status Monitoring Parameters sampled in compliance with MRP Provision C.8.c. and the associated reporting format.

Biological Response and Stressor Indicators	Monitoring Design		Reporting	
	Regional Ambient (Probabilistic)	Local (Targeted)	Regional	Local
Bioassessment & Physical Habitat Assessment	X		X	
Chlorine	X		X	
Nutrients	X		X	
Water Toxicity	X		X	
Sediment Toxicity	X		X	
Sediment Chemistry	X		X	
General Water Quality		X		X
Temperature		X		X
Bacteria		X		X
Stream Survey		X		X

Data presented in this report were collected between October 1, 2011 and September 30, 2012, referred to hereafter as "Water Year 2012". The majority of these data were collected by RMC participants to comply with Permit provision C.8.c., however, coordination with staff from the SF Bay RWQCB also resulted in their sampling[6] an additional six sites in three counties (see Section 2.0).

Prior to formation of the RMC, San Francisco Bay Area stormwater programs implemented monitoring designs that targeted creek reaches of interest to address site-specific management questions. Because the representativeness of such targeted data was unknown, the overall condition of all creek reaches in the Bay Area was also unknown. The RMC addressed this issue by augmenting targeted monitoring

[6] Due to the timing of SF Bay RWQCB data processing and analysis, these data could not be included in this report and instead will be included in the Integrated Monitoring Report, to be submitted to the SF Bay RWQCB in 2014.

designs with an ambient (probabilistic) creek status design that integrates many elements of the individualized monitoring programs that currently exist in the region.

The probabilistic monitoring design described in subsequent sections of this report complies with MRP Provision C.8.c[7] by addressing the core monitoring questions listed below, which are further elaborated upon later in this report. This monitoring designs allow each individual RMC participating program to assess stream ecosystem conditions within its program area (County boundary) while contributing data to answer regional management questions about water quality and beneficial use condition in San Francisco Bay Area creeks.

1. What is the condition of aquatic life in creeks in the San Francisco Bay Area; are water quality objectives met and are beneficial uses supported?
2. What are the major stressors[8] to aquatic life?
3. What are the long-term trends in water quality in creeks over time?

The remainder of this appendix to the RMC Urban Creeks Monitoring Report addresses Study Area and Monitoring Design (Section 2.0), Data collection and analysis methods (Section 3.0), results and data interpretation (Section 4.0), conclusions and Next Steps (Section 5.0). More specifically, this report includes the standard report content as required by MRP Provision C.8.g.vi in the respective sections referenced in Table 1-4.

Table 1-4. Index to Standard Report Content per MRP Provision C.8.g.vi.

Report Section	Standard Report Content
2.0	Monitoring purpose and study design rationale
3.0	Sampling protocols and analytical methods
3.5, Attachment B	QA/QC summaries for sample collection and analytical methods
2.1,	Sample location descriptions, sample dates, IDs
4.0	Sample concentrations detected, measurement units, detection limits
4.0	Data assessment, analysis and interpretation
NA[9]	List of volunteer and other non-Permittee entities whose data are included in the report.
5.0	Assessment of compliance with applicable water quality standards

[7] The MRP states that Provision C.8.c status monitoring is intended to answer the following questions: "Are water quality objectives, both numeric and narrative, being met in local receiving waters, including creeks, rivers and tributaries?"; "Are conditions in local receiving waters supportive of or likely to be supportive of beneficial uses?". The management questions described in this plan are intended to answer the questions posed in the MRP.

[8] Stressors are interpreted per MRP Table 8.1 (SFBRWQCB 2009) as results that "trigger" a specified threshold.

[9] Data collected by the San Francisco Regional Water Quality Control Board in Water Year 2012 coordination with the RMC were not available for inclusion in this report.

2.0 Study Area & Monitoring Design

2.1 RMC Area

Status and trends monitoring was conducted in non-tidally influenced, flowing water bodies (i.e., creeks, streams and rivers) interspersed among 3,407 square miles of land in the RMC area. The water bodies monitored were drawn from a master list that included all perennial and non-perennial creeks and rivers that run through urban and non-urban areas within the portions of the five participating counties that fall within the SF Bay RWQCB boundary, and the eastern portion of Contra Costa County that drains to the Central Valley Regional Board (Figure 2-1). A total of 66 sites were sampled in 2012 by RMC participants and SF Bay RWQCB staff (Table 2-1), however, only RMC sites (N=60) are reported herein because the timing of SF Bay RWQCB sample collection processing and analysis does not meet the MRP reporting deadline for the RMC.

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 (SFBRWQCB 2009). The regional design was developed using the Generalized Random Tessellation Stratified (GRTS) approach developed by the United States Environmental Protection Agency (USEPA) and Oregon State University (Stevens and Olson 2004). GRTS offers multiple benefits for coordinating amongst monitoring entities including the ability to develop a spatially balanced design that produces statistically representative data with known confidence intervals. The GRTS approach has been implemented recently in California by several agencies including the statewide Perennial Streams Assessment (PSA) conducted by SWAMP (Ode et al. 2011) and the Southern California Stormwater Monitoring Coalition's (SMC) regional monitoring program conducted by municipal stormwater programs in Southern California (SMC 2007). For the purpose of developing the RMC's probabilistic design, the RMC area is considered to represent the "sample universe".

2.2.1 Site Selection

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[10] (BASMAA 2011). This approach was agreed to by SF Bay RWQCB staff during RMC workgroup meetings although it differs from that specified in MRP Provision C.8.c.iv., e.g., sampling on the basis of individual watersheds in rotation and selecting sites to characterize segments of a waterbody(s). The sample frame includes non-tidally influenced perennial and non-perennial creeks within five management units representing areas managed by the storm water programs associated with the RMC. The sample frame was stratified by management unit to ensure that MRP Provision C.8.c sample size requirements (SFBRWQCB 2009) would be achieved.

The National Hydrography Plus Dataset (1:100,000) was selected as the creek network data layer to provide consistency with both the Statewide PSA and the SMC, and the opportunity for future data coordination with these programs. The RMC sample frame was classified by county and land use (i.e., urban and non-urban) to allow for comparisons between these strata. Urban areas were delineated by combining urban area boundaries and city boundaries defined by the U.S. Census (2000). Non-urban

[10] Based on discussion during RMC Workgroup meetings, with SF Bay RWQCB staff present, the sample frame was extended to include the portion of Eastern Contra Costa County that drains to the San Francisco Bay in order to address parallel provisions in CCCWP's Region 5 Permit for Eastern Contra Costa County. Reporting on data collected for that permit, other than those collected via the RMC, however, is outside the scope of this report.

areas were defined as the remainder of the areas within the sample universe (i.e., RMC area). Based on discussion during RMC Workgroup meetings, with SF Bay RWQCB staff present, RMC participants weighted their sampling efforts so that annual sampling efforts are approximately 80% in urban areas and 20% in non-urban areas for the purpose of comparison (Figures 2-2 to 2-5). RMC participants coordinated with the SF Bay RWQCB by identifying additional non-urban sites from their respective counties for SWAMP sampling. Table 2-1 lists land use stratum and target latitude and longitude for each 2012 probabilistic monitoring site as identified through the RMC sample draw.

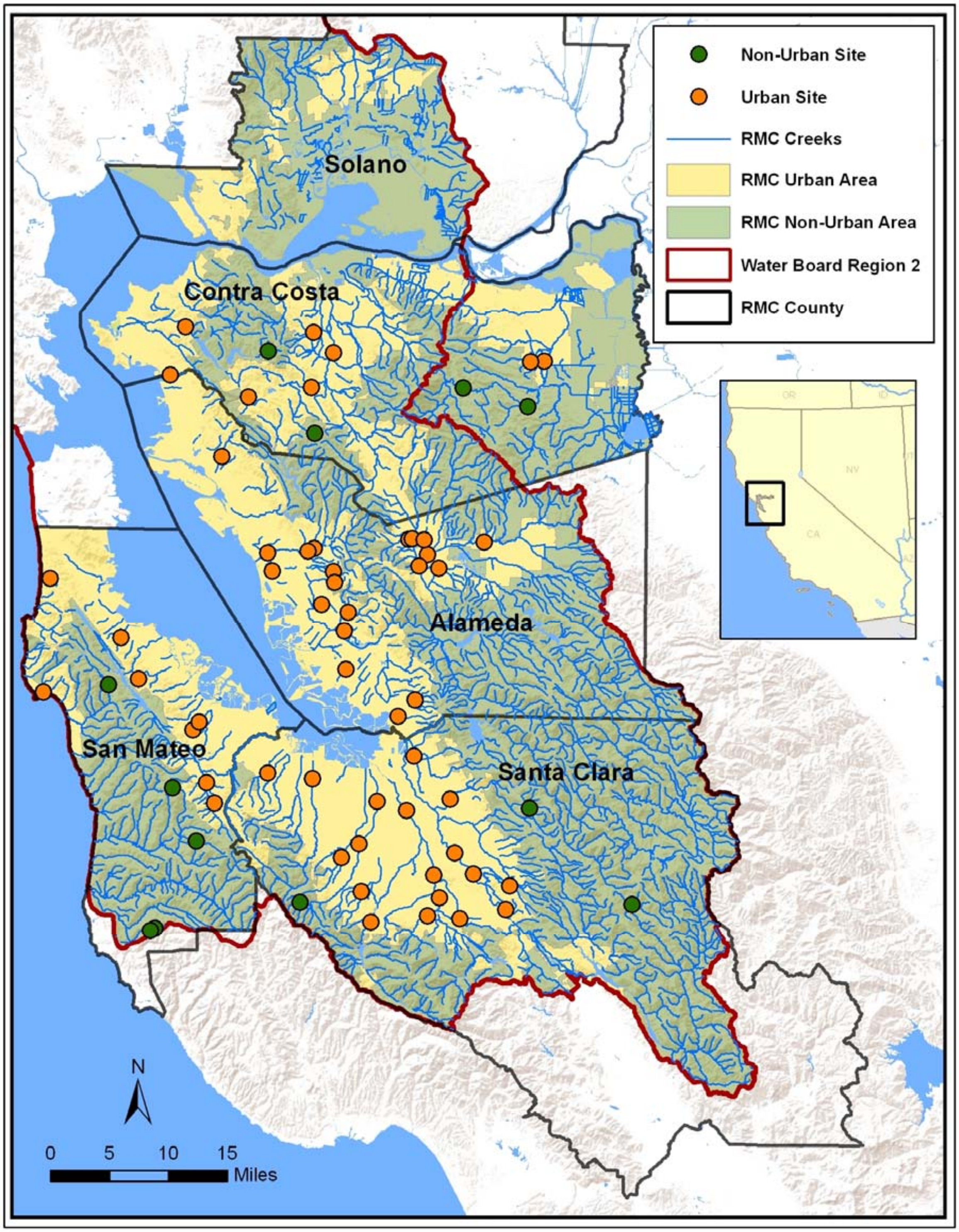

Figure 2-1. BASMAA RMC area, creeks included in the RMC probabilistic monitoring design, and the sites sampled in Water Year 2012.

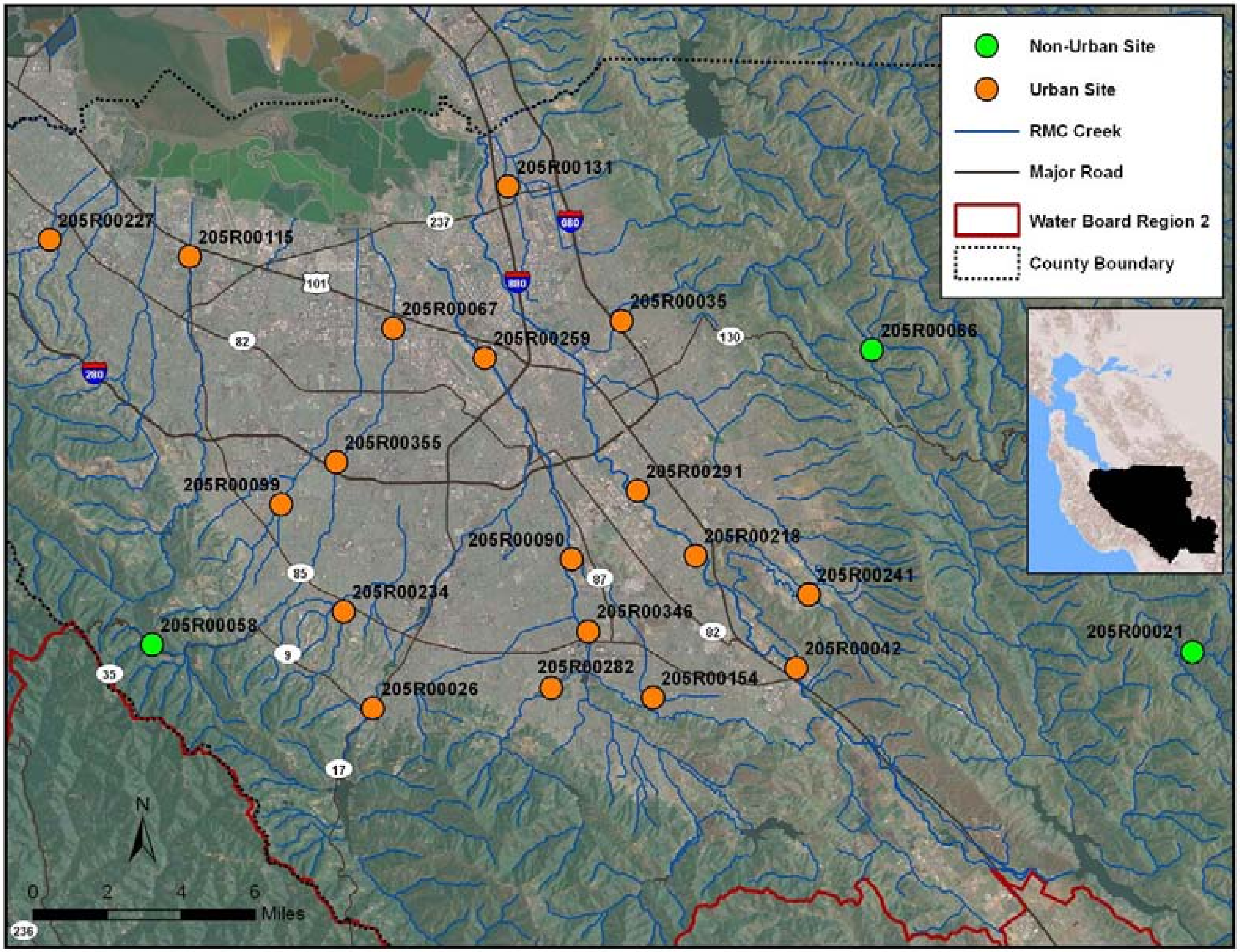

Figure 2-2. Santa Clara County sites sampled from the RMC probabilistic monitoring design in Water Year 2012.

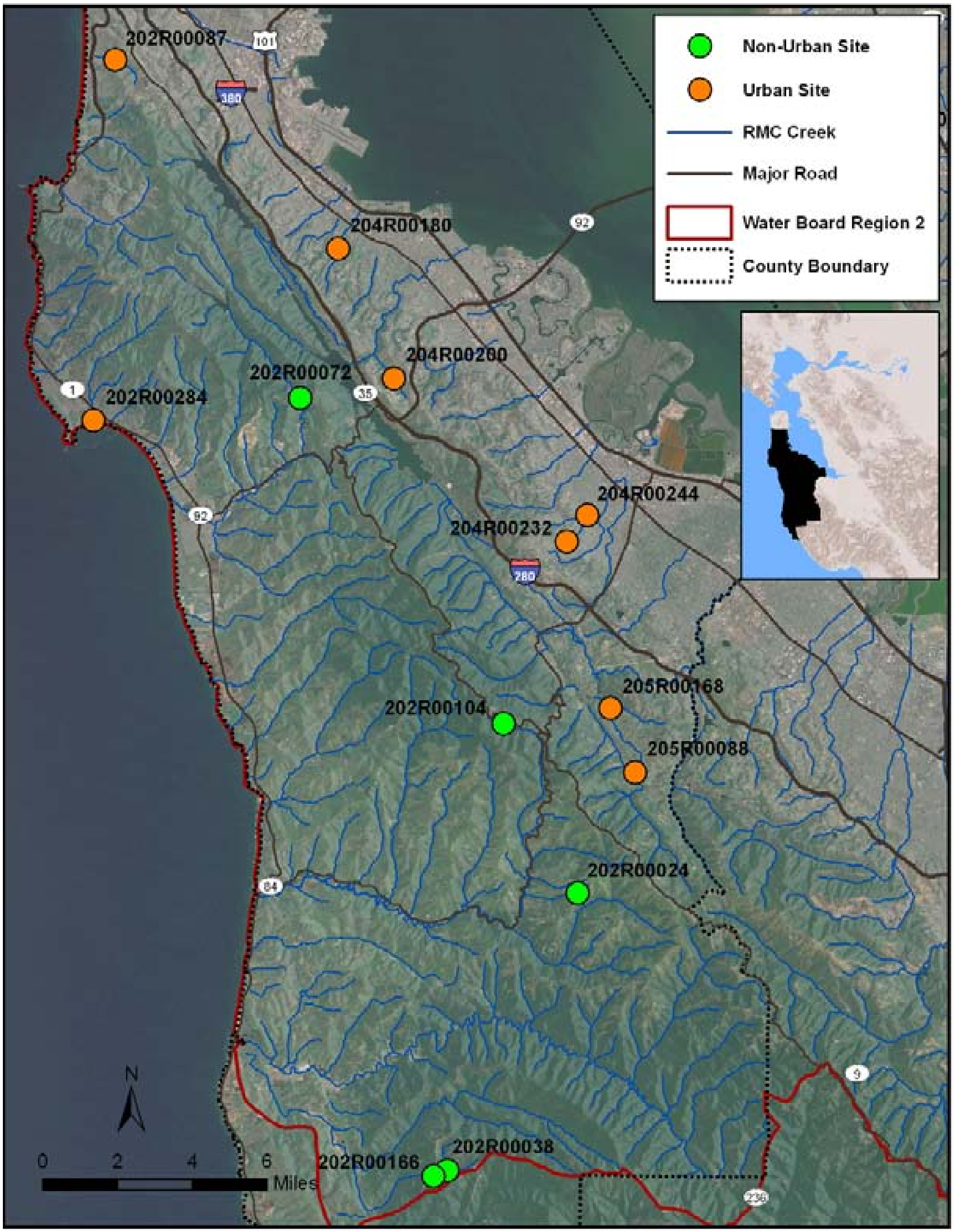

Figure 2-3. San Mateo County sites sampled from the RMC probabilistic monitoring design in Water Year 2012.

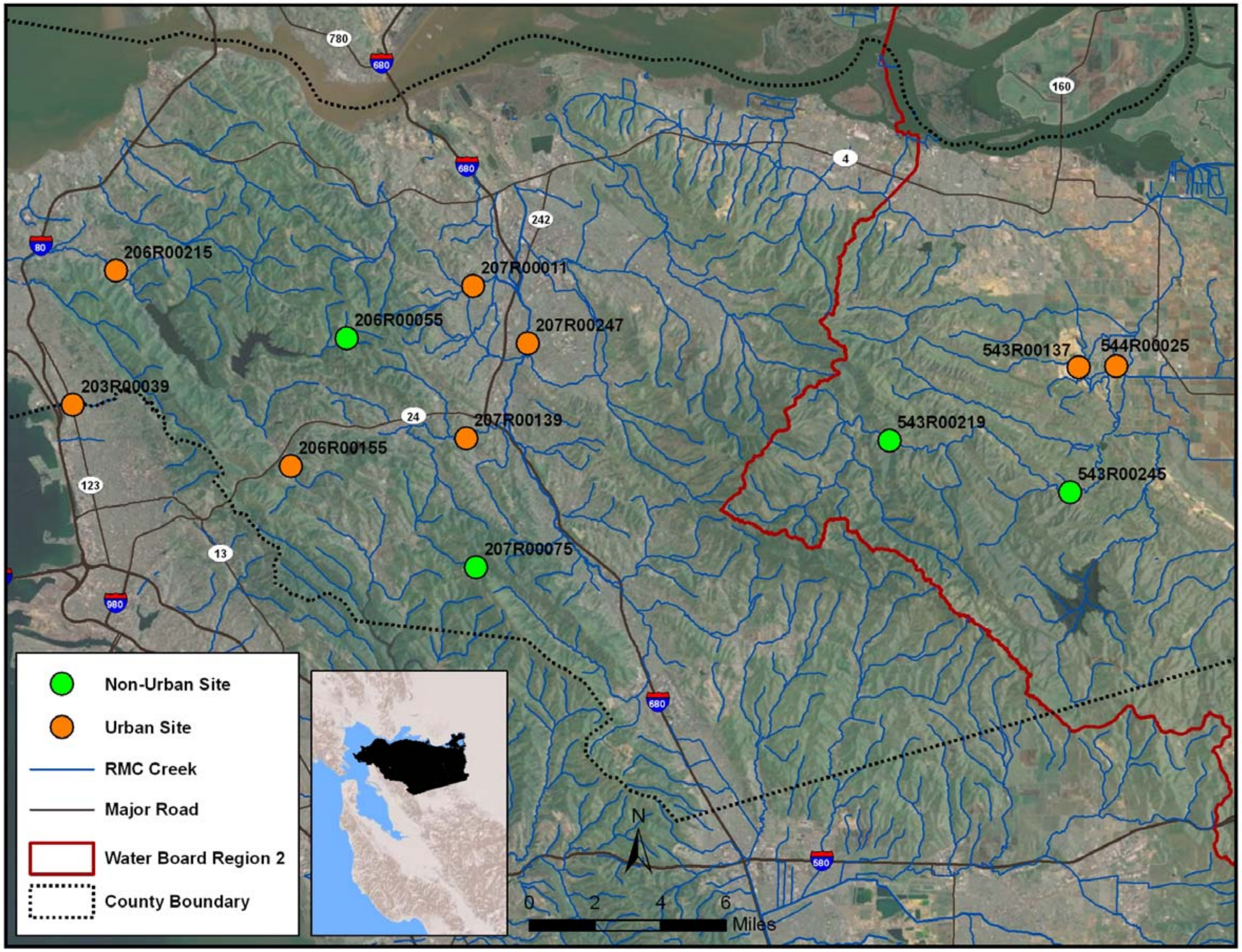

Figure 2-4. Contra Costa County sites sampled from the RMC probabilistic monitoring design in Water Year 2012.

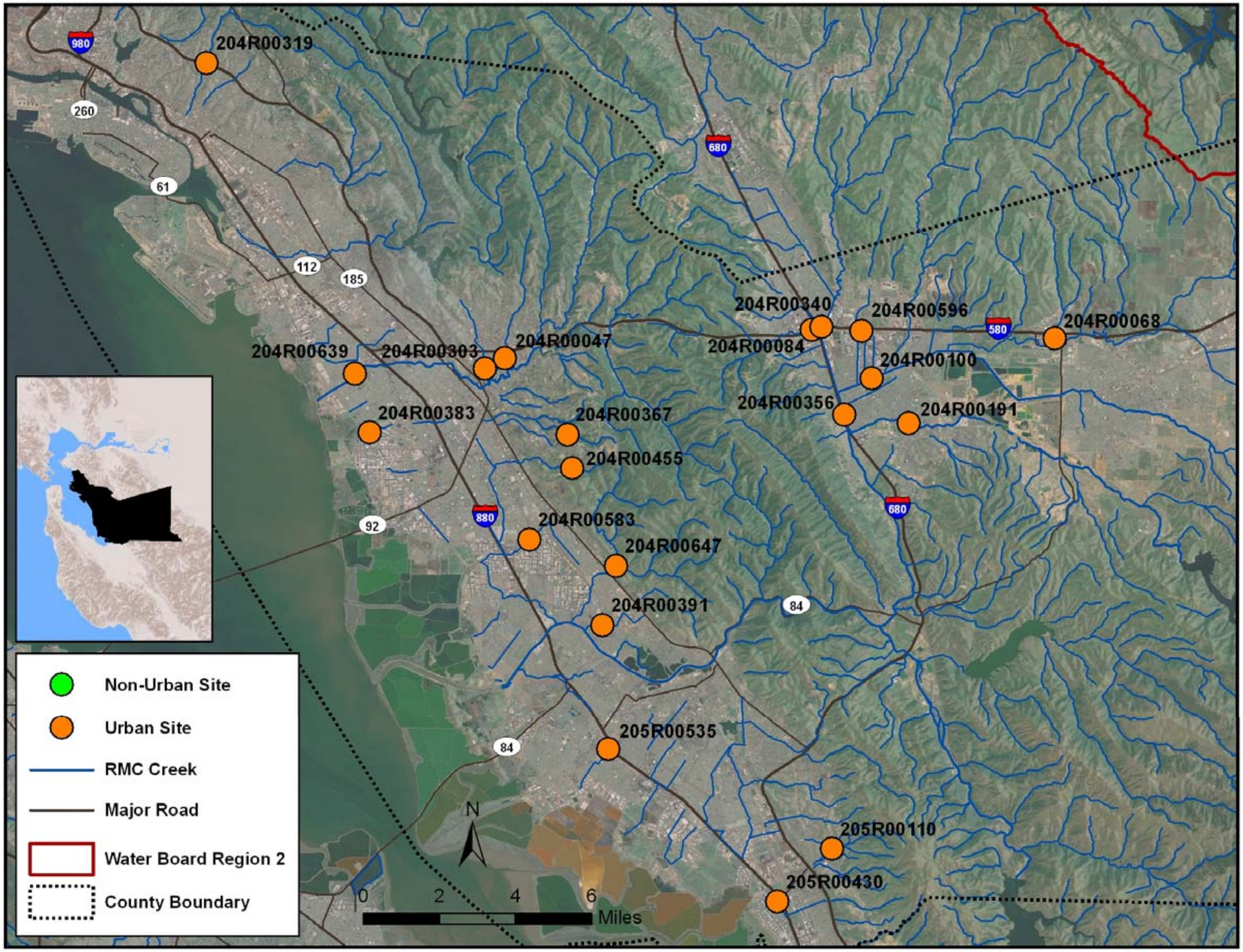

Figure 2-5. Alameda County sites sampled from the RMC probabilistic monitoring design in Water Year 2012.

Table 2-1. Parameters sampled at sites from the RMC Probabilistic Monitoring Design in Water Year 2012 by sampling agency. Water toxicity sampled on 3/17/12 and 7/25/12; sediment toxicity and chemistry sampled on 7/25/12.

Site ID	Creek Name	Land Use	Latitude	Longitude	Bioassessment, PHab, Chlorine, Nutrients	Water & Sediment Toxicity, Sediment Chemistry	Sampling Date	Sampling Agency
204R00047	Castro Valley	Urban	37.68826	-122.07257	x	x	6/6/2012	ACCWP
204R00068	Collier Channel, Line 7-M	Urban	37.69908	-121.80891	x		5/31/2012	ACCWP
204R00084	Dublin	Urban	37.70104	-121.92542	x	x	5/24/2012	ACCWP
204R00100	Arroyo Mocho	Urban	37.68280	-121.89625	x	x	5/30/2012	ACCWP
204R00191	Arroyo Valle	Urban	37.66584	-121.87840	x		5/29/2012	ACCWP
204R00303	Chabot	Urban	37.68421	-122.08200	x		6/14/2012	ACCWP
204R00319	Sausal	Urban	37.79923	-122.21818	x		6/7/2012	ACCWP
204R00340	Big Canyon, Line 7-J-1	Urban	37.70218	-121.92074	x		6/11/2012	ACCWP
204R00356	Arroyo de la Laguna	Urban	37.66873	-121.90920	x		6/4/2012	ACCWP
204R00367	Ward	Urban	37.65957	-122.04172	x		6/12/2012	ACCWP
204R00383	Sulphur	Urban	37.65909	-122.13676	x		6/11/2012	ACCWP
204R00391	Line5-M	Urban	37.58682	-122.02358	x		6/6/2012	ACCWP
204R00455	Zeile	Urban	37.64676	-122.03931	x		6/13/2012	ACCWP
204R00583	Line 3A-D	Urban	37.61906	-122.05928	x		6/13/2012	ACCWP
204R00596	Line 7-G-2	Urban	37.70094	-121.90154	x		5/31/2012	ACCWP
204R00639	San Lorenzo	Urban	37.68151	-122.14437	x		6/19/2012	ACCWP
204R00647	Dry	Urban	37.60965	-122.01750	x		6/18/2012	ACCWP
205R00110	Agua Caliente	Urban	37.50273	-121.91225	x		6/18/2012	ACCWP
205R00430	Line 6-D	Urban	37.48229	-121.93782	x		6/5/2012	ACCWP
205R00535	Line 5-F-1	Urban	37.53942	-122.01980	x		6/19/2012	ACCWP
203R00039	Cerrito	Urban	37.89802	-122.30027	x		5/14/2012	CCCWP
206R00155	San Pablo	Urban	37.92408	-121.74088	x		5/16/2012	CCCWP
206R00215	San Pablo	Urban	37.95477	-122.07821	x		5/23/2012	CCCWP
207R00011	Grayson	Urban	37.95485	-122.07829	x	x	5/22/2012	CCCWP
207R00139	Las Trampas	Urban	37.88742	-122.07995	x		5/17/2012	CCCWP
207R00247	Walnut	Urban	37.92833	-122.04745	x		5/22/2012	CCCWP
543R00137	Deer	Urban	37.92408	-121.74807	x		5/15/2012	CCCWP

Site ID	Creek Name	Land Use	Latitude	Longitude	Bioassessment, PHab, Chlorine, Nutrients	Water & Sediment Toxicity, Sediment Chemistry	Sampling Date	Sampling Agency
543R00219	Marsh	Nonurban	37.88654	-121.84347	x		5/21/2012	CCCWP
543R00245	Marsh	Nonurban	37.86732	-121.74947	x		5/21/2012	CCCWP
544R00025	Dry	Urban	37.92611	-121.71722	x	x	5/15/2012	CCCWP
205R00021	MF Coyote	Nonurban	37.25513	-121.57811	x		5/16/2012	SCVURPPP
205R00026	Los Gatos	Urban	37.23057	-121.97137	x	x	5/14/2012	SCVURPPP
205R00035	Upper Penitencia	Urban	37.38105	-121.85735	x	x	5/24/2012	SCVURPPP
205R00042	Coyote	Urban	37.24578	-121.77020	x	x	5/21/2012	SCVURPPP
205R00058	Saratoga	Nonurban	37.25170	-122.08407	x		5/15/2012	SCVURPPP
205R00067	San Thomas Aquino	Urban	37.37756	-121.96839	x		6/3/2012	SCVURPPP
205R00090	Canoas	Urban	37.28790	-121.87897	x		5/23/2012	SCVURPPP
205R00099	Calabazas	Urban	37.30758	-122.02201	x		5/17/2012	SCVURPPP
205R00115	Stevens	Urban	37.40586	-122.06906	x		6/5/2012	SCVURPPP
205R00131	Lower Penitencia	Urban	37.43408	-121.91294	x		6/3/2012	SCVURPPP
205R00154	Canoas	Urban	37.23419	-121.83801	x		5/22/2012	SCVURPPP
205R00218	Coyote	Urban	37.28988	-121.81805	x		5/23/2012	SCVURPPP
205R00227	Matadero	Urban	37.41004	-122.13828	x		6/5/2012	SCVURPPP
205R00234	San Thomas Aquino	Urban	37.26609	-121.99055	x		5/15/2012	SCVURPPP
205R00241	Upper Silver	Urban	37.27642	-121.76496	x		5/21/2012	SCVURPPP
205R00259	Guadalupe R	Urban	37.36723	-121.92477	x		6/14/2012	SCVURPPP
205R00282	Guadalupe Cr	Urban	37.23743	-121.88800	x		5/22/2012	SCVURPPP
205R00291	Coyote	Urban	37.31718	-121.84857	x		6/13/2012	SCVURPPP
205R00346	Guadalupe R	Urban	37.25975	-121.87035	x		6/14/2012	SCVURPPP
205R00355	Saratoga	Urban	37.32668	-121.99539	x		6/13/2012	SCVURPPP
202R00024	Woodhams	Nonurban	37.32468	-122.24666	x		6/6/2012	SMCWPPP
202R00072	Pilarcitos	Nonurban	37.51493	-122.38637	x		5/29/2012	SMCWPPP
202R00087	Milagra	Urban	37.64474	-122.48009	x	x	5/30/2012	SMCWPPP
202R00284	Denniston	Urban	37.50455	-122.48701	x		6/15/2012	SMCWPPP
204R00180	Sanchez	Urban	37.88721	-121.60909	x		5/30/2012	SMCWPPP
204R00200	Polhemus	Urban	37.52325	-122.34090	x		5/31/2012	SMCWPPP

Site ID	Creek Name	Land Use	Latitude	Longitude	Bioassessment, PHab, Chlorine, Nutrients	Water & Sediment Toxicity, Sediment Chemistry	Sampling Date	Sampling Agency
204R00232	Arroyo Ojo de Agua	Urban	37.46109	-122.25504	x		6/12/2012	SMCWPPP
204R00244	Trib to Arroyo Ojo de Agua	Urban	37.47147	-122.24532	x		6/12/2012	SMCWPPP
205R00088	Corte Madera	Urban	37.37200	-122.21964	x	x	6/4/2012	SMCWPPP
205R00168	Corte Madera	Urban	37.39680	-122.23231	x		6/4/2012	SMCWPPP
206R00055	Bear	Nonurban	37.92780	-122.15034	x		6/27/2012	SWAMP-CC
207R00075	Las Trampas	Nonurban	37.82957	-122.07430	x		6/12/2012	SWAMP-CC
202R00038	Little Butano	Nonurban	37.21590	-122.30728	x		6/26/2012	SWAMP-SM
202R00104	La Honda	Nonurban	37.38989	-122.28430	x		6/13/2012	SWAMP-SM
202R00166	Little Butano	Nonurban	37.21363	-122.31411	x		6/25/2012	SWAMP-SM
205R00066	Trib to Arroyo Aguague	Nonurban	37.37166	-121.73262	x		6/5/2012	SWAMP-SC

2.2.2 Management Questions

The RMC regional monitoring design was developed to address the management questions listed below. Those appearing in bolded font are addressed in this report in a preliminary manner. Those in normal font could not be addressed this year due to the limited sample size available from this one year of monitoring but can be answered in future years once sample sizes increase. Table 2-2 illustrates the length of time required to establish statistically representative sample sizes for each of the classified strata in the regional monitoring design.

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

Table 2-2. Cumulative numbers of samples per monitoring year; shaded cells indicate when a minimum sample size may be available to develop a statistically representative data set to address management questions related to condition of aquatic life.

Monitoring Year	**RMC Area** (Region-wide)		**Santa Clara County**		**Alameda County**		**Contra Costa County**		**San Mateo County**		**Fairfield, Suisun City and Vallejo** [b]	
Land Use	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*
Year 1 (WY 2012)	**48**	22	16	6	16	6	8	4	8	4	0	2
Year 2 (WY 2013)	**100**	**44**	**32**	12	**32**	12	16	8	16	8	4	4
Year 3[c] (WY 2014)	**156**	**66**	**48**	18	**48**	18	24	12	24	12	12	6
Year 4 (WY 2015)	**204**	**88**	**64**	24	**64**	24	**32**	16	**32**	16	12	8
Year 5 (WY 2016)	**256**	**110**	**80**	**30**	**80**	**30**	**40**	20	**40**	20	16	10

[a] Assumes San Francisco Bay RWQCB have agreed to sample two non-urban sites annually in each RMC County
[b] Assumes: FSURMP and Vallejo only monitor urban sites; FSURMP monitors 4 sites in Year 2, 3 and 5; and Vallejo monitors 4 sites in Year 3.
[c] Final year of monitoring under the MRP 5-Year Permit.

2.3 Monitoring Design Implementation

Sampling was conducted in accordance with the RMC Multi-year Monitoring Plan (BASMAA 2011). The sampling plan (Table 2-2) illustrates the total number of sites that each RMC Permittee[11] plans to sample within the MRP term (SFBRWQCB 2009). It also illustrates the number of sampling years required to establish statistically representative samples for each strata (e.g., management unit and urban or non-urban land use) included in the regional monitoring design. Approximately 80% of the sites sampled annually by RMC participants are in urban[12] areas and 20% are in non-urban areas. Due to unforeseen field circumstances, however, this percentage may vary by year. For example, some sites may not be sampleable due to seasonal drying and/or access issues, thereby altering the relative proportion of urban-to-non-urban sites sampled in a given year. Such outcomes can be addressed in subsequent sampling years by adjusting the relative proportion of urban and non-urban sites. In the 2012 field season 18 sites could not be sampled for these reasons (see Attachment A), resulting in a total annual sample of 54 urban and 12 non-urban sites (Table 2-3).

Table 2-3. Number of sites sampled in Water Year 2012 by land use and county.

Monitoring Year	**RMC Area** (Region-wide)		**Santa Clara County**		**Alameda County**		**Contra Costa County**		**San Mateo County**		**Fairfield, Suisun City and Vallejo** [a]	
Land Use	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*	*Urban*	*Non-Urban*
RMC Participant	**54**	6	18	2	20	0	8	2	8	2	0	0
SF Bay RWQCB	**0**	6	0	1	0	0	0	2	0	3	0	0
Year 1 Total (WY 2012)	**54**	**12**	**18**	**3**	**20**	**0**	**8**	**4**	**8**	**5**	**0**	**0**

[a] Vallejo and Fairfield-Suisun are RMC participants but the MRP did not begin sampling in Water Year 2012 – see footnote to Table 2-2.

[11] The SF Bay RWQCB planned sample effort (~2/county) is factored into the total number of nonurban sites listed.

[12] Some sites classified as urban, using the aforementioned data in a geographic information system, may be considered for reclassification as non-urban based on actual land uses of the drainage area despite location inside municipal jurisdictional boundaries.

3.0 Monitoring Methods

This section describes the methods used to evaluate monitoring sites identified in the regional sample draw, consistent with the Southern California Coastal Water Research Project (SCCWRP) Bioassessment Program (SCCWRP 2012), and to sample field data, consistent with the RMC workplan (BASMAA 2011), Field parameters sampled included bioassessments (benthic macroinvertebrates, algae, and physical habitat), physio-chemical measurements (dissolved oxygen, temperature, conductivity, and pH), chlorine, nutrients, water samples for testing water toxicity, and sediment samples for testing sediment toxicity and chemistry.

3.1 Site Evaluation

Sites identified in the regional sample draw were evaluated by each RMC participant in chronological order using a two-step process described in RMC Standard Operating Procedure FS-12 (BASMAA 2012b), consistent with the procedure described by SCCWRP[13] (2012). Each site was evaluated to determine if it met the following RMC sampling location criteria:

1. The location (latitude/longitude) provided for a site is located on or is within 300 meters of a non-impounded receiving water body[14];
2. Site is not tidally influenced;
3. Site is wadeable during the sampling index period;
4. Site has sufficient flow during the sampling index period to support standard operation procedures for biological and nutrient sampling.
5. Site is physically accessible and can be entered safely at the time of sampling;
6. Site may be physically accessed and sampled within a single day;
7. Landowner(s) grant permission to access the site[15].

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

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

During Water Year 2012, a total of 219 RMC sites were evaluated for sampling. The outcome of these site evaluations is summarized below, illustrated in Figure 3-1, and described in further detail in Attachment A.

[13] Communication with managers for the SMC and the PSA are ongoing to ensure consistency of site evaluation protocols.
[14] The evaluation procedure permits certain adjustments of actual site coordinates within a maximum of 300 meters.
[15] If landowners did not respond to at least two attempts to contact them either by written letter, email, or phone call, permission to access the respective site was effectively considered to be denied.

- **TS** – 30% of sites (N=66) met all the site evaluation criteria and were successfully sampled.
- **TNS** – 8% of sites (N= 19) met the sampleable "target" criteria but could not be sampled.
- **NT** – 35% of sites (N = 75) did not meet the sampleable "target" criteria and could not be sampled.
- **U** – 27% of sites (N = 59) had outstanding unknown characteristics and their sampling target status was unknown

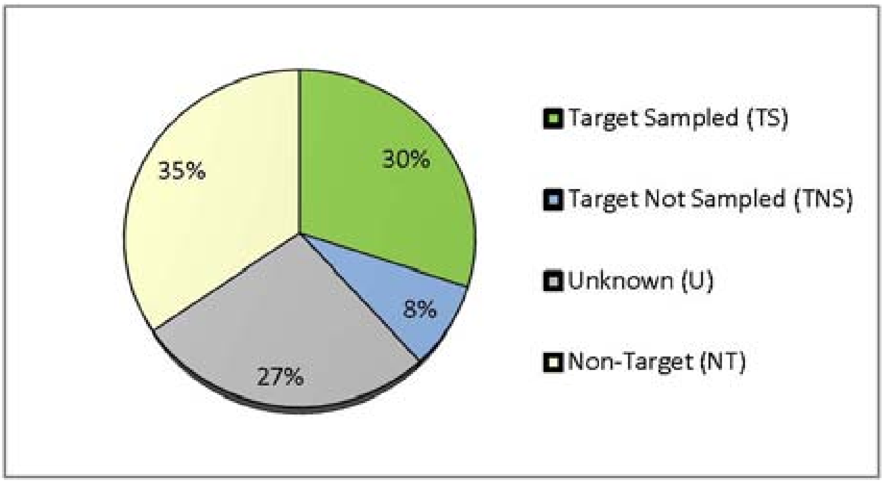

Figure 3-1: Results of RMC Site Evaluations for Water Year 2012.

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); or
- No Water (no surface water present).

Observations of flow status occurring during fall site reconnaissance events prior to occurrence of significant precipitation, and spring sampling occurring post- wet weather season were combined to classify sites as perennial or non-perennial as follows:

- **Perennial:** fall flow status either Wet Flowing or Wet Trickle and spring flow sufficient to sample.
- **Non-Perennial:** fall flow status either majority wet, minority wet, or no water; and spring flow sufficient to sample.

3.2 Field Data Collection Methods

Field data were collected in accordance with existing SWAMP-comparable methods and procedures, as described in the RMC Quality Assurance Project Plan (QAPP) (BASMAA 2012a) and the associated Standard Operating Procedures (BASMAA 2012b). These documents are updated as needed to maintain their currency and optimal applicability. The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples. The SOPs relevant to the monitoring discussed in this report are listed in Table 3-1.

Table 3-1. RMC Standard Operating Procedures (SOPs) pertaining to regional creek status monitoring.

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

3.2.1 Bioassessments

In accordance with the RMC QAPP (BASMAA 2012a) bioassessments were conducted during the spring index period (approximately April 15 – 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). During WY 2012, the last significant storm occurred on April 12-13, 2012. As a result, bioassessments began during the week of May 14th, 2012

Benthic Macroinvertebrates

Each bioassessment sampling site consisted of an approximately 150-meter stream reach that was divided into 11 equidistant transects placed perpendicular to the direction of flow. The sampling position within each transect alternated between 25%, 50% and 75% distance of the wetted width of the stream. Benthic macroinvertebrates (BMIs) were collected from a 1 ft^2 area approximately 1 m downstream of each transect (see SOP FS-1, BASMAA 2012b). The benthos were disturbed by manually rubbing coarse substrate followed by disturbing the upper layers of substrate to a depth of 4-6 inches to dislodge any remaining invertebrates into the net. Slack water habitat procedures were used at transects with deep and/or slow moving water (Ode 2007). Material collected from the eleven subsamples was composited in the field by transferring entire sample into one to two 1000 ml wide-mouth jar(s) and preserved with 95% ethanol.

Algae

Filamentous algae and diatoms were collected using the Reach-wide Benthos (RWB) method described in SOP FS-1 (BASMAA 2012b). Algae samples were collected synoptically with BMI samples. The sampling position within each transect was the same as used for BMI sampling, however, samples were collected six inches upstream of the BMI sampling position and prior to BMI collection from that location. The algae were collected using a range of methods and equipment, depending on the particular substrate occurring at the site (i.e., erosional, depositional, large and/or immobile, etc) per SOP FS-1. Erosional substrates included any material (substrate or organics) that was small enough to be removed from the stream bed, but large enough in size to isolate an area equal in size to a rubber delimiter (12.6 cm^2 in area). When a sample location along a transect was too deep to sample, a more suitable location was selected, either on the same transect or from one further upstream. Algae samples were collected at each transect prior to moving on to the next transect. Sample material (substrate and water) from all eleven transects was combined in a sample bucket, agitated, and a suspended algae sample was then poured into a 500 mL cylinder, creating a composite sample for the site. A 45 mL subsample was taken from the algae composite sample and combined with 5 mL glutaraldehyde into a 50 mL sample tube for taxonomic identification of soft algae. Similarly, a 40 mL subsample was extracted from the algae composite sample and combined with 10 mL of 10% formalin into a 50 mL sample tube for taxonomic identification of diatoms. Laboratory processing included identification and enumeration of 300 natural units of soft algae and 600 diatom valves to the lowest practical taxonomic level.

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

Physical Habitat

Physical habitat assessments (PHab) were conducted at each BMI bioassessment sampling event using the PHab protocols described in Ode (2007) (see SOP FS-1, BASMAA 2012b). Physical habitat data were collected at each of the 11 transects and at 10 additional inter-transects (located between each main transect) by implementing the “Basic” level of effort, with the following additional measurements/assessments as defined in the “Full” level of effort (as prescribed in the MRP): water depth and pebble counts, cobble embeddedness, flow habitat delineation, and instream habitat complexity. At algae sampling locations, additional assessment of presence of micro- and macroalgae was conducted during the pebble counts. In addition, water velocities were measured at a single location in the sample reach (when possible) using protocols described in Ode (2007).

3.2.2 Physico-chemical Measurements

Dissolved oxygen, temperature, conductivity, and pH were measured synoptically with algae and BMI sampling using a multi-parameter probe (see SOP FS-3, BASMAA 2012b). 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 that appears 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 bioassessments and concurrently with dry season toxicity and sediment chemistry monitoring.

3.2.4 Nutrients and Conventional Analytes

Water samples were collected for nutrient analyses using the Standard Grab Sample Collection Method as described in SOP FS-2 (BASMAA 2012b). Sample containers were rinsed using ambient water and completely filled and recapped below water surface whenever possible. An intermediate container was used to collect water for all sample containers with preservative already added in advance by laboratory. Sample container size and type, preservative type and associated holding times for each analyte are described in Table 1 FS-9, including field filtration where applicable. Syringe filtration method was used to collect samples for analyses of Dissolved Ortho-Phosphate and Dissolved Organic Carbon. All sample containers were labeled and stored on ice for transportation to laboratory.

3.2.5 Water Toxicity

Samples were collected using the Standard Grab Sample Collection Method described above, filling the required number of 4-L labeled amber glass bottles with water, putting them on ice to cool to <6°C. Bottle labels include station ID, sample code, matrix type, analysis type, project ID, and date and time of collection. The laboratory was notified of the impending sample delivery to meet the 24-hour sample delivery time requirement. Procedures used for sampling and transporting samples are described in SOP FS-2 (BASMAA 2012b).

3.2.6 Sediment Chemistry & Sediment Toxicity

Samples employed for collecting sediment toxicity and sediment chemistry samples are identical and occurred concurrently. Sediment samples were collected after any water samples were collected. Before conducting sampling, field personnel surveyed the proposed sampling area for appropriate fine-sediment depositional areas before stepping into the stream, to avoid disturbing possible sediment collection sub-sites. Personnel carefully entered the stream and started sampling at the closest appropriate reach, continuing upstream. Sediment samples were collected from the top 2 cm of sediment in a compositing container, thoroughly homogenized, and then aliquotted into separate jars for chemical or toxicological analysis using standard clean sampling techniques (see SOP FS-6, BASMAA 2012b). Sample jars were submitted to respective laboratories per SOP FS-13 (BASMAA 2012b).

3.3 Laboratory Analysis Methods

RMC participants agreed to use the same laboratory for individual parameters, developed standards for contracting with the labs, and coordinated quality assurance issues. All samples collected by RMC participants that were sent to laboratories for analysis were analyzed and reported per SWAMP-comparable methods as described in the RMC QAPP (BASMAA 2012a). Analytical laboratory methods, reporting limits and holding times for chemical water quality parameters are also reported in BASMAA (2012a). Analytical laboratory contractors included[16]:

[16] BioVir Laboratories, Incorporated was similarly contracted for Pathogen Indicators. These data are reported in each stormwater program's local monitoring report, located in Appendix C.

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

3.4 Data Analysis

This section describes methods used to analyze the bioassessment data as well as the water and sediment toxicity and sediment chemistry data. The analysis includes a preliminary condition assessment involving analysis of the biological data to characterize biological conditions within the RMC area, based on the initial year of data collection. The associated physical, chemical and toxicity testing data are then analyzed to identify potential stressors that may be impacting water quality and biological conditions. As the cumulative RMC sample sizes increase through monitoring conducted in future years (Table 2-2), it will be possible to develop a statistically representative data set to address management questions related to condition of aquatic life and report on these per MRP Provision C.8.g.iv.

3.4.1 Biological Condition

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

Biological metrics are typically (Ode et al. 2005) characterized by the following five categories:

- Richness Measures (total number of distinct taxa);
- Composition Measures (distribution of individuals among taxonomic groups and includes measures of diversity);
- Tolerance/Intolerance Measures (reflects the relative sensitivity of the assemblage to disturbance);
- Functional Feeding Groups (shows the balance of feeding strategies in the aquatic assemblage);
- Abundance (estimates total number of organisms in sample based on a nine sq. ft. sampling area).

In this report the biological condition of each RMC site sampled in Water Year 2012 was evaluated by analyzing BMI and algae metrics, and where available, using indices of biological integrity (IBI). An IBI is an analytical tool that calculates a site condition score based on a series of biological metrics representing taxonomic richness, composition, tolerance and functional feeding groups. IBI development in California is more established for BMIs (e.g., B-IBIs) than for algae. BMI metrics were analyzed using B-IBIs that have been developed and tested extensively for both Southern (Ode et al. 2005) and Northern (Rehn et al. 2005) California. A collaborative effort by BASMAA participants and others developed a provisional San Francisco Bay Region B-IBI that has been provisionally tested in Contra Costa (CCCWP 2007) and Santa Clara (SCVURPPP 2007) Counties, however, as these B-IBIs have not yet been tested for the entire San Francisco Bay Area, they were not used for the analyses presented in this report. As algae is a more recently used biological indicator, fewer IBIs exist, and those that have been developed for California are either provisional and address disparate regions (Herbst and Blinn 2008) or are in draft format, under review, and not yet available for public distribution (Fetscher, 2012). Therefore, selected algae metrics were analyzed without using an IBI as described below.

Benthic Macroinvertebrate Data Analysis

The Southern California (SoCal) B-IBI (Ode et al. 2005) and the Northern California (NorCal) B-IBI (Rehn et al. 2005) were both used in the preliminary data analysis phase to evaluate the RMC BMI data. While the data used to develop and test the SoCal and the NorCal B-IBIs were sampled from areas that exhibit some similarity in environmental gradients, results derived from using these tools were anticipated to include some bias due to the differences in environmental gradients between the RMC area and the respective areas for which these tools were developed. SoCal and NorCal B-IBI scores for RMC Water Year 2012 sites were compared in order to explore and confirm the choice in tool selection for analyzing BMI data as condition indicators for this report. No significant differences between B-IBI scores calculated using these two tools were observed (Figure 3-2). Because the ecoregions represented by that SoCal B-IBI are more similar to those in the majority of the RMC area (with the exception of coastal streams in San Mateo County), the SoCal B-IBI was used as the primary index used to evaluate biological condition. The scores calculated using the SoCal B-IBI were classified according to condition categories established for the SoCal B-IBI (Table 3-2).

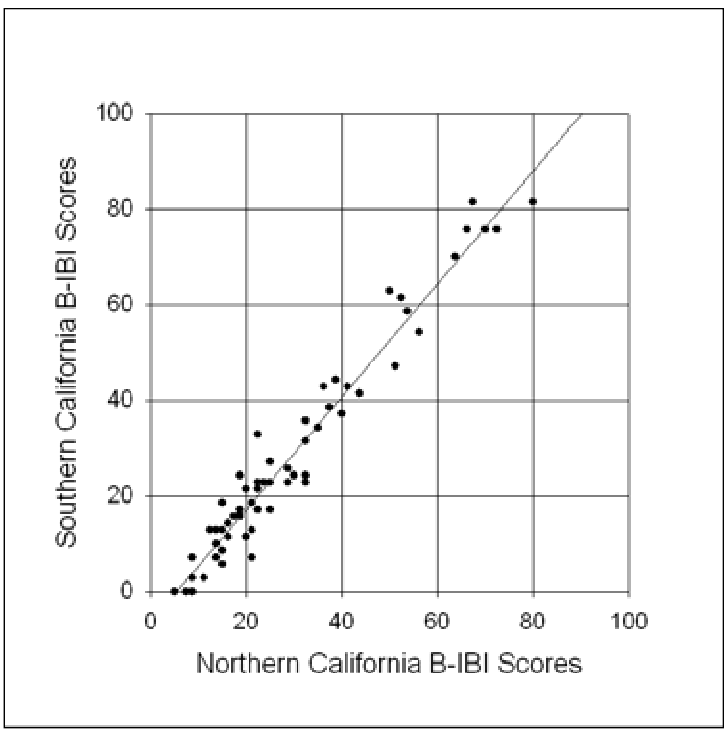

Figure 3-2. Results of regressing the Northern and Southern California B-IBIs for RMC sites sampled in Water Year 2012. (r^2 = 0.9518, $p<0.05$).

Table 3-2. Condition categories for physical habitat assessment scores compared to those used for benthic macroinvertebrates sampled at RMC sites Water Year 2012.

Condition Category	Physical Habitat Quality (PHab)	Southern California B-IBI
Very Good	60-49	80-100
Good	48-37	60-79
Fair	36-25	40-59
Poor	24-13	20-39
Very Poor	12-0	0-19

SoCal B-IBI scores were tested to determine whether they differed significantly between urban and nonurban areas. Metrics were first tested using the Kolmogorov-Smirnov test of normality and subsequently evaluated using a Student's T-test.

The SoCal and NorCal B-IBIs were developed in perennial streams in their respective regions. The majority (58 of 60) of sites sampled by the RMC in Water Year 2012 were classified as perennial steams. Due to the relatively small number of samples in the non-perennial stream population (N=2) represented in the Water Year 2012, no statistical comparison was made between B-IBI scores for perennial and non-perennial streams. However, these classifications were considered for interpretations of biological condition.

Aquatic life use support at RMC sites sampled in Water Year 2012 was evaluated by comparing the SoCal B-IBI scores and associated condition categories to warmwater (WARM) and coldwater (COLD) aquatic life uses designated by the SF Bay RWQCB (SFBRWQCB 2011).

Algae Data Analysis

In the absence of an available algae IBI tool developed for this region[17], the observed ranges of scores and descriptive statistics were summarized for each of the three fractions - epiphytes, diatoms, and microalgae - included in algae samples for the following algae metrics: species richness, Shannon-weaver H' (log e), and Margalef's Richness, and percent dominant taxa at both the species and genus levels. Dominant diatom taxa were also evaluated in terms of their classification as either pollutant tolerant or intolerant/sensitive species. Diatoms representing the dominant taxa in each RMC sample were classified according to which were highly motile (Fetscher 2012), and their relative pollutant tolerance (Blinn and Herbst 2003, Herbst and Blinn 2008). Motile diatoms are capable of moving out of deposited sediments, therefore, samples with relatively high percentages of highly motile diatoms may indicate degraded ecological conditions and poor habitat quality. The presence of these classified dominant taxa was summarized across all RMC sites and discussed. All algae metrics were tested to determine whether they differed significantly between urban and nonurban areas. Metrics were first tested using the Kolmogorov-Smirnov test of normality and subsequently evaluated using a Student's T-test.

3.4.2 Physical Habitat Condition

Physical Habitat condition was assessed using PHab scores (see Table 3-2). PHab scores range from 0 – 60, representing a combined score of three physical habitat sub-categories (epifaunal substrate/cover, sediment deposition, and channel alteration) that each can be scored for a total of 0-20 points. Higher

[17] A draft algae IBI developed for Southern California is currently under review, but not yet available for public distribution.

PHab scores reflect higher quality habitat. Numerous additional PHab endpoints can also be calculated. Further analyses of various PHab endpoints are possible and will be considered in future reports, but were not included in this report.

3.4.3 Water & Sediment Chemistry and Toxicity

As part of the Stressor Assessment for this report, water and sediment chemistry and toxicity data generated during Water Year 2012 were analyzed and evaluated to identify potential stressors that may be contributing to degraded or diminished biological conditions. Per Table 8.1 of the MRP (SFBRWQCB 2009), creek status monitoring data must be evaluated with respect to specified "Results that Trigger a Monitoring Project in Provision C.8.d.i." The trigger criteria listed in Table 8.1 were used as the principal means of evaluating the creek status monitoring data to identify sites where water quality impacts may have occurred. For water and sediment chemistry and toxicity data, the relevant trigger criteria are as follows:

- **Nutrients**: 20% of results in one waterbody exceed one or more water quality standard or established threshold. (Note: per MRP Table 8.1, this group of constituents includes variants of nitrogen and phosphorous, as well as other common, "conventional" constituents.)
- **Water Toxicity**: if toxicity results are less than 50% of Laboratory Control results, re-sample and re-test; if second sample yields less than 50% of Laboratory Control results, proceed to C.8.d.i. (Stressor/Source Identification).
- **Sediment Toxicity**: toxicity results are statistically different than and < 20% of Laboratory Control.
- **Sediment Chemistry**: three or more chemicals exceed Threshold Effects Concentrations (TECs), mean Probable Effects Concentrations (PEC) Quotient greater than 0.5, or pyrethroids Toxicity Unit (TU) sum is greater than 1.0.

For sediment chemistry trigger criteria, threshold effect concentrations (TECs) and probable effects concentrations (PECs) are as defined in MacDonald et al., 2000. For all non-pyrethroid contaminants specified in MacDonald et al. (2000), the ratio of the measured concentration to the respective TEC value was computed as the TEC quotient. All results where a TEC quotient was equal to or greater than 1.0 were identified. PEC quotients were also computed for all non-pyrethroid sediment chemistry constituents, using PEC values from MacDonald et al. (2000). For each site the mean PEC quotient was then computed, and sites where mean PEC quotient was equal to or greater than 0.5 were identified. Pyrethroids toxic unit equivalents (TUs) were computed for individual pyrethroid results, based on available literature values for pyrethroids in sediment LC50 values.[18] Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured total organic carbon (TOC) concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. Then for each site, the TU equivalents for the various individual pyrethroids were summed, and sites where the summed TU was equal to or greater than 1.0 were identified.

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

3.5 Quality Assurance & Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012). They generally involved the following:

Data Quality Objectives (DQOs) were established to ensure that data collected were of sufficient and adequate quality for the intended use. DQOs 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 quantization 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 according to the procedures described in the relevant SOPs, including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on demonstrated capability to adhere to specified protocols.

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

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

4.0 Results & Discussion

The MRP places an emphasis on minimizing sources of pollutants that could impair water quality as a central purpose of urban runoff management programs. The MRP requires monitoring to address the management question, "What are the sources to urban runoff that contribute to receiving water problems?" The RMC accomplishes this through a multi-step process that involves conducting monitoring to provide data to inform an assessment of conditions and identification of stressors that may be impacting water quality and/or biological conditions. The information generated through the condition assessment and stressor assessment will then be used to help direct efforts to identify sources of problematic pollutants or other stressors in urban runoff discharges.

In this section, following a brief statement of data quality, the biological data are evaluated to produce a preliminary condition assessment for aquatic life in creeks within the RMC area, based on the initial year of data collection. The physical, chemical and toxicity testing monitoring data are then evaluated against the trigger criteria shown in Table 8.1 and Table H-1 (for sediment triad data) of the MRP (SFBRWQCB 2009) to provide a preliminary identification of potential stressors. The results of the stressor assessment will then be used in follow-up efforts to plan and implement source identification projects.

4.1 Statement of Data Quality

A comprehensive QA/QC program was implemented by the RMC participants, covering all aspects of the regional/probabilistic monitoring. In general, QA/QC procedures were implemented as specified in the RMC QAPP (BASMAA, 2012a), and monitoring was performed according to protocols specified in the RMC SOPs (BASMAA, 2012b), and in conformity with SWAMP protocols. Details of the results of evaluations of laboratory-generated QA/QC results are included in Attachment B. Issues noted by the laboratories and/or RMC field crews are summarized below.

4.1.1 Bioassessment

Some biological assessment sites had to be sampled along a shortened reach (less than 150 m), and in some cases, stream characterization points may have been skipped along the reach due to physical limitations or obstructions. During the BMI taxonomic analysis, some minor counting discrepancies were noted between the original BioAssessment Services results and the QA recount conducted by the California Department of Fish and Game (CDFG). Collection of algae samples was difficult or impossible at several sites due to varying levels of algal growth, making it hard to collect a distinguishable clump for analysis. EcoAnalysts, the algae taxonomy laboratory, reported low sample counts for soft algae in some cases, leading to a projected increase in processing costs.

4.1.2 Sediment Chemistry

Several issues were reported by the analytical laboratory (Caltest), and the sediment chemistry data were qualified accordingly. These issues included:

- Low level contamination noted in the Method Blank (Arsenic, Chromium)
- Some 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 (Copper, Chromium, Nickel)
- Low Matrix Spike recovery was noted due to possible matrix interference in the QC sample (Arsenic)

- High Matrix Spike recovery was noted due to possible matrix interference in the QC sample (Lead).
- Several organochlorine pesticide compounds were not included in the spike mix: 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, cis-Chlordane, trans-Chlordane and Heptachlor epoxide.
- Matrix Spike recoveries were outside control limits: (Lindane, 4,4'DDT)
- Percent solids analyses on the as-received sediments were performed past regulatory holding time.
- LIMS 'Acodes' did not originally include 2,4 DDD, 2,4 DDT, 2,4 DDE as these were not standard compounds that reported by the laboratory under EPA method 8081, and the original analysis did not include these three compounds; the holding time violation is noted/qualified.
- Many laboratory reporting limits (RL) are higher than QAPP target RLs due to the dry weight conversion, as well as target and non-target matrix interferences, which required the laboratories to concentrate less than normal.

In addition, RMC coordinators noted the following issues with sediment chemistry:

- Laboratory report lists the maximum (relative percent difference) RPD for metals as 30% while the RMC QAPP lists 25%.
- Synthetic Organics in the sediment laboratory report lists the maximum RPD as 30% for most analytes and 40% for others. However, the RMC QAPP lists the Measurement Quality Objective (MQO) as less than 25% RPD.
- These discrepancies in maximum RPD resulted in several analytes not being flagged in laboratory reports when they should have been.

4.1.3 Water Chemistry

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

- RMC field crews noted numerous instances where free chlorine was measured with the Hach field kits at levels equal to or higher than total chlorine. Alternative (colorimetric) methods are being evaluated for future field work to improve chlorine measurement accuracy and validity.
- A limited number of lab sample results for nutrients and conventional parameters were reported as qualified data due to minor QA/QC issues not thought to affect the validity of sample results.
- Ash Free Dry Mass (AFDM) was not included in the initial laboratory reports or electronic data deliverables (EDDs) from Caltest; revised laboratory reports and EDDs were provided with AFDM results included.

4.1.4 Sediment Toxicity

For several sediment toxicity samples, during laboratory testing for chronic toxicity of ambient sediment to *Hyalella azteca*, the dissolved oxygen level dropped below 2.5 mg/L during testing. It was observed that some samples had an abundance of algae, which could lead to DO depletion. In these cases, aeration was initiated, as well as increased frequency of DO measurement at the laboratory, to minimize the time that test animals were subject to low DO concentrations. These adjustments follow procedures outlined in the EPA testing manual. For samples in which the DO level dropped below 2.5 mg/L, it is surmised that hypoxia could have had a role in the significantly reduced survival observed for *Hyalella azteca*.

4.1.5 Water Toxicity

Several aquatic toxicity samples were affected during testing by pathogen-related mortality (PRM), a fairly common cause of interference in aquatic sample toxicity tests with ambient surface waters. The affected samples were re-tested using a modified approach per Geis et al. (2003). BASMAA will request approval to routinely apply the modified Geis technique to avoid the reoccurrence of this type of interference.

4.2 Condition Assessment

This section addresses the RMC core management question ***"What is the condition of aquatic life in creeks in the RMC area; are aquatic life beneficial uses supported?"*** Statistical properties of the aquatic life use indicators used for this condition assessment -- benthic macroinvertebrates, and algae -- that were observed at the set of RMC sites sampled in WY 2012 are reported in sections 4.2.1 and 4.2.2, and discussed in relation to aquatic life beneficial uses designated by the SF Bay RWQCB (Table 4-1) in section 4.2.3. Due to the relatively small sample size after this first year of implementing the RMC regional probabilistic monitoring design, results are presented only in terms of their comparative statistical ranges within urbanized and non-urbanized portions of the RMC area. Future reports will provide additional analysis at the Countywide Program level.

4.2.1 Benthic Macroinvertebrate Metrics

BMI metrics for 60 sites sampled within the RMC area in the spring index period of Water Year 2012 (nominally April 15 – June 15[19], 2012) exhibited a wide range of scores (Figures 4-1, 4-2, Attachment C). Fifty-two percent (15/29) of the BMI metrics demonstrated statistically significant differences between urban and nonurban areas (Table 4-2). However, only three of these comparisons passed the Kolmogorov-Smirnov normality test. This result means that in these cases the assumption of data exhibiting a normal distribution has been violated, thus respective statistical significances lack potential power (desired test power = 0.8; less power indicates a lower likelihood of detecting a difference when one actually exists), as indicated by the power statistic in Table 4-2. No transformations were performed as visual examination of the distributions confirmed great difference between the data by land use (Figures 4-2 A,B,C).

The following BMI metrics significantly differed between urban and nonurban areas:

- All (8/8) species richness metrics;
- One of five composition metrics (i.e., Shannon Diversity Index);
- Two of five tolerance metrics (i.e., number of intolerant taxa and tolerant taxa); and,
- Four of eight functional feeding group metrics (i.e., percent collector-gatherers, percent collectors, percent scrapers, and percent non-gastropoda scrapers.

These results consistently indicate that the biological conditions of creeks in urban areas of the RMC, as reflected by BMI metrics, are lower than in nonurban areas. Specifically, these results indicate that BMI species richness, by many measures, is greater in nonurban than in urban areas. The significantly lower number of sensitive/pollutant-intolerant taxa and the greater number of taxa tolerant of pollutants in

[19] Due to late spring 2012 rains, bioassessment monitoring was conducted as late as June 20, 1012.

urban areas similarly indicates lower biological condition in urban compared to nonurban RMC areas. Lastly, the significantly greater number of generalist species (e.g., collectors and collector-gatherers) observed at RMC urban sites reflects lower quality habitat due to the fact that these species can consume a broader range of food materials than specialist species (Cummins and Klug 1979). Conversely, the significantly greater number of specialized feeders, including predators and scrapers, that were observed in significantly greater numbers at nonurban RMC sites is indicative of higher quality habitats.

Table 4-1. RMC creeks and associated designated beneficial uses listed in the San Francisco Bay Region Basin Plan (SFBRWQCB 2011). Creeks not listed in Chapter 2 of the Basin Plan do not appear in this table.

		Human Consumptive Uses							Aquatic Life Uses								Wildlife Use	Recreational Uses		
Site ID	Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
ALAMEDA COUNTY																				
205R00110	Agua Caliente Creek (Zone 6 Line F)															E	E	E	E	
204R00356	Arroyo de la Laguna				E					E			E		E	E	E	E	E	
204R00100	Arroyo Mocho				E					E			E		E	E	E	E	E	
204R00191	Arroyo del Valle		E		E					E			P	E	E	E	E	E	E	
204R00047	Castro Valley Creek									E				E		E	E	E	E	
204R00068	Collier Canyon Creek													E		E	E	E	E	
204R00647	Dry Creek													E		E	E	E	E	
204R00084	Dublin Creek															E	E	E	E	
205R00535	Plummer Creek (Zone 5 Line F-1)										E			E		E	E	E	E	
204R00639	San Lorenzo Creek		E	E	E					E			E		E	E	E	E	E	
204R00319	Sausal Creek									E				E	E	E	E	E	E	
204R00383	Sulphur Creek															E	E	E	E	
204R00367	Ward Creek															E	E	E	E	
204R00455	Zeile Creek															E	E	E	E	
CONTRA COSTA COUNTY																				
203R00039	Cerrito Creek															E	E	E	E	
543R00137	Deer Creek	E	E							E			E		E	E	E	E	E	
207R00011	Grayson Creek									E			E	E		E	E	E	E	
207R00139	Las Trampas Creek									E				E		E	E	E	E	
543R00219 543R00245	Marsh							E						E		E	E	P	P	

Site ID	Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
206R00155 206R00215	San Pablo Creek			E						E			E	E	E	E	E	E*	E	
207R00247	Walnut Creek									E			E	E	E	E	E	E	E	
SAN MATEO COUNTY																				
205R00088 205R00168	El Corte de Madera Creek									E			P	E	P	E	E	E	E	
202R00284	Denniston Creek	E	E							E			E	E	E	E	E	E	E	
204R00232	Arroyo Ojo de Agua															E	E	E	E	
202R00072	Pilarcitos Creek	E	E							E			E	E	E	E	E	E	E	
204R00200	Polhemus Creek									E						E	E	E	E	
204R00180	Sanchez Creek															E	E	E	E	
202R00087	Milagra Creek												E	E		E	E	E	E	
202R00024	Woodhams Creek									E						E	E	E	E	
SANTA CLARA COUNTY																				
205R00035	Upper Penitencia Creek			E	E					E			E	E	E	E	E	E	E	
205R00042 205R00218 205R00291 205R00021	Coyote Creek				E			E		E			E	E	E	E	E	E	E	
205R00090 205R00154	Canoas Creek															E	E	E	E	
205R00241	Upper Silver Creek													E		E	E	E	E	
205R00282	Guadalupe Creek			E	E					E			E	E	E	E	E	E	E	
205R00099	Calabazas Creek	E			E					E						E	E	E	E	
205R00259 205R00346	Guadalupe River				E					E			E	E	E	E	E	E	E	
205R00026	Los Gatos Creek		E	E	E					E			P	E	P	E	E	E	P	
205R00131	Lower Penitencia Creek															E	E	E	E	
205R00227	Matadero Creek									E			E	E	E	E	E	E	E	

Site ID	Waterbody	AGR	MUN	FRSH	GWR	IND	PROC	COMM	SHELL	COLD	EST	MAR	MIGR	RARE	SPWN	WARM	WILD	REC-1	REC-2	NAV
205R00067 205R00234	San Tomas Aquino Creek									E				E		E	E	E	E	
205R00058 205R00355	Saratoga Creek	E		E	E					E						E	E	E	E	
205R00115	Stevens Creek			E	E					E			E	E	E	E	E	E	E	

Notes:

COLD = Cold Fresh Water Habitat
FRSH = Freshwater Replenishment
GWR - Groundwater Recharge
MIGR = Fish Migration
MUN = Municipal and Domestic Water
EST = Estuarine (the Basin Plan assigns this beneficial use to slough portions of Plummer Creek; for this evaluation WARM is presumed applicable to freshwater portions)

NAV = Navigation
RARE= Preservation of Rare and Endangered Species
REC-1 = Water Contact Recreation
REC-2 = Non-contact Recreation

WARM = Warm Freshwater Habitat
WILD = Wildlife Habitat
P = Potential Use
E = Existing Use
L = Limited Use.
* = "Water quality objectives apply; water contact recreation is prohibited or limited to protect public health" (SFBRWQCB 2011).

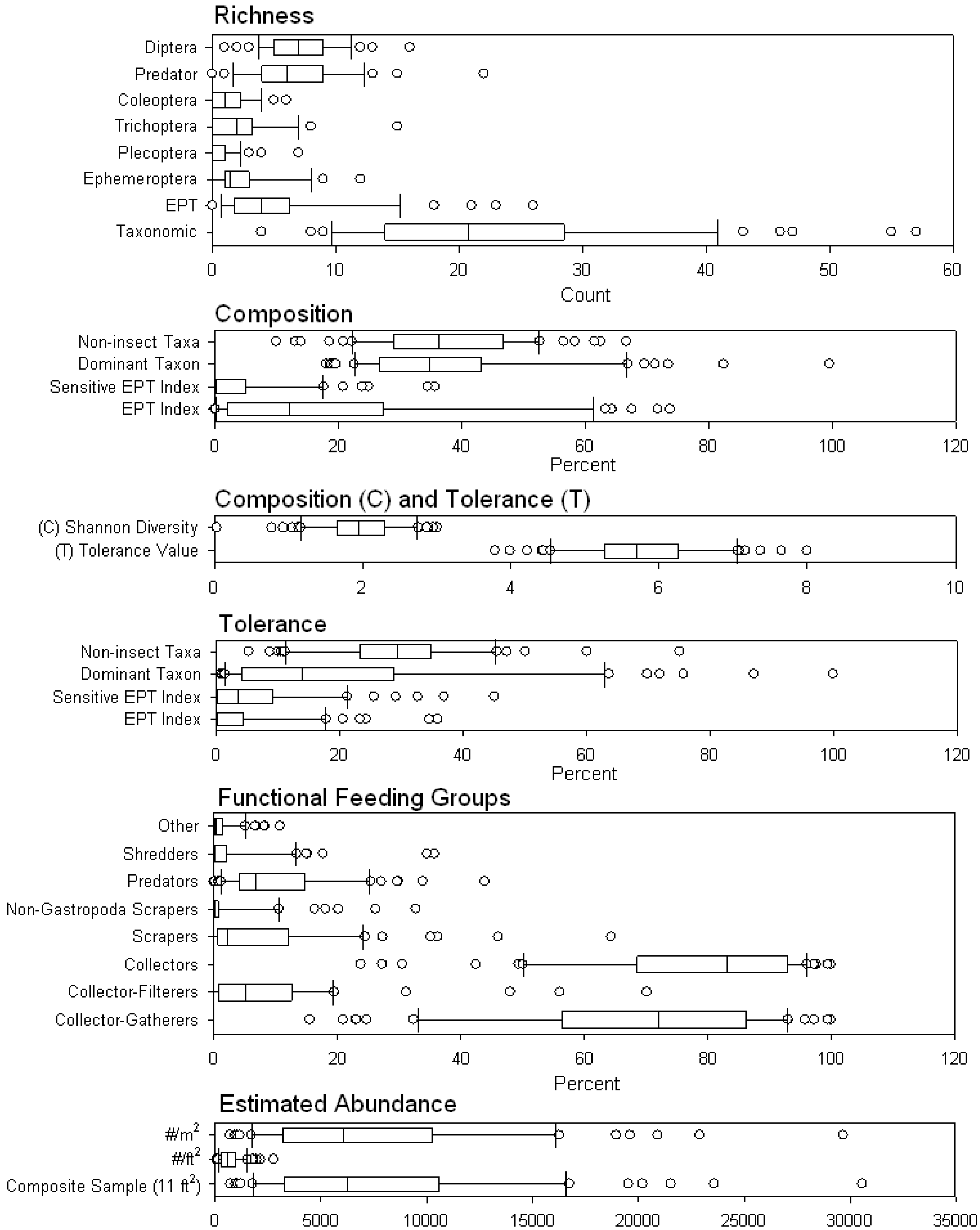

Figure 4-1. Benthic macroinvertebrate metric values derived from RMC sites sampled in Water Year 2012. Statistics include minimum (lower whisker), maximum (upper whisker), 25th percentile (lower box), median (box midline) and 75th percentile (upper box).

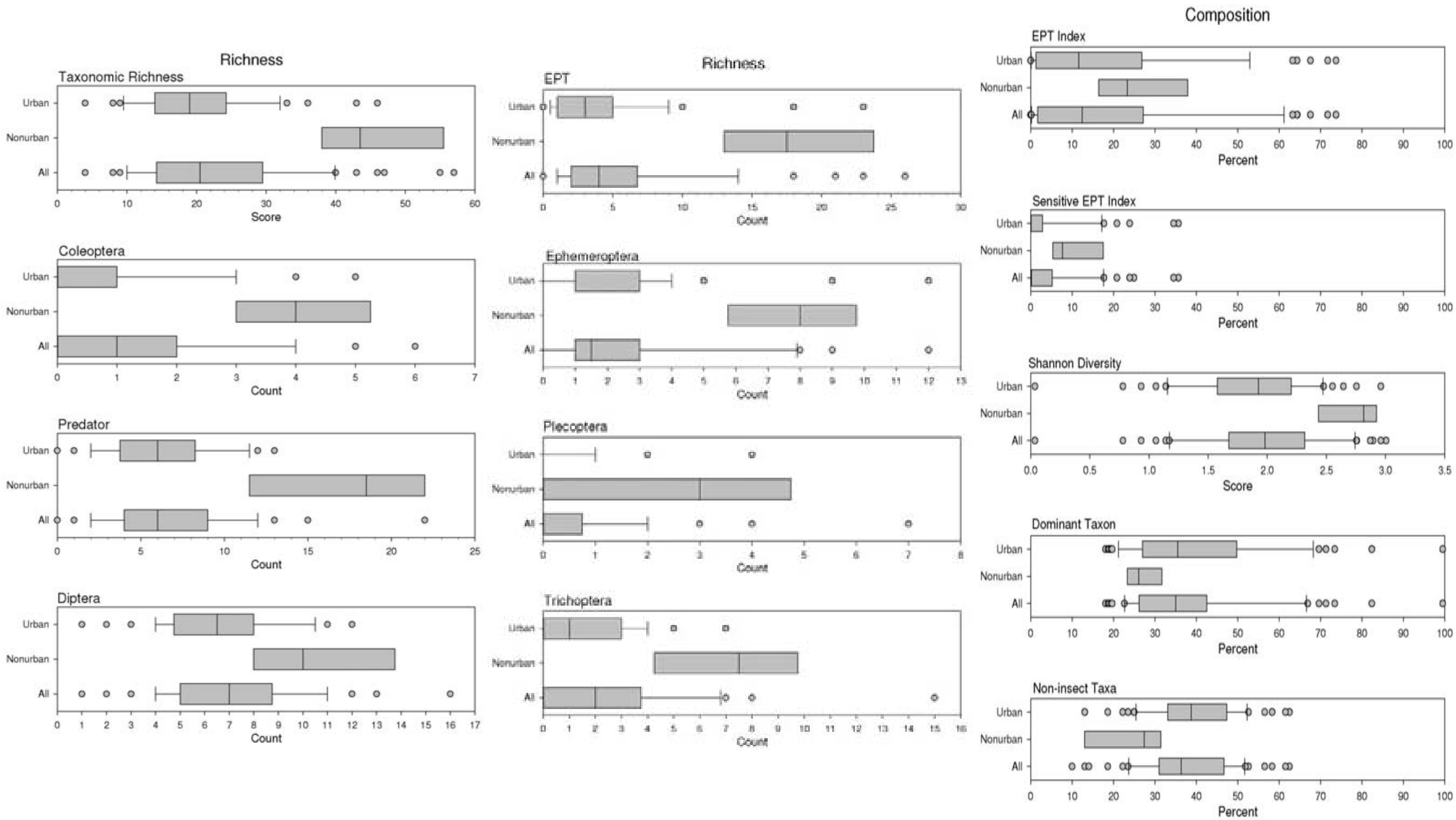

Figure 4-2-A. Richness and Composition metrics compared by land use for benthic macroinvertebrates sampled at RMC sites in Water Year 2012.

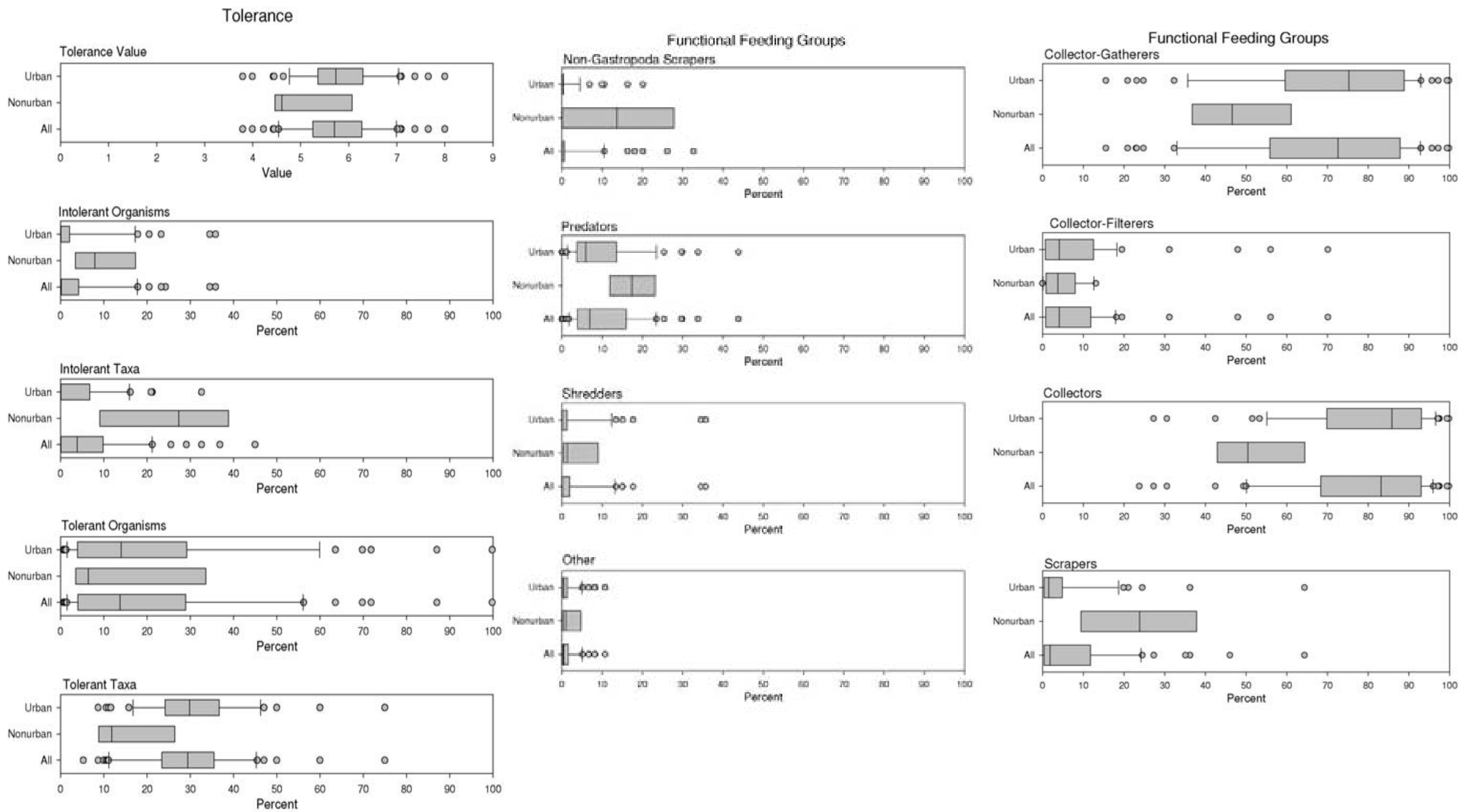

Figure 4-2-B. Tolerance and Functional Feeding Group metrics compared by land use for benthic macroinvertebrates sampled at RMC sites Water Year 2012.

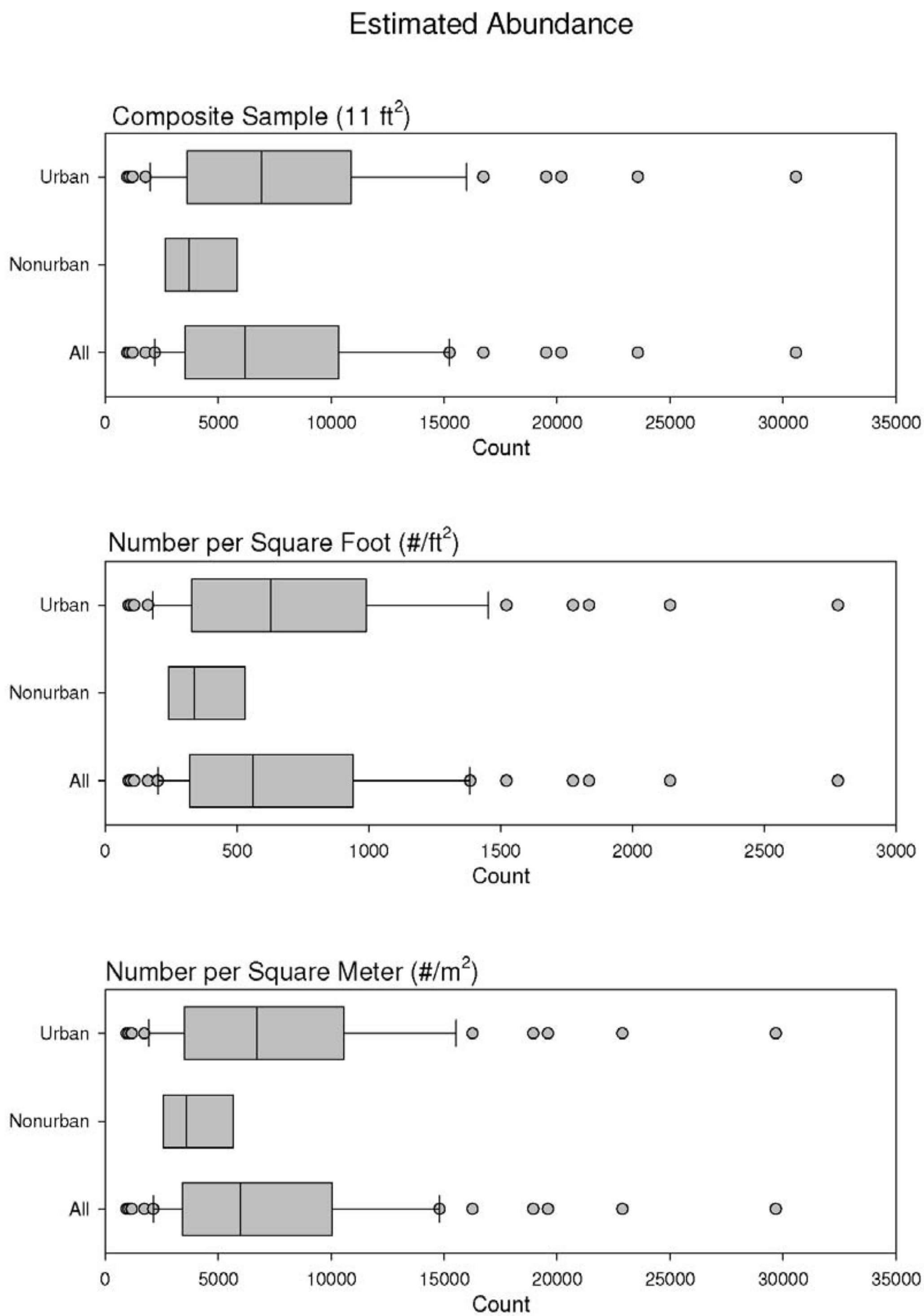

Figure 4-2-C. Estimated abundance metrics compared by land use for benthic macroinvertebrates sampled at RMC sites in Water Year 2012.

Table 4-2. Results of Student T-tests comparing benthic macroinvertebrate metrics between urban and nonurban land uses within the RMC area. DF = degrees of freedom.

Metric Type	Metric	Kolmogorov-Smirnov α = 0.05		Student T-test α = 0.05				
		Normal Distribution	p-value	Significant Difference	p-value	t-value	DF	α, Test Power
Richness	Taxonomic Richness	**Yes**	0.284	**Yes**	<0.001	6.623	58	0.050: 1.000
	EPT	No	< 0.050	**Yes**	<0.001	7.365	58	0.050: 1.000
	Ephemeroptera	No	< 0.050	**Yes**	<0.001	5.905	58	0.050: 1.000
	Plecoptera	No	< 0.050	**Yes**	<0.001	5.551	58	0.050: 1.000
	Trichoptera	No	< 0.050	**Yes**	<0.001	6.176	58	0.050: 1.000
	Coleoptera	No	< 0.050	**Yes**	<0.001	5.778	58	0.050: 1.000
	Predator	No	< 0.050	**Yes**	<0.001	7.222	58	0.050: 1.000
	Diptera	No	< 0.050	**Yes**	<0.001	3.65		0.050: 0.949
Composition	EPT Index (%)	No	< 0.050	No	0.237	1.195	58	0.050: 0.092*
	Sensitive EPT Index (%)	No	< 0.050	No	0.066	1.874	58	0.050: 0.328*
	Shannon Diversity	**Yes**	0.239	**Yes**	<0.001	3.89	58	0.050: 0.972
	Dominant Taxon (%)	No	< 0.050	No	0.097	-1.688	58	0.050: 0.251*
	Non-insect Taxa (%)	**Yes**	0.477	No	0.001	-3.362	58	0.050: 0.902
Tolerance	Tolerance Value	**Yes**	0.249	No	0.053	-1.972	58	0.050: 0.371*
	Intolerant Organisms (%)	No	< 0.050	No	0.080	1.780	58	0.050: 0.288*
	Intolerant Taxa (%)	No	< 0.050	**Yes**	<0.001	5.833	58	0.050: 1.000
	Tolerant Organisms (%)	No	< 0.050	No	0.585	-0.549	58	0.050: 0.050*
	Tolerant Taxa (%)	No	< 0.050	**Yes**	0.004	-15.328	58	0.050: 0.817
Functional Feeding Groups	Collector-Gatherers (%)	**Yes**	0.202	**Yes**	0.011	-2.632	58	0.050: 0.671
	Collector-Filterers (%)	No	< 0.050	No	0.485	-0.703	58	0.050: 0.050*
	Collectors (%)	No	< 0.050	**Yes**	<0.001	-3.716	58	0.050: 0.956
	Scrapers (%)	No	< 0.050	**Yes**	<0.001	3.568	58	0.050: 0.938
	Non-Gastropoda Scrapers (%)	No	< 0.050	**Yes**	<0.001	5.503	58	0.050: 1.000
	Predators (%)	No	< 0.050	No	0.052	1.985	58	0.050: 0.377*
	Shredders (%)	No	< 0.050	No	0.669	0.43	58	0.050: 0.050*
	Other (%)	No	< 0.050	No	0.451	0.759	58	0.050: 0.050*
Estimated Abundance	Composite Sample (11 ft2)	No	< 0.050	No	0.172	-1.384	58	0.050: 0.145*
	#/ft2	No	< 0.050	No	0.172	-1.384	58	0.050: 0.145*
	#/m2	No	< 0.050	No	0.239	-1.191	58	0.050: 0.091*

*** Indicates less than desired test power statistic of 0.800.**
Shaded rows: metrics that passed the Kolmogorov-Smirnov normality test and exhibited significant differences.

Table 4-3. Results of Student T-tests comparing the Southern California and Northern California Benthic Indices of Biotic Integrity to each other and urban and nonurban land uses for each within the RMC area.

* Indicates less than desired test power statistic of 0.800.

	(Kolmogorov-Smirnov)		Student T-test				
	α = 0.05		α = 0.05				
Comparison	**Normal Distribution**	**p-value**	**Significant Difference**	**p-value**	**t-value**	**DF**	**α, Test Power**
NorCal v SoCal B-IBI	No	< 0.050	No	0.757	0.31	118	0.050: 0.050*
NorCal B-IBI Urban v Nonurban	No	< 0.050	Yes	<0.001	-5.08	58	0.050: 1.000
SoCal B-IBI Urban v Nonurban	No	< 0.050	Yes	<0.001	-5.231	58	0.050: 1.000

4.2.2 Algae Metric Ranges

Algae metrics for sites sampled within the RMC area in the spring index period (April 15 – June 15, 2012) of Water Year 2012 exhibited a wide range of scores (Figures 4-3, 4-4, Attachment D) but none of the three metrics for any of the algae fractions - diatoms, microalgae, and epiphytes - demonstrated statistically significant differences between urban and nonurban areas (Table 4-4). The low proportion of epiphyte samples at most nonurban sites precluded these tests from being implemented for all but the species richness metric. In addition, most tests did not pass the Kolmogorov-Smirnov normality test. Typically in such cases data must be transformed to pass this test before running a T-test, however, visual examination of the distributions (Figure 4-3) indicated that taking this step would not change the T-test results, and therefore no transformations were performed.

In the absence of an available periphyton IBI pertaining to this region, diatom sensitivity and tolerance to pollutants is presented here in an exploratory data analytical mode. Table 4-5 describes the associations between dominant diatom taxa represented in each RMC sample and their relative tolerance for pollutants, including sediment, as associated with diatom motility (e.g., samples with relatively high percentages of highly motile diatoms likely indicate degraded ecological conditions and poor habitat quality). The relative presence of pollutant tolerant and intolerant diatom taxa present in the RMC samples collected in Water Year 2012 is illustrated in Figure 4-3. Pollutant tolerant dominant diatom taxa comprised a total of 33% of the RMC sample while pollutant intolerant diatom taxa comprised 27% (Figure 4-4A). The same comparison including only taxa (genus level) present at more than one site, reduced these relative percentages to 25% for pollutant tolerant taxa and 28% for pollutant intolerant taxa (Figure 4-4B.)

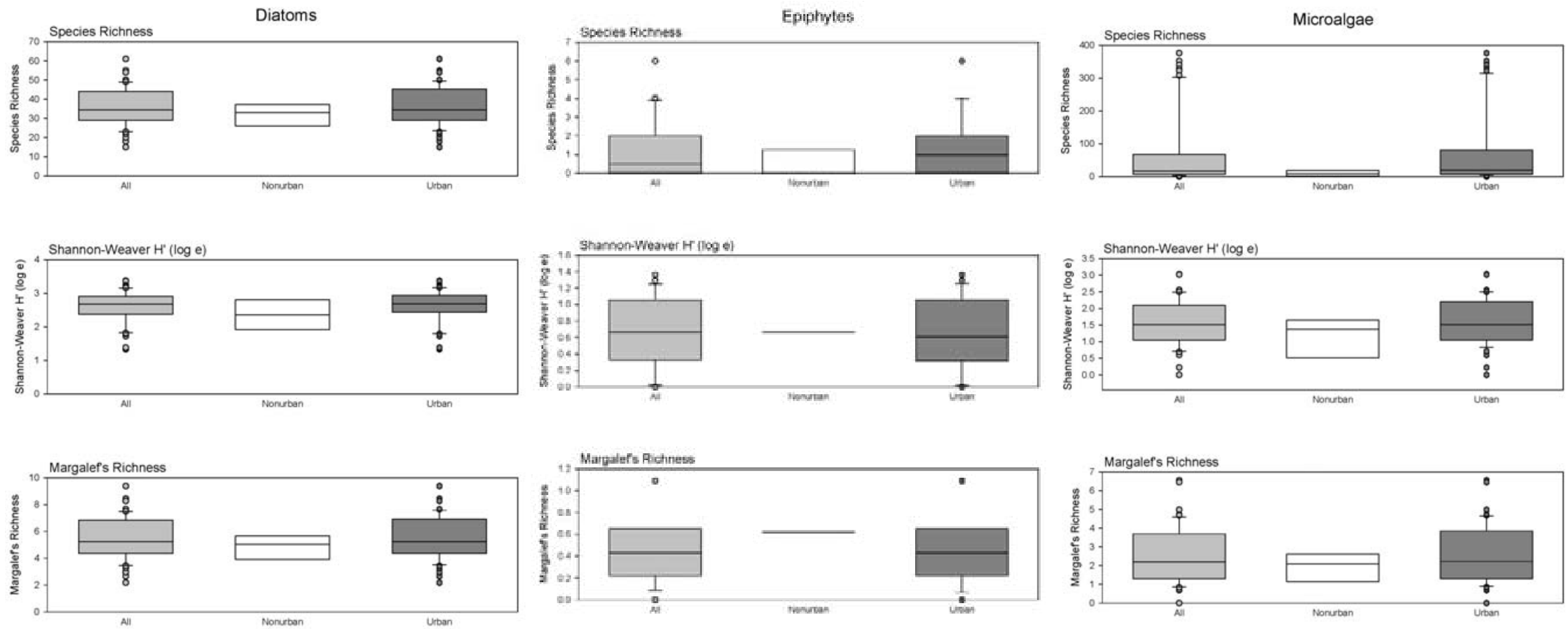

Figure 4-3. Species richness metrics for the three algae fractions – diatoms, microalgae, and epiphytes – sampled at RMC sites in Water Year 2012.

Table 4-4. Results of Student T-tests comparing algae metrics in urban and nonurban land uses within the RMC area. DF = degrees of freedom.

Algae Fraction	Metric	(Kolmogorov-Smirnov) α = 0.05		Student T-test α = 0.05				
		Normal Distribution	p-value	Significant Difference	p-value	t-value	DF	α, Test Power
Diatom	Species Richness	Yes	0.17	No	0.274	-1.103	58	0.050:0.070*
	Shannon-Weaver	No	< 0.050	No	0.232	-1.209	58	0.050:0.096*
	Margalef's Richness	Yes	0.317	No	0.278	-1.095	58	0.050:0.068*
Microalgae	Species Richness	No	< 0.050	No	0.185	-1.341	58	0.050: 0.133*
	Shannon-Weaver	Yes	0.582	No	0.137	-1.508	57	0.050: 0.185*
	Margalef's Richness	No	< 0.050	No	0.339	-0.965	56	0.050: 0.050*
Epiphytes	Species Richness	No	< 0.050	No	0.246	-1.171	58	0.050: 0.086*
	Shannon-Weaver	All Nonurban = NA						
	Margalef's Richness	All Nonurban = NA						

* Indicates less than desired test power statistic of 0.800.

Table 4-5. Dominant diatom taxa by relative pollutant tolerance and motility.

Dominant Taxa	Pollutant Intolerant	Pollutant Tolerant	Relative Motility
Amphora pediculus	x		
Achnanthidium minutissimum	x		
Nitzschia inconspicua		x	High
Nitzschia solita		x	High
Nitzschia amphibia		x	High
Nitzschia desertorum		x	High
Nitzschia microcephala		x	High
Cocconeis placentula var. euglypta		x	
Bacillaria paradoxa		x	High
Fragilaria capucina var. mesolepta		x	

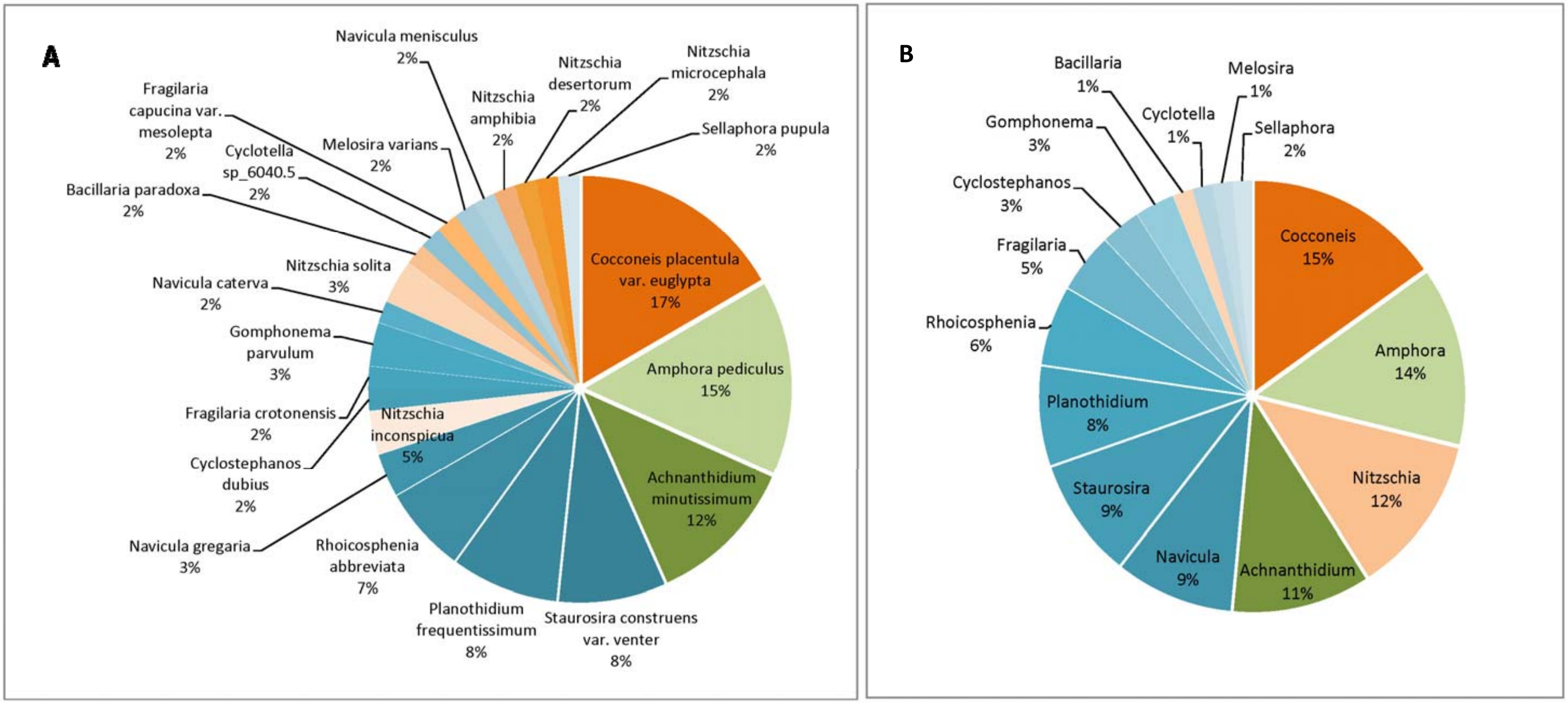

Figure 4-4. A) Dominant diatom taxa sampled at RMC sites in Water Year2012. B) Dominant diatom taxa sampled <u>at more than one RMC site</u> in Water Year 2012. Green-hued pie slices indicate sensitive species intolerant to pollutants; Orange-hued pie slices indicate species more tolerant of pollutants including fine sediment (Blinn & Herbst 2003; Herbst & Blinn 2008).

4.2.3 Benthic Index of Biological Integrity Score Ranges

The ranges in B-IBI scores using both the Southern California and the Northern California indices were similar, 0 – 81 and 8 – 80, respectively (Table 4-6). It is important to note for discussion of all B-IBI results in this report that currently no finalized B-IBI exists for the San Francisco Bay Area. Therefore, comparisons made here using these available analytical tools that were developed for other regions[20] of the state, are considered to be exploratory and provisional.

Scores calculated using the NorCal and SoCal B-IBIs did not differ significantly (see Figures 4-5 and 4-6, Table 4-7), however, differences between scores in urban and nonurban RMC areas calculated using both B-IBIs were significantly different (Table 4-7). Using the SoCal B-IBI, 43% of the sites scored in the very poor condition category, 32% in the poor category, 12% in the fair category, 10% in the good category, and 3% in the very good category (Table 4-6). All nonurban sites scored in the top condition category achieved (either good or very good) for each County.

[20] The regions from which data used to develop both the NorCal IBI and the SoCal IBI exhibit some similar characteristics to parts of the San Francisco Bay Area but neither is considered to represent the full range of ecological conditions characteristic of this region.

Table 4-6. Southern California and Northern California Benthic Indices of Biotic Integrity scores for RMC sites sampled in Water Year 2012 (N=60). Flow class: P = perennial; NP = non-perennial; U=unknown. Coldwater (COLD) and warmwater (WARM) aquatic life uses; X* assumes presumptive use as not all waterbodies are listed in the Basin Plan.

Storm-water Program	Site Names	Site IDs	Land Use	Flow Class	3-sided Concrete Channel	COLD	WARM	NorCal B-IBI Final Score	SoCal B-IBI Final Score	SoCal B-IBI Condition Categories				
										Very Poor: 0-19	Poor: 20-39	Fair: 40-59	Good: 60-79	Very Good: 80-100
ACCWP	NA (Line G-2)	204R00596	Urban	P	no		X*	11	3	X				
ACCWP	Sulphur	204R00383	Urban	P	no		X	14	7	X				
ACCWP	Arroyo de la Laguna	204R00356	Urban	P	no	X	X	15	9	X				
ACCWP	Arroyo Mocho	204R00100	Urban	NP	no	X	X	16	11	X				
ACCWP	Line 5-F-1	205R00535	Urban	P	no		X*	20	11	X				
ACCWP	Big Canyon Cr, Line 7-J-1	204R00340	Urban	P	no		X*	21	13	X				
ACCWP	Line 3A-D	204R00583	Urban	P	no		X*	16	14	X				
ACCWP	Collier Channel, Line 7-M	204R00068	Urban	P	no		X	19	16	X				
ACCWP	Dublin Creek	204R00084	Urban	P	no		X	19	17	X				
ACCWP	San Lorenzo	204R00639	Urban	P	yes	X	X	25	17	X				
ACCWP	unknown	205R00430	Urban	P	yes		X*	23	17	X				
ACCWP	Arroyo Valle	204R00191	Urban	P	no	X	X	20	21		X			
ACCWP	unknown	204R00303	Urban	P	no		X*	25	23		X			
ACCWP	unknown	204R00391	Urban	P	no		X*	29	23		X			
ACCWP	Castro Valley	204R00047	Urban	P	yes	X	X	19	24		X			
ACCWP	Agua Caliente	205R00110	Urban	P	no		X	33	36		X			
ACCWP	Zeile	204R00455	Urban	P	no		X	40	37		X			
ACCWP	Dry	204R00647	Urban	P	no		X	51	47			X		
ACCWP	Sausal	204R00319	Urban	P	no		X	56	54			X		
ACCWP	Ward	204R00367	Urban	P	no	X	X	53	61				X	
CCCWP	Deer	543R00137	Urban	U	no		X*	9	0	X				
CCCWP	Dry	544R00025	Urban	P	no		X*	9	3	X				
CCCWP	Las Trampas	207R00139	Urban	P	no	X	X	9	7	X				
CCCWP	Grayson	207R00011	Urban	P	yes	X	X	15	13	X				
CCCWP	San Pablo	206R00215	Urban	U	no	X	X	23	19	X				
CCCWP	Walnut	207R00247	Urban	U	yes	X	X	21	21		X			
CCCWP	Cerrito	203R00039	Urban	P	no		X	24	23		X			
CCCWP	San Pablo	206R00155	Urban	P	no	X	X	30	24		X			
CCCWP	Marsh	543R00219	Nonurban	P	no		X*	41	43			X		
CCCWP	Marsh	543R00245	Nonurban	U	no		X*	36	43			X		
SMCWPPP	Arroyo Ojo de Agua Trib.	204R00244	Urban	P	yes		X	13	13	X				

Storm-water Program	Site Names	Site IDs	Land Use	Flow Class	3-sided Concrete Channel	COLD	WARM	NorCal B-IBI Final Score	SoCal B-IBI Final Score	SoCal B-IBI Condition Categories				
										Very Poor: 0-19	Poor: 20-39	Fair: 40-59	Good: 60-79	Very Good: 80-100
SMCWPPP	Polhemus	204R00200	Urban	P	no		X	33	23		X			
SMCWPPP	Arroyo Ojo de Agua	204R00232	Urban	P	no	X	X	33	24		X			
SMCWPPP	Sanchez	204R00180	Urban	P	no	X	X	29	26		X			
SMCWPPP	Denniston	202R00284	Urban	P	no	X	X	54	59			X		
SMCWPPP	Milagra	202R00087	Urban	P	no	X	X	50	63				X	
SMCWPPP	Pilarcitos	202R00072	Nonurban	P	no	X	X	64	70				X	
SMCWPPP	Woodhams	202R00024	Nonurban	P	no		X	70	76				X	
SMCWPPP	Corte Madera	205R00088	Urban	P	no		X	66	76				X	
SMCWPPP	Corte Madera	205R00168	Urban	P	no	X	X	73	76				X	
SCVURPPP	Canoas	205R00090	Urban	P	yes	X	X	8	0	X				
SCVURPPP	Canoas	205R00154	Urban	P	no	X	X	5	0	X				
SCVURPPP	San Thomas Aquino	205R00067	Urban	P	no	X	X	15	6	X				
SCVURPPP	Stevens	205R00115	Urban	P	no	X	X	21	7	X				
SCVURPPP	Guadalupe	205R00346	Urban	P	no	X	X	14	10	X				
SCVURPPP	Coyote	205R00291	Urban	P	no	X	X	14	13	X				
SCVURPPP	Coyote	205R00042	Urban	P	no	X	X	18	16	X				
SCVURPPP	Lower Penitencia	205R00131	Urban	P	no	X	X	21	19	X				
SCVURPPP	Upper Silver	205R00241	Urban	P	no	X	X	15	19	X				
SCVURPPP	Guadalupe	205R00259	Urban	P	no	X	X	20	21		X			
SCVURPPP	Upper Penitencia	205R00035	Urban	P	no		X*	23	23		X			
SCVURPPP	Los Gatos	205R00026	Urban	P	no	X	X	25	27		X			
SCVURPPP	Calabazas	205R00099	Urban	P	no		X	33	31		X			
SCVURPPP	Coyote	205R00218	Urban	P	no		X	23	33		X			
SCVURPPP	Matadero	205R00227	Urban	P	no	X	X	35	34		X			
SCVURPPP	San Thomas Aquino	205R00234	Urban	P	no		X	38	39		X			
SCVURPPP	Guadalupe Cr	205R00282	Urban	P	no	X	X	44	41			X		
SCVURPPP	Saratoga	205R00355	Urban	P	no	X	X	39	44			X		
SCVURPPP	MF Coyote	205R00021	nonurban	NP	no	X	X	68	81					X
SCVURPPP	Saratoga	205R00058	nonurban	P	no	X	X	80	81					X

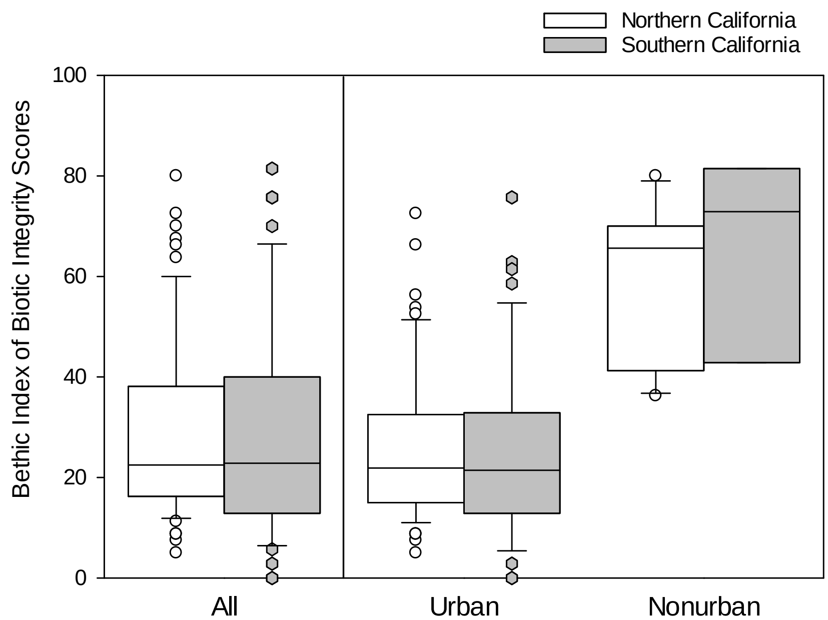

Figure 4-5. Northern and Southern California benthic macroinvertebrate Index of Biotic Integrity scores for all sites (N=60), sites classified as urban (N=54) or nonurban (N=6) sampled in Water Year 2012.

Table 4-7. Results of Student T-tests comparing scores from the Southern and the Northern California Benthic Indices of Biotic Integrity, and comparing scores from both Indices by land use (urban and nonurban) for samples collected in the RMC area in Water Year 2012.

	(Kolmogorov-Smirnov)		Student T-test				
	α = 0.05		α = 0.05				
Comparison	Normal Distribution	p-value	Significant Difference	p-value	t-value	DF	α, Test Power
SoCal v NorCal B-IBI	No	< 0.050	No	0.757	0.31	118	0.050: 0.050*
SoCal B-IBI Urban v Nonurban	No	< 0.050	Yes	<0.001	-5.231	58	0.050: 1.000
NorCal B-IBI Urban v Nonurban	No	< 0.050	Yes	<0.001	-5.08	58	0.050: 1.000

4.2.4 Analysis of Condition Indicators

To address the question ***"Are aquatic life beneficial uses supported in the RMC area?"***, biological condition scores derived from the SoCal B-IBI were compared to the WARM and COLD aquatic life uses designated by the SF Bay RWQCB (SFBRWQCB 2011) (see Table 4-6). As discussed above, in the absence of an available B-IBI developed for the San Francisco Bay Region, the SoCal B-IBI was used to assess the condition of BMI data sampled in the RMC area, and therefore these results should be considered provisional. In addition to the fact that using the SoCal B-IBI to interpret data from the RMC area may introduce bias due to the different ecological characteristics of the respective regions, the authors of the SoCal B-IBI also note that the index was developed specifically for perennial streams and therefore is also likely to produce results that are slightly biased against non-perennial streams (SFBRWQCB 2012). Since the RMC data set for Water Year 2012 contained only two non-perennial streams (Table 4-6), this factor likely has not greatly influenced the analysis of condition indicators, but should be considered. Specifically, subsequent evaluations and/or considerations of management actions at these sites and others in this region should take into account this consideration when interpreting results presented in this report.

Twenty five percent of the sites that scored in the very poor condition category were associated with a designated COLD beneficial use. Fewer sites (15%) that scored in the poor condition category were associated with a designated COLD beneficial use. Since the WARM beneficial use applies to all creeks in the sample frame, the results for the percent of sites associated with WARM are concordant with the condition results reported above, e.g., 43% in the very poor condition category, and 32% in the poor condition category. It is important to note that the B-IBI scoring is not directly linked to the distinction between COLD and WARM beneficial uses, as COLD is explicitly associated with a specific guild or taxonomic group of fishes whereas WARM is associated with general support for all aquatic life forms.

Very Poor Condition Category

Of the 26 sites that scored in the "very poor" B-IBI condition category, 15 (58%) were designated with a COLD beneficial use. A total of 5 of the 26 sites (19%) are three-sided[21] concrete channels, which would not be expected to score well for biological condition using any index. Another site that scored in very poor condition category is non-perennial, and thus its score is likely negatively biased due to the inherent nature of the assessment tool (see Section 3.4.1). As considerations of future stressor identification projects move forward, Permittees should consider these aforementioned factors.

Poor Condition Category

Of the 19 RMC sites that exhibited a "poor" B-IBI condition category, 9 (47%) are located in waterbodies with a designated COLD beneficial use. A total of 2 of 19 (11%) RMC sites that scored in this B-IBI category are three-sided concrete channels. These factors should be considered when prioritizing future studies and projects.

Fair, Good, and Very Good Categories

Twenty-five percent (15/60) of the RMC sites were classified in either the fair, good, or very good condition categories using the SoCal B-IBI, indicating substantial support for the associated designated aquatic life uses. None of these sites occurred in three-sided concrete channels, however, other degrees of channel modification exist for some. One of these sites one was a non-perennial site in a nonurban area.

4.3 Stressor Assessment

This section addresses the question: ***"What are major stressors to aquatic life in the RMC area?"*** Each monitoring category required by MRP Provision C.8.c, Table 8.1 is associated with a specification for "Results that Trigger a Monitoring Project in Provision C.8.d.i" (Stressor/Source Identification). The definitions of these "Results that Trigger…", as shown in Table 8.1, are considered to represent "trigger criteria", meaning that the relevant monitoring results should be forwarded for consideration as potential Stressor/Source Identification Projects per Provision C.8.d.i. The physical, chemical and toxicity testing data produced by RMC participants during Water Year 2012 were compiled and evaluated, and analyzed against these trigger criteria. When the data analysis indicated that the associated trigger criteria were met, those sites and results were identified as potentially warranting further investigation.

[21] A full review of channel modification at these RMC sites has not yet been conducted. The consideration of fully concretized channels is a conservative initiation into this line of inquiry that will be deepened at a later date.

4.3.1 Stressor Indicator Ranges

Physical Habitat Parameters

Box plots of selected physical habitat (PHab) metrics are presented in Figure 4-7. PHab metrics/endpoints varied dramatically among urban sites. Currently, no criteria or triggers exist for examination of PHab data in the context of water quality or biological conditions. Rather, the effects of physical habitat on biological condition will be evaluated in the future in the context of planning for stressor/source identification projects. PHab data presented in this report are therefore only included for illustrative purposes.

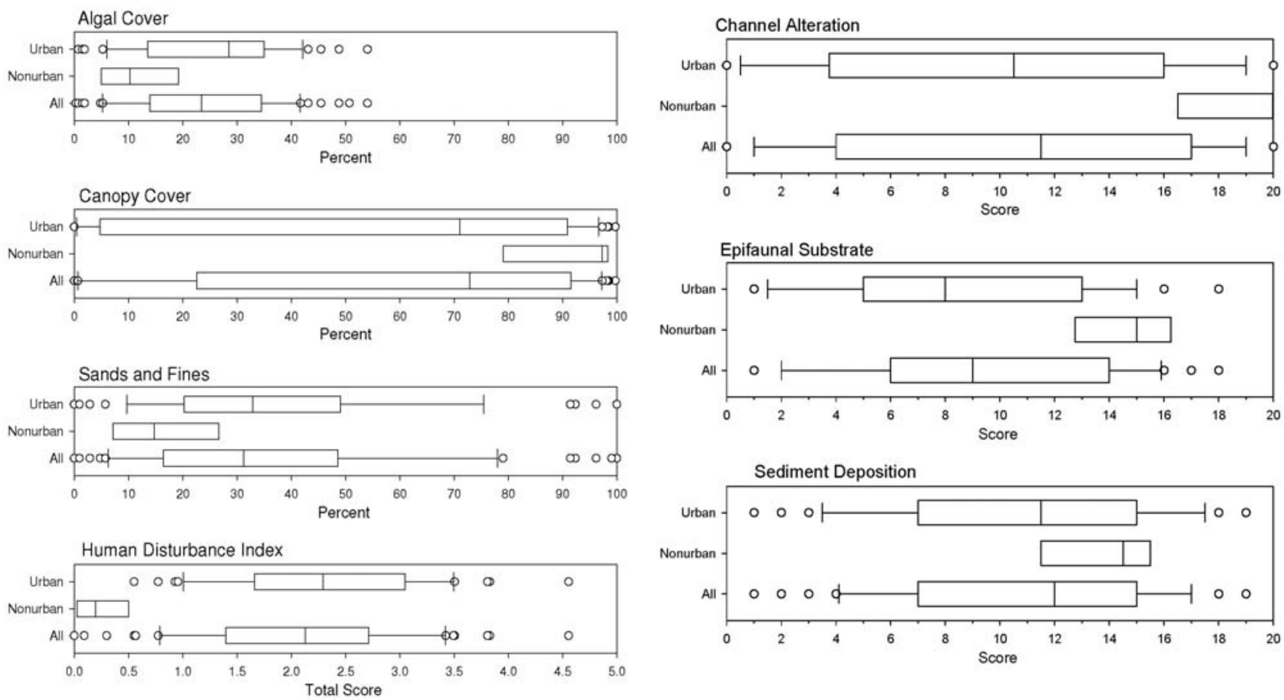

Figure 4-6. Distribution Box plots for selected Physical Habitat metrics for urban and non-urban areas.

Water Chemistry Parameters

Table 4-8 provides a summary of descriptive statistics for the nutrients and related conventional constituents collected in association with the bioassessments in receiving waters. For the purposes of data analysis and comparison to water quality thresholds (see Stressor Analysis section, below), Total Nitrogen was calculated as the sum of nitrate + nitrite + Total Kjeldahl Nitrogen (TKN).

Table 4-8. Descriptive statistics for water chemistry results collected at RMC sites during Water Year 2012.

"Nutrients"	N	N ≥ RL	Min	Max	Max Detected	Mean
Chloride	60	60	7.7	410	410	73.7
Chlorophyll a	60	41	<200	<61,000	7,000	2,383
Dissolved Organic Carbon	60	60	0.99	44	44	4.64
Ammonia as N	60	46	<0.044	0.55	0.55	0.11
Nitrate as N	60	53	<0.016	7.5	7.5	0.64
Nitrite as N	60	32	<0.002	0.19	0.19	0.02
Nitrogen, Total Kjeldahl	60	60	0.11	3.2	3.2	0.51
OrthoPhosphate as P	60	56	<0.005	0.31	0.31	0.08
Phosphorus as P	60	58	<0.005	0.35	0.35	0.09
Suspended Sediment Concentration	59	46	<1.5	68	68	9.93
Silica as SiO2	60	60	8.9	68.3	68.3	21.2

Water and Sediment Toxicity Testing

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

For water sample toxicity tests, MRP Table 8.1 identifies toxicity results of less than 50% of the Control as requiring follow-up action. For sediment sample tests, MRP Table H-1 identifies toxicity results more than 20% less than the control as requiring follow-up action.[22] Therefore, in the tables that follow, samples that are identified by the lab as toxic (based on statistical comparison of samples vs. Control at p = 0.05) are further evaluated to determine whether the result was less than 50% of the associated Control (for water samples) or statistically different and more than 20% less the Control (for sediment samples).

The toxicity testing results are therefore presented in context of the following three groups: 1) wet season water samples, 2) dry season water samples, and 3) dry season sediment samples. All samples were collected within receiving waters (i.e., creeks) at sites where bioassessments were conducted.

For each of these groups, the results are first presented in a table indicating which samples were found to be toxic by virtue of a statistically significant difference from the Control as determined by the laboratory. Detailed results are then presented in a subsequent table for the toxic samples, along with

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

an assessment as to whether the toxic effect was less than 50% of the Control for water samples or more than 20% less than the Control for sediment samples.

Wet Season Water Toxicity

Ambient water samples were collected from 10 sites throughout the region during storm events in March, 2012, and tested for toxic effects using four species: an aquatic plant (*Selenastrum capricornutum*), two aquatic invertebrates (*Ceriodaphnia dubia* and *Hyalella azteca*), and one fish species (*Pimephales promelas* or fathead minnow). Table 4-9 provides a summary of wet season toxicity testing results for these samples. Regionwide, one sample was found to be toxic to *Ceriodaphnia dubia*, and three samples were toxic to *Hyalella azteca*. The toxic *Ceriodaphnia dubia* sample was significantly different than the Control only for the "chronic" testing endpoint (reproduction). In water samples, *Hyalella azteca* are tested only for the "acute" (survival) testing endpoint.

Four wet weather samples were found to be toxic to fathead minnows. Of those four, two met the criteria for the chronic endpoint (growth) and two met the acute endpoint criteria (survival). Three of the four toxic fathead minnow test results were determined by the toxicity testing laboratory to have been caused by interference due to pathogen-related mortality (PRM), a common source of laboratory interference in receiving water samples. The lab reports for these samples include the following statement relative to the PRM-affected samples: "observations of PRM are not associated with or indicative of stormwater toxicity". In those three cases, the samples were re-tested using a method developed to minimize PRM interference (Geis et al., 2003). In all three cases, no toxic response was observed, as discussed below.

Table 4-9. Summary of Water Year 2012 wet season water toxicity results.

Wet Season Water Samples			Date of Analysis	Toxicity relative to the Lab Control treatment?					
County/ Program	Sample Station	Collection Date		*Selenastrum capricornutum*	*Ceriodaphnia dubia*		*Hyalella azteca*	Fathead Minnow	
				Growth	Survival	Reproduction	Survival	Survival	Growth
ACCWP	204R00047	3/14/2012	3/15/2012	No	No	No	**Yes**	No	**Yes ***
ACCWP	204R00084	3/14/2012	3/15/2012	No	No	No	No	No	No
ACCWP	204R00100	3/14/2012	3/15/2012	No	No	No	No	**Yes ***	No
CCCWP	207R00011	3/14/2012	3/15/2012	No	No	No	**Yes**	No	No
CCCWP	544R00025	3/14/2012	3/17/2012	No	No	No	**Yes**	No	No
SCVURPPP	205R00026	3/17/2012	3/17/2012	No	No	No	No	**Yes ***	No
SCVURPPP	205R00035	3/16/2012	3/17/2012	No	No	No	No	No	No
SCVURPPP	205R00042	3/17/2012	3/17/2012	No	No	No	No	No	No
SMCWPPP	202R00087	3/17/2012	3/17/2012	No	No	No	No	No	**Yes**
SMCWPPP	202R00088	3/17/2012	3/17/2012	No	No	**Yes**	No	No	No

* PRM was observed in multiple replicates for this stormwater sample; toxicity was not observed in re-tests using Geis technique

Table 4-10 provides detailed results for RMC Water Year 2012 wet weather receiving water samples found to be toxic relative to the laboratory control. The samples from sites 204R00047, 543R00079, and 544R00201 exhibited *Hyalella azteca* survival that was less than 50% of the control, and the sample from site 202R00088 exhibited toxicity to *Ceriodaphnia dubia*, with reproduction measured at less than 50% of the Control. Per MRP Table 8.1, resampling at these sites for these species should occur to better determine the persistence of water toxicity.

Table 4-10. Comparison between laboratory control and receiving water sample toxicity results (*Hyalella azteca* and *Ceriodaphnia dubia*) for RMC samples collected in the Water Year 2012 wet season, in the context of MRP trigger criteria.

County/ Program	Test Initiation Date (Time)	Species Tested	Treatment/ Sample ID	10-Day Mean % Survival	Mean Reproduction (# neonates/ female)	Comparison to MRP Table 8.1 Trigger Criteria
ACCWP	3/15/12 (1430)	*Hyalella azteca*	Lab Control	100	NA	NA
	3/15/12 (1430)		204R00047	**48***		**< 50% of Control**
CCCWP	3/15/12 (1430)		Lab Control	100		NA
	3/15/12 (1430)		207R00011	**32***		**< 50% of Control**
	3/15/12 (1700)		Lab Control	94		NA
	3/15/12 (1700)		544R00025	**0***		**< 50% of Control**
SMCWPPP	3/25/12 (1400)	*Ceriodaphnia dubia*	Lab Control	100	33.1	NA
	3/25/12 (1400)		202R00088	100	**16.3***	**< 50% of Control**

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

Table 4-11 provides detailed results for the fathead minnow tests that were noted to have statistically different results from laboratory Controls, as well as the results of re-testing using a version of the Geis technique. In three of the four cases, the original fathead minnow tests were found to be affected by PRM interference, based on visual examination of test organisms by the testing laboratory. When re-tested using a technique designed to prevent PRM interference (Geis et al., 2003), toxicity was not observed in these samples, confirming the original determination of PRM interference in the initial tests.

As indicated in Table 4-11, while significantly less than the associated Control values (via statistical comparison at p=0.5), the affected results were not less than the associated MRP threshold of less than 50% of the Control values for either survival or biomass growth.

Table 4-11. Comparison between laboratory control and receiving water sample toxicity results for Fathead Minnow for RMC samples collected in the Water Year 2012 wet season, in the context of MRP trigger criteria.

County/ Program	Test Initiation Date (Time)	Treatment/ Sample ID	Mean % Survival	Mean Biomass Value (mg)	Comparison to MRP Table 8.1 Trigger Criteria; Identification of PRM effects and PRM Method Re-tests
ACCWP	3/15/12 (1450)	Lab Control	100	0.52	NA
	3/15/12 (1450)	204R00047	95 (a)	**0.42***	Not < 50% of Control; PRM noted
	3/15/12 (1450)	204R00100	**72.5*** (a)	0.46	Not < 50% of Control; PRM noted
	3/23/12 (1500)	Lab Control	100	0.27	NA
	3/23/12 (1500)	204R00047	90	0.29	PRM method re-test (Geis et al., 2003)
	3/23/12 (1500)	204R00100	100	0.34	PRM method re-test (Geis et al., 2003)
SCVURPPP	3/17/12 (1700)	Lab Control	97.5	0.5	NA
	3/17/12 (1700)	205R00026	**75* (a)**	0.44	Not < 50% of Control; PRM noted
	3/17/12 (1700)	Lab Control	100	0.42	NA
	3/17/12 (1700)	205R00026	90	0.37	PRM method re-test (Geis et al., 2003)
SMCWPPP	3/17/12 (1700)	Lab Control	97.5	0.5	NA
	3/17/12 (1700)	202R00087	90	**0.43***	Not < 50% of Control

* The response at this test treatment was significantly less than the Lab Control at $p < 0.05$.
(a) PRM was observed in multiple replicates for this stormwater sample

<u>Dry Season Water Toxicity</u>

Water samples were collected during the summer 2012 period from the same ten sites where wet season sampling occurred, and were again tested for toxicity using the same four aquatic species. The results are summarized in Table 4-12. In comparisons to the control samples, only one *Hyalella* sample was found to be toxic. For this sample, the measured 10-day mean survival was 92%, compared to 100% for the Control, and therefore, the sample result was not greater than the trigger included in the MRP (i.e., less than 50% of the Control).

Table 4-12. Summary of Water Year 2012 dry season water toxicity results.

Dry Season Water Samples			Date of Analysis	Toxicity relative to the Lab Control treatment?					
County/ Program	Sample Station	Collection Date		*Selenastrum capricornutum*	*Ceriodaphnia dubia*		*Hyalella azteca*	Fathead Minnow	
				Growth	Survival	Reproduction	Survival	Survival	Growth
ACCWP	204R00047	7/25/2012	7/26/2012	No	No	No	No	No	No
ACCWP	204R00084	7/25/2012	7/26/2012	No	No	No	No	No	No
ACCWP	204R00100	7/25/2012	7/26/2012	No	No	No	No	No	No
CCCWP	207R00011	7/25/2012	7/26/2012	No	No	No	No	No	No
CCCWP	544R00025	7/25/2012	7/26/2012	No	No	No	No	No	No
SCVURPPP	205R00026	7/25/2012	7/26/2012	No	No	No	No	No	No
SCVURPPP	205R00035	7/25/2012	7/26/2012	No	No	No	**Yes** *	No	No
SCVURPPP	205R00042	7/25/2012	7/26/2012	No	No	No	No	No	No
SMCWPPP	202R00087	7/25/2012	7/26/2012	No	No	No	No	No	No
SMCWPPP	202R00088	7/25/2012	7/26/2012	No	No	No	No	No	No

Dry Season Sediment Toxicity

During the dry season, sediment samples were collected at the same ten sites and tested for both sediment toxicity and an extensive list of sediment chemistry constituents. For sediment toxicity, testing was performed with just one species, *Hyalella azteca*, a common benthic invertebrate. Both acute and chronic endpoints (survival and growth) were analyzed.

The results of the summer 2012 sediment toxicity testing are summarized in Table 4-13. Four of the ten samples were determined to be toxic to *Hyalella* for the acute endpoint (survival). No chronic endpoint results indicated chronic toxicity at any sites.

Table 4-13. Summary of Water Year 2012 dry season sediment toxicity results.

Dry Season Sediment Samples			Date of Analysis	Toxicity relative to the Lab Control treatment?	
County/ Program	Sample Station	Collection Date		*Hyalella azteca*	
				Survival	Growth
ACCWP	204R00047	7/25/2012	7/28/2012	**Yes**	N/A*
ACCWP	204R00084	7/25/2012	7/28/2012	No	No
ACCWP	204R00100	7/25/2012	7/28/2012	No	No
CCCWP	207R00011	7/25/2012	7/28/2012	**Yes**	N/A*
CCCWP	544R00025	7/25/2012	7/28/2012	**Yes**	N/A*
SCVURPPP	205R00026	7/25/2012	7/28/2012	No	No
SCVURPPP	205R00035	7/25/2012	7/28/2012	No	No
SCVURPPP	205R00042	7/25/2012	7/28/2012	**Yes**	N/A*
SMCWPPP	202R00087	7/25/2012	7/28/2012	No	No
SMCWPPP	202R00088	7/25/2012	7/28/2012	No	No

* Per EPA guidance, samples with a significant reduction in survival are not evaluated for chronic endpoints (i.e., growth).

Detailed results of both the water and sediment samples identified as having toxic effects from the 2012 dry season samples are shown in Table 4-14, along with comparisons to the relevant trigger criteria from MRP Tables 8.1 and H-1. In all five cases (one water sample and four sediment samples), the toxic effect involved *Hyalella* survival. In three of the five cases the test results did not meet the MRP trigger criteria of less than 50% of Control (water samples) or more than 20% less than Control (sediment samples). In the other two cases, sediment toxicity results were more than 20% less than the control, meeting the Table H-1 sediment threshold.

Table 4-14. Detailed water and sediment toxicity results for toxic dry season *Hyalella azteca* tests

County/ Program	Test Initiation Date (Time)	Treatment/ Sample ID	Mean % Survival	Mean Dry Weight (mg)	Comparison to MRP Tables 8.1 and H-1 Trigger Criteria
WATER					
SCVURPPP	7/26/12 (1515)	Lab Control	100	NA	NA
	7/26/12 (1515)	205R00035	**92***	NA	Not < 50% of Control
SEDIMENT					
ACCWP	7/28/12 (1215)	Lab Control	96.3	0.23	NA
	7/28/12 (1215)	204R00047	**88.8***	0.24	Not more than 20% < Control
CCCWP	7/28/12 (1215)	Lab Control	96.3	0.23	NA
	7/28/12 (1215)	207R00011	**43.8***	0.09	**More than 20% < Control**
	7/28/12 (1215)	544R00025	**60***	0.23	**More than 20% < Control**
SCVURPPP	7/28/12 (1215)	Lab Control	98.8	0.25	NA
	7/28/12 (1215)	205R00042	**80***	0.29	Not more than 20% < Control

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

Sediment Chemistry Parameters

Descriptive statistics for sediment chemistry data for samples collected in Water Year 2012 are provided in Table 4-15. Analytes are presented in alphabetical order.

In this compilation of statistics, non-detect data (“NDs”) were substituted with a concentration equal to 1/2 of the respective laboratory reporting limit (RL) as reported by the laboratory, as long as there was at least one detected value. Some of the calculated numbers may be artificially elevated due to this method used to account for filling in non-detect data.

Please note that a number of the sediment chemistry constituents required per the list in MacDonald et al. (2000) required some grouping of analytes. For example, the MacDonald “chlordane” constituent required the combination of “chlordane, cis” and “chlordane, trans” from the laboratory data, and the MacDonald “total DDTs” parameter required the aggregation of 6 analytical variants of DDD, DDE and DDT. The MacDonald list also includes 10 individual PAH compounds, as well as “Total PAHs”. For this report, “Total PAHs” was computed as the sum of all 23 PAH compounds reported by the laboratory.

Table 4-15. Descriptive statistics for Water Year 2012 sediment chemistry results[1] (samples collected 7/25/12).

Analyte	N	N ≥ RL	Min	Max	Max Detected	Mean
% Solids	10	10	23	82	82	60.00
Acenaphthene	10	0	<14	<610	--	<610
Acenaphthylene	10	0	<14	<610	--	<610
Anthracene	10	0	<14	<610	--	<610
Arsenic	10	10	0.77	5.4	5.4	3.27
Benz(a)anthracene	10	1	<14	<610	24	<610
Benzo(a)pyrene	10	2	<11	<610	62	<610
Benzo(b)fluoranthene	10	4	<14	<610	110	70.5
Benzo(e)pyrene	10	2	<11	<610	110	84.5
Benzo(g,h,i)perylene	10	2	<14	<610	87	77.3
Benzo(k)fluoranthene	10	1	<8.4	<610	8.4	<610
Bifenthrin	10	8	<0.19	21	21	4.97
Biphenyl	10	0	<14	<610	--	<610
Cadmium	10	10	0.066	0.62	0.62	0.19
Chlordane, cis-	10	0	<1.2	<43	--	<43
Chlordane, trans-	10	0	<1.2	<43	--	<43
Chromium	10	10	8.5	432	432	75.7
Chrysene	10	1	<14	<610	33	<610
Copper	10	10	8.6	52	52	25.0
Cyfluthrin, total	10	5	<0.19	11	11	2.33
Cyhalothrin, lambda, total	10	1	<0.11	<3.6	0.11	<3.6
Cypermethrin, total	10	2	<0.19	<3.6	1.2	0.76
DDD(o,p')	10	0	<1.2	<43	--	<43
DDD(p,p')	10	2	<1.2	<43	17	7.74
DDE(o,p')	10	0	<1.2	<43	--	<43
DDE(p,p')	10	1	<1.2	240	240	28.6
DDT(o,p')	10	0	<1.2	<43	--	<43
DDT(p,p')	10	1	<1.2	<43	9.2	6.44
Deltamethrin/Tralomethrin	10	2	<0.19	<3.6	1.5	0.81
Dibenz(a,h)anthracene	10	0	<14	<610	--	<610
Dibenzothiophene	10	0	<14	<610	--	<610
Dieldrin	10	0	<1.2	<43	--	<43
Dimethylnaphthalene, 2,6-	10	2	<14	<610	160	86.9
Endrin	10	0	<1.2	<43	--	<43
Esfenvalerate/Fenvalerate, total	10	1	<0.19	<3.6	0.31	<3.6
Fluoranthene	10	5	<14	<610	380	111
Fluorene	10	0	<14	<610	--	<610
HCH, gamma	10	0	<1.2	<43	--	<43
Heptachlor epoxide	10	0	<1.2	<43	--	<43
Indeno(1,2,3-c,d)pyrene	10	1	<8.1	<610	8.1	<610
Lead	10	10	2.9	21	21	9.52
Mercury	10	10	0.0055	0.29	0.29	0.08
Methylnaphthalene, 1-	10	0	<14	<610	--	<610
Methylnaphthalene, 2-	10	0	<14	<610	--	<610
Methylphenanthrene, 1-	10	1	<9.3	<610	9.3	<610
Naphthalene	10	0	<14	<610	--	<610
Nickel	10	10	9.8	301	301	79.2
Permethrin, cis-	10	2	<0.195	5.4	5.4	1.23
Permethrin, Total	10	3	<0.195	7	7	1.59
Permethrin, trans-	10	2	<0.195	<3.6	1.6	0.80
Perylene	10	1	<14	<610	33	<610
Phenanthrene	10	2	<14	<610	140	89.0
Pyrene	10	6	<8	<610	420	115
Total Organic Carbon	10	10	0.15	2.3	2.3	0.97
Zinc	10	10	24	170	170	72.7

[1] "N" = number of samples; "N>RL" = number of samples detected above the laboratory reporting limit

4.3.2 Stressor Analysis

This section provides an analysis of the water and sediment chemistry and toxicity testing results in comparison to various thresholds included in the MRP. This analysis is intended to provide a means of identifying potential stressors that may impact beneficial uses at the creek status monitoring locations.

Water Chemistry Parameters

Per MRP Table 8.1, the trigger criterion ("Results that Trigger a Monitoring Project in Provision C.8.d.i) for the "Nutrients" constituents analyzed in conjunction with the bioassessment monitoring is *"20% of results in one waterbody exceed one or more water quality standard or established threshold*." A search for relevant water quality standards or accepted thresholds was conducted using available sources, including the SF Basin Water Quality Control Plan (Basin Plan) (SFBRWQCB 2011), the California Toxics Rule (CTR) (USEPA 2000), and various USEPA sources. Of the eleven water quality constituents monitored in association with the bioassessment monitoring (referred to collectively as "Nutrients" in MRP Table 8.1), water quality standards or established thresholds are available only for ammonia (unionized form), chloride , and nitrate (for waters with MUN beneficial use only), as indicated in Table 4-16.

For ammonia, the standard provided in the SF Bay Basin Plan (p. 3-7) applies to the unionized fraction, as the underlying criterion is based on unionized ammonia, which is the more toxic form. Conversion of RMC monitoring data from the measured total ammonia to unionized ammonia was therefore necessary. The conversion was based on a formula provided by the American Fisheries Society (AFS, internet source), and includes calculation from total ammonia, as well as field-measured pH, temperature, and electrical conductivity.

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 (CDPH, internet source), and the USEPA Drinking Water Quality Standards (USEPA, internet source). This same threshold is additionally established in the Basin Plan (Table 3-7) for waters in the Alameda Creek watershed above Niles. For all other waters, the water quality criterion of 230 mg/L established by USEPA (2009) (USEPA Water Quality Criteria[23]) for the protection of aquatic life is assumed to apply. The aquatic life criterion is a four-day average value, while the Secondary MCL is a maximum value.

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

[23] National Recommended Water Quality Criteria**.** EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants. These criteria are published pursuant to Section 304(a) of the Clean Water Act (CWA) and provide guidance for states and tribes to use in adopting water quality standards. http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

Table 4-16. Water quality thresholds available for comparison to Water Year 2012 water chemistry constituents

Sample Parameter	Threshold	Units	Frequency/ Period	Application	Source
Ammonia	0.025	mg/L	Annual median	Unionized 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, p. 3-7
Chloride	230	mg/L	4-day average	Freshwater aquatic life	USEPA Nat'l. Rec. WQ Criteria
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, Tables 3-5 and 3-7; CA Code Title 22; USEPA Drinking Water Stds. Secondary MCL
Nitrate (as N)	10	mg/L	Primary Maximum Contaminant Level	MUN waters, Title 22 Drinking Waters, Drinking waters per federal criteria	SF Bay Basin Plan Ch. 3, Table 3-5; CA Code Title 22; USEPA Drinking Water Stds. Primary MCL, USEPA Nat'l. Rec. WQ Criteria (Human Health)

The comparisons of the measured "Nutrients" data to the thresholds listed in Table 4-16 are shown in Table 4-17. The results for these three constituents are plotted against the prevailing thresholds in Figures 4-6 through 4-8. Of the 60 sites monitored, the water quality standard was exceeded at one site for chloride; no results exceeded the unionized ammonia standard or the nitrate standard. The MRP Table 8.1 trigger criterion for "Nutrients" (20% of results in one waterbody exceed one or more water quality standards or applicable thresholds) was therefore considered to be met at only one of the 60 sites.

Table 4-17. Comparison of water quality (nutrient) data to associated water quality thresholds for Water Year 2012 water chemistry results.

County/ Program	Site Code	Alameda Creek Above Niles	MUN	Parameter and Threshold			# of Parameters >Threshold/ Waterbody	% of Parameters >Threshold/ Waterbody
				Unionized Ammonia (as N)	Chloride	Nitrate (as N)		
				25 µg/L	230/250 mg/L [1]	10 mg/L [2]		
ACCWP	204R00047			25.0	97	NA	0	0%
ACCWP	204R00068	X		10.1	**410**	NA	1	**50%**
ACCWP	204R00084	X		0.13	64	NA	0	0%
ACCWP	204R00100	X		2.26	87	NA	0	0%
ACCWP	204R00191	X	X	1.25	57	<0.1	0	0%
ACCWP	204R00303			2.46	46	NA	0	0%
ACCWP	204R00319			4.31	24	NA	0	0%
ACCWP	204R00340	X		1.46	160	NA	0	0%
ACCWP	204R00356	X		3.08	110	NA	0	0%
ACCWP	204R00367			1.57	54	NA	0	0%
ACCWP	204R00383			1.46	54	NA	0	0%
ACCWP	204R00391			1.46	93	NA	0	0%
ACCWP	204R00455			1.18	36	NA	0	0%
ACCWP	204R00583			5.70	51	NA	0	0%
ACCWP	204R00596	X		0.67	240	NA	0	0%
ACCWP	204R00639		X	8.97	64	0.056	0	0%
ACCWP	204R00647			0.67	39	NA	0	0%
ACCWP	205R00110			1.15	32	NA	0	0%
ACCWP	205R00430			4.57	80	NA	0	0%
ACCWP	205R00535			0.86	110	NA	0	0%
CCCWP	203R00039			1.41	38	NA	0	0%
CCCWP	206R00155			2.57	23	NA	0	0%
CCCWP	206R00215			0.51	97	NA	0	0%
CCCWP	207R00011			5.23	80	NA	0	0%
CCCWP	207R00139			1.40	40	NA	0	0%
CCCWP	207R00247			4.05	46	NA	0	0%
CCCWP	543R00137			9.49	210	NA	0	0%
CCCWP	543R00219			3.57	140	NA	0	0%
CCCWP	543R00245			0.19	180	NA	0	0%
CCCWP	544R00025			2.30	160	NA	0	0%
SCVURPPP	205R00021			0.43	7.7	NA	0	0%
SCVURPPP	205R00026		X	0.18	16	0.19	0	0%
SCVURPPP	205R00035			2.05	46	NA	0	0%
SCVURPPP	205R00042			4.10	43	NA	0	0%
SCVURPPP	205R00058			0.10	10	NA	0	0%
SCVURPPP	205R00067			9.97	71	NA	0	0%
SCVURPPP	205R00090			5.79	87	NA	0	0%
SCVURPPP	205R00099			0.88	58	NA	0	0%
SCVURPPP	205R00115			0.22	27	NA	0	0%
SCVURPPP	205R00131			8.83	100	NA	0	0%
SCVURPPP	205R00154			0.76	79	NA	0	0%

County/ Program	Site Code	Alameda Creek Above Niles	MUN	Parameter and Threshold			# of Parameters >Threshold/ Waterbody	% of Parameters >Threshold/ Waterbody
				Unionized Ammonia (as N)	Chloride	Nitrate (as N)		
				25 µg/L	230/250 mg/L [1]	10 mg/L [2]		
SCVURPPP	**205R00218**			0.75	42	NA	0	0%
SCVURPPP	**205R00227**			1.44	100	NA	0	0%
SCVURPPP	**205R00234**			2.00	59	NA	0	0%
SCVURPPP	**205R00241**			5.03	87	NA	0	0%
SCVURPPP	**205R00259**			0.49	56	NA	0	0%
SCVURPPP	**205R00282**			0.23	30	NA	0	0%
SCVURPPP	**205R00291**			0.41	69	NA	0	0%
SCVURPPP	**205R00346**			1.09	42	NA	0	0%
SCVURPPP	**205R00355**			4.64	56	NA	0	0%
SMCWPPP	**202R00024**			2.30	13	NA	0	0%
SMCWPPP	**202R00072**		**X**	0.01	17	0.33	0	0%
SMCWPPP	**202R00087**			0.38	69	NA	0	0%
SMCWPPP	**202R00284**		**X**	0.17	27	0.16	0	0%
SMCWPPP	**204R00180**			0.52	47	NA	0	0%
SMCWPPP	**204R00200**			0.98	85	NA	0	0%
SMCWPPP	**204R00232**			0.96	30	NA	0	0%
SMCWPPP	**204R00244**			3.75	53	NA	0	0%
SMCWPPP	**205R00088**			0.26	33	NA	0	0%
SMCWPPP	**205R00168**			1.70	41	NA	0	0%
# Values >Threshold:				0	2	0		
% Values >Threshold:				0%	3%	0%		
Overall Number and % of Sites Meeting Trigger Criterion [3]:							**1**	**2%**

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

[2] Nitrate threshold applies only to sites with MUN beneficial use

[3] Sites where >20% of results exceed one or more water quality standard or established threshold

NA = threshold does not apply

Bolded value is above threshold

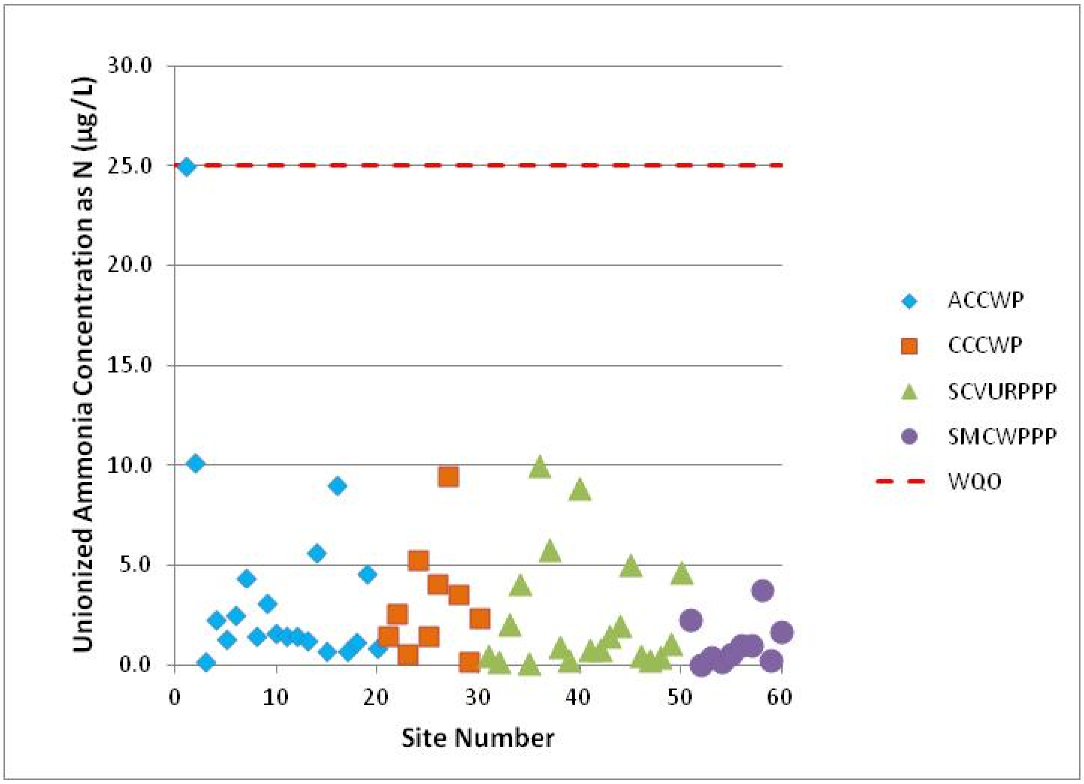

Figure 4-6. Plot of unionized ammonia* with threshold indicated, RMC WY 2012 data.
*** calculated from total ammonia, pH, temperature and electrical conductivity**

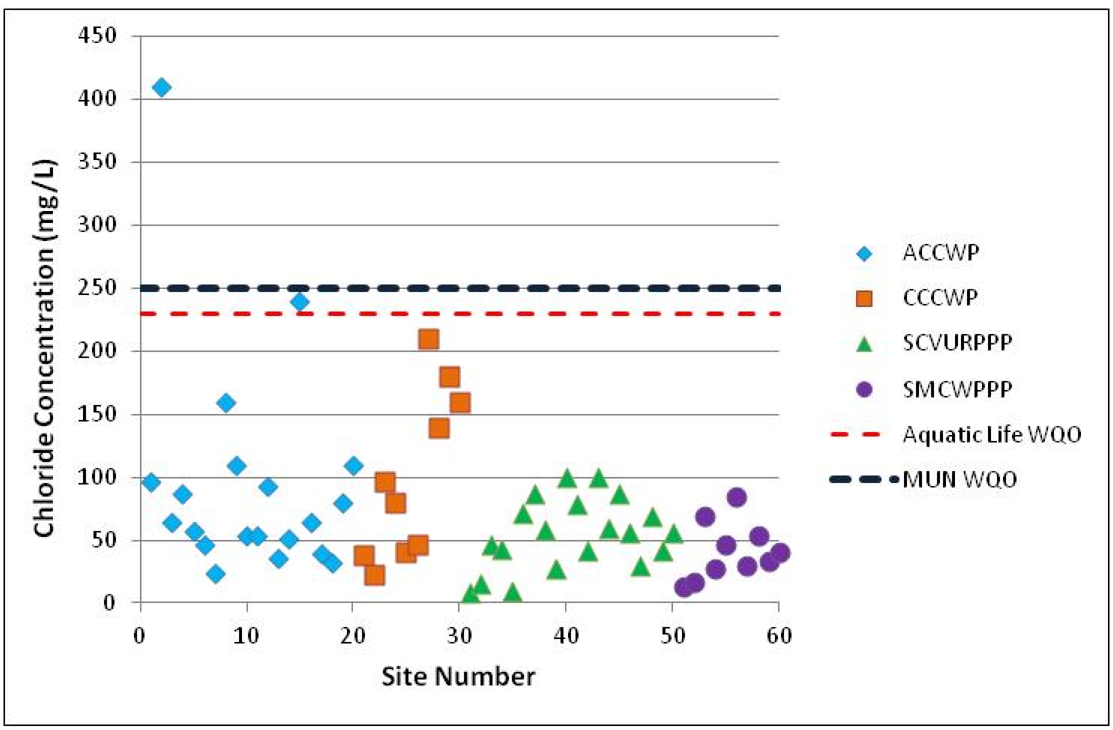

Figure 4-7. Plot of chloride with Aquatic Life and MUN thresholds indicated, RMC WY 2012 data

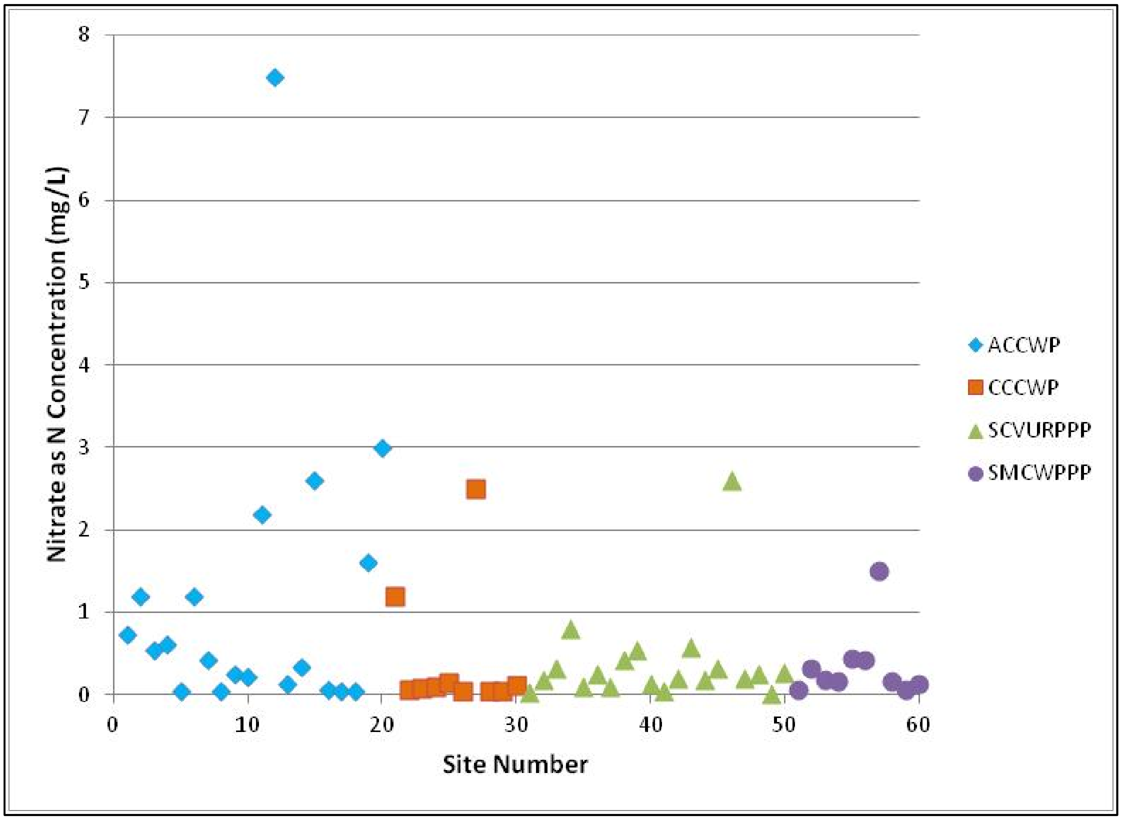

Figure 4-8. Plot of nitrate as N, RMC WY 2012 data (threshold not shown = 10 mg/L; drinking water standard)

Free and Total Chlorine Testing

The results of field testing for free and total chlorine and comparisons to the MRP Table 8.1 trigger threshold are summarized in Table 4-18. The MRP trigger criterion for chlorine states, "After immediate resampling, concentrations remain >0.08 mg/L". There were 69 site measurements for free and total chlorine in 2012, as the toxicity sites were each tested twice (spring and summer), and one site could not be measured due to discoloration. Of the 69 measurements in 2012, 26% exceeded the threshold for free chlorine, and 17% exceeded the threshold for total chlorine. (As noted previously, there appears to be an issue with the field kits and free chlorine measurements sometimes exceeded total.) Overall, the percentage of samples exceeding the threshold for free and/or total chlorine was 29%. The exceedances represent data from 18 sites; two of the toxicity testing sites exceeded the threshold on both measurement dates.

Table 4-18. Summary of chlorine testing results in comparison to Municipal Regional Permit trigger criteria.

County/ Program	Site Code	Sample Date	Chlorine, Free	Chlorine, Total	Meets Trigger Threshold?
ACCWP	204R00047	6/6/12	**0.12**	0.08	**Yes**
ACCWP	204R00047	7/25/12	0.00	0.04	No
ACCWP	204R00068	5/31/12	0.00	0.04	No
ACCWP	204R00084	5/24/12	0.00	**0.10**	**Yes**
ACCWP	204R00084	7/25/12	0.00	0.00	No
ACCWP	204R00100	5/30/12	**0.12**	0.04	**Yes**
ACCWP	204R00100	7/25/12	**0.12**	0.08	**Yes**
ACCWP	204R00191	5/29/12	**0.10**	0.00	**Yes**
ACCWP	204R00303	6/14/12	0.00	0.00	No
ACCWP	204R00319	6/7/12	0.00	0.00	No
ACCWP	204R00340	6/11/12	0.08	0.08	No
ACCWP	204R00356	6/4/12	0.04	0.04	No
ACCWP	204R00367	6/12/12	0.00	0.00	No
ACCWP	204R00383	6/11/12	**0.12**	**0.12**	**Yes**
ACCWP	204R00391	6/6/12	0.02	0.02	No
ACCWP	204R00455	6/13/12	**0.10**	0.00	**Yes**
ACCWP	204R00583	6/13/12	**0.12**	**0.16**	**Yes**
ACCWP	204R00596	5/31/12	**0.12**	**0.12**	**Yes**
ACCWP	204R00639	6/19/12	0.04	0.04	No
ACCWP	204R00647	6/18/12	0.00	0.00	No
ACCWP	205R00110	6/18/12	0.00	0.00	No
ACCWP	205R00430	6/5/12	0.04	0.00	No
ACCWP	205R00535	6/20/12	0.02	0.02	No
CCCWP	203R00039	5/14/12	0.00	0.02	No
CCCWP	206R00155	5/16/12	0.01	0.01	No
CCCWP	206R00215	5/23/12	0.00	0.00	No
CCCWP	207R00011	5/22/12	0.00	0.00	No
CCCWP	207R00011	7/25/12	0.04	0.02	No
CCCWP	207R00139	5/17/12	**0.12**	0.04	**Yes**
CCCWP	207R00247	5/22/12	0.03	0.04	No
CCCWP	543R00137	5/15/12	0.00	0.00	No
CCCWP	543R00219	5/21/12	0.04	0.06	No
CCCWP	543R00245	5/21/12	0.04	0.00	No
CCCWP	544R00025	5/15/12	0.00	0.00	No
CCCWP	544R00025	7/25/12	0.00	**0.12**	**Yes**
SCVURPPP	205R00021	5/16/12	0.02	0.05	No
SCVURPPP	205R00026	5/14/12	0.02	0.00	No
SCVURPPP	205R00026	7/25/12	0.04	0.04	No
SCVURPPP	205R00035	5/24/12	**0.20**	**0.20**	**Yes**
SCVURPPP	205R00035	7/25/12	**0.10**	0.08	**Yes**
SCVURPPP	205R00042	5/21/12	0.06	0.06	No
SCVURPPP	205R00042	7/25/12	0.04	0.04	No
SCVURPPP	205R00058	5/15/12	0.04	0.02	No
SCVURPPP	205R00067	6/3/12	**0.16**	**0.12**	**Yes**

County/ Program	Site Code	Sample Date	Chlorine, Free	Chlorine, Total	Meets Trigger Threshold?
SCVURPPP	205R00090	5/23/12	**0.25**	**0.25**	**Yes**
SCVURPPP	205R00099	5/17/12	0.06	0.07	No
SCVURPPP	205R00115	6/5/12	0.06	0.04	No
SCVURPPP	205R00131	6/3/12	**0.16**	**0.12**	**Yes**
SCVURPPP	205R00154	5/22/12	**0.40**	**0.15**	**Yes**
SCVURPPP	205R00218	5/23/12	0.02	0.02	No
SCVURPPP	205R00227*	6/5/12			
SCVURPPP	205R00234	5/15/12	0.02	0.04	No
SCVURPPP	205R00241	5/21/12	0.02	0.02	No
SCVURPPP	205R00259	6/14/12	**0.40**	**0.15**	**Yes**
SCVURPPP	205R00282	5/22/12	**0.10**	0.06	**Yes**
SCVURPPP	205R00291	6/13/12	0.05	0.04	No
SCVURPPP	205R00346	6/14/12	0.02	0.02	No
SCVURPPP	205R00355	6/13/12	0.06	0.02	No
SMCWPPP	202R00024	6/6/12	0.00	0.00	No
SMCWPPP	202R00072	5/29/12	0.00	0.02	No
SMCWPPP	202R00087	5/30/12	0.00	0.00	No
SMCWPPP	202R00087	7/25/12	0.04	0.04	No
SMCWPPP	202R00284	6/15/12	0.02	0.00	No
SMCWPPP	204R00180	5/30/12	0.04	0.04	No
SMCWPPP	204R00200	5/31/12	0.05	0.04	No
SMCWPPP	204R00232	6/12/12	0.02	0.02	No
SMCWPPP	204R00244	6/12/12	**0.16**	**0.12**	**Yes**
SMCWPPP	205R00088	6/4/12	0.00	0.00	No
SMCWPPP	205R00088	7/25/12	0.08	0.08	No
SMCWPPP	205R00168	6/4/12	0.00	0.00	No
Number of samples exceeding 0.8 mg/L:			18	12	20
Percentage of samples exceeding 0.8 mg/L:			26%	17%	29%

* Unable to sample at SCVURPPP site 205R00227 due to water discoloration.

Water and Sediment Toxicity Testing

The analysis of toxicity testing results and comparisons to MRP trigger thresholds, as presented in detail earlier in this section, are summarized in Table 4-19 for those samples that have initially exceeded thresholds.

The MRP Table 8.1 trigger criterion for water column toxicity stipulates "If toxicity results less than 50% of control results, repeat sample. If 2nd sample yields less than 50% of control results, proceed to C.8.d.i.". Therefore the four water samples indicated in Table 4-19 as having results "< 50% of Control" should be retested, and a determination should then be made, based on the follow-up tests, as to whether the results meet the MRP Table 8.1 trigger criteria and should proceed to consideration of a stressor/source identification project.

Table 4-19. Overall summary of toxicity results in comparison to Municipal Regional Permit trigger criteria.

County/ Program	Test Initiation Date (Time)	Species Tested	Test Regimen	Treatment/ Sample ID	Comparison to Table 8.1 (Water) and Table H-1 (Sediment) Trigger Criteria
Water					
ACCWP	3/15/12 (1430)	*Hyalella azteca*	Acute (survival)	204R00047	< 50% of Control
CCCWP	3/15/12 (1430)	*Hyalella azteca*	Acute (survival)	207R00011	< 50% of Control
CCCWP	3/15/12 (1700)	*Hyalella azteca*	Acute (survival)	544R00025	< 50% of Control
SMCWPPP	3/25/12 (1400)	*Ceriodaphnia dubia*	Chronic (reproduction)	202R00088	< 50% of Control
Sediment					
CCCWP	7/28/12 (1215)	*Hyalella azteca*	Acute (survival)	207R00011	More than 20% < Control
CCCWP	7/28/12 (1215)	*Hyalella azteca*	Acute (survival)	544R00025	More than 20% < Control

For the sediment toxicity results, any sample that meets the MRP Table H-1 criterion for sediment toxicity (interpreted as “statistically different than and more than 20 percent less than control”) should then be compared to the sediment chemistry and bioassessment results for that site. These comparisons are performed in the Sediment Triad Assessment, which is described in the following section.

Sediment Chemistry Parameters

Sediment chemistry results are evaluated as potential stressors in three ways, based on the following criteria from MRP Table H-1:

- Calculation of threshold effect concentration (TEC) quotients; determine whether site has three or more TEC quotients greater than or equal to 1.0;[24]
- Calculation of probable effect concentration (PEC) quotients; determine whether site has mean PEC quotient greater than or equal to 0.5; and,
- Calculation of pyrethroid toxic unit (TU) equivalents as sum of TU equivalents for all measured pyrethroids; determine whether site has sum of TU equivalents greater than or equal to 1.0.

More detail is provided below on each of these three factors. For the sediment chemistry results, any sample that meets one or more of the above-listed MRP Table H-1 sediment chemistry criteria should then be compared to the sediment toxicity and bioassessment results for that site. These comparisons are performed in the Sediment Triad Assessment presented below.

Table 4-20 provides threshold effect concentration (TEC) quotients for all non-pyrethroid sediment chemistry constituents, calculated as the measured concentration divided by the TEC value, per MacDonald et al. (2000). This table also provides a count of the number of constituents that exceed TEC values for each site, as evidenced by a TEC quotient greater than or equal to 1.0.

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

The number of TEC quotients exceeded per site ranges from a low of 1 to a high of 19, out of 27 constituents included in MacDonald et al. (2000). Nine of the ten sites exceeded the relevant trigger criterion from MRP Table H-1, which is interpreted to stipulate three or more constituents with TEC quotients greater than or equal to 1.0. The TEC quotients for each constituent are shown graphically in plots for each of the ten sites in Attachment E.

Table 4-21 provides PEC quotients for all non-pyrethroid sediment chemistry constituents, and calculated mean values of the PEC quotients for each site, with the mean PEC quotient highlighted for sites where mean PEC quotient greater than or equal to 0.5. Two sites meet the MRP Table H-1 action criteria with a mean PEC greater than 0.5. The mean PEC quotients are shown graphically per site in Figure 4-9.

Table 4-22 provides a summary of the calculated toxic unit equivalents for the pyrethroids for which there are published LC50 values in the literature, as well as a sum of calculated toxic unit (TU) equivalents for each site. Because organic carbon mitigates the toxicity of pyrethroid pesticides in sediments, the LC50 values were derived on the basis of TOC-normalized pyrethroid concentrations. Therefore, the pyrethroid concentrations as reported by the lab were divided by the measured TOC concentration at each site, and the TOC-normalized concentrations were then used to compute TU equivalents for each pyrethroid. The individual TU equivalents were then summed to produce a total pyrethroid TU equivalent value for each site. Seven of the ten sites meet the MRP Table H-1 action criterion with TU sums greater than or equal to 1.0. These results are shown graphically in Figure 4-10. Only four sites have TU sums that substantially exceed 1.0; in three of these cases the results are due to elevated bifenthrin concentrations; in the fourth case, the cause is an elevated cyfluthrin concentration. Scatter plots of the TOC-normalized concentrations of the individual pyrethroids are shown along with the corresponding LC50 values in Attachment F.

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

Biological Condition Summary for Sites with Sediment Data

Table 4-23 provides a summary of the condition assessment for bioassessment sites that were also monitored for sediment chemistry and toxicity. All ten sites score in either the Poor or Very Poor biological condition categories, indicating that they meet the MRP Table H-1 criterion for “Indications of alterations” in relation to bioassessment results.

Table 4-20. Threshold Effect Concentration (TEC) quotients for 2012 sediment chemistry constituents. Bolded values indicate TEC quotient > 1.0

Stormwater Program, Site ID	ACCWP 204R00047	ACCWP 204R00084	ACCWP 204R00100	CCCWP 207R00011	CCCWP 544R00025	SCVURPPP 205R00026	SCVURPPP 205R00035	SCVURPPP 205R00042	SMCWPPP 202R00087	SMCWPPP 205R00088
Metals (mg/kg DW)										
Arsenic	0.32	0.55	0.51	0.21	0.46	0.34	0.17	0.20	0.08	0.49
Cadmium	0.23	0.63	0.08	0.07	0.16	0.10	0.10	0.09	0.10	0.31
Chromium	0.20	0.76	**1.34**	0.20	0.65	**1.89**	0.35	**1.54**	**9.95**	0.58
Copper	0.70	0.70	0.85	0.27	0.89	0.85	0.82	0.63	**1.65**	0.54
Lead	0.36	0.59	0.25	0.18	0.36	0.31	0.11	0.26	0.08	0.16
Mercury	0.28	0.21	**1.61**	0.83	0.14	0.34	0.30	0.36	0.03	0.37
Nickel	0.57	**1.32**	**4.23**	0.43	**1.15**	**4.41**	0.84	**6.61**	**13.26**	**2.07**
Zinc	**1.40**	0.79	0.44	0.38	0.74	0.54	0.20	0.39	0.65	0.49
PAHs (µg/kg DW)										
Anthracene	**2.97**	**1.31**	0.27	**3.50**	**5.33**	**1.22**	0.43	0.35	0.24	0.43
Fluorene	**2.20**	0.97	0.20	**2.58**	**3.94**	0.90	0.32	0.26	0.18	0.32
Naphthalene	0.97	0.43	0.09	**1.14**	**1.73**	0.40	0.14	0.11	0.08	0.14
Phenanthrene	0.69	0.37	0.08	0.98	**1.50**	0.34	0.12	0.10	0.07	0.13
Benz(a)anthracene	**1.57**	0.69	0.14	**1.85**	**2.82**	0.65	0.23	0.19	0.13	0.22
Benzo(a)pyrene	0.41	0.50	0.10	**1.33**	**2.03**	0.47	0.16	0.13	0.09	0.07
Chrysene	**1.02**	0.45	0.09	**1.20**	**1.84**	0.42	0.15	0.12	0.08	0.20
Fluoranthene	0.90	0.15	0.04	0.50	0.72	0.07	0.06	0.05	0.03	0.13
Pyrene	**2.15**	0.36	0.08	**1.03**	**1.56**	0.23	0.04	0.10	0.07	0.25
Total PAHs	**2.55**	**1.01**	0.22	**2.70**	**4.36**	0.96	0.34	0.29	0.20	0.35
Pesticides (µg/kg DW)										
Chlordane	**13.27**	**1.79**	0.96	**5.25**	**7.72**	**1.70**	0.74	**1.23**	**1.70**	**1.51**
Dieldrin	**11.32**	**1.53**	0.82	**4.47**	**6.58**	**1.45**	0.63	**1.05**	**1.45**	**1.29**
Endrin	**9.68**	**1.31**	0.70	**3.83**	**5.63**	**1.24**	0.54	0.90	**1.24**	**1.10**
Heptachlor Epoxide	**8.70**	**1.17**	0.63	**3.44**	**5.06**	**1.11**	0.49	0.81	**1.11**	0.99
Lindane (gamma-BHC)	**9.07**	**1.22**	0.65	**3.59**	**5.27**	**1.16**	0.51	0.84	**1.16**	**1.03**
Sum DDD	**8.81**	**4.08**	0.64	**3.48**	**5.43**	**1.13**	0.49	0.82	**1.13**	**1.75**
Sum DDE	**13.61**	**1.84**	0.98	**5.38**	**79.91**	**1.74**	0.76	**1.27**	**1.74**	**1.55**
Sum DDT	**10.34**	**2.91**	0.75	**4.09**	**6.01**	**1.32**	0.58	0.96	**1.32**	**1.47**
Total DDTs	**24.43**	**7.16**	**1.76**	**9.66**	**57.58**	**3.13**	**1.36**	**2.27**	**3.13**	**3.70**
Number of constituents with TEC quotient > 1.0	**16**	**12**	**4**	**17**	**19**	**12**	**1**	**6**	**12**	**9**

Table 4-21. Probable Effect Concentration (PEC) quotients for 2012 sediment chemistry constituents. Yellow highlighted cells indicate sites where mean PEC quotient ≥ 0.5 (trigger threshold per MRP Table H-1); bolded values indicate individual PEC quotients > 1.0.

Stormwater Program, Site ID	ACCWP 204R00047	ACCWP 204R00084	ACCWP 204R00100	CCCWP 207R00011	CCCWP 544R00025	SCVURPPP 205R00026	SCVURPPP 205R00035	SCVURPPP 205R00042	SMCWPPP 202R00087	SMCWPPP 205R00088
Metals (mg/kg DW)										
Arsenic	0.09	0.16	0.15	0.06	0.14	0.10	0.05	0.06	0.02	0.15
Cadmium	0.05	0.12	0.02	0.01	0.03	0.02	0.02	0.02	0.02	0.06
Chromium	0.08	0.30	0.52	0.08	0.25	0.74	0.14	0.60	**3.89**	0.23
Copper	0.15	0.15	0.18	0.06	0.19	0.18	0.17	0.13	0.35	0.11
Lead	0.10	0.16	0.07	0.05	0.10	0.09	0.03	0.07	0.02	0.04
Mercury	0.05	0.03	0.27	0.14	0.02	0.06	0.05	0.06	0.01	0.06
Nickel	0.27	0.62	**1.98**	0.20	0.53	**2.06**	0.39	**3.09**	**6.19**	0.97
Zinc	0.37	0.21	0.12	0.10	0.19	0.14	0.05	0.10	0.17	0.13
PAHs (µg/kg DW)										
Anthracene	0.20	0.09	0.02	0.24	0.36	0.08	0.03	0.02	0.02	0.03
Fluorene	0.32	0.14	0.03	0.37	0.57	0.13	0.05	0.04	0.03	0.05
Naphthalene	0.30	0.13	0.03	0.36	0.54	0.12	0.04	0.04	0.02	0.04
Phenanthrene	0.12	0.06	0.01	0.17	0.26	0.06	0.02	0.02	0.01	0.02
Benz(a)anthracene	0.16	0.07	0.01	0.19	0.29	0.07	0.02	0.02	0.01	0.02
Benzo(a)pyrene	0.04	0.05	0.01	0.14	0.21	0.05	0.02	0.01	0.01	0.01
Chrysene	0.13	0.06	0.01	0.16	0.24	0.05	0.02	0.02	0.01	0.03
Fluoranthene	0.17	0.03	0.01	0.09	0.14	0.01	0.01	0.01	0.01	0.02
Pyrene	0.28	0.05	0.01	0.13	0.20	0.03	0.01	0.01	0.01	0.03
Total PAHs	0.18	0.07	0.02	0.19	0.31	0.07	0.02	0.02	0.01	0.02
Pesticides (µg/kg DW)										
Chlordane	**2.44**	0.33	0.18	0.97	**1.42**	0.31	0.14	0.23	0.31	0.28
Dieldrin	0.35	0.05	0.03	0.14	0.20	0.04	0.02	0.03	0.04	0.04
Endrin	0.10	0.01	0.01	0.04	0.06	0.01	0.01	0.01	0.01	0.01
Heptachlor Epoxide	**1.34**	0.18	0.10	0.53	0.78	0.17	0.08	0.13	0.17	0.15
Lindane (gamma-BHC)	**4.31**	0.58	0.31	**1.70**	**2.51**	0.55	0.24	0.40	0.55	0.49
Sum DDD	**1.54**	0.71	0.11	0.61	0.95	0.20	0.09	0.14	0.20	0.31
Sum DDE	**1.37**	0.19	0.10	0.54	**8.07**	0.18	0.08	0.13	0.18	0.16
Sum DDT	0.68	0.19	0.05	0.27	0.40	0.09	0.04	0.06	0.09	0.10
Total DDTs	0.23	0.07	0.02	0.09	0.53	0.03	0.01	0.02	0.03	0.03
Mean PEC Quotient	**0.57**	**0.18**	**0.16**	**0.28**	**0.72**	**0.21**	**0.07**	**0.20**	**0.46**	**0.13**

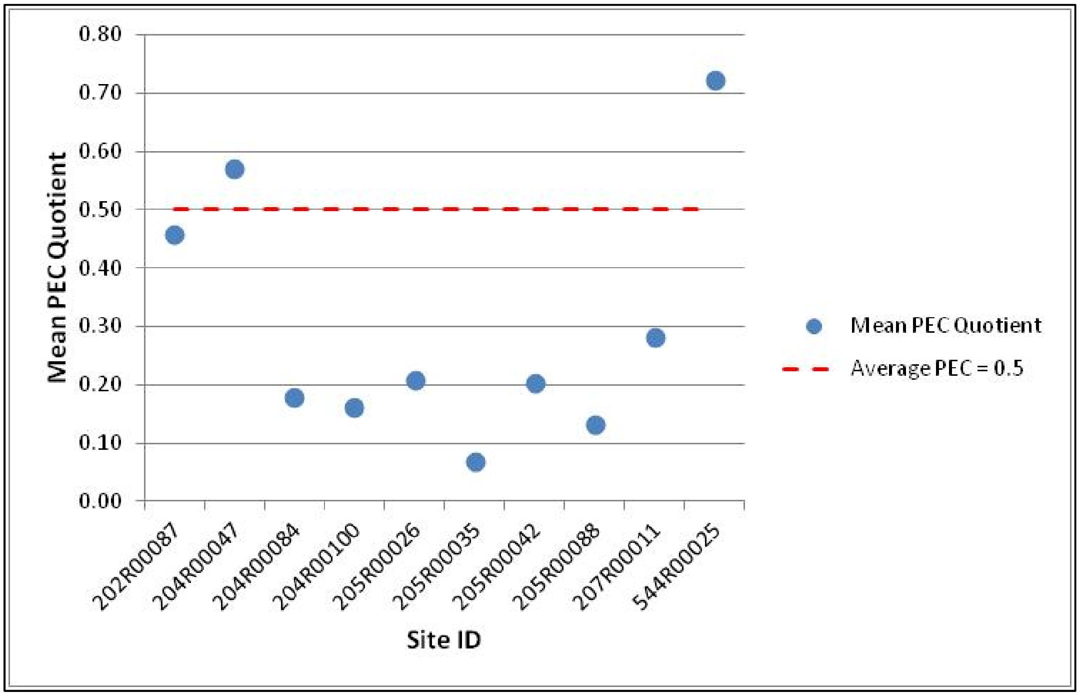

Figure 4-9. Plot of mean PEC quotient per site, RMC WY 2012 data

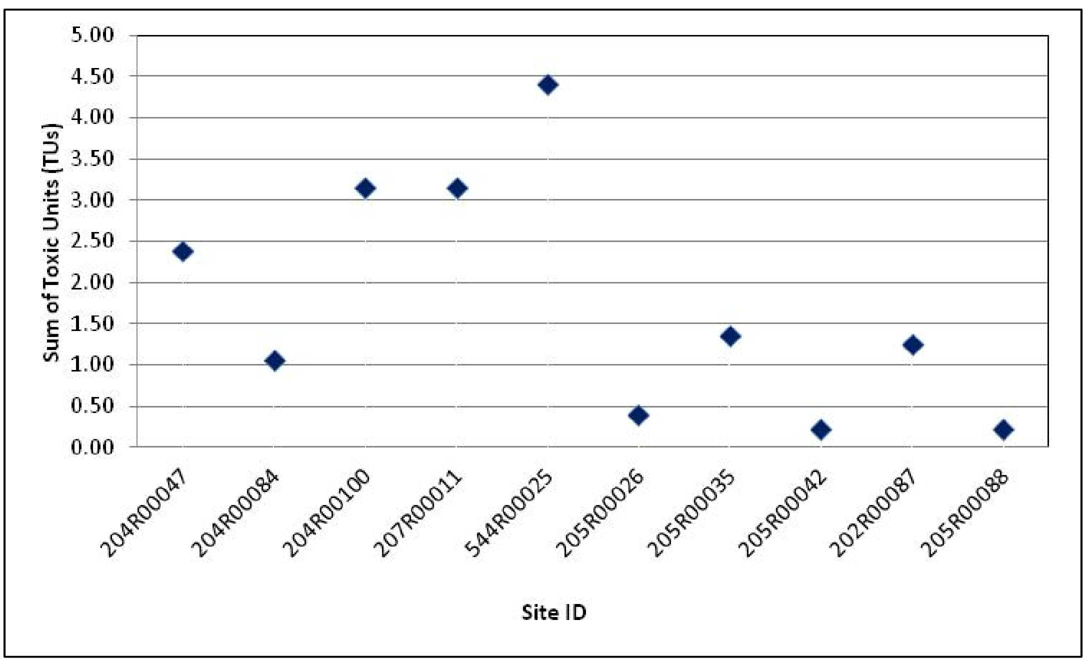

Figure 4-10. Plot of the sum of pyrethroid toxic unit equivalents per site, RMC WY 2012 data

Table 4-22. Calculated pyrethroid toxic unit equivalents, 2012 sediment chemistry data. Yellow highlighted cells indicate sites where the sum of the pyrethroid TU equivalents is ≥ 1.0; bolded values indicate individual pyrethroid TUs > 1.0.

Pyrethroid	LC50	ACCWP 204R00047	ACCWP 204R00084	ACCWP 204R00100	CCCWP 207R00011	CCCWP 544R00025	SCVURPPP 205R00026	SCVURPPP 205R00035	SCVURPPP 205R00042	SMCWPPP 202R00087	SMCWPPP 205R00088
Bifenthrin	0.52	**1.76**	0.37	0.10	**1.47**	**3.30**	0.17	0.27	0.04	0.24	0.04
Cyfluthrin	1.08	0.20	0.08	**2.68**	0.30	0.13	0.03	0.13	0.02	0.12	0.02
Cypermethrin	0.38	0.14	0.23	0.15	0.53	0.37	0.08	0.37	0.06	0.34	0.06
Deltamethrin	0.79	0.08	0.11	0.07	0.26	0.18	0.04	0.18	0.03	0.16	0.04
Esfenvalerate	1.54	0.04	0.06	0.04	0.13	0.09	0.02	0.09	0.01	0.08	0.02
Lambda-Cyhalothrin	0.45	0.14	0.20	0.12	0.45	0.31	0.07	0.31	0.05	0.29	0.02
Permethrin	10.83	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.01	0.02
Sum of Toxic Unit Equivalents per Site		**2.38**	**1.06**	**3.16**	**3.16**	**4.40**	**0.41**	**1.36**	**0.22**	**1.26**	**0.23**

Table 4-23. Summary of bioassessment results, site characteristics, and B-IBI condition categories

Agency/Program	Site Name	Site ID	Land Use	Flow Class	Ecoregion ID	SoCal B-IBI Final Score	B-IBI Condition Category
ACCWP	Castro Valley	204R00047	Urban	P	6	24	Poor
ACCWP	Dublin Creek	204R00084	Urban	P	6	17	Very Poor
ACCWP	Arroyo Mocho	204R00100	Urban	NP	6	11	Very Poor
CCCWP	Grayson	207R00011	Urban	P	6	13	Very Poor
CCCWP	Dry	544R00025	Urban	P	7	3	Very Poor
SCVURPPP	Los Gatos	205R00026	Urban	P	6	27	Poor
SCVURPPP	Upper Penitencia	205R00035	Urban	P	6	23	Poor
SCVURPPP	Coyote	205R00042	Urban	P	6	16	Very Poor
SMCWPPP	Milagra Creek	202R00087	Urban	P	6	63	Good
SMCWPPP	Corte Madera	205R00088	Urban	P	1	76	Good

P = perennial stream; NP = non-perennial stream
Condition categories are based on scoring of bioassessment taxonomic metrics using SoCal B-IBI

Sediment Triad Analysis

The results of the preceding analysis of sediment-related trigger criteria are presented in Table 4-23, with the three aspects of the sediment triad summarized by site. As defined in MRP Table H-1, these results indicate that eight of the ten sites will have some required follow-up action; the only exceptions being the two sites for which there was neither a bioassessment trigger nor a toxicity trigger.

Table 4-24. Summary of sediment quality triad analysis results, WY 2012 RMC data. Yellow highlighted cells indicate exceedance of threshold.

Agency/ Program	Waterbody	Site ID	B-IBI Condition Category	Sediment Toxicity	# TEC Quotients ≥ 1.0:	Mean PEC Quotient	Sum of TU Equiv.	Next Step per MRP Table H-1
ACCWP	Castro Valley	204R00047	Poor	No	16	0.57	2.38	A
ACCWP	Dublin Creek	204R00084	Very Poor	No	12	0.18	1.06	A
ACCWP	Arroyo Mocho	204R00100	Very Poor	No	4	0.16	3.16	A
CCCWP	Grayson	207R00011	Very Poor	Yes	17	0.28	3.16	C
CCCWP	Dry	544R00025	Very Poor	Yes	19	0.72	4.40	C
SCVURPPP	Los Gatos	205R00026	Poor	No	12	0.21	0.41	A
SCVURPPP	Upper Penitencia	205R00035	Poor	No	1	0.07	1.36	A
SCVURPPP	Coyote	205R00042	Very Poor	No	6	0.20	0.22	A
SMCWPPP	Milagra	202R00087	Good	No	12	0.46	1.26	B
SMCWPPP	Corte Madera	205R00088	Good	No	9	0.13	0.23	B

Key to Next Steps:

Action Code	Exceeds Bioassessment/ Toxicity/ Chemistry Threshold	Next Step per MRP Table H-1
A	Yes/No/Yes	(1) Identify cause of impacts. (2) Where impacts are under Permittee's control, take management actions to minimize the impacts caused by urban runoff; initiate no later than the second fiscal year following the sampling event.
B	No/No/Yes	If PEC exceedance is Hg or PCBs, address under TMDLs.
C	Yes/Yes/Yes	(1) Identify cause(s) of impacts and spatial extent. (2) Where impacts are under Permittee's control, take management actions to address impacts.

5.0 Conclusions and Next Steps

During WY 2012 sixty sites were monitored by RMC participants under the regional probabilistic design for bioassessment, physical habitat, and related water chemistry parameters. Ten of the sixty sites were also monitored for water and sediment toxicity and sediment chemistry. The bioassessment and related data were used to develop a preliminary condition assessment for the monitored creeks, and the water and sediment chemistry and toxicity data were used to evaluate potential stressors that may affect aquatic habitat quality and beneficial uses.

The following MRP reporting requirements (Provision C.8.g.iv) were addressed within this report:

- Descriptions of monitoring purpose and study design rationale
- QA/QC summaries for sample collection and analytical methods, including a discussion of any limitations of the data;
- Descriptions of sampling protocols and analytical methods;
- Tables and Figures describing: Sample location descriptions (including waterbody names, and lat/longs); sample ID, collection date (and time where relevant), media (e.g., water, filtered water, bed sediment, tissue); concentrations detected, measurement units, and detection limits;
- Data assessment, analysis, and interpretation for Provision C.8.c.;
- A listing of volunteer and other non-Permittee entities whose data are included in the report;
- Assessment of compliance with applicable water quality standards;

Sites classified with unknown sampling status (Attachment A) may continue to be evaluated by individual stormwater programs for sampling in Water Year 2013.

5.1 Summary of Biological Condition Assessments

Under the level of MRP-required monitoring, the RMC probabilistic design requires at least three years of data to develop a statistically-robust characterization of biological conditions of the creeks within each RMC participating program. The analysis and interpretation that is feasible with the first year dataset presented in this report are therefore limited to assessing the overall condition of creeks at a regional-scale. The preliminary **overall biological condition assessment** that can be derived based on the Water Year 2012 RMC bioassessment data is summarized as follows:

- Bioassessment metrics for the 60 sites sampled within the RMC area during the spring index period (April 15 – June 15, 2012) exhibited a wide range of scores, based on the results of benthic macroinvertebrate (BMI) taxonomic analysis.
- Using the southern California benthic index of biological integrity (SoCal B-IBI) as a multi-metric measure of BMI communities:
    - 43% of the sites scored in the very poor condition category,
    - 32% in the poor category,
    - 12% in the fair category,
    - 10% in the good category, and
    - 3% in the very good category.

All nonurban sites scored in the top condition category achieved (either good or very good) for the each respective County.

- Pollutant tolerant diatom taxa comprised a total of 33% of the regional RMC sample while pollutant intolerant diatom taxa comprised 27% of the sample.

The condition assessment for **creeks in the urbanized portion** of the RMC area is summarized as follows:

- Analyses of benthic macroinvertebrates sampled in the RMC area consistently indicated lower biological condition scores in creeks within urban areas compared to nonurban areas of the Bay Area.
- Analyses of algae metrics sampled in the RMC area did not indicate significant differences between creeks in urban and nonurban areas of the RMC.

5.2 Summary of Stressor Analyses

The stressor analysis revealed the following potential stressors, based on an analysis of the first year RMC data:

- **Water Quality –** Of 11 parameters[25] sampled in association with bioassessment monitoring, applicable water quality standards were only identified for ammonia, chloride, and nitrate (sites with MUN beneficial use only). Of the results generated at the 60 sites monitored by RMC participants for those three parameters, only one chloride concentration exceeded the applicable water quality standard or threshold. The MRP Table 8.1 trigger threshold for "Nutrients" (i.e., 20% of results in one waterbody exceed one or more water quality standards or applicable thresholds) was therefore met at only one of the 60 sites.
- **Water Toxicity –** 120 toxicity endpoints were derived through testing of 4 species at 10 sites regionwide during one wet season and one dry season event. Of these endpoints, four exhibited results "< 50% of Control" and should be resampled, per MRP Table 8.1. Following a review of the results of retesting, a determination should be made as to whether the results meet the MRP Table 8.1 trigger thresholds, and if these sites should be considered high priority for stressor/source identification projects.
- **Sediment Toxicity –** Of the bedded sediment collected from 10 sites, toxicity to test species *Hyalella azteca* was observed at 6 sites. Results were more than 20% less than the control at 2 sites, thus meeting the Table H-1 definition of sediment toxicity. These 2 sites should be considered for future stressor/source identification projects by RMC participants.
- **Sediment Chemistry -** Results produced evidence of potential stressors in 3 ways, based on the criteria from MRP Table H-1: 1) at 9 of 10 sites, 3 or more constituents had TEC quotients greater than 1.0[26], 2) at 2 of 10 sites, the mean PEC quotient was > 0.5, and 3) at 7 of 10 sites, the sum of TU equivalents for all measured pyrethroids was greater than or equal to 1.0.

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[25] Algal mass (ash-free dry weight), Chlorophyll a, Dissolved Organic Carbon, Ammonia, Nitrate, Total Nitrogen, Dissolved OrthoPhosphate, Phosphorus, Suspended Sediment Concentration, Silica and Chlorid.

[26] For nearly all sites, chromium and nickel concentrations in sediment exceeded TEC values. Considering that both metals are naturally occurring at relatively high levels in Bay Area soils, and concentrations generally exceed TEC values in reference or non-urban sites, TEC values presented in MacDonald et al. (2000) may not be applicable to the Bay Area. These observations should be considered in future evaluations of sediment chemistry data collected by RMC participants in Bay Area creeks.

Sediment chemistry and toxicity results were evaluated along with preliminary bioassessment condition scores (i.e., sediment quality triad) to evaluate which next steps (if any) should be pursued by RMC participants. Data collected from 8 of the 10 sites should be further evaluated and following the evaluation, should be considered for follow-up actions as described in Table H-1 of the MRP.

5.3 Next Steps

The preceding analysis has identified a number of potential sites that may deserve further evaluation and/or investigation to provide better understanding of the sources/stressors that may be contributing to the observed water quality and biological conditions at these sites. In the near future, the RMC participants will consider these sites as potentially suitable for stressor/source ID projects. Evaluation of potential stressor/source ID projects is a high priority for the RMC following completion of this analysis and report. Per MRP Provision C.8.d.i, the first follow-up stressor/source ID project shall be initiated as soon as possible and must begin no later than the second fiscal year following the sampling event that triggered the project. Additional discussion of the Stressor/Source Identification process is provided in Section 4 of the *Regional Monitoring Coalition Urban Creeks Monitoring Report Water Year 2012*, and a tentative schedule for implementation is provided in Table 3 of that document.

In addition to the identification of sites where stressor/source identification should proceed, 4 sites that exhibited water toxicity will also be resampled and retested by RMC participants for toxicity to the aquatic invertebrate species that initially exhibited a response. Results of the initial test and retest will then be evaluated per the trigger thresholds in MRP Table 8.1 to determine the need to consider stressor/source identification projects at these sites.

RMC participants are continuing to implement the regional probabilistic monitoring design in Water Year 2013. Site evaluation and sampling are planned at new sites for this Water Year. Results of Water Year 2012 and 2013 will be reported in the Integrated Monitoring Report in March 2014.

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Attachment A.
Sites from the RMC Probabilistic Design Master Draw Evaluated in Water Year 2012.

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

Table A-1 describes the sampling status of 219 sites from the RMC probabilistic monitoring design that were evaluated in order to successfully sample the number of sites required to comply with the MRP Provision C.8.c for Water Year 2012 (e.g., October 1, 2011 through September 30, 2012) during the bioassessment sampling period. A summary of the site target status is provided in the bullets below. The site target status detail categories are also described below.

Of the 219 sites from the RMC probabilistic monitoring design evaluated in Water year 2012:

- 66 were sampled (TS = target sampled) – note that 6 of these sites were sampled by the SFRWQCB.
- 19 sites met the sampleable "target" criteria but could not be sampled (TNS=target not sampleable).
- 75 sites did not meet the sampleable "target" criteria and could not be sampled (NT=non-target).
- 59 sites had outstanding unknown characteristics so that their status is unknown (U=target status unknown). Some may be considered for further evaluation next year (see target status details)

Table A-1. Sites from Probabilistic Design Master Draw that could not be sampled in Water Year 2012, but will remain on the list for future consideration, and those that were removed from the Master Draw list for reasons stated in Table Legend.

Site ID	Site Target Status	Site Target Status Detail	Sampling Agency	Stratum
544R00165	NT	NT_AGDITCH	CCCWP	CC_R5_Nonurb
544R00181	NT	NT_AGDITCH	CCCWP	CC_R5_Nonurb
205R00037	NT	NT_AGDITCH	SCVURPPP	SC_R2_Urb
205R00074	NT	NT_H	SCVURPPP	SC_R2_Nonurb
543R00043	NT	NT_IA	CCCWP	CC_R5_Nonurb
202R00204	NT	NT_IA	SMCWPPP	SM_R2_Urb
205R00017	NT	NT_IA	SWAMP	SC_R2_Nonurb
543R00079	NT	NT_NC	CCCWP	CC_R2R5_Urb
204R00014	NT	NT_NC	ACCWP	Al_R2_Nonurb
204R00030	NT	NT_NC	ACCWP	Al_R2_Nonurb
204R00023	NT	NT_NC	ACCWP	Al_R2_Urb
204R00199	NT	NT_NC	ACCWP	Al_R2_Urb
207R00015	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00048	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00112	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00123	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00143	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00176	NT	NT_NC	CCCWP	CC_R2R5_Urb
207R00183	NT	NT_NC	CCCWP	CC_R2R5_Urb
544R00201	NT	NT_NC	CCCWP	CC_R2R5_Urb
204R00045	NT	NT_NC	SCVURPPP	SC_R2_Nonurb
205R00019	NT	NT_NC	SCVURPPP	SC_R2_Urb
205R00298	NT	NT_NC	SCVURPPP	SC_R2_Urb
204R00105	NT	NT_NC	SWAMP	Al_R2_Nonurb
204R00212	NT	NT_NLSF	ACCWP	Al_R2_Urb
206R00151	NT	NT_NLSF	CCCWP	CC_R2R5_Urb
207R00032	NT	NT_NLSF	CCCWP	CC_R2R5_Urb
207R00203	NT	NT_NLSF	CCCWP	CC_R2R5_Urb

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

Site ID	Site Target Status	Site Target Status Detail	Sampling Agency	Stratum
543R00009	NT	NT_NLSF	CCCWP	CC_R2R5_Urb
543R00207	NT	NT_NLSF	CCCWP	CC_R2R5_Urb
543R00073	NT	NT_NLSF	CCCWP	CC_R5_Nonurb
204R00029	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
204R00077	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
205R00002	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
205R00005	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
205R00007	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
205R00069	NT	NT_NLSF	SCVURPPP	SC_R2_Nonurb
205R00071	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
205R00195	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
205R00202	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
205R00323	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
205R00387	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
205R00403	NT	NT_NLSF	SCVURPPP	SC_R2_Urb
204R00040	NT	NT_NLSF	SMCWPPP	SM_R2_Urb
204R00424	NT	NT_NLSF	SMCWPPP	SM_R2_Urb
204R00070	NT	NT_NLSF	SWAMP	Al_R2_Nonurb
204R00098	NT	NT_NLSF	SWAMP	Al_R2_Nonurb
204R00132	NT	NT_NLSF	SWAMP	CC_R2_Nonurb
205R00049	NT	NT_NLSF	SWAMP	SC_R2_Nonurb
205R00081	NT	NT_NLSF	SWAMP	SC_R2_Nonurb
202R00012	NT	NT_NLSF	SWAMP	SM_R2_Nonurb
202R00102	NT	NT_NLSF	SWAMP	SM_R2_Nonurb
204R00153	NT	NT_NW	ACCWP	Al_R2_Nonurb
204R00041	NT	NT_NW	ACCWP	Al_R2_Urb
204R00292	NT	NT_NW	ACCWP	Al_R2_Urb
205R00558	NT	NT_NW	ACCWP	Al_R2_Urb
204R00020	NT	NT_NW	CCCWP	CC_R2R5_Urb
204R00091	NT	NT_NW	CCCWP	CC_R2R5_Urb
207R00027	NT	NT_NW	CCCWP	CC_R2R5_Urb
544R00053	NT	NT_NW	CCCWP	CC_R5_Nonurb
205R00003	NT	NT_NW	SCVURPPP	SC_R2_Urb
204R00223	NT	NT_P	ACCWP	Al_R2_Urb
204R00468	NT	NT_P	ACCWP	Al_R2_Urb
205R00371	NT	NT_P	SCVURPPP	SC_R2_Urb
202R00140	NT	NT_P	SMCWPPP	SM_R2_Urb
202R00588	NT	NT_P	SMCWPPP	SM_R2_Urb
204R00264	NT	NT_P	SMCWPPP	SM_R2_Urb
204R00500	NT	NT_P	SMCWPPP	SM_R2_Urb
207R00059	NT	NT_RI	CCCWP	CC_R2R5_Urb
204R00575	NT	NT_T	ACCWP	Al_R2_Urb
205R00279	NT	NT_T	ACCWP	Al_R2_Urb
544R00089	NT	NT_T	CCCWP	CC_R5_Nonurb
544R00117	NT	NT_T	CCCWP	CC_R5_Nonurb
204R00196	NT	NT_W	CCCWP	CC_R2R5_Urb
207R00119	NT	NT_W	CCCWP	CC_R2R5_Urb
207R00171	NT	NT_W	CCCWP	CC_R2R5_Urb
204R00473	TNS	TNS_TD	ACCWP	Al_R2_Urb
202R00028	TNS	TNS_IA	SMCWPPP	SM_R2_Urb
204R00061	TNS	TNS_NR	SCVURPPP	SC_R2_Nonurb
205R00065	TNS	TNS_NR	SCVURPPP	SC_R2_Nonurb
204R00013	TNS	TNS_NR	SCVURPPP	SC_R2_Nonurb
204R00018	TNS	TNS_NR	SCVURPPP	SC_R2_Nonurb

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

Site ID	Site Target Status	Site Target Status Detail	Sampling Agency	Stratum
202R00054	TNS	TNS_NR	SWAMP	SM_R2_Nonurb
202R00056	TNS	TNS_NR	SWAMP	SM_R2_Nonurb
543R00107	TNS	TNS_PD	CCCWP	CC_R5_Nonurb
205R00179	TNS	TNS_PD	SCVURPPP	SC_R2_Urb
202R00076	TNS	TNS_PD	SMCWPPP	SM_R2_Nonurb
204R00008	TNS	TNS_PD	SMCWPPP	SM_R2_Urb
204R00520	TNS	TNS_PD	SMCWPPP	SM_R2_Urb
205R00307	TNS	TNS_PD	SMCWPPP	SM_R2_Urb
204R00094	TNS	TNS_TD	ACCWP	Al_R2_Urb
204R00127	TNS	TNS_TD	ACCWP	Al_R2_Urb
205R00494	TNS	TNS_TD	ACCWP	Al_R2_Urb
205R00010	TNS	TNS_TD	SCVURPPP	SC_R2_Nonurb
202R00024	TS	TS	SMCWPPP	SM_R2_Nonurb
202R00038	TS	TS	SWAMP	SM_R2_Nonurb
202R00072	TS	TS	SMCWPPP	SM_R2_Nonurb
202R00087	TS	TS	SMCWPPP	SM_R2_Urb
202R00104	TS	TS	SWAMP	SM_R2_Nonurb
202R00166	TS	TS	SWAMP	SM_R2_Nonurb
202R00284	TS	TS	SMCWPPP	SM_R2_Urb
203R00039	TS	TS	CCCWP	CC_R2R5_Urb
204R00047	TS	TS	ACCWP	Al_R2_Urb
204R00068	TS	TS	ACCWP	Al_R2_Urb
204R00084	TS	TS	ACCWP	Al_R2_Urb
204R00100	TS	TS	ACCWP	Al_R2_Urb
204R00180	TS	TS	SMCWPPP	SM_R2_Urb
204R00191	TS	TS	ACCWP	Al_R2_Urb
204R00200	TS	TS	SMCWPPP	SM_R2_Urb
204R00232	TS	TS	SMCWPPP	SM_R2_Urb
204R00244	TS	TS	SMCWPPP	SM_R2_Urb
204R00303	TS	TS	ACCWP	Al_R2_Urb
204R00319	TS	TS	ACCWP	Al_R2_Urb
204R00340	TS	TS	ACCWP	Al_R2_Urb
204R00356	TS	TS	ACCWP	Al_R2_Urb
204R00367	TS	TS	ACCWP	Al_R2_Urb
204R00383	TS	TS	ACCWP	Al_R2_Urb
204R00391	TS	TS	ACCWP	Al_R2_Urb
204R00455	TS	TS	ACCWP	Al_R2_Urb
204R00583	TS	TS	ACCWP	Al_R2_Urb
204R00596	TS	TS	ACCWP	Al_R2_Urb
204R00639	TS	TS	ACCWP	Al_R2_Urb
204R00647	TS	TS	ACCWP	Al_R2_Urb
205R00021	TS	TS	SCVURPPP	SC_R2_Nonurb
205R00026	TS	TS	SCVURPPP	SC_R2_Urb
205R00035	TS	TS	SCVURPPP	SC_R2_Urb
205R00042	TS	TS	SCVURPPP	SC_R2_Urb
205R00058	TS	TS	SCVURPPP	SC_R2_Nonurb
205R00066	TS	TS	SWAMP	SC_R2_Nonurb
205R00067	TS	TS	SCVURPPP	SC_R2_Urb
205R00088	TS	TS	SMCWPPP	SM_R2_Urb
205R00090	TS	TS	SCVURPPP	SC_R2_Urb
205R00099	TS	TS	SCVURPPP	SC_R2_Urb
205R00110	TS	TS	ACCWP	Al_R2_Urb
205R00115	TS	TS	SCVURPPP	SC_R2_Urb
205R00131	TS	TS	SCVURPPP	SC_R2_Urb

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

Site ID	Site Target Status	Site Target Status Detail	Sampling Agency	Stratum
205R00154	TS	TS	SCVURPPP	SC_R2_Urb
205R00168	TS	TS	SMCWPPP	SM_R2_Urb
205R00218	TS	TS	SCVURPPP	SC_R2_Urb
205R00227	TS	TS	SCVURPPP	SC_R2_Urb
205R00234	TS	TS	SCVURPPP	SC_R2_Urb
205R00241	TS	TS	SCVURPPP	SC_R2_Urb
205R00259	TS	TS	SCVURPPP	SC_R2_Urb
205R00282	TS	TS	SCVURPPP	SC_R2_Urb
205R00291	TS	TS	SCVURPPP	SC_R2_Urb
205R00346	TS	TS	SCVURPPP	SC_R2_Urb
205R00355	TS	TS	SCVURPPP	SC_R2_Urb
205R00430	TS	TS	ACCWP	Al_R2_Urb
205R00535	TS	TS	ACCWP	Al_R2_Urb
206R00055	TS	TS	SWAMP	CC_R2_Nonurb
206R00155	TS	TS	CCCWP	CC_R2R5_Urb
206R00215	TS	TS	CCCWP	CC_R2R5_Urb
207R00011	TS	TS	CCCWP	CC_R2R5_Urb
207R00075	TS	TS	SWAMP	CC_R2_Nonurb
207R00139	TS	TS	CCCWP	CC_R2R5_Urb
207R00247	TS	TS	CCCWP	CC_R2R5_Urb
543R00137	TS	TS	CCCWP	CC_R2R5_Urb
543R00219	TS	TS	CCCWP	CC_R5_Nonurb
543R00245	TS	TS	CCCWP	CC_R5_Nonurb
544R00025	TS	TS	CCCWP	CC_R2R5_Urb
204R00004	U	U	ACCWP	Al_R2_Nonurb
204R00006	U	U	ACCWP	Al_R2_Nonurb
204R00022	U	U	ACCWP	Al_R2_Nonurb
204R00031	U	U	ACCWP	Al_R2_Nonurb
204R00034	U	U	ACCWP	Al_R2_Nonurb
204R00050	U	U	ACCWP	Al_R2_Nonurb
204R00057	U	U	ACCWP	Al_R2_Nonurb
204R00062	U	U	ACCWP	Al_R2_Nonurb
204R00078	U	U	ACCWP	Al_R2_Nonurb
204R00086	U	U	ACCWP	Al_R2_Nonurb
204R00095	U	U	ACCWP	Al_R2_Nonurb
204R00111	U	U	ACCWP	Al_R2_Nonurb
204R00114	U	U	ACCWP	Al_R2_Nonurb
204R00116	U	U	ACCWP	Al_R2_Nonurb
204R00126	U	U	ACCWP	Al_R2_Nonurb
204R00134	U	U	ACCWP	Al_R2_Nonurb
204R00142	U	U	ACCWP	Al_R2_Nonurb
204R00146	U	U	ACCWP	Al_R2_Nonurb
204R00148	U	U	ACCWP	Al_R2_Nonurb
204R00162	U	U	ACCWP	Al_R2_Nonurb
204R00169	U	U	ACCWP	Al_R2_Nonurb
204R00175	U	U	ACCWP	Al_R2_Nonurb
204R00178	U	U	ACCWP	Al_R2_Nonurb
204R00190	U	U	ACCWP	Al_R2_Nonurb
204R00206	U	U	ACCWP	Al_R2_Nonurb
204R00210	U	U	ACCWP	Al_R2_Nonurb
204R00217	U	U	ACCWP	Al_R2_Nonurb
204R00222	U	U	ACCWP	Al_R2_Nonurb
204R00226	U	U	ACCWP	Al_R2_Nonurb
204R00242	U	U	ACCWP	Al_R2_Nonurb

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

Site ID	Site Target Status	Site Target Status Detail	Sampling Agency	Stratum
203R00295	U	U	ACCWP	Al_R2_Urb
204R00158	U	U	ACCWP	Al_R2_Urb
204R00327	U	U	ACCWP	Al_R2_Urb
204R00334	U	U	ACCWP	Al_R2_Urb
204R00447	U	U	ACCWP	Al_R2_Urb
204R00548	U	U	ACCWP	Al_R2_Urb
204R00559	U	U	ACCWP	Al_R2_Urb
204R00623	U	U	ACCWP	Al_R2_Urb
205R00046	U	U	ACCWP	Al_R2_Urb
205R00174	U	U	ACCWP	Al_R2_Urb
205R00238	U	U	ACCWP	Al_R2_Urb
205R00302	U	U	ACCWP	Al_R2_Urb
205R00366	U	U	ACCWP	Al_R2_Urb
205R00622	U	U	ACCWP	Al_R2_Urb
205R00686	U	U	ACCWP	Al_R2_Urb
204R00063	U	U_AU	ACCWP	Al_R2_Urb
204R00135	U	U_AU	ACCWP	Al_R2_Urb
204R00479	U	U_AU	ACCWP	Al_R2_Urb
205R00001	U	U_PD	SCVURPPP	SC_R2_Nonurb
205R00033	U	U_PD	SCVURPPP	SC_R2_Nonurb
205R00051	U	U_PD	SCVURPPP	SC_R2_Urb
205R00263	U	U_PD	SCVURPPP	SC_R2_Urb
205R00293	U	U_PD	SCVURPPP	SC_R2_Urb
205R00369	U	U_PD	SCVURPPP	SC_R2_Urb
205R00374	U	U_PD	SCVURPPP	SC_R2_Urb
204R00239	U	U_TD	ACCWP	Al_R2_Urb
204R00036	U	U_TD	SWAMP	CC_R2_Nonurb
204R00052	U	U_TD	SWAMP	CC_R2_Nonurb
204R00103	U	U_TI	ACCWP	Al_R2_Urb
Subtotals by Target Site Status	**18**	**TNS**		
	59	**U**		
	66	**TS**		
	76	**NT**		
Total # Sites	**219**			

Site Target Status Detail Legend:

Code	Description
TNS: target not sampleable	
TNS_PD	access permanently denied OR no owner response, so access effectively denied
TNS_NR	no response from owners
TNS_TD	access temporarily denied or temporarily inaccessible for other reasons
TNS_TNW	temporarily no water due to water management activities
TNS_IA	terrain is steep and unsafe for crews, and/or channel is too choked with vegetation to approach and/or walk through and sample
TNS_DIST	physically inaccessible either because cannot hike RT and sample in one day, and/or no good roads to access.
NT: non-target	
NT_W	wetland
NT_NLSF	no/low spring flow
NT_IA	inaccessible due to terrain

Attachment A. Sites from the RMC Probabilistic Design Master Draw evaluated in Water Year 2012.

NT_DIST	too far to sample in one day
NT_NW	not Wadeable
NT_H	human hazards; unsafe for field crews
NT_NW	non-wadable
NT_NC	not a stream channel
NT_AGDITCH	agricultural ditch; not natural, historic receiving water
NT_P	pipeline
NT_T	tidally influenced
NT_RI	reservoir or impoundment
U: Unknown	
U_AU	accessibility unknown
U_TD	temporarily denied access and other criteria unknown
U_PD	permanantly denied access and other criteria unknown
U_DIST	physically inaccessible either because cannot hike RT and sample in one day, and/or no good roads to access and other criteria unknown
U_IA	terrain is steep and unsafe for crews, and/or channel is too choked with vegetation to approach and/or walk through and sample and flow status and/or wadeability unknown

Attachment B. Data Quality Detailed Description

A comprehensive QA/QC program was implemented by the RMC participants, covering all aspects of the regional/probabilistic monitoring. In general, QA/QC procedures were implemented as specified in the RMC QAPP (BASMAA, 2012a), and monitoring was performed according to protocols specified in the RMC SOPs (BASMAA, 2012b), and in conformity with SWAMP protocols.

All findings and data reported during 2012 were reviewed by RMC participants and their Local Quality Assurance Officers (LQAO) to determine whether data quality objectives were met. Field activity audits and sampling crew interviews were conducted for each program by the responsible LQAO to assess sample collection procedures, field measurement methods, and record keeping. Laboratories are responsible for conducting a set of internal QA/QC procedures as well as adhere to the protocols specified in the RMC QAPP, and for reporting any issues that arose during testing. The laboratory results for the regional/probabilistic monitoring parameters were also reviewed by each LQAO, as well as by the authors of this regional report. The results of these reviews are summarized below.

Field Measurements and Sample Collection

Audits conducted by the LQAOs did not result in any notable issues needing to be addressed regarding field procedures. Field sampling protocols, sample handling, documentation and packaging/delivery of samples were all executed properly as required by the QAPP and in accordance with the RMC SOPs. All field instruments were properly calibrated and cleaned within the necessary time restrictions.

RMC field crews noted numerous instances where free chlorine was measured with the Hach field kits at levels equal to or higher than total chlorine. To address this issue, alternative (colorimetric) methods are being evaluated for future field work. Lack of shade at the sites in question may have played in a role in these unexpected results.

Bioassessment

Some biological assessment sites had to be sampled along a shortened reach (<150m), and in some cases, stream characterization points may have been skipped along the reach due to physical limitations or obstructions. Very low flow was noted at a limited number of sampling sites, preventing the field crew from making discharge measurements at those locations.

BMI Taxonomy: During the BMI taxonomic analysis, some minor counting discrepancies were noted between the original BioAssessment Services results and the QA recount conducted by the California Department of Fish and Game. All sorting counts met QA/QC criteria for sorting accuracy of >95% following recount.

Algae Taxonomy: Collection of algae samples was difficult or impossible at several sites due to varying levels of algal growth, making it hard to collect a distinguishable clump for analysis. EcoAnalysts, the algae taxonomy lab, reported low sample counts for soft algae in some cases which required alternative procedures of analysis in order to ensure complete and quality data. Additional algae analysis was a time-consuming process, leading to a projected increase in processing costs.

Sediment Chemistry

Caltest Laboratories performed all sediment chemistry analysis for the RMC in 2012, with the exception of the grain size distribution and total organic carbon (TOC) analyses, which were sub-contracted by Caltest to Soil Control Laboratories. Caltest conducted all QA/QC requirements as specified in the RMC QAPP and reported their findings to the RMC. Key sediment chemistry Measurement Quality Objectives (MQOs) are listed in RMC QAPP tables 26-4, 26-6, and 26-7. A number of issues were noted by the laboratory in relation to the sediment chemistry analyses; none of the issues were considered to significantly impact the quality of the data. These issues included:

- Low level contamination noted in the Method Blank (Arsenic, Chromium)
- Reporting limits (RLs) exceeded RLs specified in the RMC QAPP for certain analytes
- Some 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 (Copper, Chromium, Nickel)
- Low Matrix Spike recovery was noted due to possible matrix interference in the QC sample (Arsenic)
- High Matrix Spike recovery was noted due to possible matrix interference in the QC sample (Lead)
- Several organochlorine pesticide compounds were not included in the spike mix: 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, cis-Chlordane, trans-Chlordane and Heptachlor epoxide
- Matrix Spike recoveries were outside control limits: (Lindane, 4,4'DDT)
- Percent solids analyses on the as-received sediments were performed past regulatory holding time
- LIMS 'Acodes' did not originally include 2,4 DDD, 2,4 DDT, 2,4 DDE as these were not standard compounds that reported by the laboratory under EPA method 8081, and the original analysis did not include these three compounds; the holding time violation is noted/qualified
- Some levels of acceptable relative percent difference (RPD) as reported by Caltest were higher than the maximum allowable RPD as specified in the RMC QAPP

These issues are further discussed below.

Many laboratory reporting limits (RLs) were higher for sediment chemistry analytes than RMC QAPP RLs due to the dry weight conversion, as well as target and non-target matrix interferences, which required the laboratories to concentrate less than normal. A high number of matrix spike (MS) samples failed to meet the MQOs for percent recovery. Caltest reported that this issue was likely due to possible matrix interference in the QC sample batch. In some cases MS/MSD percent recoveries were not calculated due to the high native concentration in the selected MS/MSD sample compared to laboratory spike concentration. Several organochlorine pesticide compounds were not included in the spike mix or the spike recoveries were outside of the control limits. As documented in the laboratory reports, all analytes which failed to meet MS/MSD MQOs were accepted by Caltest based on LCS and RPD QC results.

Due to internal lab issues, holding times were exceeded for several organochlorine pesticides and for the percent solids analysis on as-received sediments. For 2012 RMC sediment chemistry results for the constituents DDD(o,p'), DDE(o,p'), and DDT(o,p') (which the pdf lab reports refer to as 2,4 DDD, 2,4 DDT, 2,4 DDE), and "% Solids" (applies to re-analysis on 9/10/12, not original analysis on 8/7/12), the "VH" qualifier code was added to the data files, indicating “Holding Time Violation, flagged by QA Officer”.

Many of the lab reporting limits exceeded those that were included in the RMC QAPP due to issues associated with the dry weight conversion. Non-target matrix interference required the lab to use a lower than normal concentration, resulting in elevated RLs to account for an accurate initial volume compared to the final volume. All lab QA/QC issues were properly noted as qualified in lab reports and EDDs, and Caltest notified the responsible RMC programs.

Some discrepancies were observed in the MQO limits Caltest applied to duplicate RPDs in lab reports versus the acceptable RPDs specified in the RMC QAPP. Caltest applied a maximum allowable RPD for metals in sediment of 30% compared to the RPD specified in the RMC QAPP of 25%. For synthetic organics in sediment Caltest applied a maximum allowable RPD of 30-40% compared to 25% specified in the QAPP. Because the laboratory calculates acceptable RPDs based on historical values, in some cases lab internal protocols specify different control limits than those specified in the QAPP. In such cases additional qualification by the Quality Assurance Officer is necessary. RMC data managers were asked to apply the qualifier code "VFDP" to the results for the affected constituents to all 2012 RMC sediment chemistry data files, indicating “Field duplicate RPD above QC limit, flagged by QA Officer”.

Field Duplicates: The RMC QAPP requires collection and analysis of duplicate sediment samples at a rate of 10% of total samples collected. One sediment sample duplicate was collected to account for the 10 sediment sites monitored by the RMC in 2012. Relative Percent Difference (RPD) was in exceedance of the MQO in two of the grain size test results (% Granule and % Sand) for the sediment chemistry field duplicate sample. The qualifier code "VFDP", indicating “Field duplicate RPD above QC limit, flagged by QA Officer” was applied to all RMC sediment chemistry results for these two parameters. Lab results of the sediment chemistry field duplicates are shown in table B-1. [Note that because of the variability in reporting limits, ND and DNQ data were not evaluated for sediment RPDs.]

Water Chemistry

Caltest Labs analyzed all water chemistry samples for the RMC in 2012. Caltest performed all internal QA/QC requirements as specified in the QAPP and reported their findings to the RMC. An initial screening of water chemistry data reports found that Ash Free Dry Weight (AFDW) was not included in certain lab reports or EDDs; revised lab reports and EDDs were provided with AFDW results included. A limited number of internal QA/QC tests failed to meet data quality requirements for matrix spike (MS) percent recovery; these results are reported as qualified in EDDs and Lab Reports by Caltest. Analytes failing to meet MQOs include Chloride, Dissolved Organic Carbon, Nitrite as N and Silica. Key water chemistry MQOs are listed in RMC QAPP tables 26-1, 26-2, 26-5, and 26-7.

Field Blanks: One water chemistry field blank sample was collected in 2012 at ACCWP site 204R00068 and analyzed for orthophosphate and dissolved organic carbon by Caltest. Lab analysis of the water chemistry field blank detected no contaminants. The RMC QAPP requires field blanks to be collected and analyzed at a frequency of 5% of all samples collected for these parameters; this equates to a total of three such samples for the RMC total of 60 in 2012. This requirement was not completely met in 2012. No sediment chemistry field blanks are required by the RMC QAPP.

Field Duplicates: The RMC QAPP requires collection and analysis of duplicate samples at a rate of 10% of total samples collected. Six duplicate water samples were collected and analyzed to account for the 60 water monitoring locations. Relative Percent Difference (RPD) was in exceedance of the Measurement Quality Objective (MQO) for a total of 7 results, involving the constituents Ammonia as N, Chlorophyll a, Suspended Sediment Concentration and Total Kjeldahl Nitrogen (TKN). Lab results of water chemistry field duplicate results are shown in Tables B-2 through B-7. For the affected sites and constituents, RMC program data managers were asked to add a qualifier code of "VFDP" to the data files, to signify "Field duplicate RPD above QC limit; flagged by QAO". Because each RMC participating program provided a representative set of field duplicate water samples for analysis, the qualifier codes resulting from the field duplicate results apply only to the other samples from the particular RMC program.

Sediment Toxicity

Sediment Toxicity lab analysis was conducted by Pacific EcoRisk labs. All QA/QC measures listed in the QAPP were met. In multiple instances the dissolved oxygen level fell below 2.5 mg/L during testing for *Hyalella azteca*. RMC data managers were asked to apply the qualifier code “VTW” for these samples, indicating "Water quality parameters outside recommended test method ranges, flagged by QA Officer", with a note in the comment field indicating, “Dissolved oxygen levels fell below 2.5 mg/L during testing. Aeration was initiated following this observation per USEPA protocols. Hypoxia could have had a role in the significantly reduced survival observed in this sample.”

Water Toxicity

Water Toxicity lab analysis was conducted by Pacific EcoRisk labs. All QA/QC measures listed in the QAPP were met. Pacific EcoRisk reported several water toxicity samples were affected by pathogen-related mortality (PRM), a fairly common cause of interference in aquatic sample toxicity tests with ambient surface waters. The affected samples were re-tested using a modified approach per Geis et al. (2003). BASMAA has requested approval to routinely apply the modified Geis technique to fathead minnow water toxicity tests to avoid the reoccurrence of this type of interference.

RMC data managers were asked to apply the qualifier code "PRM" for PRM-affected samples (this is a new code that the RMC is requesting be added to the SWAMP “QACode Lookup List”). Data managers also were asked to add the following comment to the data files for PRM-affected samples: "Low survival resulted from test interference due to pathogen related mortality (PRM). The data should not be used for regulatory purposes. A re-test was initiated using a method to control for PRM." For the Geis method re-tests, because the tests were conducted outside of acceptable holding times, RMC data managers were asked to apply the qualifier code "VH" QACode, indicating “Holding Time Violation flagged by QA Officer”.

Table B-1 Sediment Chemistry - Field Duplicate Results and QA Results

Method Name	MDL	RL	Analyte Name	Unit	SampleResult	Sample Result Qual Code	Field Duplicate Result	Field Duplicate Result Qual Code	RPD	Exceeds MQO (>25%)
SM 2540 B	0.1	0	% Solids	%	52		55		6%	No
SM 2540 B	0.1	0	% Solids	%	50		54		8%	No
EPA 8270C	6	40	Acenaphthene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Acenaphthylene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Anthracene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 6020	0.01	0	Arsenic	mg/Kg dw	2		1.9		5%	No
EPA 8270C	6	40	Benz(a)anthracene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Benzo(a)pyrene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Benzo(b)fluoranthene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Benzo(e)pyrene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Benzo(g,h,i)perylene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Benzo(k)fluoranthene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
GCMS-NCI-SIM	0.19	1	Bifenthrin	ng/g dw	-0.19	ND	-0.91	ND	N/A	N/A
EPA 8270C	40	40	Biphenyl	ng/g dw	-40	ND	-37	ND	N/A	N/A
EPA 6020	0.01	0	Cadmium	mg/Kg dw	0.09		0.09		0%	No
EPA 8081A	2	4	Chlordane, cis-	ng/g dw	-2	ND	-1.9	ND	N/A	N/A
EPA 8081A	2	4	Chlordane, trans-	ng/g dw	-2	ND	-1.9	ND	N/A	N/A
EPA 6020	0.02	0	Chromium	mg/Kg dw	67		64		5%	No
EPA 8270C	6	40	Chrysene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-1 Sediment Chemistry - Field Duplicate Results and QA Results

Method Name	MDL	RL	Analyte Name	Unit	SampleResult	Sample Result Qual Code	Field Duplicate Result	Field Duplicate Result Qual Code	RPD	Exceeds MQO (>25%)
Plumb, 1981, GS	0.01	0	Clay	%	21.07		20.83		1%	No
Plumb, 1981, GS	0.01	0	Clay	%	6.01		4.91		20%	No
EPA 6020	0.05	0	Copper	mg/Kg dw	20		20		0%	No
GCMS-NCI-SIM	0.21	1	Cyfluthrin, total	ng/g dw	-0.21	ND	-1	ND	N/A	N/A
GCMS-NCI-SIM	0.11	1	Cyhalothrin, lambda, total	ng/g dw	-0.11	ND	-0.55	ND	N/A	N/A
GCMS-NCI-SIM	0.19	1	Cypermethrin, total	ng/g dw	-0.19	ND	-0.91	ND	N/A	N/A
EPA 8081A	4	4	DDD(o,p')	ng/g dw	-4	ND	-3.7	ND	N/A	N/A
EPA 8081A	1.6	4	DDD(p,p')	ng/g dw	-1.6	ND	-1.5	ND	N/A	N/A
EPA 8081A	4	4	DDE(o,p')	ng/g dw	-4	ND	-3.7	ND	N/A	N/A
EPA 8081A	2.4	4	DDE(p,p')	ng/g dw	-2.4	ND	-2.2	ND	N/A	N/A
EPA 8081A	4	4	DDT(o,p')	ng/g dw	-4	ND	-3.7	ND	N/A	N/A
EPA 8081A	1.2	4	DDT(p,p')	ng/g dw	-1.2	ND	-1.1	ND	N/A	N/A
EPA 8081A	-88	-88	Decachlorobiphenyl(Surrogate)	% recovery	33		38		14%	No
GCMS-NCI-SIM	-88	-88	Decachlorobiphenyl(Surrogate)	% recovery	94		76		21%	No
GCMS-NCI-SIM	0.23	1	Deltamethrin/Tralomethrin	ng/g dw	-0.23	ND	-1.1	ND	N/A	N/A
EPA 8270C	6	40	Dibenz(a,h)anthracene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	40	40	Dibenzothiophene	ng/g dw	-40	ND	-37	ND	N/A	N/A
EPA 8081A	2.4	4	Dieldrin	ng/g dw	-2.4	ND	-2.2	ND	N/A	N/A
EPA 8270C	6	40	Dimethylnaphthalene, 2,6-	ng/g dw	-6	ND	-5.6	ND	N/A	N/A

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-1 Sediment Chemistry - Field Duplicate Results and QA Results

Method Name	MDL	RL	Analyte Name	Unit	SampleResult	Sample Result Qual Code	Field Duplicate Result	Field Duplicate Result Qual Code	RPD	Exceeds MQO (>25%)
EPA 8081A	0.99	4	Endrin	ng/g dw	-0.99	ND	-0.93	ND	N/A	N/A
GCMS-NCI-SIM	0.25	1	Esfenvalerate/Fenvalerate, total	ng/g dw	-0.25	ND	-1.2	ND	N/A	N/A
GCMS-NCI-SIM	-88	-88	Esfenvalerate-d6;#1(Surrogate)	% recovery	101		96		5%	No
GCMS-NCI-SIM	-88	-88	Esfenvalerate-d6;#2(Surrogate)	% recovery	95		95		0%	No
EPA 8270C	6	40	Fluoranthene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Fluorene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	-88	-88	Fluorobiphenyl, 2-(Surrogate)	% recovery	84		89		6%	No
Plumb, 1981, GS	0.01	0	Granule	%	0.64		0.38		51%	Yes
EPA 8081A	1.4	4	HCH, gamma	ng/g dw	-1.4	ND	-1.3	ND	N/A	N/A
EPA 8081A	1.6	4	Heptachlor epoxide	ng/g dw	-1.6	ND	-1.5	ND	N/A	N/A
EPA 8270C	6	40	Indeno(1,2,3-c,d)pyrene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 6020	0.01	0	Lead	mg/Kg dw	9.3		8.7		7%	No
EPA 7471A	0	0	Mercury	mg/Kg dw	0.065		0.058		11%	No
EPA 8270C	6	40	Methylnaphthalene, 1-	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Methylnaphthalene, 2-	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Methylphenanthrene, 1-	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Naphthalene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 6020	0.03	0	Nickel	mg/Kg dw	150		140		7%	No
EPA 8270C	-88	-88	Nitrobenzene-d5(Surrogate)	% recovery	80		85		6%	No

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-1 Sediment Chemistry - Field Duplicate Results and QA Results

Method Name	MDL	RL	Analyte Name	Unit	SampleResult	Sample Result Qual Code	Field Duplicate Result	Field Duplicate Result Qual Code	RPD	Exceeds MQO (>25%)
Plumb, 1981, GS	0.01	0	Pebble	%	-0.01	ND	-0.01	ND	N/A	N/A
Plumb, 1981, GS	0.01	0	Pebble	%	-0.01	ND	-0.01	ND	N/A	N/A
Plumb, 1981, GS	0.01	0	Pebble	%	-0.01	ND	-0.01	ND	N/A	N/A
Plumb, 1981, GS	0.01	0	Pebble	%	-0.01	ND	-0.01	ND	N/A	N/A
GCMS-NCI-SIM	0.21	1	Permethrin, cis-	ng/g dw	-0.21	ND	-1	ND	N/A	N/A
GCMS-NCI-SIM	0.21	1	Permethrin, Total	ng/g dw	-0.21	ND	-1	ND	N/A	N/A
GCMS-NCI-SIM	0.21	1	Permethrin, trans-	ng/g dw	-0.21	ND	-1	ND	N/A	N/A
EPA 8270C	6	40	Perylene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Phenanthrene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
EPA 8270C	6	40	Pyrene	ng/g dw	-6	ND	-5.6	ND	N/A	N/A
Plumb, 1981, GS	0.01	0	Sand	%	15.94		15.41		3%	No
Plumb, 1981, GS	0.01	0	Sand	%	12.2		12.7		4%	No
Plumb, 1981, GS	0.01	0	Sand	%	14.52		17.59		19%	No
Plumb, 1981, GS	0.01	0	Sand	%	2.92		3.27		11%	No
Plumb, 1981, GS	0.01	0	Sand	%	0.9		1.66		59%	Yes
Plumb, 1981, GS	0.01	0	Silt	%	4.49		4.43		1%	No
Plumb, 1981, GS	0.01	0	Silt	%	3.31		3.46		4%	No
Plumb, 1981, GS	0.01	0	Silt	%	6.25		5.76		8%	No
Plumb, 1981, GS	0.01	0	Silt	%	12.39		9.98		22%	No

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-1 Sediment Chemistry - Field Duplicate Results and QA Results

Method Name	MDL	RL	Analyte Name	Unit	SampleResult	Sample Result Qual Code	Field Duplicate Result	Field Duplicate Result Qual Code	RPD	Exceeds MQO (>25%)
EPA 8270C	-88	-88	Terphenyl-d14(Surrogate)	% recovery	124		134		8%	No
EPA 8081A	-88	-88	Tetrachloro-m-xylene(Surrogate)	% recovery	50		48		4%	No
EPA 9060	0.01	0	Total Organic Carbon	% dw	1.4		1.5		7%	No
EPA 6020	0.07	2	Zinc	mg/Kg dw	47		44		7%	No

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-2 Water Chemistry Field Duplicate Site 204R00319

Agency/ Program	Sample Date	SampleID	Analyte Name	Fraction Name	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
ACCWP	5/7/2012	204R00319-W	Alkalinity as CaCO3	Total	mg/L	198	198	0.00%	No
ACCWP	5/7/2012	204R00319-W	Ammonia as N	Total	mg/L	0.15	0.13	7.14%	No
ACCWP	5/7/2012	204R00319-W	Bicarbonate	None	mg/L	198	198	0.00%	No
ACCWP	5/7/2012	204R00319-W	Carbonate	None	mg/L	-1.2	-1.2	0.00%	No (ND)
ACCWP	5/7/2012	204R00319-W	Chloride	None	mg/L	24	25	2.04%	No
ACCWP	5/7/2012	204R00319-W	Chlorophyll a	Particulate	ug/L	380	-200	322.22%	Yes (ND)
ACCWP	5/7/2012	204R00319-W	Dissolved Organic Carbon	None	mg/L	2.7	2.8	1.82%	No
ACCWP	5/7/2012	204R00319-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
ACCWP	5/7/2012	204R00319-W	Nitrate as N	None	mg/L	0.43	0.42	1.18%	No
ACCWP	5/7/2012	204R00319-W	Nitrite as N	None	mg/L	-0.002	-0.002	0.00%	No (ND)
ACCWP	5/7/2012	204R00319-W	Nitrogen, Total Kjeldahl	None	mg/L	0.14	0.36	44.00%	Yes (DNQ)
ACCWP	5/7/2012	204R00319-W	Ortho Phosphate as P	Dissolved	mg/L	0.058	0.055	2.65%	No
ACCWP	5/7/2012	204R00319-W	Phosphorus as P	Total	mg/L	0.059	0.058	0.85%	No
ACCWP	5/7/2012	204R00319-W	Silica as SiO2	Total	mg/L	20.1	19.9	0.50%	No
ACCWP	5/7/2012	204R00319-W	Suspended Sediment Concentration	None	mg/L	-2	-2	0.00%	No (ND)

Table B-3 Water Chemistry Field Duplicate Site 205R00535

Agency/ Program	Sample Date	Sample ID	Analyte Name	FractionName	Unit Name	Result	DUP Result	RPD	Exceeds (>25%)
ACCWP	6/20/2012	205R00535-W	Alkalinity as CaCO3	Total	mg/L	362	358	0.56%	No
ACCWP	6/20/2012	205R00535-W	Ammonia as N	Total	mg/L	-0.04	0.055	633.33%	Yes (ND)
ACCWP	6/20/2012	205R00535-W	Bicarbonate	None	mg/L	362	358	0.56%	No
ACCWP	6/20/2012	205R00535-W	Carbonate	None	mg/L	-1.2	-1.2	0.00%	No (ND)
ACCWP	6/20/2012	205R00535-W	Chloride	None	mg/L	110	110	0.00%	No
ACCWP	6/20/2012	205R00535-W	Chlorophyll a	Particulate	ug/L	4800	3000	23.08%	No
ACCWP	6/20/2012	205R00535-W	Dissolved Organic Carbon	None	mg/L	0.99	1	0.50%	No (DNQ)
ACCWP	6/20/2012	205R00535-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
ACCWP	6/20/2012	205R00535-W	Nitrate as N	None	mg/L	3	3	0.00%	No
ACCWP	6/20/2012	205R00535-W	Nitrite as N	None	mg/L	0.014	0.017	9.68%	No (DNQ)
ACCWP	6/20/2012	205R00535-W	Nitrogen, Total Kjeldahl	None	mg/L	0.19	0.12	22.58%	No
ACCWP	6/20/2012	205R00535-W	OrthoPhosphate as P	Dissolved	mg/L	0.016	0.016	0.00%	No
ACCWP	6/20/2012	205R00535-W	Phosphorus as P	Total	mg/L	0.022	0.025	6.38%	No
ACCWP	6/20/2012	205R00535-W	Silica as SiO2	Total	mg/L	19	18.6	1.06%	No
ACCWP	6/20/2012	205R00535-W	Suspended Sediment Concentration	None	mg/L	2.4	-2	1100.00%	Yes (ND)

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Attachment D. Data Quality Detailed Description

Table B-4 Water Chemistry Field Duplicate Site 207R00139

Agency/Program	Sample Date	SampleID	Analyte Name	Fraction Name	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
CCCWP	5/17/2012	207R00139-W	Alkalinity as CaCO3	Total	mg/L	309	308	0.16%	No
CCCWP	5/17/2012	207R00139-W	Ammonia as N	Total	mg/L	-0.04	-0.04	0.00%	No (ND)
CCCWP	5/17/2012	207R00139-W	Bicarbonate	None	mg/L	306	306	0.00%	No
CCCWP	5/17/2012	207R00139-W	Carbonate	None	mg/L	2.4	1.9	11.63%	No (DNQ)
CCCWP	5/17/2012	207R00139-W	Chloride	None	mg/L	40	39	1.27%	No
CCCWP	5/17/2012	207R00139-W	Chlorophyll a	Particulate	ug/L	780	-560	609.09%	Yes (ND)
CCCWP	5/17/2012	207R00139-W	Dissolved Organic Carbon	None	mg/L	3.3	3.3	0.00%	No
CCCWP	5/17/2012	207R00139-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
CCCWP	5/17/2012	207R00139-W	Nitrate as N	None	mg/L	0.15	0.15	0.00%	No
CCCWP	5/17/2012	207R00139-W	Nitrite as N	None	mg/L	-0.002	-0.002	0.00%	No (ND)
CCCWP	5/17/2012	207R00139-W	Nitrogen, Total Kjeldahl	None	mg/L	0.11	0.18	24.14%	No
CCCWP	5/17/2012	207R00139-W	OrthoPhosphate as P	Dissolved	mg/L	0.21	0.21	0.00%	No
CCCWP	5/17/2012	207R00139-W	Phosphorus as P	Total	mg/L	0.22	0.22	0.00%	No
CCCWP	5/17/2012	207R00139-W	Silica as SiO2	Total	mg/L	20.8	20.4	0.97%	No
CCCWP	5/17/2012	207R00139-W	Suspended Sediment Concentration	None	mg/L	4.5	5.2	7.22%	No

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Attachment D. Data Quality Detailed Description

Table B-5 Water Chemistry Field Duplicate Site 205R00035

Agency/ Program	Sample Date	SampleID	Analyte Name	FractionName	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
SCVURPPP	5/24/2012	205R00035-W	Alkalinity as CaCO3	Total	mg/L	78	78	0.00%	No
SCVURPPP	5/24/2012	205R00035-W	Ammonia as N	Total	mg/L	0.12	-0.04	200.00%	Yes (ND)
SCVURPPP	5/24/2012	205R00035-W	Bicarbonate	None	mg/L	78	78	0.00%	No
SCVURPPP	5/24/2012	205R00035-W	Carbonate	None	mg/L	-1.2	-1.2	0.00%	No (ND)
SCVURPPP	5/24/2012	205R00035-W	Chloride	None	mg/L	46	44	2.22%	No
SCVURPPP	5/24/2012	205R00035-W	Chlorophyll a	Particulate	ug/L	1300	950	15.56%	No
SCVURPPP	5/24/2012	205R00035-W	Dissolved Organic Carbon	None	mg/L	4.2	4.2	0.00%	No
SCVURPPP	5/24/2012	205R00035-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
SCVURPPP	5/24/2012	205R00035-W	Nitrate as N	None	mg/L	0.33	0.34	1.49%	No
SCVURPPP	5/24/2012	205R00035-W	Nitrite as N	None	mg/L	-0.002	-0.002	0.00%	No (ND)
SCVURPPP	5/24/2012	205R00035-W	Nitrogen, Total Kjeldahl	None	mg/L	0.44	0.37	8.64%	No
SCVURPPP	5/24/2012	205R00035-W	Ortho Phosphate as P	Dissolved	mg/L	0.072	0.071	0.70%	No
SCVURPPP	5/24/2012	205R00035-W	Phosphorus as P	Total	mg/L	0.087	0.087	0.00%	No
SCVURPPP	5/24/2012	205R00035-W	Silica as SiO2	Total	mg/L	10.9	11.1	0.91%	No
SCVURPPP	5/24/2012	205R00035-W	Suspended Sediment Concentration	None	mg/L	2.99	3.2	3.39%	No (DNQ)

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Attachment D. Data Quality Detailed Description

Table B-6 Water Chemistry Field Duplicate Site 205R00346

Agency/ Program	Sample Date	SampleID	Analyte Name	Fraction Name	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
SCVURPPP	6/14/2012	205R00346-W	Alkalinity as CaCO3	Total	mg/L	169	169	0.00%	No
SCVURPPP	6/14/2012	205R00346-W	Ammonia as N	Total	mg/L	0.055	0.044	11.11%	No (DNQ)
SCVURPPP	6/14/2012	205R00346-W	Bicarbonate	None	mg/L	169	169	0.00%	No
SCVURPPP	6/14/2012	205R00346-W	Carbonate	None	mg/L	-1.2	-1.2	0.00%	No (ND)
SCVURPPP	6/14/2012	205R00346-W	Chloride	None	mg/L	42	43	1.18%	No
SCVURPPP	6/14/2012	205R00346-W	Chlorophyll a	Particulate	ug/L	360	1100	50.68%	Yes (DNQ)
SCVURPPP	6/14/2012	205R00346-W	Dissolved Organic Carbon	None	mg/L	3.2	3.2	0.00%	No
SCVURPPP	6/14/2012	205R00346-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
SCVURPPP	6/14/2012	205R00346-W	Nitrate as N	None	mg/L	0.016	0.02	11.11%	No (DNQ)
SCVURPPP	6/14/2012	205R00346-W	Nitrite as N	None	mg/L	0.005	0.005	0.00%	No (DNQ)
SCVURPPP	6/14/2012	205R00346-W	Nitrogen, Total Kjeldahl	None	mg/L	0.32	0.31	1.59%	No
SCVURPPP	6/14/2012	205R00346-W	Ortho Phosphate as P	Dissolved	mg/L	0.017	0.016	3.03%	No
SCVURPPP	6/14/2012	205R00346-W	Phosphorus as P	Total	mg/L	0.04	0.042	2.44%	No
SCVURPPP	6/14/2012	205R00346-W	Silica as SiO2	Total	mg/L	14.2	14.1	0.35%	No
SCVURPPP	6/14/2012	205R00346-W	Suspended Sediment Concentration	None	mg/L	10	11	4.76%	No

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Table B-7 Water Chemistry Field Duplicate Site 204R00232

Agency/ Program	Sample Date	Sample ID	Analyte Name	Fraction Name	Unit Name	Result	DUP Result	RPD	Exceeds MQO (>25%)
SMCWPPP	6/12/2012	204R00232-W	Alkalinity as CaCO3	Total	mg/L	470	467	0.32%	No
SMCWPPP	6/12/2012	204R00232-W	Ammonia as N	Total	mg/L	-0.04	-0.04	0.00%	No (ND)
SMCWPPP	6/12/2012	204R00232-W	Bicarbonate	None	mg/L	438	434	0.46%	No
SMCWPPP	6/12/2012	204R00232-W	Carbonate	None	mg/L	31	33	3.13%	No
SMCWPPP	6/12/2012	204R00232-W	Chloride	None	mg/L	30	30	0.00%	No
SMCWPPP	6/12/2012	204R00232-W	Chlorophyll a	Particulate	ug/L	-200	-200	0.00%	No (ND)
SMCWPPP	6/12/2012	204R00232-W	Dissolved Organic Carbon	None	mg/L	2.8	2.8	0.00%	No
SMCWPPP	6/12/2012	204R00232-W	Hydroxide	None	mg/L	-1.2	-1.2	0.00%	No (ND)
SMCWPPP	6/12/2012	204R00232-W	Nitrate as N	None	mg/L	1.5	1.5	0.00%	No
SMCWPPP	6/12/2012	204R00232-W	Nitrite as N	None	mg/L	-0.002	-0.002	0.00%	No (ND)
SMCWPPP	6/12/2012	204R00232-W	Nitrogen, Total Kjeldahl	None	mg/L	0.46	0.36	12.20%	No
SMCWPPP	6/12/2012	204R00232-W	Ortho Phosphate as P	Dissolved	mg/L	0.1	0.1	0.00%	No
SMCWPPP	6/12/2012	204R00232-W	Phosphorus as P	Total	mg/L	0.11	0.11	0.00%	No
SMCWPPP	6/12/2012	204R00232-W	Silica as SiO2	Total	mg/L	68.3	68.4	0.07%	No
SMCWPPP	6/12/2012	204R00232-W	Suspended Sediment Concentration	None	mg/L	-2	-2	0.00%	No (ND)

Notes: negative values indicate data not detected at the reporting limit (absolute value of number shown)
ND = Non-Detect (either or both results below method detection limit)
DNQ = Result Did Not Qualify (either or both results below reporting limit)

Attachment C. BMI Metric Values

Table E-1. All BMI metric values for BMIs for urban and non-urban sites sampled in the RMC area in spring, 2012. P=perennial; NP=non-perennial.

				Metrics:	Richness								Composition					Tolerance					Functional Feeding Groups								Estimated Abundance		
Sampling Agency	Creek Name	Land Use	Flow Class	Station ID	Taxonomic	EPT	Ephemeroptera	Plecoptera	Trichoptera	Coleoptera	Predator	Diptera	EPT Index (%)	Sensitive EPT Index (%)	Shannon Diversity	Dominant Taxon (%)	Non-insect Taxa (%)	Tolerance Value	Intolerant Organisms (%)	Intolerant Taxa (%)	Tolerant Organisms (%)	Tolerant Taxa (%)	Collector-Gatherers (%)	Collector-Filterers (%)	Collectors (%)	Scrapers (%)	Non-Gastropoda Scrapers (%)	Predators (%)	Shredders (%)	Other (%)	Composite Sample (11 ft^2)	#/ft^2	#/m^2
ACCWP	Castro Valley	U	P	204R00047	9	2	1	0	1	0	1	5	11	0.0	1.9	35	22	6.1	0.0	0.0	14	11	89	2.5	91	0.0	0.0	3.8	0.0	4.7	12680	1153	12311
ACCWP	Collier Channel, Line 7-M	U	P	204R00068	17	5	3	0	2	0	4	5	72	0.2	1.8	43	35	4.6	0.0	0.0	2.5	29	96	0.3	96	0.5	0.0	3.3	0.0	0.2	11558	1051	11221
ACCWP	Dublin Creek	U	P	204R00084	17	2	2	0	0	2	6	5	1.3	0.0	1.8	34	41	6.2	0.0	0.0	29	41	92	0.1	92	0.3	0.0	7.0	0.0	0.4	13740	1249	13340
ACCWP	Arroyo Mocho	U	NP	204R00100	15	2	2	0	0	0	4	5	64	0.0	1.6	56	40	5.0	0.0	0.0	17	40	83	0.5	83	11	0.0	5.3	0.0	0.0	7531	685	7312
ACCWP	Arroyo Valle	U	P	204R00191	27	6	3	0	3	0	7	7	14	2.6	2.1	37	52	7.1	0.0	0.0	72	30	71	1.1	72	15	0.0	8.1	0.0	4.2	7368	670	7153
ACCWP	unknown	U	P	204R00303	17	3	1	0	2	0	5	9	5.7	0.0	1.9	26	24	5.8	0.0	0.0	1.3	18	75	19	94	0.8	0.0	4.3	0.2	0.3	6310	574	6126
ACCWP	Sausal	U	P	204R00319	31	5	2	1	2	4	11	12	37	18	2.5	19	26	4.9	18	13	4.0	23	53	18	70	2.1	1.3	9.1	18	0.8	3546	322	3443
ACCWP	Big Canyon, Line 7-J-1	U	P	204R00340	15	1	1	0	0	0	6	4	0.3	0.0	1.7	42	47	6.8	0.0	0.0	44	60	76	0.2	76	4.9	0.0	19	0.0	0.0	8422	766	8177
ACCWP	Arroyo de la Laguna	U	P	204R00356	18	4	3	0	1	0	3	5	63	0.0	2.0	30	44	4.9	0.0	0.0	13	33	90	3.0	93	3.0	0.0	3.8	0.0	0.2	2928	266	2843
ACCWP	Ward	U	P	204R00367	19	4	2	1	1	3	9	7	74	36	2.0	36	26	3.8	36	21	2.2	21	57	0.0	57	0.0	0.0	7.4	36	0.0	5088	463	4940
ACCWP	Sulphur	U	P	204R00383	10	0	0	0	0	0	4	4	0.0	0.0	1.2	50	50	5.7	0.0	0.0	6.1	30	92	1.2	93	0.9	0.0	6.2	0.0	0.0	3525	320	3422
ACCWP	unknown	U	P	204R00391	24	4	4	0	0	1	8	10	1.3	0.0	1.9	41	26	6.8	0.2	4.3	51	35	88	5.5	93	0.0	0.0	6.8	0.0	0.2	3708	337	3600
ACCWP	Zeile	U	P	204R00455	22	4	2	1	1	1	8	8	25	13	2.3	36	36	5.4	13	14	12	27	66	8.4	74	4.5	0.6	7.4	13	0.3	7936	721	7705
ACCWP	Line 3A-D	U	P	204R00583	8	0	0	0	0	0	2	2	0.0	0.0	1.1	52	63	6.6	0.0	0.0	17	38	53	0.0	53	2.9	0.0	44	0.0	0.0	10656	969	10346
ACCWP	NA (Line G-2)	U	P	204R00596	11	1	1	0	0	0	3	4	0.2	0.0	1.1	73	45	7.7	0.0	0.0	87	36	89	8.2	98	0.0	0.0	2.5	0.0	0.0	19520	1775	18951
ACCWP	San Lorenzo	U	P	204R00639	14	2	1	0	1	0	5	5	3.1	0.0	1.2	71	38	5.9	0.0	0.0	4.8	31	83	0.0	83	0.0	0.0	17	0.0	0.3	11558	1051	11221
ACCWP	Dry	U	P	204R00647	31	10	5	2	3	1	11	8	39	16	2.4	24	32	5.7	11	16	39	26	68	0.6	68	1.9	0.3	14	15	0.5	6038	549	5862
ACCWP	Agua Caliente	U	P	205R00110	21	4	1	0	3	2	5	7	3.2	0.2	2.0	33	33	7.0	0.2	4.8	47	29	21	6.4	27	36	0.3	34	0.2	2.6	12038	1094	11687
ACCWP	unknown	U	P	205R00430	23	5	3	0	2	1	5	8	5.9	0.3	1.9	27	35	6.7	0.0	0.0	42	43	92	0.6	92	1.0	0.0	1.7	0.0	5.1	12096	1100	11744
ACCWP	Line 5-F-1	U	P	205R00535	13	1	1	0	0	0	2	5	0.3	0.0	1.9	33	62	6.6	0.0	0.0	56	38	64	2.2	66	12	0.0	22	0.0	0.5	15240	1385	14796
CCCWP	Cerrito	U	P	203R00039	19	4	1	1	2	0	4	8	12	3.5	1.7	52	32	5.2	3.5	16	1.8	16	88	5.4	93	0.8	0.0	2.3	3.5	0.0	5306	482	5151
CCCWP	San Pablo	U	P	206R00155	20	3	2	1	0	1	6	10	18	1.9	2.1	25	25	5.4	1.9	5.0	1.3	30	81	11	92	0.3	0.0	5.2	1.9	0.5	2190	199	2126
CCCWP	San Pablo	U	P	206R00215	19	2	1	0	1	1	6	8	5.5	0.0	1.7	41	32	5.7	0.3	5.3	1.9	32	93	2.0	95	0.2	0.0	4.6	0.0	0.3	1197	109	1162
CCCWP	Grayson	U	P	207R00011	14	2	1	0	1	0	4	7	13	0.0	2.1	29	43	6.0	0.0	0.0	11	29	70	16	86	3.7	0.0	2.2	0.0	8.1	16747	1522	16259
CCCWP	Las Trampas	U	P	207R00139	11	2	1	0	1	0	2	3	5.5	0.0	1.5	51	45	5.6	0.0	0.0	14	45	86	0.0	86	13	0.0	1.2	0.3	0.2	2420	220	2350
CCCWP	Walnut	U	P	207R00247	17	5	2	0	3	0	4	6	27	0.2	2.2	19	29	5.6	0.0	0.0	3.1	29	82	4.1	86	0.3	0.0	2.8	0.0	10.7	9856	896	9569
CCCWP	Marsh	NU	P	543R00219	39	14	7	0	7	3	10	8	19	4.6	2.8	23	31	5.9	3.7	10	26	31	68	13	81	2.3	0.2	12	0.5	4.1	10496	954	10190

Attachment C. BMI Metric Values

Sampling Agency	Creek Name	Land Use	Flow Class	Metrics:	Richness								Composition					Tolerance					Functional Feeding Groups								Estimated Abundance		
				Station ID	Taxonomic	EPT	Ephemeroptera	Plecoptera	Trichoptera	Coleoptera	Predator	Diptera	EPT Index (%)	Sensitive EPT Index (%)	Shannon Diversity	Dominant Taxon (%)	Non-insect Taxa (%)	Tolerance Value	Intolerant Organisms (%)	Intolerant Taxa (%)	Tolerant Organisms (%)	Tolerant Taxa (%)	Collector-Gatherers (%)	Collector-Filterers (%)	Collectors (%)	Scrapers (%)	Non-Gastropoda Scrapers (%)	Predators (%)	Shredders (%)	Other (%)	Composite Sample (11 ft^2)	$\#/ft^2$	$\#/m^2$
	Marsh	NU	P	543R00245	35	10	8	0	2	4	12	8	8.4	5.6	2.5	38	33	6.7	2.8	5.6	55	25	23	0.8	24	46	0.0	23	0.0	6.8	2693	245	2615
	Deer	U	P	543R00137	8	0	0	0	0	0	1	4	0.0	0.0	1.5	40	50	6.8	0.0	0.0	43	38	89	5.4	94	1.7	0.0	4.2	0.0	0.0	6933	630	6731
	Dry	U	P	544R00025	12	0	0	0	0	0	2	6	0.0	0.0	1.8	35	42	6.0	0.0	0.0	25	42	93	4.1	97	1.6	0.0	1.1	0.0	0.2	4645	422	4510
SCVURPPP	MF Coyote	NU	NP	205R00021	40	21	9	7	5	4	15	8	64	5.9	2.3	30	10	4.5	6.8	45	5.9	10	59	0.0	59	27	26	12	2.0	0.3	3280	298	3184
SCVURPPP	Los Gatos	U	P	205R00026	21	5	1	0	4	1	7	8	15	0.5	2.0	32	33	5.3	0.5	4.8	2.3	24	86	6.2	92	0.7	0.5	4.6	0.5	2.5	7308	664	7095
SCVURPPP	Upper Penitencia	U	P	205R00035	30	9	5	0	4	0	8	6	24	1.1	1.9	50	47	5.5	0.3	6.7	4.4	23	71	18	89	3.3	2.2	6.0	0.0	1.4	20192	1836	19604
SCVURPPP	Coyote	U	P	205R00042	24	6	2	0	4	1	4	4	30	0.2	1.8	40	46	5.5	0.2	4.2	20	29	23	70	93	2.7	0.6	3.2	0.0	0.8	5402	491	5245
SCVURPPP	Saratoga	NU	P	205R00058	57	26	8	3	15	5	22	16	23	15	3.0	24	14	4.6	15	37	1.4	5.3	49	1.4	51	20	18	22	7.0	0.2	4286	390	4161
SCVURPPP	San Thomas Aquino	U	P	205R00067	14	1	1	0	0	1	3	6	0.3	0.3	0.8	82	43	5.9	0.3	7.1	1.8	36	97	0.0	97	1.0	0.2	1.8	0.0	0.0	23578	2143	22891
SCVURPPP	Canoas	U	P	205R00090	8	1	1	0	0	0	1	3	1.2	0.0	0.9	67	50	6.0	0.0	0.0	9.0	50	99	0.0	99	0.2	0.0	0.2	0.0	0.3	6901	627	6700
SCVURPPP	Calabazas	U	P	205R00099	28	7	4	0	3	1	9	10	34	1.5	2.3	24	36	5.4	1.0	3.6	6.7	25	74	16	90	0.6	0.0	8.9	0.0	0.8	4928	448	4784
SCVURPPP	Stevens	U	P	205R00115	10	0	0	0	0	0	3	4	0.0	0.0	1.5	38	50	6.3	0.0	0.0	23	50	78	0.0	78	1.3	0.0	21	0.0	0.0	30576	2780	29685
SCVURPPP	Lower Penitencia	U	P	205R00131	16	1	0	0	1	0	9	4	0.2	0.0	1.7	38	47	6.2	0.0	0.0	28	47	68	1.8	70	0.0	0.0	30	0.0	0.2	3900	355	3786
SCVURPPP	Canoas	U	P	205R00154	4	1	1	0	0	0	0	1	0.2	0.0	0.0	100	50	8.0	0.0	0.0	100	75	100	0.0	100	0.2	0.0	0.0	0.0	0.0	15096	1372	14656
SCVURPPP	Coyote	U	P	205R00218	31	5	1	0	4	1	13	7	12	5.0	2.5	35	48	5.4	0.2	3.2	22	29	32	48	80	4.8	0.0	8.2	0.0	6.6	7428	675	7212
SCVURPPP	Matadero	U	P	205R00227	25	7	3	0	4	0	7	8	21	12	2.2	37	36	5.6	12	12	11	24	75	3.8	78	14	11	4.4	1.1	2.1	5320	484	5165
SCVURPPP	San Thomas Aquino	U	P	205R00234	33	9	4	0	5	3	7	9	11	5.3	2.4	26	36	5.8	4.6	6.1	24	24	78	6.1	84	4.4	0.2	5.7	3.8	1.6	9744	886	9460
SCVURPPP	Upper Silver	U	P	205R00241	16	1	0	0	1	0	4	6	0.2	0.0	1.5	61	50	7.4	0.0	0.0	70	31	25	5.8	31	64	0.0	4.8	0.0	0.3	9696	881	9414
SCVURPPP	Guadalupe R	U	P	205R00259	23	4	2	0	2	0	8	4	43	0.0	2.1	29	57	5.2	0.0	0.0	20	35	16	56	72	3.0	0.5	17.2	0.0	8.3	2305	210	2238
SCVURPPP	Guadalupe Cr	U	P	205R00282	28	5	2	0	3	2	9	7	18	4.4	2.8	20	39	5.6	4.4	7.1	29	32	39	13	52	18	9.9	25	4.2	1.3	2952	268	2866
SCVURPPP	Coyote	U	P	205R00291	24	3	1	0	2	0	6	6	38	0.0	2.3	23	58	5.3	0.0	0.0	7.5	29	61	31	92	1.4	0.0	5.5	0.0	0.8	1780	162	1728
SCVURPPP	Guadalupe R	U	P	205R00346	19	3	1	0	2	1	4	4	9.3	0.0	1.3	70	53	5.9	0.0	0.0	11	32	82	13	95	0.3	0.3	4.5	0.0	0.5	9856	896	9569
SCVURPPP	Saratoga	U	P	205R00355	36	7	3	0	4	3	12	12	2.8	0.5	2.2	38	33	6.3	0.3	5.6	23	33	63	5.5	68	20	1.2	10	0.3	1.3	1208	110	1173
SMCWPPP	Woodhams	NU	P	202R00024	47	14	2	4	8	6	22	13	29	25	2.9	26	28	4.2	24	26	7.0	13	44	6.1	50	12	9.3	23	15.0	0.2	4128	375	4008
SMCWPPP	Pilarcitos	NU	P	202R00072	55	23	12	3	8	3	22	12	24	9.5	2.9	26	27	4.7	9.0	29	4.2	11	41	8.0	49	35	33	13	0.8	1.6	2496	227	2423
SMCWPPP	Milagra	U	P	202R00087	19	4	1	1	2	3	7	7	68	35	1.8	34	26	4.0	35	11	1.0	11	56	3.4	59	1.6	0.8	4.8	35	0.0	2918	265	2833
SMCWPPP	Denniston	U	P	202R00284	33	10	3	2	5	4	12	8	18	17	2.6	19	33	4.9	17	21	22	24	39	3.2	42	24	6.8	21	11	0.8	974	89	946
SMCWPPP	Sanchez	U	P	204R00180	22	2	1	0	1	2	9	9	13	0.1	2.1	26	36	5.5	0.1	4.5	0.7	23	76	13	89	0.3	0.0	10	0.1	0.3	8040	731	7806
SMCWPPP	Polhemus	U	P	204R00200	23	2	1	1	0	1	8	10	11	2.6	2.1	27	39	5.9	2.6	4.3	16	26	64	18	82	1.1	0.0	13	2.9	0.2	3678	334	3571

Attachment C. BMI Metric Values

				Metrics:	Richness								Composition					Tolerance					Functional Feeding Groups								Estimated Abundance		
Sampling Agency	**Creek Name**	**Land Use**	**Flow Class**	**Station ID**	Taxonomic	EPT	Ephemeroptera	Plecoptera	Trichoptera	Coleoptera	Predator	Diptera	EPT Index (%)	Sensitive EPT Index (%)	Shannon Diversity	Dominant Taxon (%)	Non-insect Taxa (%)	Tolerance Value	Intolerant Organisms (%)	Intolerant Taxa (%)	Tolerant Organisms (%)	Tolerant Taxa (%)	Collector-Gatherers (%)	Collector-Filterers (%)	Collectors (%)	Scrapers (%)	Non-Gastropoda Scrapers (%)	Predators (%)	Shredders (%)	Other (%)	Composite Sample (11 ft^2)	$\#/ft^2$	$\#/m^2$
	Ojo de Agua Arroyo	U	P	204R00232	23	1	1	0	0	0	10	11	5.3	0.0	2.3	31	35	6.1	0.3	8.7	12	30	54	15	68	0.7	0.2	30	0.0	1.0	1072	97	1041
	Trib to Arroyo Ojo de Agua	U	P	204R00244	11	2	1	0	1	0	2	5	20	0.0	1.3	63	36	7.1	0.0	0.0	64	18	93	2.8	95	0.0	0.0	0.7	0.0	4.0	3632	330	3526
	Corte Madera	U	P	205R00088	46	23	12	4	7	5	12	11	28	21	3.0	18	13	4.4	20	33	0.6	8.7	60	8.4	69	16	16	10	4.4	0.0	5952	541	5779
	Corte Madera	U	P	205R00168	43	18	9	2	7	4	12	11	27	24	2.6	28	19	4.4	23	21	3.8	12	57	1.6	58	21	20	18	2.4	0.5	8722	793	8468

Attachment D. Algae Metric Values

Table F-1. Epiphyte fraction metric values by land use for sites sampled in the RMC area in the spring index period (April 15 – June 15), 2012.

					Abundance Measures		Dominance Measures																Diversity/Evenness Measures			
SW Program	Site ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
ACCWP	204R00084	Dublin Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00191	Arroyo Valle	U	P	104	4	*Heteroleibleinia kuetzingii*	56	*Chamaesiphon sp.*	37	*Leptolyngbya foveolarum*	9	*Uronema confericolum*	2	--	--	53.85	35.58	8.65	1.92	--	0.99	0.43	1.43	0.65
	204R00100	Arroyo Mocho	U	NP	100	3	*Heteroleibleinia kuetzingii*	98	*Oedogonium sp.*	1	*Leptolyngbya tenuis*	1	--	--	--	--	98	1	1	--	--	0.11	0.05	0.16	0.43
	204R00068	Collier Creek	U	P	100	1	*Heteroleibleinia kuetzingii*	100	--	--	--	--	--	--	--	--	100	--	--	--	--	--	--	--	--
	204R00596	--	U	P	100	2	*Heteroleibleinia kuetzingii*	90	*Chamaesiphon sp.*	10	--	--	--	--	--	--	90	10	--	--	--	0.33	0.14	0.47	0.22
	204R00391	--	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00383	Sulphur Creek	U	P	100	4	*Uronema confericolum*	66	*Heteroleibleinia kuetzingii*	23	*Chamaesiphon sp.*	8	*Leptolyngbya foveolarum*	3	--	--	66	23	8	3	--	0.92	0.4	1.33	0.65
	204R00047	Castro Valley Creek	U	P	100	2	*Uronema confericolum*	83	*Heteroleibleinia kuetzingii*	17	--	--	--	--	--	--	83	17	--	--	--	0.46	0.2	0.66	0.22
	204R00340	--	U	P	1	1	*Epipyxis utriculus*	1	--	--	--	--	--	--	--	--	100	--	--	--	--	--	--	--	--
	204R00319	Sausal Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00356	Arroyo de la Laguna	U	P	13	2	*Heteroleibleinia kuetzingii*	11	*Leptolyngbya foveolarum*	2	--	--	--	--	--	--	84.62	15.38	--	--	--	0.43	0.19	0.62	0.39
	204R00367	Ward Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00303	--	U	P	100	3	*Leptolyngbya*	47	*Leptolyngbya*	31	*Heteroleibleinia*	22	--	--	--	--	47	31	22	--	--	1.05	0.46	1.52	0.43

Attachment D. Algae Metric Values

					Abundance Measures		Dominance Measures															Diversity/Evenness Measures			
SW Program	Site ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
							foveolarum		*tenuis*		*kuetzingii*														
	205R00535	Line 5-F-1	U	P	100	2	*Chamaesiphon sp.*	83	*Leptolyngbya foveolarum*	17	--	--	--	--	--	--	83	17	--	--	--	0.46	0.2	0.66	0.22
	204R00647	Dry Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00430	NA	U	P	100	3	*Heteroleibleinia kuetzingii*	44	*Gongrosira sp.*	33	*Xenococcus sp.*	23	--	--	--	--	44	33	23	--	--	1.07	0.46	1.54	0.43
	204R00639	San Lorenzo Creek	U	P	100	3	*Leptolyngbya foveolarum*	65	*Heteroleibleinia kossinskajae*	32	*Oedogonium sp.*	3	--	--	--	--	65	32	3	--	--	0.75	0.33	1.08	0.43
	204R00583	Line 3A-D	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00110	Agua Caliente Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00455	Zeili Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CCCWP	203R00039	El Cerrito Creek	U	P	100	1	*Heteroleibleinia kuetzingii*	100	--	--	--	--	--	--	--	--	100	--	--	--	--	NA	NA	NA	NA
	543R00137	Marsh Creek	U	P	100	1	*Heteroleibleinia kuetzingii*	100	--	--	--	--	--	--	--	--	100	--	--	--	--	NA	NA	NA	NA
	544R00025	--	U	P	100	1	*Heteroleibleinia kuetzingii*	100	--	--	--	--	--	--	--	--	100	--	--	--	--	NA	NA	NA	NA
	206R00155	San Pablo Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	207R00139	Las Trampas	U	P	7	1	*Oedogonium sp.*	7	--	--	--	--	--	--	--	--	100	--	--	--	--	NA	NA	NA	NA
	543R00245	Marsh Creek	NU	P	17	1	*Oedogonium sp.*	17	--	--	--	--	--	--	--	--	100	--	--	--	--	NA	NA	NA	NA
	543R00219	Marsh Creek	NU	P	5	2	*Oedogonium sp.*	3	*Leptolyngbya foveolarum*	2	--	--	--	--	--	--	60	40	--	--	--	0.67	0.29	0.97	0.62
	207R00247	Walnut Creek	U	P	100	3	*Heteroleibleinia kuetzingii*	57	*Oedogonium sp.*	38	*Leptolyngbya foveolarum*	5	--	--	--	--	57	38	5	--	--	0.84	0.36	1.21	0.43
	207R00011	Grason Creek	U	P	100	4	*Oedogonium sp.*	31	*Chantransia*	28	*Heteroleibleinia*	25	*Heteroleiblein*	16	--	--	31	28	25	16	--	1.36	0.59	1.96	0.65

Attachment D. Algae Metric Values

					Abundance Measures		Dominance Measures															Diversity/Evenness Measures			
SW Program	Site ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
									sp.1		*kossinskajae*		*ia pusilla*												
	206R00215	San Pablo Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SMCWPPP	202R00072	Pilarcitos Creek	NU	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	202R00087	Milagra Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00180	Sanchez Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00200	Polhemus Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	202R00024	Woodhams Creek	NU	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00088	Corte Madera Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00168	Corte Madera Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00232	Ojo de Agua Arroyo	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	204R00244	Trib to Ojo de Agua Arroyo	U	P	100	1	*Oedogonium sp 1_EcoA*	100	--	--	--	--	--	--	--	--	100	--	--	--	--	0	0	0	0
	202R00284	Denniston Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SCVURPPP	205R00026	Los Gatos Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00058	Saratoga Creek	NU	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00234	San Thomas Creek	U	P	100	6	*Heteroleibleinia kuetzingii*	49	*Leptolyngbya foveolarum*	33	*Chamaesiphon sp.*	12	*Oedogonium sp.*	4	*Chroococcopsis epiphytica*	1	49	33	12	4	1	1.19	0.52	1.72	1.09
	205R00021	MF Coyote Creek	NU	NP	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00099	Calabazas Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00042	Coyote Creek	U	P	100	4	*Heteroleibleinia kossinskajae*	43	*Leptolyngbya foveolarum*	25	*Chamaesiphon sp.*	19	*Heteroleibleinia kuetzingii*	13	--	--	43	25	19	13	--	1.29	0.56	1.86	0.65
	205R00241	Upper Silver Creek	U	P	100	2	*Heteroleibleinia kossinskajae*	99	*Uronema confervicolum*	1	--	--	--	--	--	--	99	1	--	--	--	0.06	0.02	0.08	0.22

Attachment D. Algae Metric Values

					Abundance Measures		Dominance Measures															Diversity/Evenness Measures			
SW Program	Site ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	205R00154	Canoas Creek	U	P	100	4	*Heteroleibleinia kuetzingii*	47	*Chamaesiphon sp.*	36	*Leptolyngbya foveolarum*	13	*Oedogonium sp.*	4	--	--	47	36	13	4	--	1.12	0.48	1.61	0.65
	205R00282	Guadalupe Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00090	Canoas Creek	U	P	100	2	*Chamaesiphon sp.*	77	*Leptolyngbya foveolarum*	23	--	--	--	--	--	--	77	23	--	--	--	0.54	0.23	0.78	0.22
	205R00218	Coyote Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00035	Upper Penitencia Creek	U	P	100	2	*Heteroleibleinia kossinskajae*	92	*Leptolyngbya foveolarum*	8	--	--	--	--	--	--	92	8	--	--	--	0.28	0.12	0.4	0.22
	205R00067	San Thomas Aquino	U	P	100	2	*Leptolyngbya foveolarum*	57	*Heteroleibleinia kuetzingii*	43	--	--	--	--	--	0	57	43	--	--	--	0.68	0.3	0.99	0.22
	205R00115	Stevens Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00131	Lower Penitencia Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00227	Matadero Creek	U	P	8	2	*Leptolyngbya foveolarum*	7	*Oedogonium sp.*	1	--	--	--	--	--	--	87.5	12.5	--	--	--	0.38	0.16	0.54	0.48
	205R00259	Guadalupe River	U	P	16	1	*Heteroleibleinia kuetzingii*	16	--	--	--	--	--	--	--	--	100	--	--	--	--	0	0	0	0
	205R00291	Coyote Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00346	Guadalupe River	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	205R00355	Saratoga Creek	U	P	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Attachment D. Algae Metric Values

Table F-2. Diatom fraction metric values by land use for sites sampled in the RMC area in the spring index period (April 15 – June 15), 2012.

					Abundance Measures			Dominance Measures						Dominance Measures									Diversity/Evenness Measures			
Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Number of Valves Counted	Total Cells Counted	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
SMCWPPP	202R00072	Pilarcitos Creek	NU	P	603	301.5	37	*Navicula gregaria*	117	*Planothidium frequentissimum*	69	*Planothidium lanceolatum*	63	*Amphora pediculus*	59	*Parlibellus protractoides*	57	19	11	10	10	9	3	1	4	6
	202R00087	Milagra Creek	U	P	600	300	24	*Cocconeis placentula var. euglypta*	320	*Amphora pediculus*	59	*Planothidium lanceolatum*	55	*Planothidium frequentissimum*	48	*Cocconeis placentula var. lineata*	27	53	10	9	8	5	2	1	3	4
	204R00180	Sanchez Creek	U	P	601	300.5	34	*Planothidium frequentissimum*	195	*Planothidium lanceolatum*	82	*Amphora pediculus*	65	*Cocconeis placentula var. euglypta*	63	*Navicula antonii*	34	32	14	11	10	6	2	1	4	5
	204R00200	Polhemus Creek	U	P	601	300.5	35	*Planothidium frequentissimum*	127	*Cocconeis placentula var. euglypta*	87	*Planothidium lanceolatum*	78	*Rhoicosphenia abbreviata*	71	*Amphora pediculus*	47	21	14	13	12	8	3	1	4	5
	202R00024	Woodhams Creek	NU	P	550	275	30	*Rhoicosphenia abbreviata*	177	*Planothidium frequentissimum*	91	*Cocconeis placentula var. euglypta*	65	*Reimeria sinuata*	49	*Amphora pediculus*	26	32	17	12	9	5	2	1	3	5
	205R00088	Corte Madera Creek	U	P	601	300.5	34	*Cocconeis placentula var. euglypta*	159	*Amphora pediculus*	75	*Gomphonema olivaceum*	50	*Planothidium frequentissimum*	45	*Nitzschia inconspicua*	40	26	12	8	7	7	3	1	4	5
	205R00168	Corte Madera Creek	U	P	601	300.5	36	*Amphora pediculus*	115	*Planothidium frequentissimum*	95	*Nitzschia inconspicua*	52	*Navicula gregaria*	48	*Cocconeis placentula var. euglypta*	45	19	16	9	8	7	3	1	4	5
	204R00232	Ojo de Agua Arroyo	U	P	603	301.5	23	*Cyclostephanos dubius*	318	*Planothidium frequentissimum*	65	*Cocconeis placentula var. euglypta*	57	*Planothidium lanceolatum*	56	*Amphora pediculus*	16	53	11	9	9	3	2	1	3	3
	204R00244	Trib to Ojo de Agua Arroyo	U	P	603	301.5	29	*Rhoicosphenia abbreviata*	116	*Cocconeis placentula var. euglypta*	97	*Cocconeis pediculus*	73	*Planothidium frequentissimum*	71	*Amphora pediculus*	43	19	16	12	12	7	3	1	4	4
	202R00284	Denniston Creek	U	P	525	262.5	44	*Amphora pediculus*	150	*Achnanthidium minutissimum*	55	*Rhoicosphenia abbreviata*	54	*Fragilaria vaucheriae*	36	*Planothidium lanceolatum*	21	29	10	10	7	4	3	1	4	7
SCVURPPP	205R00026	Los Gatos Creek	U	P	601	300.5	41	*Achnanthidium minutissimum*	87	*Rhoicosphenia abbreviata*	72	*Amphora pediculus*	69	*Cocconeis placentula var.*	51	*Aulacoseira alpigena*	34	14	12	11	8	6	3	1	4	6

Attachment D. Algae Metric Values

Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Abundance Measures			Dominance Measures						Dominance Measures									Diversity/Evenness Measures			
					Number of Valves Counted	Total Cells Counted	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
														euglypta												
	205R00058	Saratoga Creek	NU	P	600	300	23	*Cocconeis placentula var. euglypta*	242	*Rhoicosphenia abbreviata*	133	*Planothidium frequentissimum*	62	*Amphora pediculus*	46	*Cocconeis fluviatilis*	43	40	22	10	8	7	2	1	3	3
	205R00234	San Thomas Creek	U	P	602	301	29	*Cocconeis placentula var. euglypta*	123	*Achnanthidium minutissimum*	95	*Amphora pediculus*	75	*Planothidium frequentissimum*	55	*Rhoicosphenia abbreviata*	50	20	16	12	9	8	3	1	4	4
	205R00021	MF Coyote Creek	NU	NP	604	302	27	*Fragilaria capucina var. mesolepta*	298	*Planothidium frequentissimum*	75	*Rhoicosphenia abbreviata*	57	*Achnanthidium minutissimum*	40	*Fragilaria crotonensis*	30	49	12	9	7	5	2	1	3	4
	205R00099	Calabazas Creek	U	P	605	302.5	33	*Cocconeis placentula var. euglypta*	174	*Planothidium frequentissimum*	89	*Nitzschia inconspicua*	40	*Navicula antonii*	38	*Melosira varians*	30	29	15	7	6	5	3	1	4	5
	205R00042	Coyote Creek	U	P	601	300.5	55	*Cocconeis placentula var. euglypta*	137	*Karayevia ploenensis var. gessneri*	59	*Navicula radiosa*	50	*Achnanthidium minutissimum*	47	*Amphora pediculus*	37	23	10	8	8	6	3	1	4	8
	205R00241	Upper Silver Creek	U	P	600	300	46	*Cocconeis placentula var. euglypta*	163	*Rhoicosphenia abbreviata*	72	*Amphora pediculus*	42	*Synedra ulna*	38	*Planothidium frequentissimum*	35	27	12	7	6	6	3	1	4	7
	205R00154	Canoas Creek	U	P	604	302	28	*Staurosira construens var. venter*	116	*Nitzschia amphibia*	93	*Achnanthidium minutissimum*	81	*Planothidium frequentissimum*	61	*Nitzschia inconspicua*	46	19	15	13	10	8	3	1	4	4
	205R00282	Guadalupe Creek	U	P	606	303	47	*Cocconeis placentula var. euglypta*	80	*Rhoicosphenia abbreviata*	65	*Navicula gregaria*	57	*Amphora pediculus*	55	*Navicula tripunctata*	50	13	11	9	9	8	3	1	5	7
	205R00090	Canoas Creek	U	P	608	304	15	*Staurosira construens var. venter*	285	*Denticula kuetzingii*	234	*Nitzschia inconspicua*	20	*Rhoicosphenia abbreviata*	19	*Nitzschia fonticola*	15	47	38	3	3	2	1	1	2	2
	205R00218	Coyote Creek	U	P	602	301	45	*Amphora pediculus*	105	*Karayevia ploenensis var. gessneri*	79	*Cocconeis placentula var. euglypta*	66	*Platessa conspicua*	40	*Melosira varians*	26	17	13	11	7	4	3	1	4	7

Attachment D. Algae Metric Values

Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Abundance Measures: Number of Valves Counted	Total Cells Counted	Species Richness	Dominance Measures: Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	Dominance Measures: 4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Diversity/Evenness Measures: Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	205R00035	Upper Penitencia Creek	U	P	602	301	47	*Rhoicosphenia abbreviata*	81	*Cocconeis placentula var. euglypta*	73	*Nitzschia inconspicua*	62	*Navicula cryptotenella*	48	*Amphora pediculus*	41	13	12	10	8	7	3	1	5	7
	205R00067	San Thomas Aquino	U	P	603	301.5	22	*Achnanthidium minutissimum*	321	*Denticula kuetzingii*	196	*Encyonopsis microcephala*	10	*Rhoicosphenia abbreviata*	10	*Gomphonema parvulum*	8	53	33	2	2	1	1	1	2	3
	205R00115	Stevens Creek	U	P	602	301	49	*Amphora pediculus*	107	*Navicula gregaria*	66	*Nitzschia amphibia*	66	*Planothidium frequentissimum*	45	*Staurosira construens*	31	18	11	11	7	5	3	1	5	8
	205R00131	Lower Penitencia Creek	U	P	603	301.5	50	*Nitzschia solita*	176	*Staurosira construens var. venter*	56	*Nitzschia microcephala*	40	*Cyclotella meneghiniana*	36	*Nitzschia desertorum*	30	29	9	7	6	5	3	1	4	8
	205R00227	Matadero Creek	U	P	601	300.5	28	*Amphora pediculus*	287	*Bacillaria paradoxa*	80	*Nitzschia inconspicua*	32	*Melosira varians*	31	*Planothidium frequentissimum*	27	48	13	5	5	4	2	1	3	4
	205R00259	Guadalupe River	U	P	604	302	55	*Navicula menisculus*	72	*Rhoicosphenia abbreviata*	68	*Karayevia ploenensis var. gessneri*	45	*Amphora ovalis*	35	*Amphora pediculus*	31	12	11	7	6	5	3	1	5	8
	205R00291	Coyonte Creek	U	P	601	300.5	61	*Bacillaria paradoxa*	72	*Karayevia ploenensis var. gessneri*	69	*Amphora pediculus*	63	*Cocconeis placentula var. euglypta*	43	*Rhoicosphenia abbreviata*	39	12	11	10	7	6	3	1	5	9
	205R00346	Guadalupe River	U	P	601	300.5	44	*Fragilaria crotonensis*	218	*Staurosira construens var. venter*	71	*Amphora pediculus*	39	*Pseudostaurosira brevistriata*	37	*Staurosira construens*	34	36	12	6	6	6	3	1	4	7
	205R00355	Saratoga Creek	U	P	603	301.5	33	*Nitzschia inconspicua*	92	*Achnanthidium minutissimum*	84	*Nitzschia fonticola*	60	*Navicula antonii*	56	*Amphora pediculus*	49	15	14	10	9	8	3	1	4	5
CCCWP	203R00039	El Cerrito Creek	U	P	600	300	25	*Planothidium frequentissimum*	130	*Cocconeis placentula var. euglypta*	90	*Amphora pediculus*	82	*Nitzschia palea*	51	*Nitzschia inconspicua*	46	22	15	14	9	8	3	1	4	4
CCCWP	543R00137	Marsh Creek	U	P	606	303	42	*Nitzschia inconspicua*	74	*Planothidium frequentissimum*	67	*Navicula gregaria*	42	*Navicula caterva*	40	*Nitzschia frustulum*	36	12	11	7	7	6	3	1	5	6
CCCWP	544R00025	N/A	U	P	601	300.5	31	*Nitzschia amphibia*	98	*Nitzschia desertorum*	86	*Cyclotella meneghiniana*	72	*Rhoicosphenia abbreviata*	44	*Nitzschia inconspicua*	37	16	14	12	7	6	3	1	4	5

Attachment D. Algae Metric Values

					Abundance Measures			Dominance Measures						Dominance Measures									Diversity/Evenness Measures			
Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Number of Valves Counted	Total Cells Counted	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	206R00155	San Pablo Creek	U	P	606	303	28	*Amphora pediculus*	130	*Nitzschia inconspicua*	106	*Cocconeis placentula var. euglypta*	78	*Planothidium frequentissimum*	67	*Navicula caterva*	32	21	17	13	11	5	2	1	4	4
	207R00139	Las Trampas	U	P	600	300	36	*Navicula caterva*	138	*Navicula gregaria*	99	*Rhoicosphenia abbreviata*	55	*Navicula tripunctata*	44	*Nitzschia dissipata*	44	23	17	9	7	7	3	1	4	5
	543R00245	Marsh Creek	NU	P	602	301	38	*Achnanthidium minutissimum*	113	*Rhoicosphenia abbreviata*	64	*Cocconeis placentula var. euglypta*	61	*Nitzschia inconspicua*	54	*Navicula gregaria*	48	19	11	10	9	8	3	1	4	6
	543R00219	Marsh Creek	NU	P	603	301.5	36	*Achnanthidium minutissimum*	273	*Nitzschia microcephala*	42	*Cyclotella meneghiniana*	38	*Navicula gregaria*	38	*Cymbella affinis*	24	45	7	6	6	4	2	1	3	5
	207R00247	Walnut Creek	U	P	618	309	29	*Cyclotella sp_6040.5*	174	*Cocconeis pediculus*	92	*Gomphonema minutum*	72	*Cyclotella meneghiniana*	42	*Rhoicosphenia abbreviata*	24	28	15	12	7	4	3	1	4	4
	207R00011	Grason Creek	U	P	601	300.5	20	*Cocconeis placentula var. euglypta*	396	*Cocconeis pediculus*	68	*Amphora pediculus*	52	*Rhoicosphenia abbreviata*	20	*Planothidium frequentissimum*	19	66	11	9	3	3	1	1	2	3
	206R00215	San Pablo Creek	U	P	463	231.5	35	*Melosira varians*	121	*Surirella minuta*	54	*Navicula gregaria*	52	*Nitzschia dubia*	34	*Tryblionella apiculata*	26	26	12	11	7	6	3	1	4	6
ACCWP	204R00084	Dublin Creek	U	P	605	302.5	32	*Navicula gregaria*	176	*Planothidium frequentissimum*	139	*Melosira varians*	47	*Cyclotella meneghiniana*	36	*Nitzschia palea*	28	29	23	8	6	5	2	1	4	5
ACCWP	204R00191	Arroyo Valle	U	P	607	303.5	54	*Rhoicosphenia abbreviata*	91	*Pseudostaurosira brevistriata*	69	*Fragilaria capucina var. mesolepta*	52	*Staurosira construens var. venter*	49	*Cocconeis placentula var. lineata*	45	15	11	9	8	7	3	1	5	8
ACCWP	204R00100	Arroyo Mocho	U	NP	601	300.5	39	*Achnanthidium minutissimum*	107	*Nitzschia inconspicua*	83	*Gomphonema parvulum*	74	*Rhoicosphenia abbreviata*	67	*Cocconeis pediculus*	47	18	14	12	11	8	3	1	4	6
ACCWP	204R00068	Collier Creek	U	P	604	302	33	*Nitzschia microcephala*	195	*Achnanthidium minutissimum*	61	*Planothidium frequentissimum*	56	*Nitzschia inconspicua*	44	*Staurosira construens var. venter*	36	32	10	9	7	6	3	1	4	5
ACCWP	204R00596	N/A	U	P	601	300.5	41	*Staurosira construens var. venter*	192	*Cyclotella meneghiniana*	64	*Tabularia tabulata*	35	*Surirella brebissonii*	32	*Nitzschia inconspicua*	30	32	11	6	5	5	3	1	4	6
ACCWP	204R00391	N/A	U	P	601	300.5	46	*Nitzschia desertorum*	109	*Nitzschia palea*	95	*Nitzschia solita*	64	*Achnanthidium minutissimum*	51	*Gomphonema parvulum*	46	18	16	11	8	8	3	1	4	7

Attachment D. Algae Metric Values

Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Abundance Measures: Number of Valves Counted	Total Cells Counted	Species Richness	Dominance Measures: Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	Dominance Measures: 4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Diversity/Evenness Measures: Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	204R00383	Sulphur Creek	U	P	606	303	27	*Sellaphora pupula*	248	*Planothidium frequentissimum*	96	*Nitzschia amphibia*	70	*Navicula minima*	38	*Nitzschia palea*	30	41	16	12	6	5	2	1	3	4
	204R00047	Castro Valley Creek	U	P	607	303.5	30	*Gomphonema parvulum*	80	*Amphora pediculus*	75	*Cocconeis pediculus*	73	*Denticula kuetzingii*	71	*Rhoicosphenia abbreviata*	62	13	12	12	12	10	3	1	4	5
	204R00340	N/A	U	P	602	301	29	*Staurosira construens var. venter*	199	*Cyclotella meneghiniana*	116	*Nitzschia microcephala*	74	*Nitzschia amphibia*	56	*Nitzschia palea*	55	33	19	12	9	9	2	1	3	4
	204R00319	Sausal Creek	U	P	600	300	41	*Amphora pediculus*	151	*Rhoicosphenia abbreviata*	135	*Navicula gregaria*	36	*Planothidium frequentissimum*	33	*Cyclotella meneghiniana*	32	25	23	6	6	5	3	1	4	6
	204R00356	Arroyo de la Laguna	U	P	603	301.5	48	*Achnanthidium minutissimum*	79	*Staurosira construens var. venter*	77	*Nitzschia inconspicua*	50	*Cocconeis pediculus*	41	*Gomphonema parvulum*	34	13	13	8	7	6	3	1	5	7
	204R00367	Ward Creek	U	P	601	300.5	25	*Planothidium frequentissimum*	180	*Amphora pediculus*	113	*Nitzschia inconspicua*	89	*Cocconeis placentula var. euglypta*	72	*Planothidium lanceolatum*	28	30	19	15	12	5	2	1	3	4
	204R00303	N/A	U	P	604	302	33	*Amphora pediculus*	125	*Nitzschia amphibia*	45	*Navicula veneta*	40	*Rhoicosphenia abbreviata*	39	*Nitzschia microcephala*	38	21	7	7	6	6	3	1	4	5
	205R00535	Line 5-F-1	U	P	606	303	46	*Achnanthidium minutissimum*	105	*Nitzschia microcephala*	103	*Staurosira construens var. venter*	89	*Nitzschia amphibia*	42	*Amphora pediculus*	29	17	17	15	7	5	3	1	4	7
	204R00647	Dry Creek	U	P	603	301.5	18	*Amphora pediculus*	296	*Rhoicosphenia abbreviata*	87	*Nitzschia inconspicua*	74	*Planothidium frequentissimum*	39	*Cocconeis placentula var. euglypta*	33	49	14	12	6	5	2	1	2	3
	205R00430	NA	U	P	604	302	32	*Staurosira construens var. venter*	273	*Achnanthidium minutissimum*	63	*Gomphonema minutum*	44	*Nitzschia microcephala*	36	*Navicula minima*	30	45	10	7	6	5	2	1	3	5
	204R00639	San Lorenzo Creek	U	P	605	302.5	44	*Gomphonema parvulum*	117	*Cocconeis pediculus*	95	*Cyclotella meneghiniana*	51	*Nitzschia microcephala*	38	*Nitzschia inconspicua*	29	19	16	8	6	5	3	1	4	7
	204R00583	Line 3A-D	U	P	604	302	44	*Nitzschia solita*	174	*Nitzschia desertorum*	90	*Navicula germainii*	50	*Tryblionella apiculata*	44	*Nitzschia palea*	32	29	15	8	7	5	3	1	4	7

Attachment D. Algae Metric Values

Sampling Agency	Station ID	Creek Name	Land use	Flow Class	Abundance Measures			Dominance Measures							Dominance Measures									Diversity/Evenness Measures			
					Number of Valves Counted	Total Cells Counted	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance		4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	205R00110	Agua Caliente Creek	U	P	601	300.5	48	*Cocconeis placentula var. euglypta*	218	*Synedra gaillonii*	65	*Planothidium frequentissimum*	48		*Rhoicosphenia abbreviata*	39	*Amphora pediculus*	31	36	11	8	6	5	3	1	4	7
	204R00455	Zeili Creek	U	P	605	302.5	34	*Planothidium frequentissimum*	205	*Amphora pediculus*	93	*Cocconeis placentula var. euglypta*	61		*Achnanthidium minutissimum*	47	*Planothidium lanceolatum*	40	34	15	10	8	7	2	1	3	5

Table F-3. Microalgae fraction metric values by land use for sites sampled in the RMC area in the spring index period (April 15 – June 15), 2012. Land use: U = urban; NU=Nonurban. Flow Class: P = perennial; NP = non-perennial.

					Abundance Measures		Dominance Measures						Dominance Measures										Diversity/Evenness Measures			
SW program	Station ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
CCCWP	203R00039	El Cerrito Creek	U	P	20	5	*Leptolyngbya sp. 1_EcoA*	15	*Heteroleibleinia sp.*	2	*Monoraphidium sp. 1_EcoA*	1	*Cryptomonas sp. 1_EcoA*	1	*Leptolyngbya notata*	1	75	10	5	5	5	1	0	1	1
CCCWP	543R00137	Marsh Creek	U	P	47	6	*Leptolyngbya sp. 1_EcoA*	35	*Oscillatoria sp. 1_EcoA*	5	*Heteroleibleinia sp.*	4	*Euglena sp. 1_EcoA*	1	*Cryptomonas sp. 1_EcoA*	1	74	11	9	2	2	1	0	1	1
CCCWP	544R00025	--	U	P	23	4	*Heteroleibleinia sp.*	15	*Leptolyngbya sp. 1_EcoA*	4	*Cryptomonas sp. 1_EcoA*	3	*Scenedesmus sp. 1_EcoA*	1	--	--	65	17	13	4	0	1	0	1	1
CCCWP	206R00155	San Pablo Creek	U	P	12	4	*Heteroleibleinia sp.*	7	*Leptolyngbya sp. 1_EcoA*	3	*Monoraphidium sp. 1_EcoA*	1	*Cryptomonas sp. 1_EcoA*	1	--	--	58	25	8	8	--	1	0	2	1
CCCWP	207R00139	Las Trampas	U	P	22	5	*Heteroleibleinia sp.*	8	*Leptolyngbya tenuis*	5	*Leptolyngbya sp. 1_EcoA*	4	*Leptolyngbya foveolarum*	4	*Chantransia sp. 1*	1	36	23	18	18	5	1	1	2	1
CCCWP	543R00245	Marsh Creek	NU	P	35	4	*Leptolyngbya sp. 1_EcoA*	16	*Heteroleibleinia kossinskajae*	9	*Oedogonium sp. 1_EcoA*	8	*Scenedesmus sp. 1_EcoA*	2	--	--	46	26	23	6	--	1	1	2	1
CCCWP	543R00219	Marsh Creek	NU	P	11	6	*Leptolyngbya foveolarum*	5	*Scenedesmus sp. 1_EcoA*	2	*Uronema sp. 1_EcoA*	1	*Phormidium sp. 1_EcoA*	1	*Oscillatoria sp. 1_EcoA*	1	45	18	9	9	9	2	1	2	2
CCCWP	207R00247	Walnut Creek	U	P	98	8	*Scenedesmus sp. 1_EcoA*	79	*Heteroleibleinia sp.*	6	*Leptolyngbya foveolarum*	4	*Monoraphidium sp. 1_EcoA*	3	*Oedogonium sp. 1_EcoA*	2	81	6	4	3	2	1	0	1	2
CCCWP	207R00011	Grayson Creek	U	P	11	3	*Heteroleibleinia sp.*	9	*Leptolyngbya foveolarum*	1	*Oedogonium sp. 1_EcoA*	1	--	--	--	--	82	9	9	--	--	1	0	1	1
CCCWP	206R00215	San Pablo Creek	U	P	8	4	*Leptolyngbya sp. 1_EcoA*	4	*Heteroleibleinia sp.*	2	*Euglena sp. 1_EcoA*	1	*Oedogonium sp. 1_EcoA*	1	--	--	50	25	13	13	--	1	1	2	1
ACCWP	204R00084	Dublin Creek	U	P	322	22	*Scenedesmus ellipticus*	127	*Scenedesmus acuminatus*	62	*Scenedesmus hystrix*	32	*Oocystis solitaria*	21	*Sphaerocystis planctonica*	14	39	19	10	7	4	2	1	3	4
ACCWP	204R00191	Arroyo Valle	U	P	181	20	*Leptolyngbya foveolarum*	61	*Leptolyngbya tenuis*	23	*Phormidium sp. 3*	21	*Phormidium subfuscum*	18	*Leptolyngbya notata*	16	34	13	12	10	9	2	1	3	4

Attachment D. Algae Metric Values

SW program	Station ID	Creek Name	Land use	Flow Class	Abundance Measures		Dominance Measures						Dominance Measures										Diversity/Evenness Measures			
					Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	204R00100	Arroyo Mocho	U	NP	24	9	*Cladophora glomerata*	12	*Closterium acerosum var. tumidium*	3	*Tetrastrum sp.*	2	*Merismopedia glauca*	2	*Leptolyngbya tenuis*	1	50	13	8	8	4	2	1	2	3
	204R00068	Collier Creek	U	P	340	30	*Merismopedia glauca*	127	*Scenedesmus ellipticus*	90	*Scenedesmus communis*	20	*Scenedesmus sp. 3_EcoA*	18	*Merismopedia punctata*	18	37	26	6	5	5	2	1	3	5
	204R00596	--	U	P	105	31	*Scenedesmus ellipticus*	18	*Scenedesmus sp. 8_EcoA*	10	*Scenedesmus sp. 2*	8	*Phormidium subfuscum*	8	*Scenedesmus microspina*	7	17	10	8	8	7	3	1	4	6
	204R00391	--	U	P	30	14	*Phormidium sp. 2*	9	*Leptolyngbya tenuis*	4	*Leptolyngbya foveolarum*	3	*Scenedesmus communis*	2	*Cladophora glomerata*	2	30	13	10	7	7	2	1	3	4
	204R00383	Sulphur Creek	U	P	376	24	*Scenedesmus ellipticus*	140	*Scenedesmus circumfusus*	84	*Scenedesmus sp. 2*	59	*Scenedesmus sp. 8_EcoA*	24	*Scenedesmus microspina*	16	37	22	16	6	4	2	1	3	4
	204R00047	Castro Valley Creek	U	P	308	28	*Merismopedia glauca*	141	*Scenedesmus acuminatus*	30	*Scenedesmus subspicatus*	20	*Monoraphidium arcuatum*	17	*Scenedesmus raciborskii*	17	46	10	6	6	6	2	1	3	5
	204R00340	--	U	P	352	26	*Scenedesmus ellipticus*	62	*Scenedesmus acuminatus*	55	*Scenedesmus raciborskii*	50	*Scenedesmus subspicatus*	50	*Chantransia sp. 2*	24	18	16	14	14	7	3	1	4	4
	204R00319	Sausal Creek	U	P	209	18	*Monoraphidium arcuatum*	116	*Leptolyngbya notata*	33	*Monoraphidium contortum*	15	*Heteroleibleinia sp. 1_EcoA*	14	*Leptolyngbya sp. 1*	4	57	16	7	7	2	2	1	2	3
	204R00356	Arroyo de la Laguna	U	P	72	21	*Cladophora glomerata*	13	*Oedogonium sp. 1*	12	*Microspora amoena*	10	*Scenedesmus subspicatus*	7	*Merismopedia glauca*	5	18	17	14	10	7	3	1	4	5
	204R00367	Ward Creek	U	P	14	8	*Chantransia sp. 2*	6	*Monoraphidium obtusum*	2	*Scenedesmus dimorphus*	1	*Scenedesmus raciborskii*	1	*Pediastrum boryanum*	1	43	14	7	7	7	2	1	3	3
	204R00303	--	U	P	53	27	*Scenedesmus subspicatus*	7	*Scenedesmus acuminatus*	6	*Scenedesmus raciborskii*	5	*Leptolyngbya notata*	4	*Monoraphidium arcuatum*	3	13	11	9	8	6	3	1	4	7
	205R00535	Line 5-F-1	U	P	101	16	*Phormidium retzii*	70	*Apatococcus sp. 1*	11	*Scenedesmus subspicatus*	3	*Leptolyngbya foveolarum*	2	*Phormidium sp. 1*	2	69	11	3	2	2	1	1	2	3
	204R00647	Dry Creek	U	P	253	17	*Leptolyngbya sp.*	129	*Phormidium sp.*	36	*Leptolyngbya*	21	*Monoraphidium*	18	*Phormidium*	11	51	14	8	7	4	2	1	3	3

Attachment D. Algae Metric Values

SW program	Station ID	Creek Name	Land use	Flow Class	Abundance Measures		Dominance Measures						Dominance Measures										Diversity/Evenness Measures			
					Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
							4_EcoA		*1*		*foveolarum*		*arcuatum*		*retzii*										
	205R00430	NA	U	P	202	18	*Scenedesmus ellipticus*	136	*Scenedesmus subspicatus*	16	*Pediastrum boryanum*	12	*Sphaerocystis planctonica*	10	*Cladophora glomerata*	7	67	8	6	5	3	1	1	2	3
	204R00639	San Lorenzo Creek	U	P	328	16	*Scenedesmus racibrskii*	114	*Scenedesmus dimorphus*	80	*Monoraphidium contortum*	41	*Coelastrum microporum*	17	*Scenedesmus subspicatus*	16	35	24	13	5	5	2	1	3	3
	204R00583	Line 3A-D	U	P	54	1	*Phormidium retzii*	54	--	--	--	--	--	--	--	--	100	--	--	--	--	0	0	0	0
	205R00110	Agua Caliente Creek	U	P	75	4	*Phormidium retzii*	59	*Phormidium uncinatum*	10	*Mougeotia sp. 3_EcoA*	4	*Chantransia sp. 1*	2	--	--	79	13	5	3	--	1	0	1	1
	204R00455	Zeili Creek	U	P	0	0	*No algae observed*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SMCWPPP	202R00072	Pilarcitos Creek	NU	P	57	13	*Leptolyngbya notata*	22	*Monoraphidium contortum*	14	*Oocystis sp. 2*	6	*Lyngbya sp. 1*	3	*Chlamydomonas sp. 1*	2	39	25	11	5	4	2	1	3	3
	202R00087	Milagra Creek	U	P	35	6	*Leptolyngbya tenuis*	23	*Leptolyngbya notata*	7	*Chantransia sp. 2*	2	*Chantransia sp. 1*	1	*Leptolyngbya foveolarum*	1	66	20	6	3	3	1	0	2	1
	204R00180	Sanchez Creek	U	P	8	5	*Leptolyngbya tenuis*	4	*Chroococcus minor*	1	*Euglena viridis*	1	*Oedogonium sp. 3*	1	*Scenedesmus communis*	1	50	13	13	13	13	1	1	2	2
	204R00200	Polhemus Creek	U	P	6	3	*Leptolyngbya tenuis*	4	*Chlorococcum sp. 1*	1	*Phormidium sp. 2*	1	--	--	--	--	67	17	17	--	--	1	0	1	1
	202R00024	Woodhams Creek	NU	P	2	2	*Chantransia sp. 2*	1	*Sphaerocystis planctonica*	1	--	--	--	--	--	--	50	50	--	--	--	1	0	1	1
	205R00088	Corte Madera Creek	U	P	18	7	*unknown Chlorophyte 2_EcoA*	7	*Monoraphidium contortum*	5	*Staurastrum sp. 1*	2	*Chroococcus minor*	1	*Leptolyngbya tenuis*	1	39	28	11	6	6	2	1	2	2
	205R00168	Corte Madera Creek	U	P	49	7	*Leptolyngbya sp. 1*	17	*Leptolyngbya notata*	14	*Monoraphidium contortum*	13	*Leptolyngbya foveolarum*	2	*Sphaerocystis planctonica*	1	35	29	27	4	2	1	1	2	2

Attachment D. Algae Metric Values

SW program	Station ID	Creek Name	Land use	Flow Class	Abundance Measures Total Abundance (Natural Taxonomic Units)	Species Richness	Dominance Measures Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	Dominance Measures 4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Diversity/Evenness Measures Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
	204R00232	Ojo de Agua Arroyo	U	P	57	17	*Scenedesmus communis*	14	*Pediastrum boryanum*	11	*Leptolyngbya foveolarum*	6	*Chantransia sp. 2*	4	*Leptolyngbya tenuis*	4	25	19	11	7	7	2	1	3	4
	204R00244	Trib to Ojo de Agua Arroyo	U	P	140	22	*Merismopedia glauca*	50	*Leptolyngbya notata*	16	*Leptolyngbya sp. 3*	11	*Monoraphidium contortum*	10	*Scenedesmus communis*	8	36	11	8	7	6	2	1	3	4
	202R00284	Denniston Creek	U	P	105	7	*Chantransia sp. 2*	64	*Leptolyngbya notata*	25	*Leptolyngbya foveolarum*	5	*Leptolyngbya tenuis*	4	*Chlamydomonas sp. 1*	1	63	25	5	4	1	1	0	2	1
SCVURPPP	205R00026	Los Gatos Creek	U	P	330	6	*Phormidium ambiguum*	317	*Chroococcus minor*	7	*Monoraphidium contortum*	3	*Cladophora glomerata*	1	*Heteroleibleinia kossinskajae*	1	96	2	1	0	0	0	0	0	1
	205R00058	Saratoga Creek	NU	P	1	1	*Tribonema sp. 1_EcoA*	1	--	--	--	--	--	--		--	100	--	--	--	--	0	0	0	--
	205R00234	San Thomas Creek	U	P	9	5	*Monoraphidium contortum*	4	*Cladophora glomerata*	2	*Chantransia sp. 1*	1	*Monoraphidium minutum*	1	*Scenedesmus obliquus*	1	44	22	11	11	11	1	1	2	2
	205R00021	MF Coyote Creek	NU	NP	14	7	*Mougeotia sp. 2*	7	*Trichormus sp. 1_EcoA*	2	*Cryptomonas erosa*	1	*Dichothrix gypsophila*	1	*Phormidium uncinatum*	1	50	14	7	7	7	2	1	2	2
	205R00099	Calabazas Creek	U	P	19	8	*Heteroleibleinia kossinskajae*	10	*Cryptomonas erosa*	2	*Staurastrum anaticum*	2	*Monoraphidium arcuatum*	1	*Phacus sp. 2_EcoA*	1	53	11	11	5	5	2	1	2	2
	205R00042	Coyote Creek	U	P	15	5	*Phormidium retzii*	7	*Chantransia sp. 2*	4	*Scenedesmus armatus*	2	*Cladophora glomerata*	1	*Scenedesmus opoliensis*	1	47	27	13	7	7	1	1	2	1
	205R00241	Upper Silver Creek	U	P	90	11	*unknown Cyanophyte_EcoA*	42	*Phormidium retzii*	25	*Heteroleibleinia kossinskajae*	6	*Scenedesmus opoliensis var. mononensis*	5	*Leptolyngbya notata*	4	47	28	7	6	4	2	1	2	2
	205R00154	Canoas Creek	U	P	89	19	*Leptolyngbya foveolarum*	16	*Scenedesmus subspicatus*	16	*Leptolyngbya notata*	12	*Heteroleibleinia kossinskajae*	8	*Scenedesmus ellipticus*	8	18	18	13	9	9	2	1	4	4
	205R00282	Guadalupe Creek	U	P	102	13	*Chantransia sp. 2*	57	*Phormidium retzii*	21	*Phacus sp. 2_EcoA*	5	*Leptolyngbya tenuis*	4	*Heteroleibleinia kossinskajae*	3	56	21	5	4	3	2	1	2	3
	205R00090	Canoas Creek	U	P	177	23	*Scenedesmus*	43	*Scenedesmus*	25	*Monoraphidium*	16	*Heteroleibleinia*	13	*Scenedesmus*	9	28	17	11	9	6	2	1	3	4

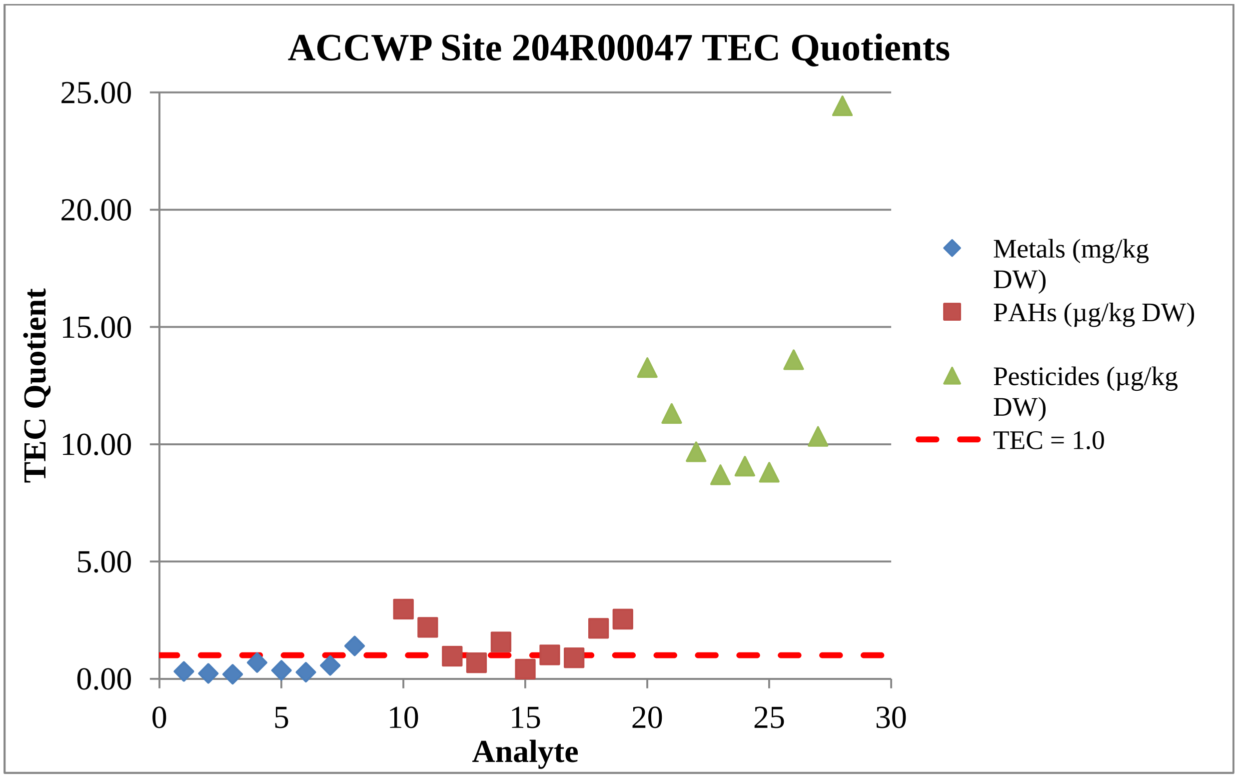
Attachment D. Algae Metric Values

					Abundance Measures		Dominance Measures						Dominance Measures									Diversity/Evenness Measures			
SW program	Station ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness
							subspicatus		*ellipticus*		*minutum*		*kossinskajae*		*obliquus*										
	205R00218	Coyote Creek	U	P	79	16	*Phormidium retzii*	22	*Scenedesmus subspicatus*	11	*Heteroleibleinia kossinskajae*	9	*Leptolyngbya foveolarum*	7	*Leptolyngbya notata*	7	28	14	11	9	9	2	1	3	3
	205R00035	Upper Penitencia Creek	U	P	80	20	*Monoraphidium arcuatum*	16	*Heteroleibleinia kossinskajae*	13	*Phormidium retzii*	9	*Phormidium sp. 3_EcoA*	9	*Leptolyngbya notata*	8	20	16	11	11	10	3	1	4	4
	205R00067	San Thomas Aquino	U	P	447	29	*Scenedesmus subspicatus*	111	*Pediastrum integrum*	105	*Spherocystis planctonica*	69	*Scenedesmus ellipticus*	33	*Scenedesmus dimorphus*	27	25	23	15	7	6	2	1	3	5
	205R00115	Stevens Creek	U	P	25	8	*Ulothrix sp. 11_EcoA*	6	*Scenedesmus ellipticus*	5	*Chantransia sp. 1*	3	*Scenedesmus communis*	3	*Oedogonium sp. 4_EcoA*	2	24	20	12	12	8	2	1	3	2
	205R00131	Lower Penitencia Creek	U	P	48	6	*Phormidium retzii*	32	*Leptolyngbya foveolarum*	7	*Scenedesmus ellipticus*	6	*Merismopedia glauca*	1	*Oedogonium sp. 1_EcoA*	1	67	15	13	2	2	1	0	2	1
	205R00227	Matadero Creek	U	P	19	7	*Leptolyngbya foveolarum*	12	*Phormidium retzii*	2	*Cladophora glomerata*	1	*Closterium moniliferum*	1	*Leptolyngbya tenuis*	1	63	11	5	5	5	1	1	2	2
	205R00259	Guadalupe River	U	P	6	3	*Leptolyngbya foveolarum*	3	*Chantransia sp. 1*	2	*Phormidium retzii*	1	--	--	--	--	50	33	17	--	--	1	0	1	1
	205R00291	Coyonte Creek	U	P	16	3	*Chantransia sp. 1*	11	*Leptolyngbya foveolarum*	3	*Leptolyngbya tenuis*	2	--	--	--	--	69	19	13	--	--	1	0	1	1
	205R00346	Guadalupe River	U	P	33	5	*Leptolyngbya foveolarum*	23	*Phormidium retzii*	5	*Anabaena sp. 11_EcoA*	3	*Dictyosphaerium pulchellum*	1	*Pediastrum duplex*	1	70	15	9	3	3	1	0	1	1
	205R00355	Saratoga Creek	U	P	6	4	*Phormidium retzii*	2	*Scenedesmus communis*	2	*Phacus longicauda*	1	*Scenedesmus opoliensis*	1	--	--	33	33	17	17	--	1	1	2	2

Attachment D. Algae Metric Values

					Abundance Measures		Dominance Measures						Dominance Measures									Diversity/Evenness Measures			
SW program	Station ID	Creek Name	Land use	Flow Class	Total Abundance (Natural Taxonomic Units)	Species Richness	Dominant Taxon	Dominant Taxon Abundance	2nd Dominant Taxon	2nd Dominant Taxon Abundance	3rd Dominant Taxon	3rd Dominant Taxon Abundance	4th Dominant Taxon	4th Dominant Taxon Abundance	5th Dominant Taxon	5th Dominant Taxon Abundance	% Dominant Taxon	% 2nd Dominant Taxon	% 3rd Dominant Taxon	% 4th Dominant Taxon	% 5th Dominant Taxon	Shannon-Weaver H' (log e)	Shannon-Weaver H' (log 10)	Shannon-Weaver H' (log 2)	Margalef's Richness

Attachment E. Plots of the TEC Quotients by Site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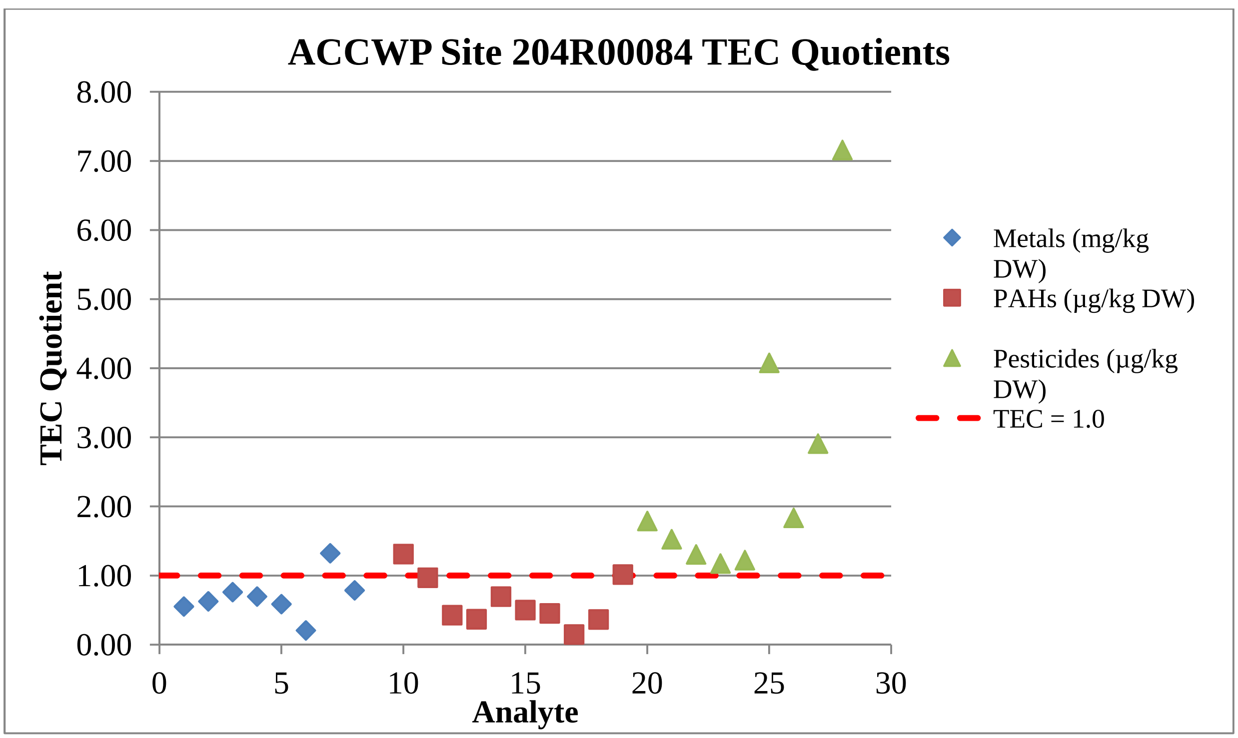
25
30
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0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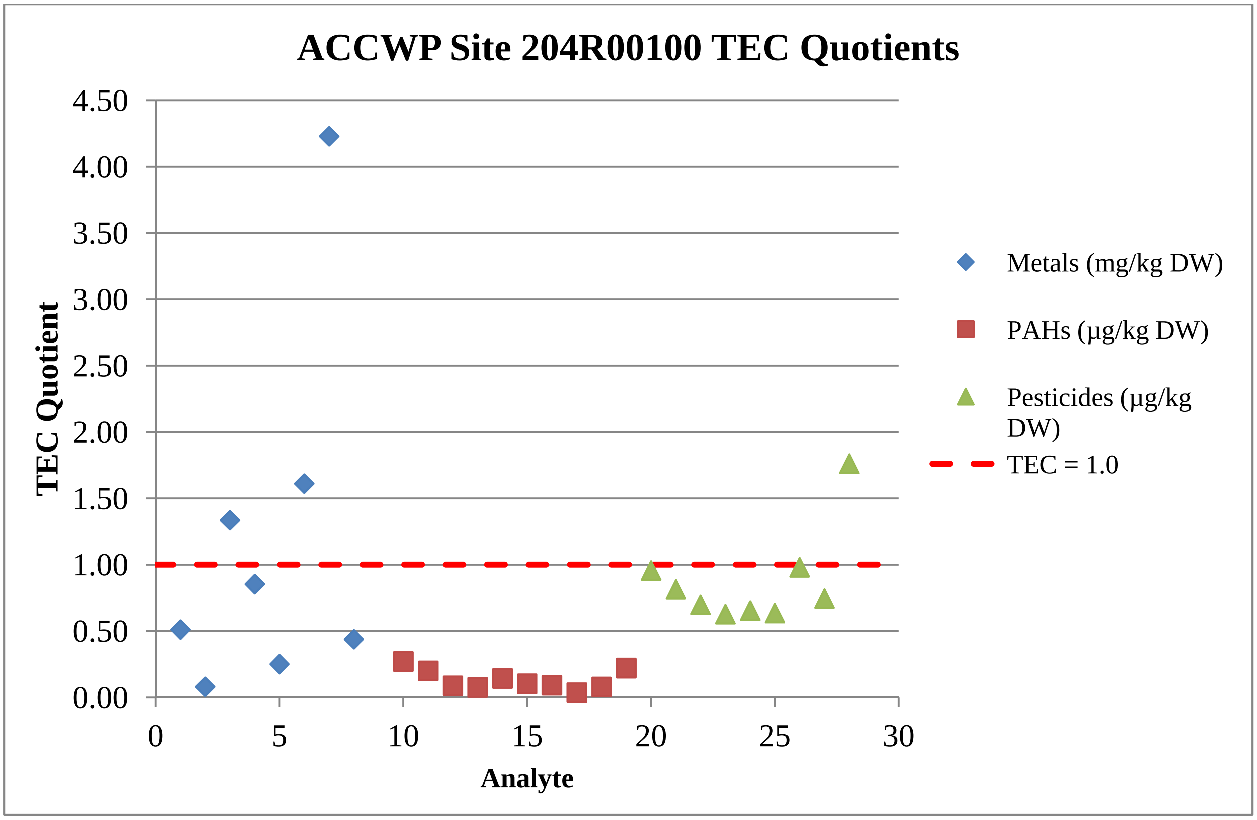
Pesticides (µg/kg DW)
TEC = 1.0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0
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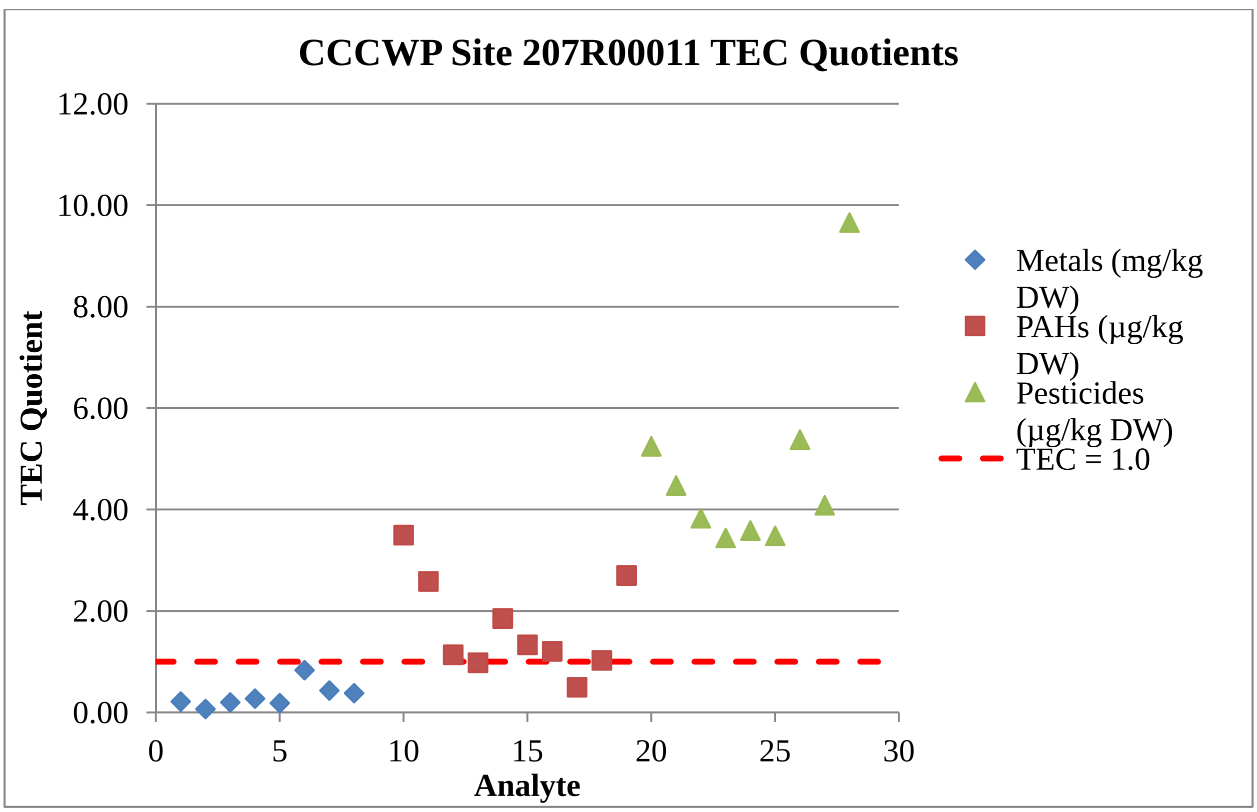
25
30
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0


CCCWP Site 207R00011 TEC Quotients
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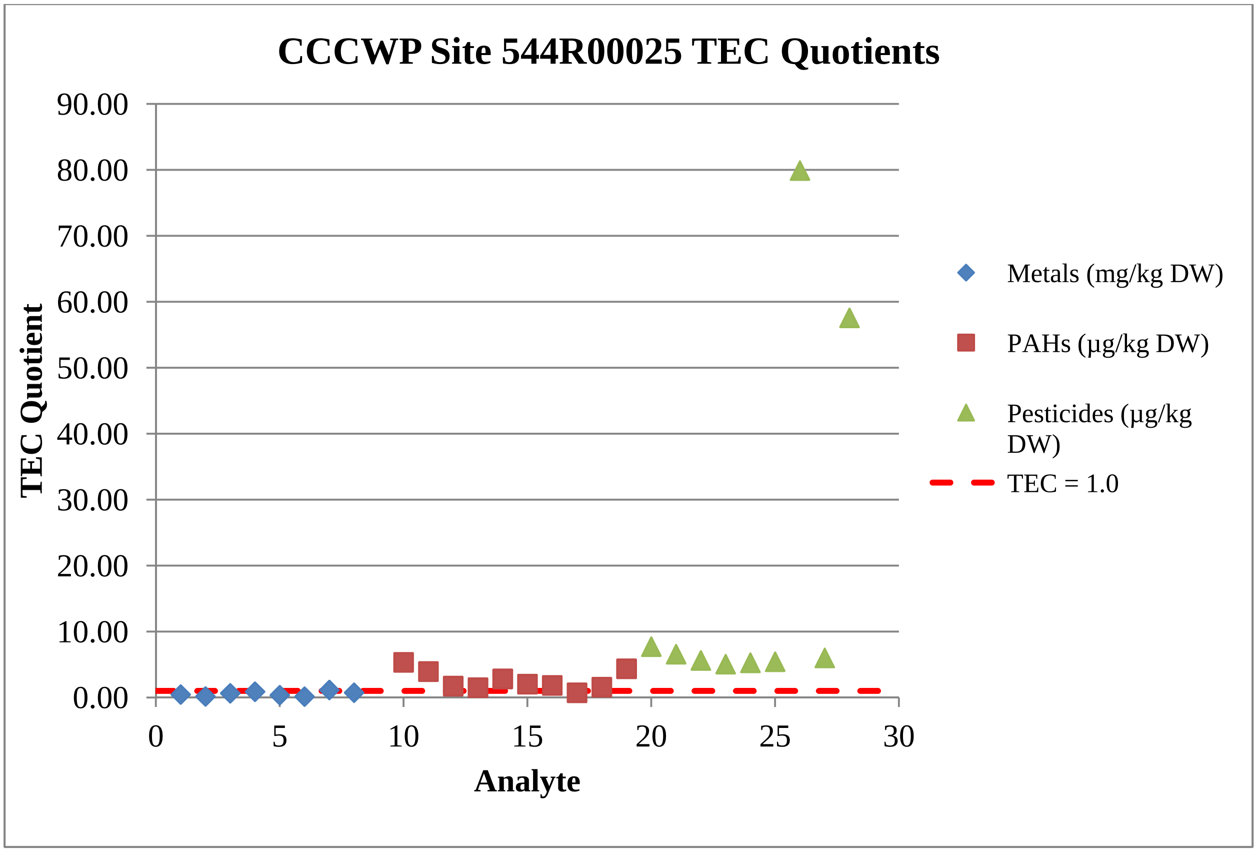
TEC = 1.0


CCCWP Site 544R00025 TEC Quotients
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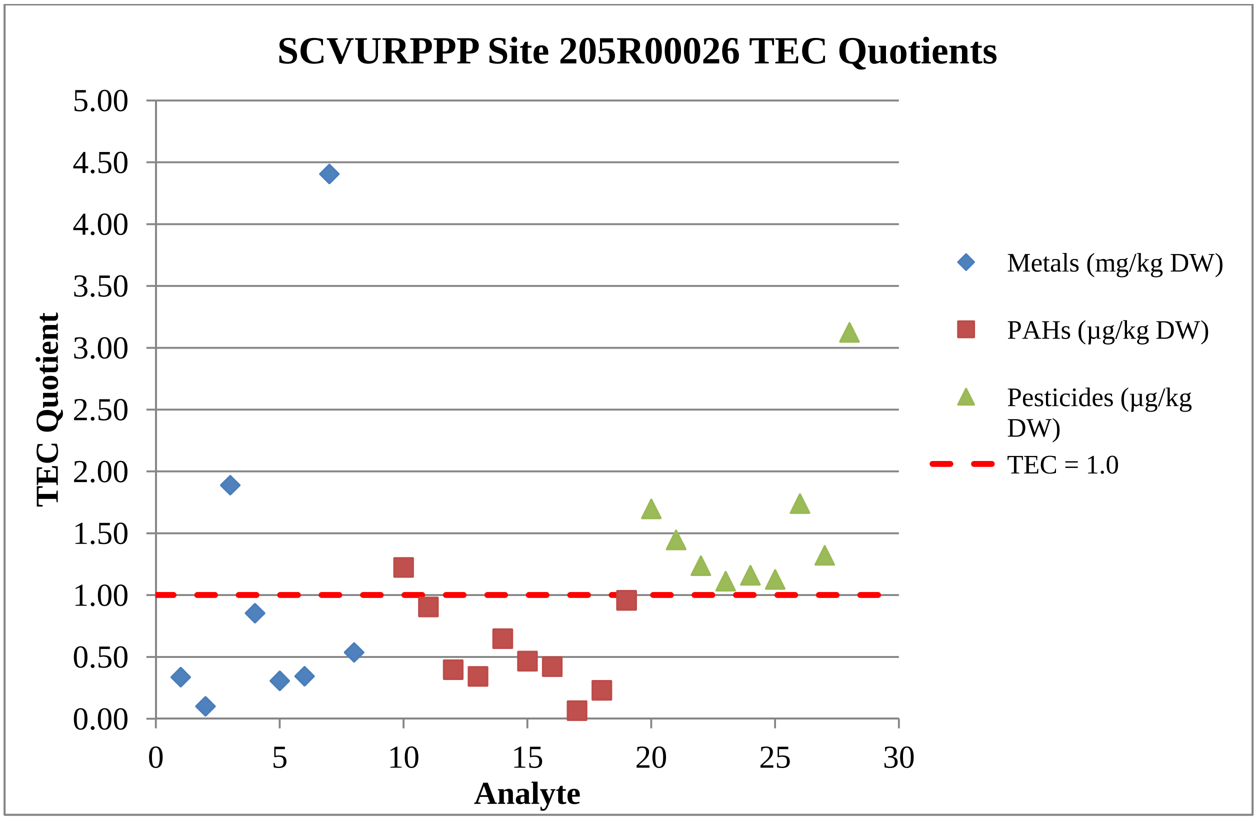
Pesticides (µg/kg DW)
TEC = 1.0


SCVURPPP Site 205R00026 TEC Quotients
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1.00
0.50
0.00
0
5
10
15
20
25
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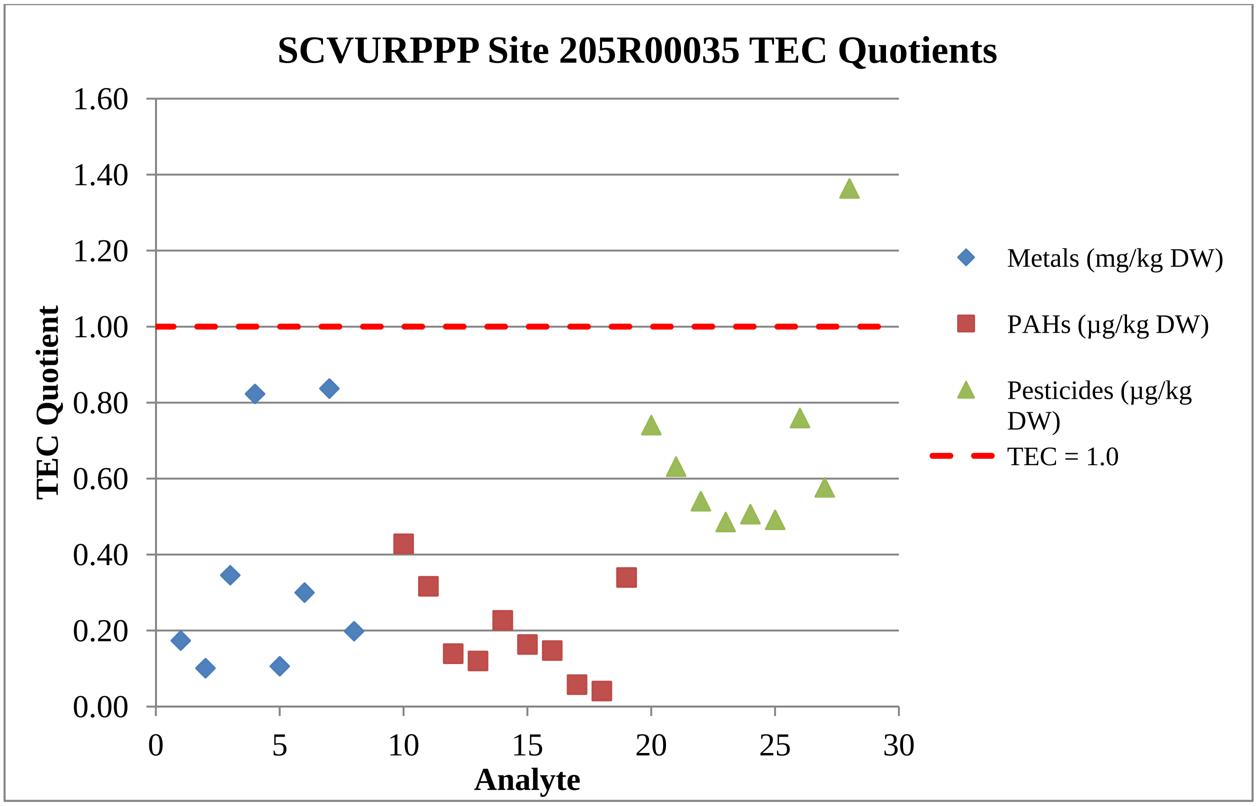
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0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0.00
0
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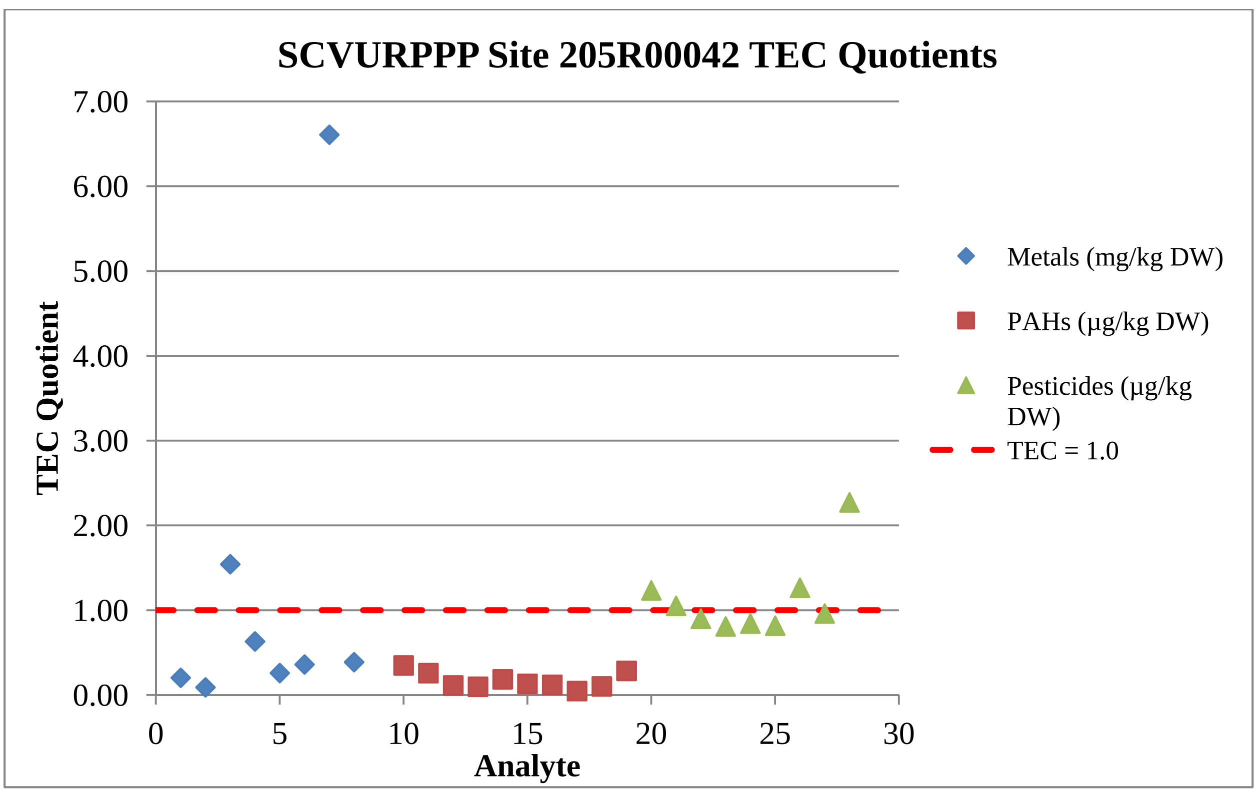
20
25
30
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0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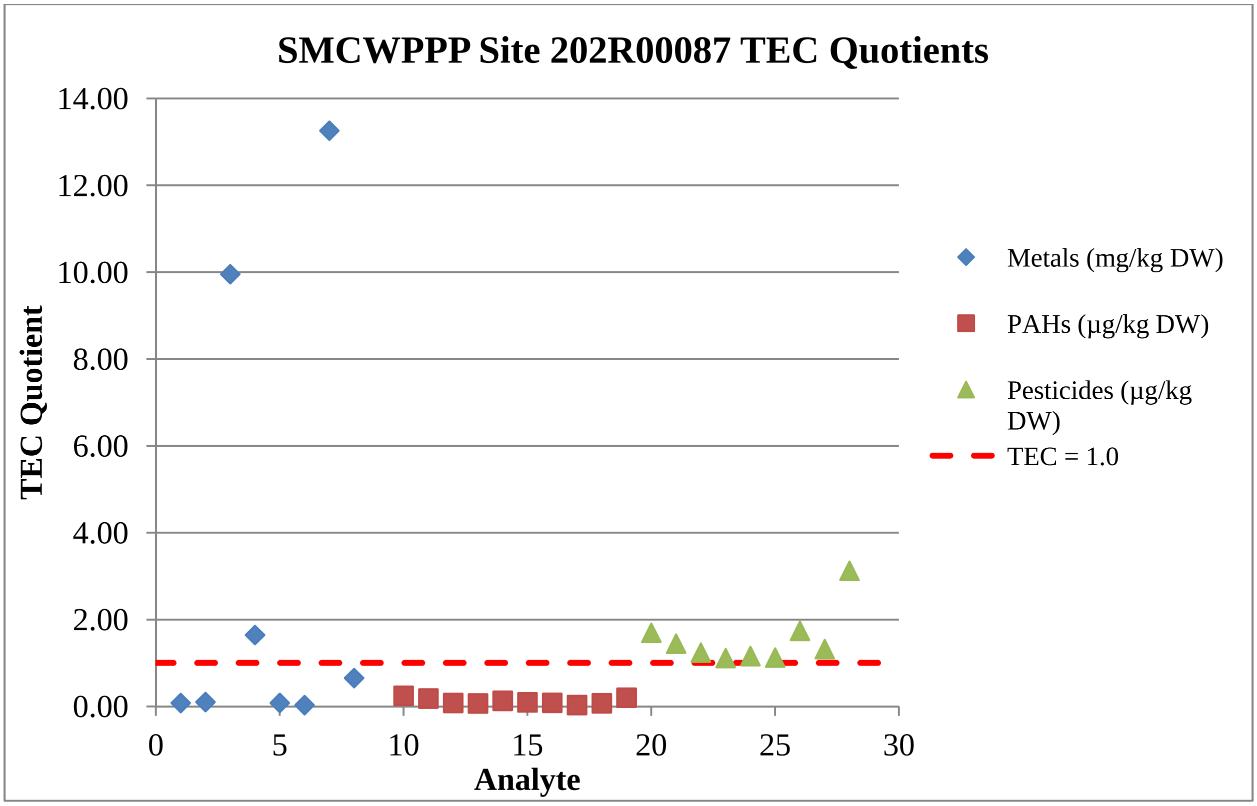
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0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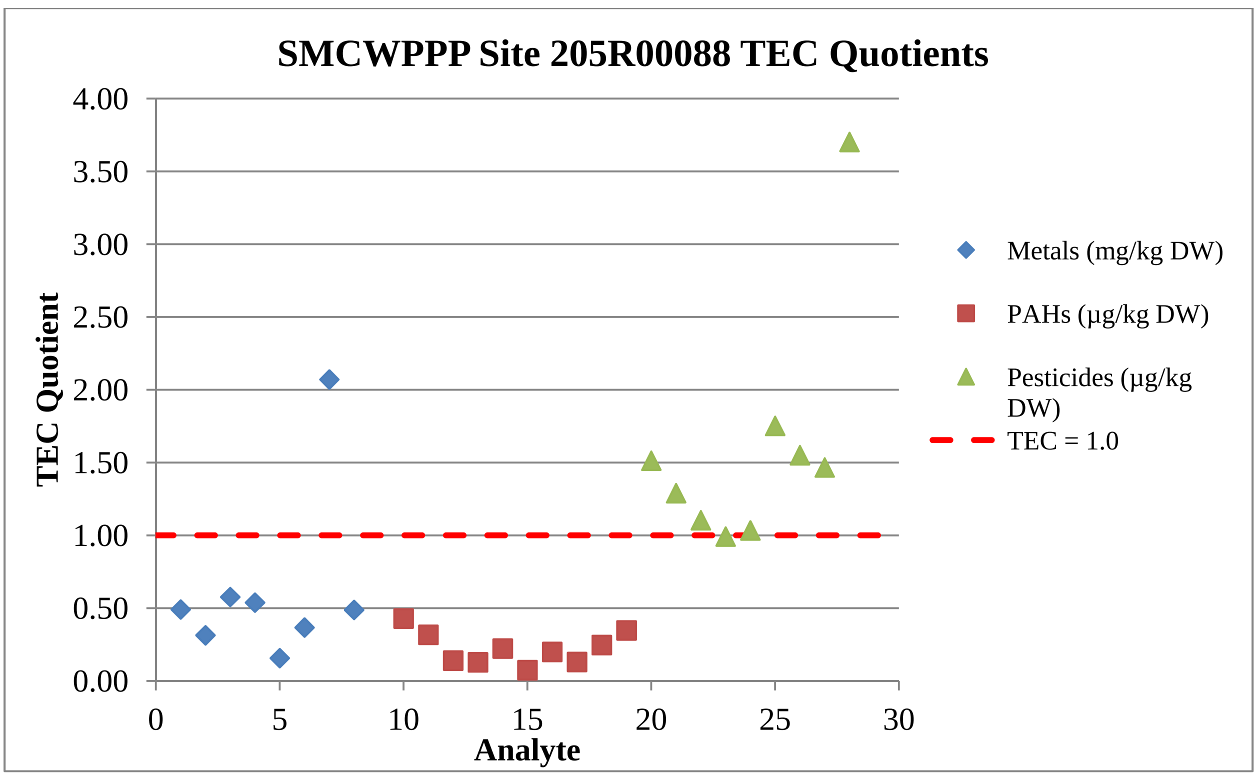
TEC = 1.0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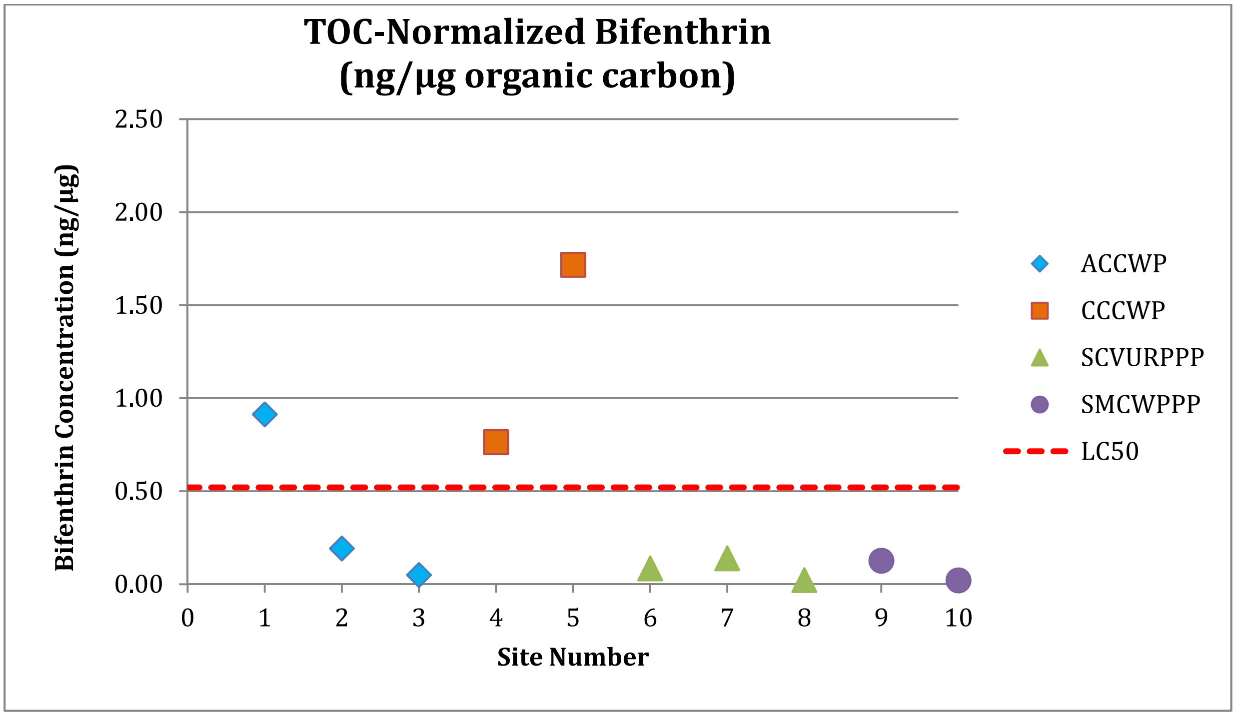
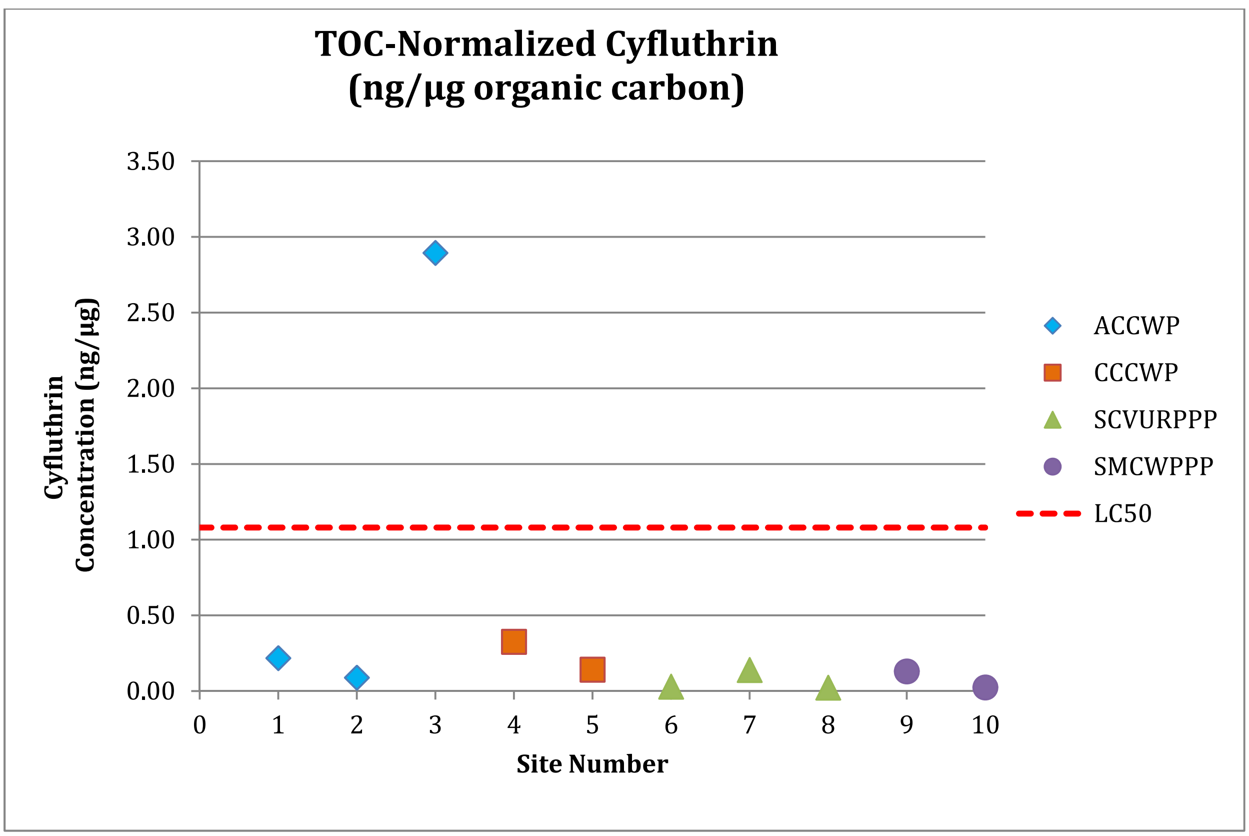
5
10
15
20
25
30
Analyte
Metals (mg/kg DW)
PAHs (µg/kg DW)
Pesticides (µg/kg DW)
TEC = 1.0

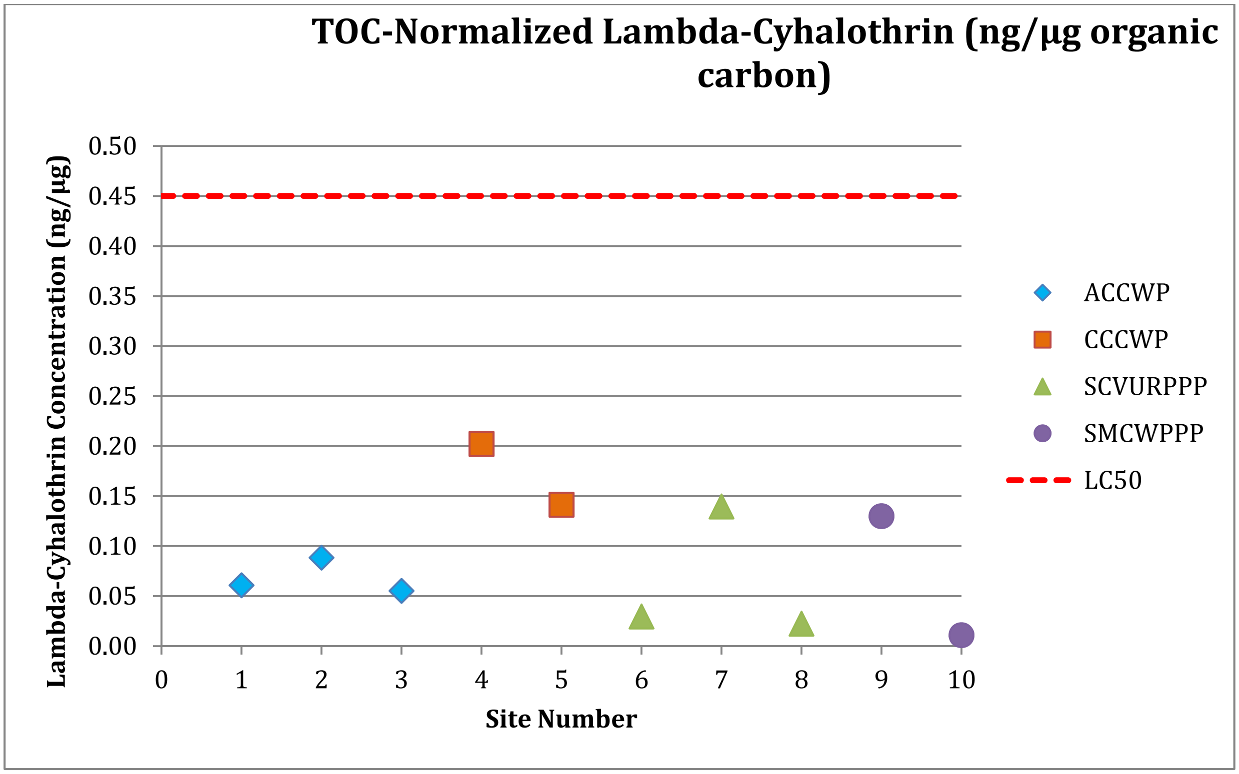
Attachment F. Plots of TOC Normalized Pyrethroid Concentrations, with Comparisons to LC50s.

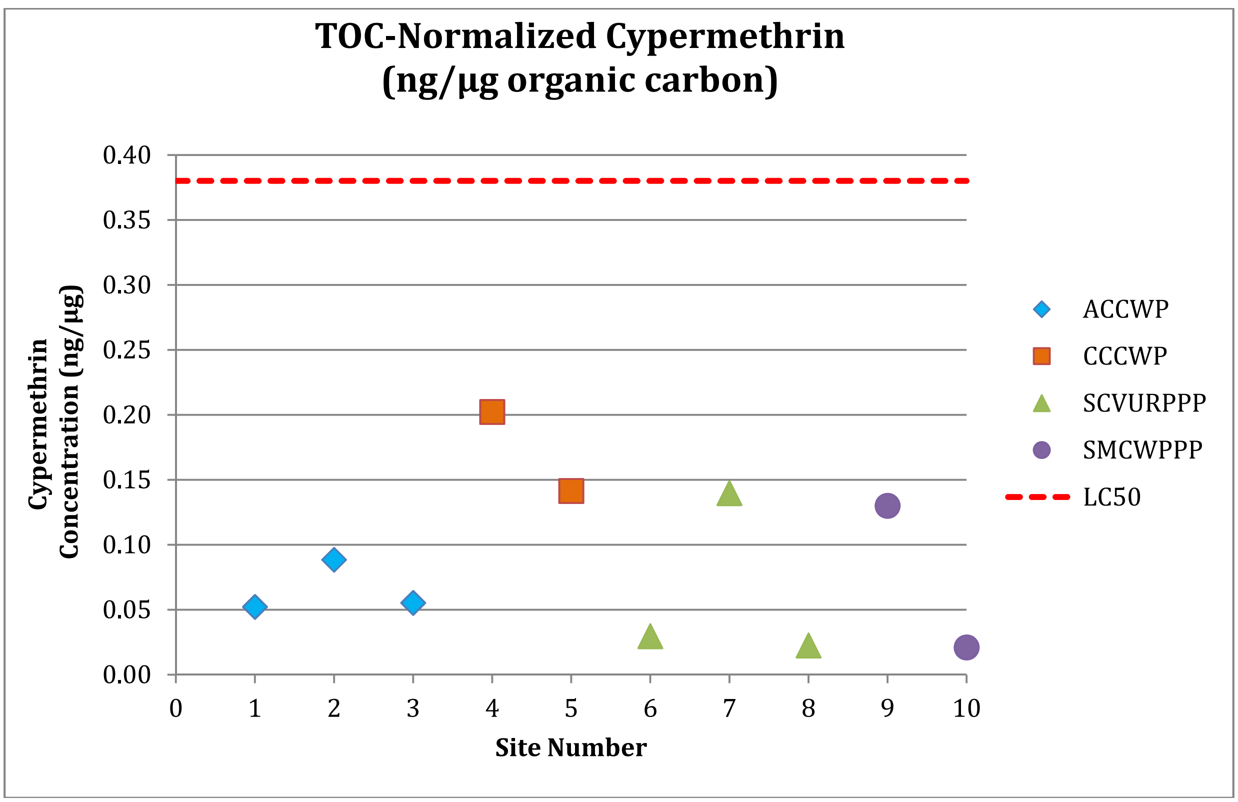
Attachment F. TOC Normalized Pyrethroid Concentrations, with Comparisons to LC 50.



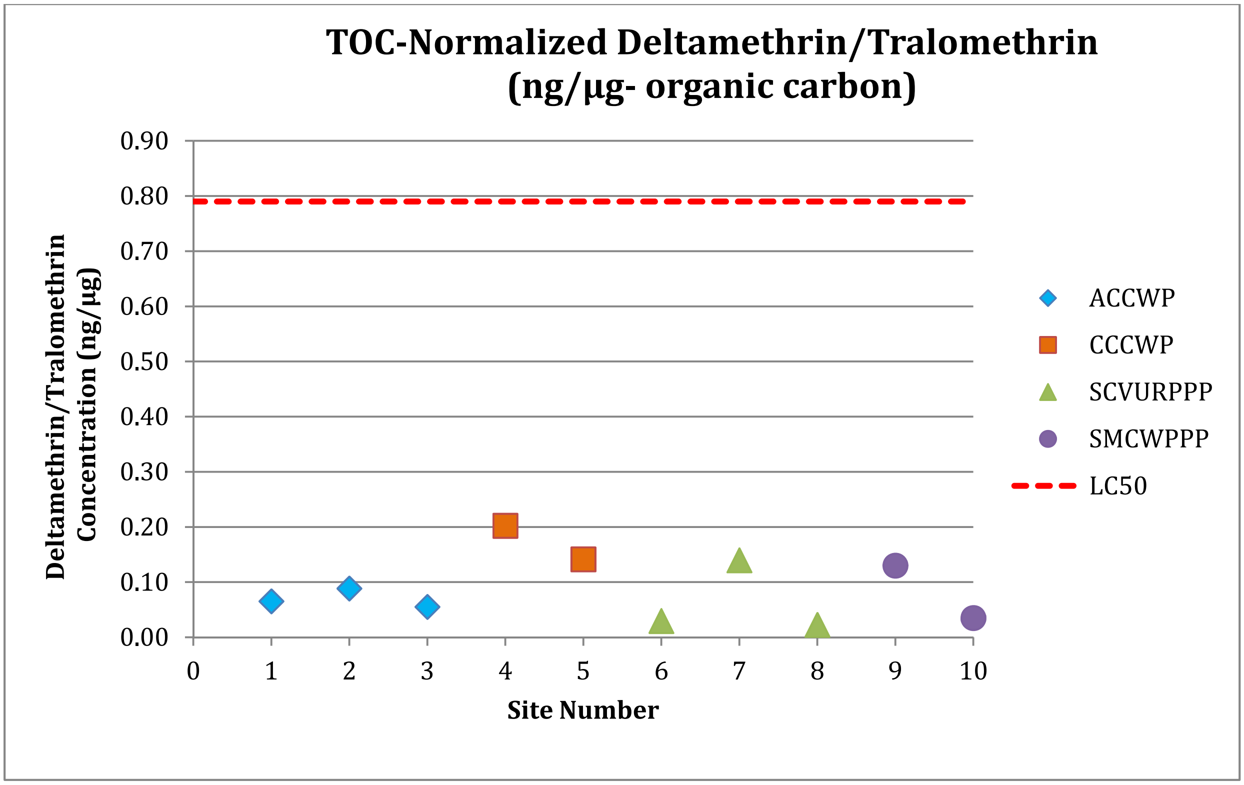


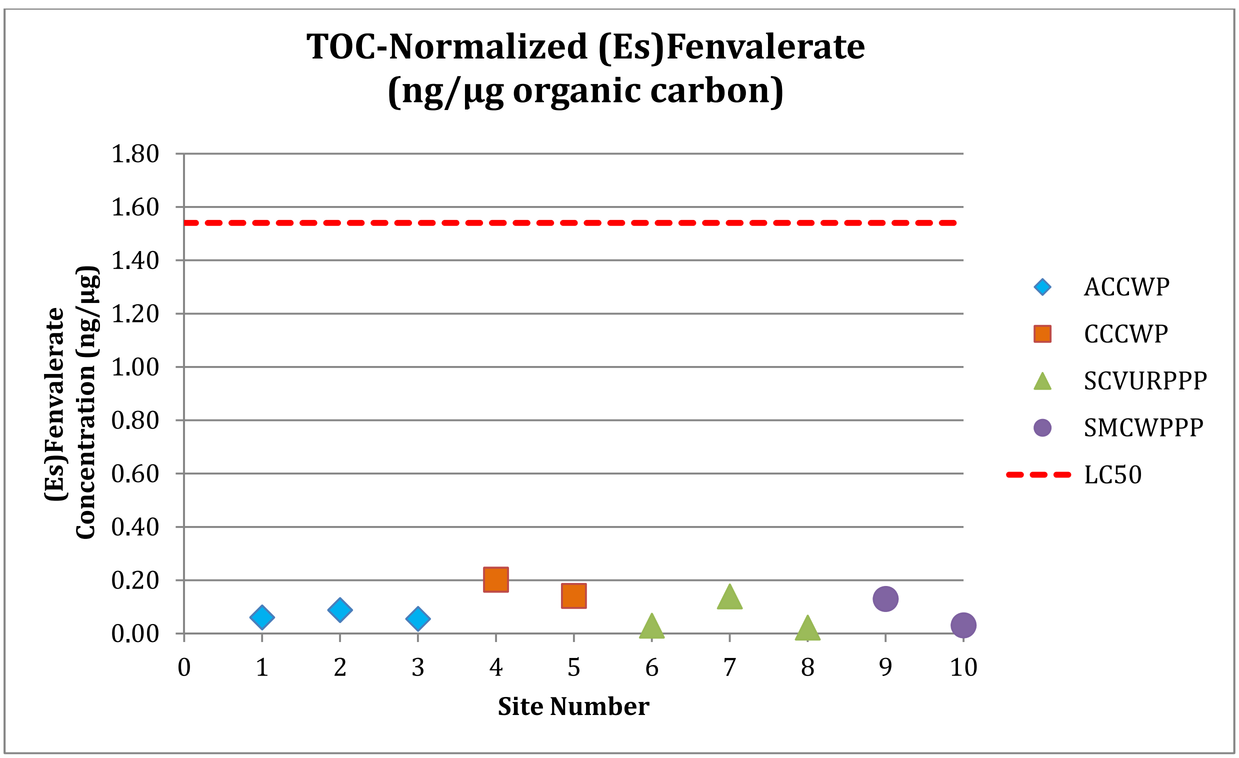
Attachment F. TOC Normalized Pyrethroid Concentrations, with Comparisons to LC 50.



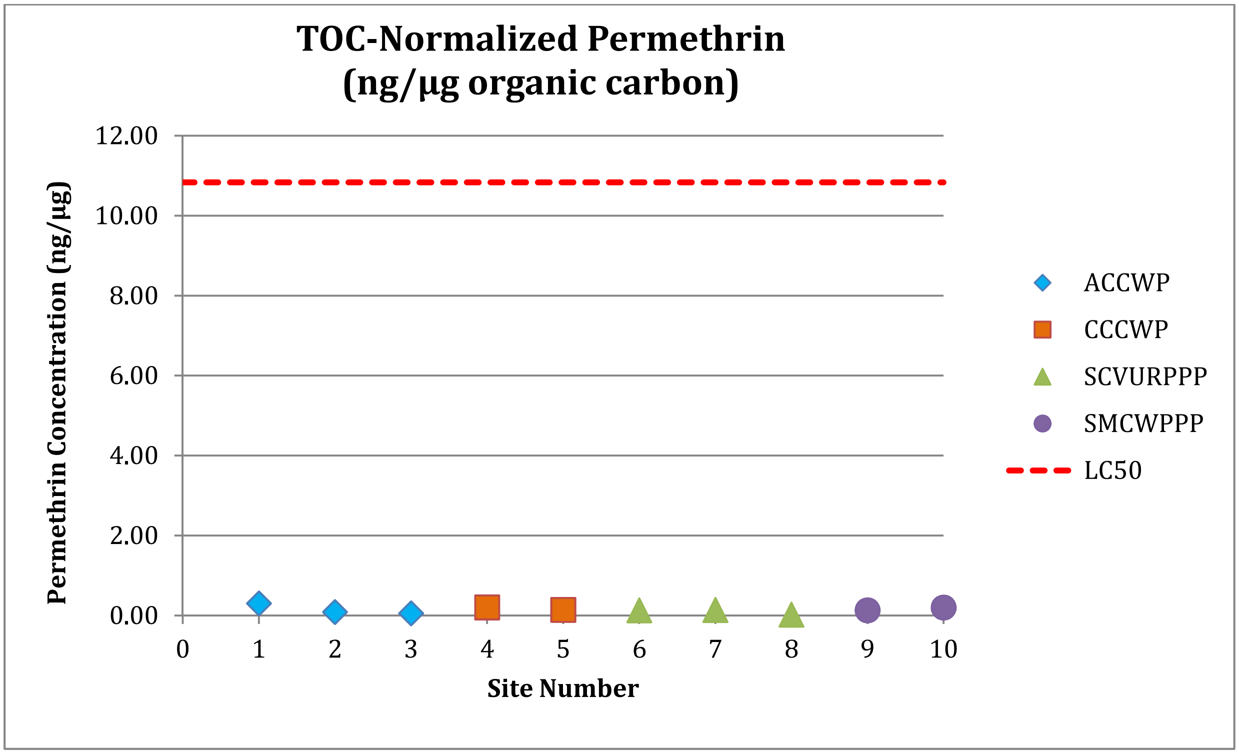


Attachment F. TOC Normalized Pyrethroid Concentrations, with Comparisons to LC 50.





Attachment F. TOC Normalized Pyrethroid Concentrations, with Comparisons to LC 50.



Appendix B

Local Urban Creeks Status Monitoring Reports (Provision C.8.c)

B1 – Alameda Countywide Clean Water Program

B2 – Contra Costa Clean Water Program

B3 – San Mateo Countywide Water Pollution Prevention Program

B4 – Santa Clara Valley Urban Runoff Pollution Prevention Program

B1

Alameda Countywide Clean Water Program

clean water
PROGRAM

MEMBER AGENCIES:

Alameda

Albany

Berkeley

Dublin

Emeryville

Fremont

Hayward

Livermore

Newark

Oakland

Piedmont

Pleasanton

San Leandro

Union City

County of Alameda

Alameda County Flood Control and Water Conservation District

Zone 7 Water Agency

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

LOCAL URBAN CREEKS STATUS MONITORING REPORT

WATER YEAR 2012

Report prepared by

Alameda Countywide Clean Water Program 399 Elmhurst Street,
Hayward, California 94544

Submitted to:

California Regional Water Quality Control Board, San Francisco Bay Region

March 8, 2013

Protecting Alameda County Creeks, Wetlands & the Bay

Preface

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

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

This Local Urban Creeks Status Monitoring Report (Appendix B-1 to the overall BASMAA RMC Urban Creeks Monitoring Report) complies with the MRP Reporting Provision C.8.g for a portion of Creek Status Monitoring data (MRP Provision C.8.c) collected on behalf of Alameda County Permittees during Water Year 2012 (October 1, 2011 through September 30, 2012). Data presented in this report were produced under the direction of the ACCWP using a targeted (non-probabilistic) monitoring design. Other data collected in Alameda County during this period pursuant to MRP Provision C.8 are reported in the main body and other appendices of the BASMAA RMC Urban Creeks Monitoring Report.

In accordance with the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011), targeted monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2012a) and BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2012b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[2]. ACCWP also submitted the data included in this report to the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) in electronic SWAMP-comparable format (see Attachment A).

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

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

List of Acronyms

Acronym	**Definition**
AMS	Applied Marine Sciences
ACCWP	Alameda Countywide Clean Water Program
BASMAA	Bay Area Stormwater Management Agency Association
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
CRAM	California Rapid Assessment Method
DO	Dissolved oxygen
E.coli	*Escherichia coli*
FSURMP	Fairfield Suisun Urban Runoff Management Program
MPN	Most Probable Number
MRP	Municipal Regional Permit
MQO	Minimum Quality Objective
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollution Discharge Elimination System
QAPP	Quality Assurance Project Plan
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RWQCB	Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SFEI	San Francisco Estuary Institute
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SWAMP	Surface Water Ambient Monitoring Program
USA	Unified Stream Assessment

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List of Attachments

Attachment A: Electronic Data Submittal Transmittal Letter dated January 15, 2013 with attached file list and preliminary evaluation relative to applicable Water Quality Standards

Executive Summary

In 2010, the seventeen members of the Alameda Countywide Clean Water Program (ACCWP) joined other members of the Bay Area Stormwater Agencies Association (BASMAA) to form the Regional Monitoring Coalition (RMC), to coordinate and oversee water quality monitoring required by Provision C.8 of the Municipal Regional National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (MRP). This report presents the details of the Creek Status Monitoring for parameters that use a targeted (non-probabilistic) monitoring design, and is one of several documents prepared to comply with the MRP Reporting Provision C.8.g.

The ACCWP targeted Creek Status monitoring in Water Year 2012 (October 1, 2011 to September 30, 2012) was conducted in two urban watersheds (Sausal Creek and portions of the San Lorenzo Creek system) and included:

- Continuous temperature monitoring at eight locations at hourly intervals over five months;
- General water quality monitoring at three locations with assessment of temperature, dissolved oxygen (DO), pH and specific conductivity at 15-minute intervals during two one week periods in Spring and Fall;
- Pathogen indicator (*E. coli* and fecal coliform) quantification at five sites on one occasion each; and
- Stream surveys (in 27 reaches) using the Center for Watershed Protection's protocol for Unified Stream Assessment were conducted on the main stem San Lorenzo Creek and two tributaries with a total of 8.6 miles assessed.

The results of the targeted Urban Creek Monitoring indicated:

Continuous Temperature

- The average temperature recorded in Crow Creek at Site CRW030 was 16.6ºC while Site CRW050 was 14.7ºC; and

- The average temperatures in Sausal Creek ranged between 14.3ºC and 15.6ºC.

General Water Quality

- Temperature
  - Late Spring temperatures were generally higher than Fall with average temperatures between 14ºC and 16ºC and greater temperature fluctuations in Spring; and

    - The highest instantaneous temperature was recorded at Site 204SLO065 (22.2ºC) while the lowest was 13.4ºC at Site 204CRW030.
- Dissolved oxygen
    - Dissolved oxygen concentrations averaged between 7mg/L to 10mg/L at most sites. The highest dissolved oxygen measurement of 11.8mg/L was recorded on May 27, 2012 at Site 204CRW030. This site also had the lowest DO measurements of 1.86mg/L on September 22, 2012.
    - At Site 204CRW030 the dissolved oxygen daily mean was consistently lower than 8mg/L but above 5mg/L. The fluctuating dissolved oxygen at this site was presumed to be due, in part, by the site location. Site 204CRW030 is located directly downstream of an artificial reservoir, Cull Reservoir. It may be assumed that discharges or impeded flow from this reservoir impacts algal growth and associated dissolved oxygen concentrations in the downstream creek;
- pH
    - Most pH measurements were within the range of 7.8 and 8.4. A number of data measurements collected at Site 204CVY005 suggest fluctuating pH levels ranging up to 9.34.
- Specific Conductivity
    - Specific conductivity was lowest at Site 204CVY005, on June 14, 2012 with 322µs/cm. The highest specific conductivity, of 1196µs/cm was measured at Site 204CRW030 on September 23, 2012 during Fall monitoring.

Pathogen Indicator Bacteria

- All five water samples collected for pathogen indicators recorded elevated fecal coliform and *E. coli* concentrations of between 500 and >16,000 most probable number (MPN) per 100mL.

Stream Survey

The reach assessment scores for individual reaches ranged from 26 to 86. Castro Valley Creek had the highest average score of 55, with a more complex instream habitat, vegetated banks and less floodplain encroachment. Chabot Creek had the second highest average score of 46, with a mix of concrete and natural channels in both residential and urban areas. The lower main stem of San Lorenzo Creek had the lowest average score of 31, with 100% of concrete channel reaches in urban areas with significant floodplain encroachment.

The majority of all outfalls were stormdrains. Channel modification was common throughout all three streams surveyed. Erosion and trash were found to be minimal. Only two recreational sites were found, with minimal dry season flow at each, indicating very little opportunity for immersive recreational activities.

Stressor Evaluation

Where applicable, targeted monitoring data were evaluated against numeric Water Quality Objectives or other applicable thresholds described for each parameter in Table 8.1 of the MRP, to determine whether results “trigger” a potential stressor/source identification monitoring project as described in MRP Provision C.8.d.i). The following trigger conditions were identified:

- Four of the five water samples analyzed for pathogen indicators were above trigger levels for lightly and moderately used REC1 beneficial use.
- Dissolved oxygen concentrations were lower than 7mg/L in 67% of analyses at Site 204CRW030.

ACCWP and local watershed managers will evaluate potential follow-up activities on WY2012 results, which may include:

- Further investigation of the Crow Creek site (Site 204CRW030) where fluctuating dissolved oxygen and temperature are likely to be associated with the upstream artificial reservoir, Cull Reservoir.
- Further investigation of the Castro Valley site (Site 204CVY140) where elevated fecal indicator bacterial concentrations suggested the potential presence of a source.

1 Introduction

This Local Urban Creeks Status Monitoring Report complies with Municipal Regional Permit (MRP) Reporting Provision C.8.g for a portion of Creek Status Monitoring data collected on behalf of Alameda County Permittees during Water Year 2012 (October 1, 2011 through September 30, 2012) in compliance with MRP Provision C.8.c. Data presented in this report were developed using a targeted (non-probabilistic) monitoring design. This report is Appendix B-1 to the overall to the Urban Creeks Monitoring Report (UCMR) prepared by the BASMAA Regional Monitoring Coalition (RMC).

The RMC was formed in early 2010 as a collaboration among a number of BASMAA members and MRP Permittees, listed in Table 1-1. The RMC's focus is developing and implementing a regionally coordinated water quality monitoring program to address water quality monitoring required by the MRP. Implementation of the RMC's Creek Status and Long-Term Trends Monitoring Plan allows Permittees and the Water Board to effectively modify their existing creek monitoring programs, and improve their ability to collectively answer core management questions in a cost-effective and scientifically rigorous way. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC) and its associated RMC Work Group.

The goals of the RMC are to:

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

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

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

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 of the Alameda County Flood Control and Water Conservation District.
Contra Costa Clean Water Program (CCCWP)	Cities of Antioch, Brentwood, Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek, Danville, and Moraga; Contra Costa County; and, Contra Costa County Flood Control and Water Conservation District.
San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)	Cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, Atherton, Colma, Hillsborough, Portola Valley, and Woodside; San Mateo County Flood Control District; and, San Mateo County.
Fairfield-Suisun Urban Runoff Management Program (FSURMP)	Cities of Fairfield and Suisun City.
Vallejo Permittees	City of Vallejo and Vallejo Sanitation and Flood Control District.

The RMC addresses the scope of sub-provisions specified in MRP Provision C.8.c (Table 1-2). This report focuses on the Creek Status and Long-Term Trends Monitoring activities that were conducted to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (Table 1-3) as described in the RMC's Status and Long-Term Trends Monitoring Plan (BASMAA, 2011).

Table 1-2. Municipal Regional Permit Provisions Addressed by the Regional Monitoring Coalition.

MRP C.8 Subprovision Number	MRP C.8 Sub-provision Title	Reporting Documents
C.8.a	Compliance Options	Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan.
C.8.b	San Francisco Bay Estuary Monitoring	Regional Monitoring Plan Annual Monitoring Results.
C.8.c	Creek Status and Long-Term Trends Monitoring	Regional Urban Creeks Monitoring Report; Local Urban Creeks Monitoring Report.
C.8.d	Monitoring Projects: • Stressor/Source Identification; • BMP Effectiveness Investigation; • Geomorphic Project.	• Stressor/Source Identification Report; • BMP Effectiveness Report; • Integrated Monitoring Report.
C.8.e	Pollutants of Concern (Loads) Monitoring	Integrated Monitoring Report.
C.8.f	Citizen Monitoring and Participation	Annual Urban Creeks Monitoring Report.
C.8.g	Data Analysis and Reporting	As described above.

Table 1-3. Creek Status Monitoring Parameters Monitored in Compliance with MRP Provision C.8.c. and the Associated Reporting Format.

Monitoring Elements of MRP Provision C.8.c	Monitoring Design		Reporting	
	Regional Ambient (Probabilistic)	Local (Targeted)	Regional	Local
Bioassessment & Physical Habitat Assessment	X		X	
Chlorine	X		X	
Nutrients	X		X	
Water Toxicity	X		X	
Sediment Toxicity	X		X	
Sediment Chemistry	X		X	
General Water Quality		X		X
Temperature		X		X
Bacteria		X		X
Stream Survey		X		X

The remainder of this report describes the Study Area and Monitoring Design (Section 2), the Monitoring Methods (Section 3), the Results (Section 4), the preliminary Stressor Assessment (Section 5), and the Conclusions & Next Steps (Section 6).

2 Study Area & 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 the portions of the five participating counties that fall within the San Francisco Bay RWQCB boundary, as well as the eastern portion of Contra Costa County that drains to the Central Valley region (Figure 2-1). Creek Status monitoring is being conducted in flowing water bodies (i.e., creeks, streams and rivers) interspersed among the RMC area, including perennial and non-perennial creeks and rivers that run through both urban and non-urban areas.

2.2 Alameda County Targeted Monitoring Areas

Alameda County occupies 739 square miles (1,914 sq km) of land area in the East Bay region of the San Francisco Bay Area, and discharges to portions of the Central Bay, South Bay and Lower South Bay. Its population of 1,510,271 (as of April 2010) is densest in the Bay Plain western portion of the County, where the largest cities include Oakland, Fremont, Berkeley and Hayward. The eastern portion of the county includes the cities of Dublin, Livermore and Pleasanton occupying the Livermore-Amador Valley, a portion of the very large and mostly undeveloped Alameda Creek Watershed.

ACCWP's targeted monitoring in Water Year 2012 focused on two watersheds, each with distinct management issues and stakeholder concerns as described below.

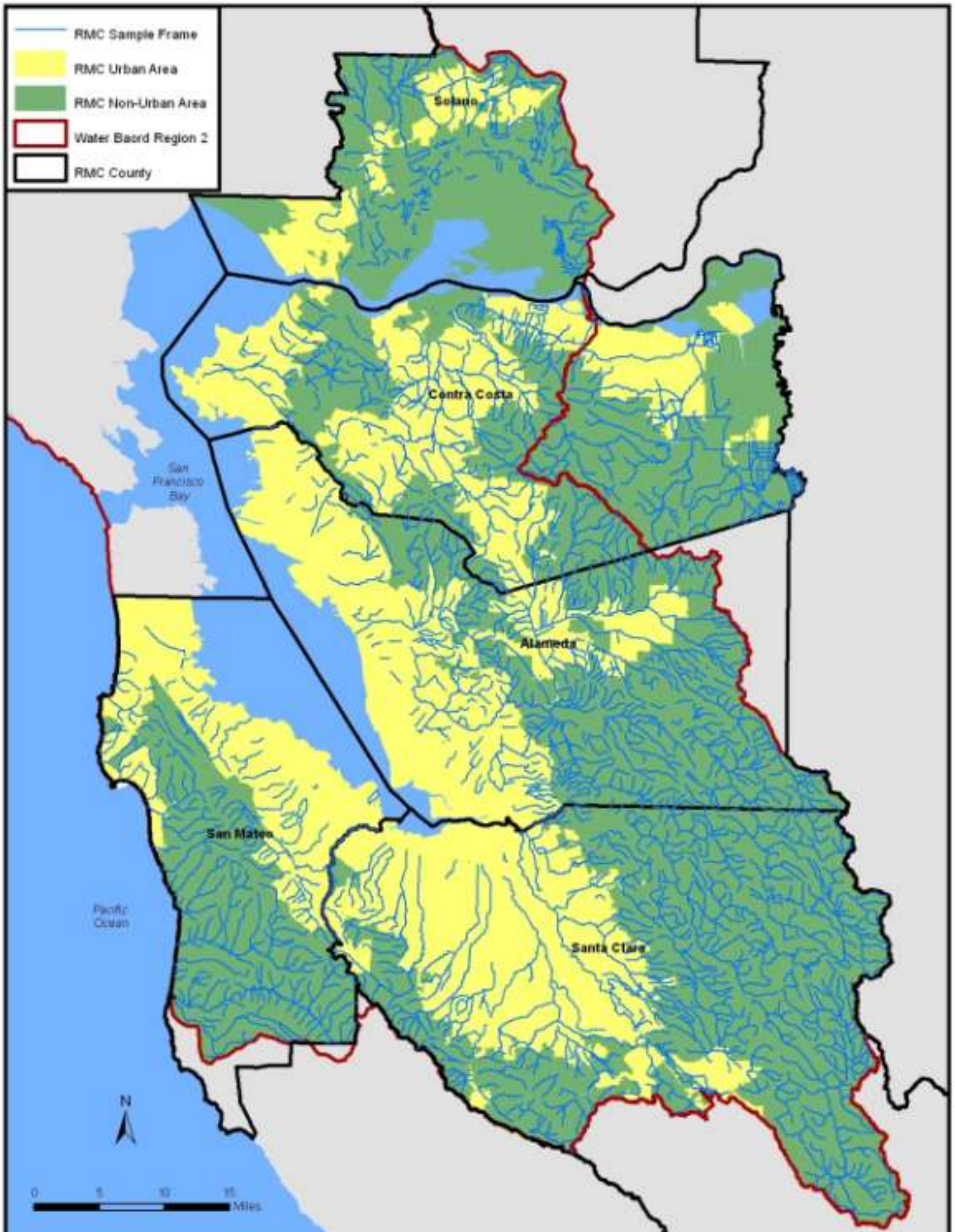

Figure 2-1. Map of BASMAA RMC Area, Major Creeks, Transportation Features.

2.2.1 San Lorenzo Creek Watershed

The San Lorenzo Creek Watershed encompasses over 49 square miles (30,000 acres) of land and extends from the San Francisco Bay to the ridge-tops of the East Bay hills (Figure 2-2). The watershed encompasses both urban and non-urban areas, mostly in unincorporated portions of Alameda County. Within the watershed are over 81 miles of natural creeks including some segments of Castro Valley and Chabot Creeks within the urbanized area, and Crow Creek spanning both rural and suburban development. Upper Sulphur Creek (formerly a separate drainage) also discharges part of its runoff into San Lorenzo Creek near Second Street in Hayward.

The San Lorenzo Creek watershed has undergone extensive hydromodification in the 20th century, including construction of the flood control channel in the lower portions of the watershed by the US Army Corps of Engineers, and Cull Canyon and Don Castro Reservoirs by the Alameda County Flood Control and Water Conservation District (SFEI 2001). The San Lorenzo Creek Watershed is also coterminous with Zone 2 of the District, which has in recent years sponsored several restoration projects along Castro Valley Creek and other tributaries and sponsored geomorphic and fisheries surveys in non-urban portions of several creeks.

Beneficial uses (SFRWQCB, 2011) assigned to San Lorenzo Creek and its tributaries are as follows:

- Cold Freshwater Habitat (COLD) is assigned to San Lorenzo Creek and all of its tributaries;
- Fish Migration (MIGR) is assigned to the main stem of San Lorenzo Creek and to Crow Creek, along with the non-urban tributary Palomares Creek;
- Water Contact and Non-contact Recreation (REC-1 and REC-2). Public parks or other facilities allow access or approaches to sections of Castro Valley, Chabot and Crow Creeks. Swimming recreational areas at Cull and Don Castro Reservoirs are managed by the East Bay Regional Park District; and
- Municipal and Domestic Supply (MUN), Freshwater Replenishment (FRESH) and Groundwater Recharge (GWR) are assigned to San Lorenzo Creek but none of its tributaries. The aquifer beneath the downstream portion of San Lorenzo Creek is a site of an EBMUD project for groundwater storage to provide drought protection.

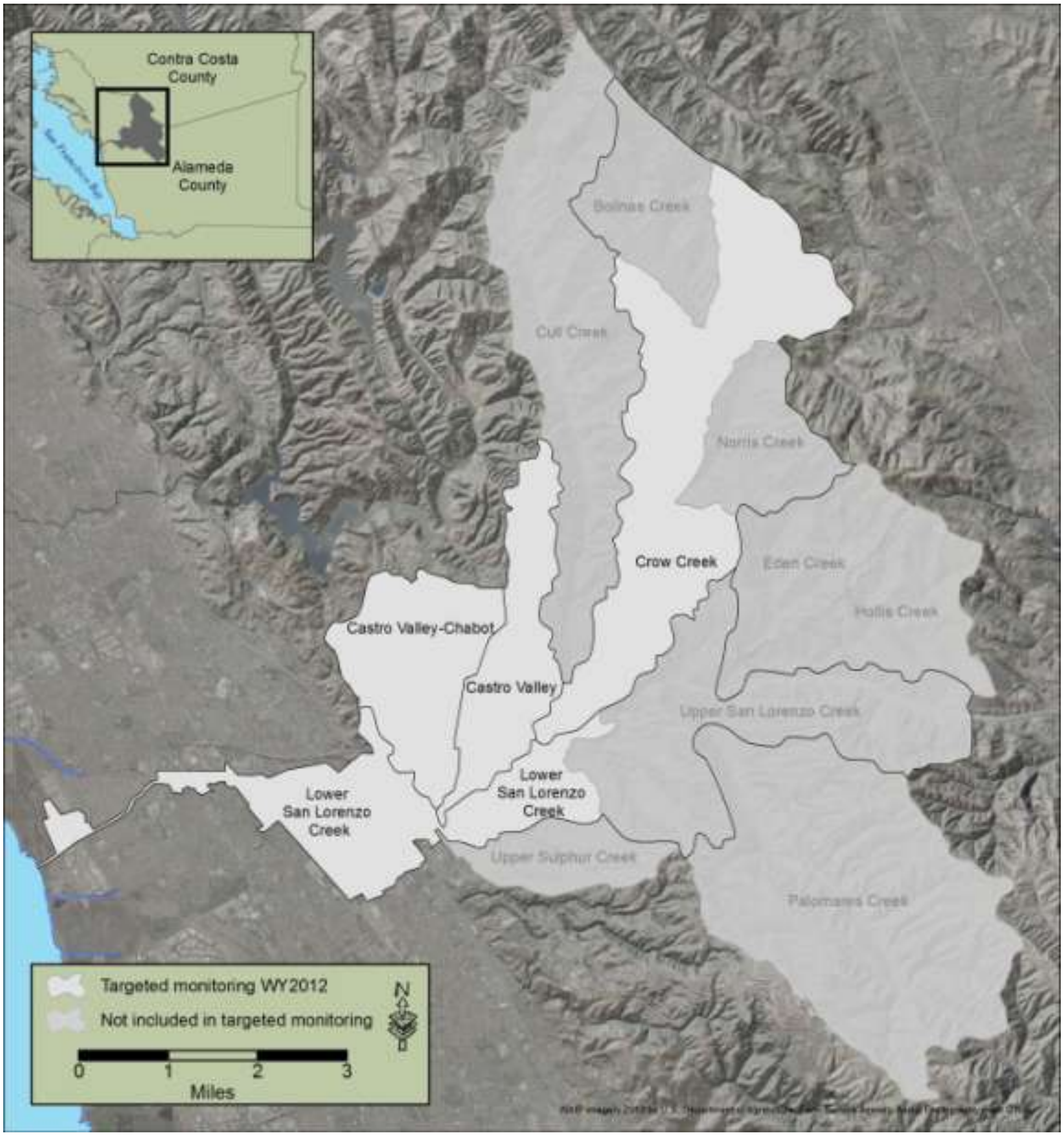

Figure 2-2. Map of the San Lorenzo Creek Watershed and Major Subwatersheds.

2.2.1.1 Crow Creek Subwatershed

The upper tributaries of Crow Creek lie in grasslands and oak woodlands. Much of this estimated 5.8 square mile watershed is heavily grazed, and also has the most equine facilities of any of the subwatersheds of San Lorenzo Creek. The Unincorporated Alameda County Clean Water Program and the District have worked with the Alameda Resource Conservation District on outreach and inspection for these facilities. Most ownership of creeks is private. In the lower, suburban reaches of Crow Creek it receives sporadic inputs from Cull Creek, a primarily non-urban watershed that is partially detained in Cull Reservoir just above the confluence.

2.2.1.2 Castro Valley and Chabot Creek Subwatersheds

The total Castro Valley Creek watershed encompasses nearly seven square miles of primarily residential land use with smaller amounts of open space and commercial and industrial areas. The creek's two main branches have undergone different degrees of alteration:

- Castro Valley Creek is the longer, eastern branch that flows from undeveloped open space through urbanized Castro Valley to its confluence with the main stem of San Lorenzo Creek. While most of the reaches have been extensively channelized, and culverted sections are extensive in side tributaries and under major roads or freeways, the main channel remains open for much of its length; and

- Chabot Creek, the western branch, is located almost entirely in storm drains and engineered channels. A relatively natural channel section occurs in Carlos Bee Park just above its confluence with the Castro Valley branch.

2.2.1.3 Lower and Middle Reaches of San Lorenzo Creek

The Federal flood control channel of San Lorenzo Creek extends from Foothill Boulevard to San Francisco Bay and receives relatively little drainage from the adjacent urban area. Most of this channel is concrete-lined and presents a barrier to upstream fish passage due to the uniform gradient and lack of resting pools. From Foothill Boulevard to its confluence with Crow Creek, San Lorenzo Creek flows through mixed urban land use but retains its natural channel alignment and has localized areas of channeling or bank hardening. Upper San Lorenzo Creek is above Don Castro Dam in a non-urban setting, although affected by the reservoir and by construction of Interstate 580 above or over much of its length.

2.2.2 Sausal Creek Watershed

The Sausal Creek Watershed encompasses 2,656 acres within the city of Oakland (Figure 2-3). Although approximately twenty percent of the watershed remains as open space, most of the watershed is a mix of residential and commercial land uses. The headwaters and riparian corridor are relatively intact, while the sections below Dimond Park are mostly culverted or channelized. The watershed is home to an active watershed stewardship group, the Friends of Sausal Creek (FOSC), which developed a Watershed Action Plan (Stott Associates, 2000) focusing on six overall goals, including improvement of water quality as well as protection and restoration of natural resources and enhancing community awareness and stewardship.

Beneficial uses (SFRWQCB 2011) assigned to Sausal Creek include:

- Cold Freshwater Habitat (COLD). FOSC has monitored and advocated for a resident population of rainbow trout in the upper watershed; and
- Water Contact and Non-contact Recreation (REC-1 and REC-2). Public access to Sausal Creek and its tributaries occurs in most of its daylighted reaches, especially in Dimond Canyon and the headwaters of the Palo Seco branch in Joaquin Miller Park.

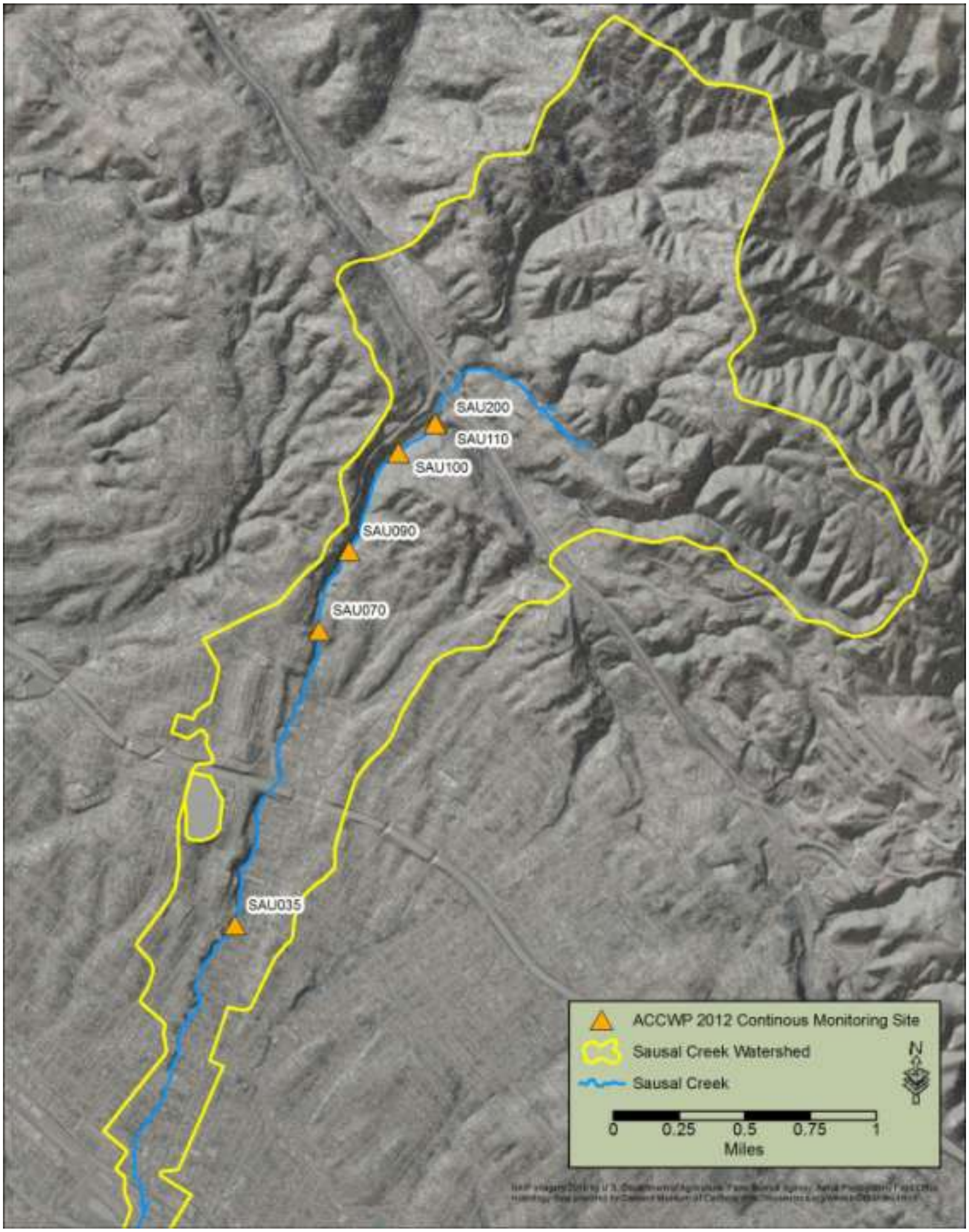

Figure 2-3. Sausal Creek Watershed - Alameda Countywide Clean Water Program Targeted Monitoring Locations within the Program Area for Water Year 2012.

2.3 Targeted Monitoring Design

In the targeted monitoring program design, site locations were identified based on the directed principle[3] 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 water contact recreation may occur?*
4) *What are the overall physical and/or ecological conditions of creek reaches and specific point impacts within each reach?*

Within the County of Alameda, targeted monitoring was conducted during Water Year 2012 (October 1, 2011– September 30, 2012) with:

- Eight Continuous Water Temperature monitoring locations (Table 2-1);
- Three General Water Quality monitoring locations (Table 2-1);
- Five Pathogen Indicator monitoring locations (Table 2-1); and
- Twenty-seven Stream Survey Reaches monitored encompassing approximately nine creek miles (Table 2-2).

[3] The Directed Monitoring Design Principle is 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. Summary of Targeted Monitoring Locations and Parameters for Water Year 2012 in Alameda County

Site Code (RMC No)	Site Description	Creek/Sub-watershed	Watershed	Latitude	Longitude	Water Temperature (continuous)[4]	General Water Quality	Pathogen Indicators
204CRW030	Crow Creek below confluence with Cull Creek	Crow Creek	San Lorenzo	37.70056	-122.05500	X		
204CRW050	Crow Creek below Norris Creek	Crow Creek	San Lorenzo	37.71750	-122.03750	X		
204SAU035	Sausal Creek at the corner of E. 27th Street and Barry Place	Sausal Creek	Sausal	37.79126	-122.22140	X		
204SAU070	Sausal Creek at El Centro pool off El Centro Ave	Sausal Creek	Sausal	37.80745	-122.21589	X		
204SAU090	Sausal Creek at Leimert Avenue, upstream of SAU070	Sausal Creek	Sausal	37.81197	-122.21391	X		
204SAU100	Sausal Creek at Dimond Canyon at golf course upstream of SAU090	Sausal Creek	Sausal	37.81735	-122.21061	X		
204SAU110	Palo Seco Creek above confluence with Sausal, upstream of SAU100	Sausal Creek	Sausal	37.81894	-122.20756	X		
204SAU200	Sausal Creek above confluence with Palo Seco Creek	Sausal Creek	Sausal	37.81903	-122.20748	X		
204CRW 030 – Spring	Crow Creek below confluence with Cull Creek	Crow Creek	San Lorenzo	37.70056	-122.05500		X	
204CRW 030 – Fall	Crow Creek below confluence with Cull Creek	Crow Creek	San Lorenzo	37.70120	-122.05511		X	
204CVY005	Castro Valley Creek above confluence with San Lorenzo (Alternate code: CVC)	Castro Valley Creek	San Lorenzo	37.67846	-122.08011		X	

[4] Sampling site locations were adjusted by field staff to optimize locations where (1) water level was expected to be of sufficient depth to cover probes over the course of the entire dry season, and (2) avoid highly trafficked areas.

Site Code (RMC No)		Site Description	Creek/Sub-watershed	Watershed	Latitude	Longitude	Water Temperature (continuous)[4]	General Water Quality	Pathogen Indicators
204SLO065	Spring	San Lorenzo Creek above confluence with Castro Valley (Alternate code: SLZ)	San Lorenzo Creek	San Lorenzo	37.67795	-122.08014		X	
	Fall	San Lorenzo Creek above confluence with Castro Valley (Alternate code: SLZ)	San Lorenzo Creek	San Lorenzo	37.67801	-122.08066		X	
204CVY020		Chabot Creek within Carlos Bee Park above confluence with Castro Valley Creek	Chabot Creek	San Lorenzo	37.68205	-122.08073			X
204CVY080		Castro Valley Creek within Carlos Bee Park above confluence with Chabot Creek	Castro Valley Creek	San Lorenzo	37.68180	-122.08061			X
204CVY120		Castro Valley Creek adjacent to Norbridge Avenue and Redwood Road	Castro Valley Creek	San Lorenzo	37.69285	-122.07163			X
204CVY140		Castro Valley Creek between Berdina Road and Forest Avenue	Castro Valley Creek	San Lorenzo	37.70136	-122.07028			X
204CVY150		Castro Valley Creek adjacent to Heyer Ave.	Castro Valley Creek	San Lorenzo	37.70446	-122.06913			X

Table 2-2. Summary of Stream Survey Reaches in San Lorenzo Watershed targeted for Water Year 2012 Monitoring in Alameda County.

Watershed Reach ID	Latitude	Longitude	Survey Date	Channel Type
San Lorenzo Creek-A	37.675957	-122.153074	9/26/12	Concrete, trapezoidal
San Lorenzo Creek-B	37.682041	-122.143105	9/26/12	Concrete, vertical
San Lorenzo Creek-C	37.684763	-122.138659	9/26/12	Concrete, vertical
San Lorenzo Creek-D	37.684476	-122.130122	9/27/12	Concrete, vertical
San Lorenzo Creek-E	37.684858	-122.128679	9/27/12	Concrete, vertical
San Lorenzo Creek-F	37.685616	-122.116805	9/27/12	Concrete, vertical
San Lorenzo Creek-G	37.684371	-122.108477	9/27/12	Concrete, vertical
San Lorenzo Creek-H	37.685765	-122.098482	9/28/12	Concrete, vertical
San Lorenzo Creek-I	37.680619	-122.093675	9/28/12	Concrete, vertical
Castro Valley Creek-A	37.677973	-122.080438	10/3/12	Natural channel
Castro Valley Creek-C	37.684044	-122.075577	10/4/12	Concrete, trapezoidal
Castro Valley Creek-E	37.687069	-122.073371	10/4/12	Concrete, trapezoidal
Castro Valley Creek-H	37.691227	-122.070817	10/4/12	Concrete, trapezoidal
Castro Valley Creek-I	37.692792	-122.071414	10/4/12	Natural channel
Castro Valley Creek-K	37.695533	-122.071989	10/5/12	Concrete channel
Castro Valley Creek-M	37.69744	-122.071341	10/5/12	Concrete and natural
Castro Valley Creek-N	37.704465	-122.069049	10/5/12	Concrete channel
Castro Valley Creek-O	37.708626	-122.064453	10/11/12	Concrete channel
Castro Valley Creek-P	37.711428	-122.063624	10/11/12	Concrete channel
Castro Valley Creek-Q	37.713676	-122.063455	10/11/12	Natural channel
Castro Valley Creek-R	37.713676	-122.063455	10/11/12	Natural channel
Chabot Creek-A	37.681829	-122.080683	10/11/12	Natural channel
Chabot Creek-B	37.684281	-122.082039	10/12/12	Concrete and natural
Chabot Creek-C	37.688189	-122.082333	10/12/12	Concrete and natural
Chabot Creek-E	37.691186	-122.083263	10/3/12	Concrete, trapezoidal
Chabot Creek-G	37.694777	-122.087368	10/3/12	Concrete, trapezoidal
Chabot Creek-H	37.695766	-122.086374	10/11/12	Concrete, trapezoidal

Notes: 1. Coordinates represent the downstream starting point for each stream survey reach.
2. San Lorenzo Creek Reach K and Castro Valley Creek Reach B were not surveyed due to access or safety issues.
Castro Valley Creek Reaches P, Q and R channels were not fully accessible throughout their length.

2.3.1 Criteria for Site Selection

All target sampling sites were selected by the ACCWP Program Manager, in coordination with others as described below. Specific considerations applied to selection of locations for the different parameters as described below:

Continuous Temperature

The eight continuous water quality monitoring locations were chosen based on a combination of criteria. A predominant criterion in the selection of San Lorenzo Creek and Sausal Creek for continuous monitoring was that both streams have COLD beneficial use designation for which these parameters are important indicators. Based on available historical data for the San Lorenzo Creek watershed, simple temperature monitoring was chosen for the less urbanized portions of Crow Creek to complement the shorter-duration water quality monitoring in more urbanized reaches within Sausal Creek.

In the case of Sausal Creek, ACCWP took the opportunity to collaborate with FOSC in their effort to redesign a watershed monitoring program. ACCWP's temperature loggers were deployed at six sites recommended by Robert Leidy, an active FOSC Board member interested in assessment of different tributaries' suitability for trout.

Sampling sites were adjusted in the field in order to deploy continuous monitoring equipment at locations where (1) water level was expected to be of sufficient depth to cover loggers over the course of the entire dry season, and (2) avoid highly trafficked areas.

General Water Quality

The goal of site selection for the three general water quality monitoring locations within the San Lorenzo Creek watershed was to characterize the different water quality attributes present along an urban gradient. The placement of sondes within these streams provided additional water quality information to use in assessing the creek's support of designated beneficial uses. The three monitoring locations were chosen as distinct in terms of land use characteristics. The Crow Creek site (204CRW030) has a tributary watershed comprising only suburban drainage and open space. The San Lorenzo Creek site (204SLO065) carries flows from mixed land uses of urban and non-urban areas. The Castro Valley Creek sampling site (204CVY005) is predominantly urban, and in previous toxicity testing by ACCWP (Hansen, 1995) showed significant differences from the San Lorenzo site in close proximity but with differing tributary land use.

Pathogen Indicators

The five pathogen indicator sampling sites were all located within a 2.8km segment of Castro Valley Creek. Castro Valley is an urban watershed and several of the Castro Valley Creek reaches have public access.

Stream Survey

Surveyed reaches in WY2012 targeted some of the most urban portions of San Lorenzo Creek, and the heavily urbanized Castro Valley and Chabot Creeks. The remaining urban portions of San Lorenzo and Crow Creeks are planned for assessment in Water Year 2012, which will allow a more comprehensive analysis of the watershed results. Gaps within surveyed reaches were unable to be assessed due to a variety of reasons, including water depths too great to allow safe access, overgrown areas, and areas accessed by private property where access permission was unable to be obtained.

3 Monitoring Methods

3.1 Data Collection Methods

Field data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC Quality Assurance Project Plan (QAPP) (BASMAA 2012a) and Standard Operating Procedures (SOP) (BASMAA 2012b). These documents were provided in final draft form to the Water Board with earlier RMC Monitoring Status Reports and will be finalized in 2013 to reflect lessons learned through 2012 implementation; these revisions will also incorporate updated data Quality Assurance procedures consistent with added data checking functions of the RMC database to supplement the tools available through SWAMP. The SOPs relevant to the monitoring discussed in this report are listed in Table 3-1.

Table 3-1: Standard Operating Procedures Pertaining to BASMAA RMC Monitoring at Targeted Sites.

SOP #	SOP Title
FS-1	BMI and Algae Bioassessments, and Physical Habitat Measurements
FS-2	Water Quality Sampling for Chemical Analysis, Pathogen Indicators, and Toxicity
FS-3	Field Measurements, Manual
FS-4	Field Measurements, Continuous General Water Quality
FS-5	Temperature, Automated, Digital Logger
FS-7	Field Equipment Cleaning Procedures
FS-8	Field Equipment Decontamination Procedures
FS-9	Sample Container, Handling, and Chain of Custody Procedures
FS-10	Completion and Processing of Field Datasheets
FS-11	Site and Sample Naming Convention
N/A	Unified Stream Assessment: A User's Manual, v2.0

This section provides a brief overview of methods employed to measure each parameter in the targeted monitoring design. Greater detail on each method is included in the referenced SOPs.

3.1.1 Continuous Temperature Monitoring

All sampling conformed to protocols identified in the RMC QAPP and SOPs (Table 3-1). Field crews deployed digital temperature loggers at eight sites according to those dates specified in Table 3-2. Temperature loggers were programmed to record temperature data at sixty-minute intervals.

Table 3-2. Continuous Water Temperature Monitoring at Alameda County Targeted Monitoring Locations.

Site Code (RMC No)	Watershed	Latitude	Longitude	Install Date	Mid-term download	Removal Date
204CRW030	Crow Creek	37.70056	-122.05500	April 26	June 28	Sept 25
204CRW050	Crow Creek	37.71750	-122.03750	April 26	June 28	Sept 25
204SAU035	Sausal Creek	37.79126	-122.22140	April 30	June 28	Oct 4
204SAU070	Sausal Creek	37.80745	-122.21589	April 30	June 28	Oct 4
204SAU090*	Sausal Creek	37.81197	-122.21391	July 10	June 28	Oct 4
204SAU100	Sausal Creek	37.81735	-122.21061	April 30	June 28	Oct 4
204SAU110	Sausal Creek	37.81894	-122.20756	April 30	June 28	Oct 4
204SAU200	Sausal Creek	37.81903	-122.20748	April 30	June 28	Oct 4

* Logger was noted missing on June 28. Logger was replaced July 10, 2012.

3.1.2 General Water Quality Measurements

General water quality monitoring included continuous measurements for temperature, DO, pH and specific conductivity at three sites: CVY005, CRW030 and SLO065. Parameters were measured for a period of between one and two weeks twice per year, once during the spring and again during the August – September timeframe (Table 3-3). All sampling conformed to protocols identified in the RMC QAPP and SOPs.

Automated monitoring equipment (YSI 6600 Sonde) was deployed with the data recorded automatically at fifteen-minute intervals.

Table 3-3. General Water Quality Monitoring at Alameda County Targeted Monitoring Locations.

Site Code (RMC No)	Watershed	Latitude	Longitude	Spring Monitoring	Early Fall Monitoring
204CVY005	Castro Valley Creek	37.67846	-122.08011	6/7/12 - 6/19/12	8/29/12 - 9/11/12
204CRW030	Crow Creek	37.70056	-122.05500	5/23/12 - 6/5/12	9/13/12 - 9/25/12
204SLO065 – Spring*	San Lorenzo Creek	37.67795	-122.08014	6/7/12 - 6/19/12	NA
204SLO065 – Fall*	San Lorenzo Creek	37.67801	-122.08066	NA	8/29/12 - 9/11/12

*slight adjustments to the 204SLO065 monitoring site were made to optimize water depth over the unit at differing flows in Spring and Fall.

3.1.3 Pathogen Indicators Sampling

Field crews collected water samples for analysis of pathogen indicators, specifically *Escherichia coli* (*E. coli*) and fecal coliform, at five sites on July 11, 2012. The sampling sites were 204CVY020, 204CVY080, 204CVY120, 204CVY140 and 204CVY150. Single samples were collected for pathogen indicator enumeration in accordance with the requirements of the permit. It should be noted that his sampling strategy is different to the USEPA sampling protocol where a series of five samples are collected in order to estimate a geometric mean.

Field crews conducted pathogen indicator sampling using the RMC SOPs (Table 3-1). Sampling techniques included direct filling of containers, and immediate transfer of samples to analytical laboratories within specified holding time requirements.

3.1.4 Stream Surveys

Field crews conducted stream surveys using the RMC SOPs. Procedures were modified from *Unified Stream Assessment: A User's Manual* (Center for Watershed Protection, 2005) by SCVURPPP to better reflect conditions in urbanized streams (SCVWD 2005). The Unified Stream Assessment (USA) uses visual observations and limited measurements taken during a continuous walk of accessible portions of the targeted creek corridor to rapidly evaluate creek conditions, problems, and opportunities for improvement within the urban creek corridor.

In order to increase survey efficiency and be consistent with previous investigations performed for the ACCWP (e.g., EOA 2006), minor modifications were made to the standard USA protocol in the way in which assessed information was recorded. Modified versions of several impact forms were used when less detailed data were needed for the purposes of the assessment. For example, in place of using a separate sheet to record each occurrence of an outfall, stream crossing, and utility within a reach, field crews compiled information for multiple occurrences of these on a single form.

The USA protocol includes separating the creek corridor into survey reaches. Each reach represents a relatively uniform set of conditions within the creek corridor. Factors that contribute to delineating a reach include land use in the immediate vicinity, elevation, creek order, access, and total length. In this study, reaches were identified and delineated by the ACCWP Program Coordinator, began and ended at major creek crossings or grade changes. Creek sections that were inaccessible (due to factors such as culverts, vegetation, or access permission not granted) were not assessed.

A single overall reach assessment was conducted for each reach. The reach level assessment qualitatively evaluated characteristics such as base flow, dominant substrate, water clarity, biota, shading, and active channel dynamics. In addition, each reach was ranked for overall creek condition and overall buffer and floodplain condition based on eight subcategories:

- instream habitat;
- vegetative protection;
- bank erosion;
- floodplain connection;
- vegetated buffer width;
- floodplain vegetation, floodplain habitat; and
- floodplain encroachment.

Each subcategory was given a score on a 20-point scale. The subcategory scores were summed to give a total reach score ranging from zero (poor condition) to 160 (optimal condition).

Per the USA protocol, field datasheets were completed to identify within each reach the locations and general characteristics of seven potential creek impacts:

- erosion;
- channel modification;
- outfalls;
- creek crossings;
- trash/debris;
- utilities; and
- miscellaneous features.

All survey work was completed between September 26, 2012 and October 12, 2012. Approximately 8.6 miles of the targeted nine miles were assessed during the effort. Inability to complete the full nine creek miles was due to private property access issues and stream reaches that were not wadable. The remaining 0.4 miles are planned to be made up during 2013 sampling efforts.

3.1.5 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012a). Data Quality Objectives (DQOs) were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-survey field training and *in-situ* field assessments were conducted. Data were collected according to the procedures described in the relevant SOPs, including appropriate documentation of data sheets and samples, and sample handling and custody. Laboratories providing analytical support to the RMC were selected based on demonstrated capability to adhere to specified protocols.

3.2 Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the Local Monitoring Coordinator or Quality Assurance Officer, and compared both against the methods and protocols specified in the SOPs and QAPP. The findings and results then were evaluated against the relevant DQOs to provide the basis for an assessment of programmatic data quality. The data quality assessment included the following elements:

- Conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc;
- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples;
- Results of duplicate analyses based on calculation of relative percent differences (precision results);
- Results of field blanks associated with filtered samples (bias results)
- Results of spiked sample analyses based on spike percent recovery (accuracy results); and
- Identification of any contamination issues based on analyses of lab blanks and field blanks

3.3 Data Analysis and Interpretation

Continuous temperature and general water quality data were plotted as box plots[5] for each site during each deployment.

The hourly water temperature measurements were calculated as daily arithmetic means over a 24-hour period from midnight to 11:00 PM. Seven-day "rolling" average stream temperatures were calculated for each day, beginning on deployment Day 7, by averaging temperatures collected at fifteen-minute intervals throughout the previous seven days. Seven-day rolling averages for general water quality parameters were calculated in a similar fashion, although the

[5] A box plot splits the data set into quartiles. The body of the plot consists of a "box", which goes from the first quartile to the third quartile. Within the box, a vertical line is drawn at the median of the data set. Two horizontal lines, called whiskers, extend from the front and back of the box. The front whisker goes from the first quartile to the smallest non-outlier in the data set, and the back whisker goes from the third quartile to the largest non-outlier. If the data set includes one or more outliers, they are plotted separately as points.

frequency of measurements was higher (15 minutes for general water quality vs. one hour for continuous temperature)

Targeted monitoring data were evaluated against Water Quality Objectives or other applicable thresholds, as described in Table 5-1, to determine whether results may "trigger" a potential stressor/source identification monitoring project (per MRP Provision C.8.d.i). Sites that exceed triggers for one or more parameters may be eligible for consideration as a Stressor/Source Identification project per MRP Provision C.8.d.i.

4 Results

4.1 Statement of Data Quality

Field data sheets and laboratory reports were reviewed by the local Monitoring Coordinator or Program Quality Assurance Officer, and the results evaluated against the relevant DQOs as described in the QAPP (BASMAA, 2012a) and SOPs (BASMAA, 2012b). Results were compiled for the qualitative metrics (representativeness and comparability), as well as the quantitative metrics (completeness, sensitivity [detection and quantization limits], precision, accuracy, and contamination). The following sections (4.1.1 - 4.1.6) provide summaries of all pertinent data quality issues from the Water Year 2012 and corrective actions to address data quality issues.

4.1.1 Method Deviations

There were no deviations from the methods provided in the QAPP with the exception of pathogen indicator analyses where Standard Methods 9221 was used instead of the IDEXX Quantitray method. Both use a most probable number analysis and therefore have comparable results. Corrective action: QAPP DQOs associated with analysis of fecal indicator bacteria will be reviewed and revised prior to 2013 Creek Status Monitoring implementation to ensure consistency of methods with QAPP requirements.

4.1.2 Number of Measurements Taken Compared to Planned

There were no deviations from the planned number of samples collected described in the QAPP with the exception of:

- Stream Survey miles – a total of 8.6 stream miles were surveyed during the Water Year 2012 instead of the target of nine miles due to issues regarding accessing target stream reaches. Corrective action: additional stream miles will be collected in Water Year 2013 in order to compensate.

- Water temperature loggers – Due to the theft of the data logger at Site SAU090, there are no data reported for the period May 6, 2012 through July 16, 2012, when a replacement logger was installed. Corrective action: none.

- Bacteria pathogen indicator data – laboratory blanks and duplicates were not collected for the bacteria analysis. Therefore results for *E.coli* and fecal coliforms are qualified with VQCA,VQCP flags for not meeting minimum quality objectives (MQO) for accuracy and precision. Corrective action: laboratory duplicates and blanks will be conducted on 5% of future samples.

4.1.3 Non-detects – Reporting Limits Not Met

4.1.4 Precision Results

Bacterial pathogen enumeration results were flagged with the VQCP qualifier as noted in Section 4.1.2 during Water Year 2012.

4.1.5 Accuracy Results

No matrix spike samples were found to be outside of acceptable percent recovery range collected during Water Year 2012.

4.1.6 Contamination Issues

There were no contamination issues observed in any of the samples, as determined by field and laboratory blanks collected during Water Year 2012.

4.2 Monitoring Results

This section presents monitoring results based on each program component. Each section addresses the study question:

> *What are the ranges of general water quality, continuous water temperature, pathogen indicators, and stream ecosystem conditions at locations sampled in the Program area?*

4.2.1 Continuous Water Temperature Monitoring

Data were collected over a five-month period with measurements recorded at 60-minute intervals. Continuous temperature monitoring was conducted at eight locations within two watersheds: Crow Creek and Sausal Creek.

4.2.1.1 Crow Creek

Continuous monitoring was conducted from April 26th through September 25th at two sites within the Crow Creek sub-watershed (CRW030 and CRW050).

Figure 4-1 presents the results of the continuous monitoring results for those two locations. Box plots of the temperature data are shown in Figure 4-2.

The average temperature recorded at the CRW030 site was 16.6ºC with a minimum of 12.4ºC and a maximum of 22.9ºC. At Site CRW050 the average temperature was 14.7ºC with a minimum temperature of 10.2ºC and a maximum temperature of 20.3ºC.

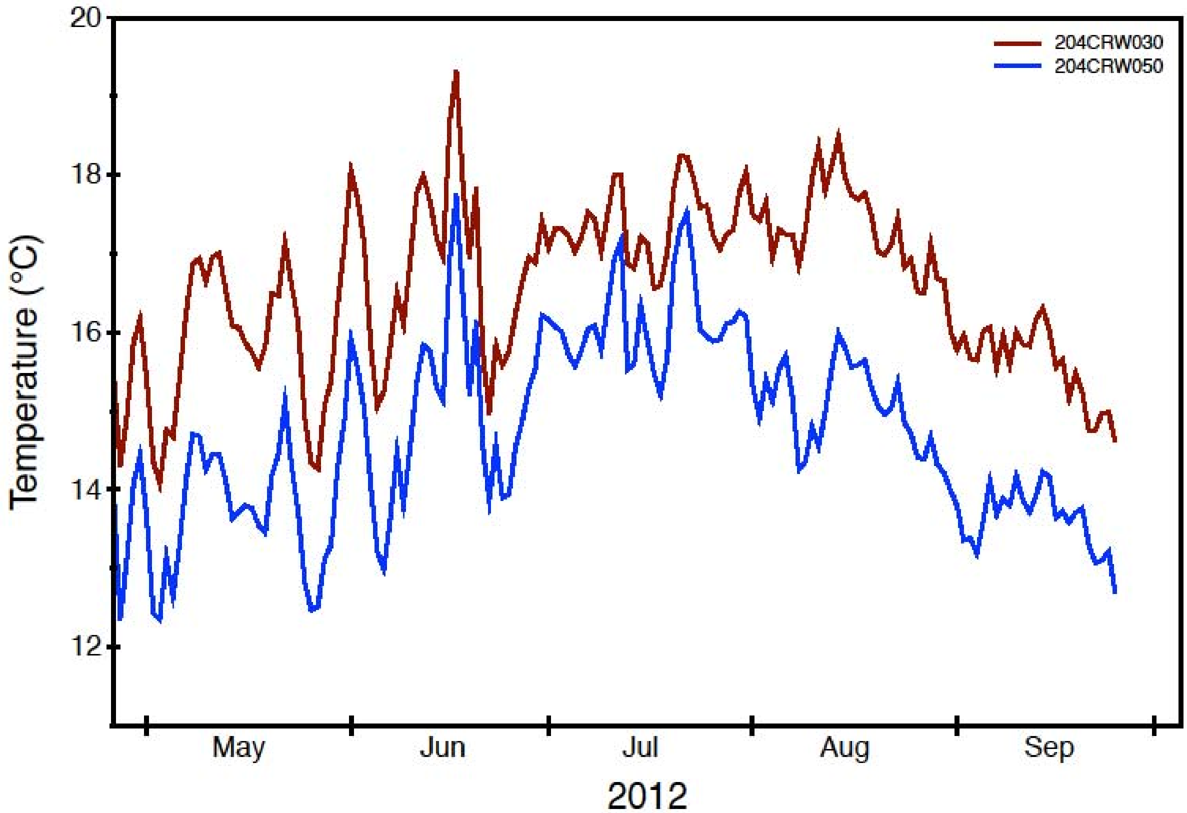

Figure 4-1. Temperature (7 Day Rolling Average Calculated Daily) Line Graph at Crow Creek, May 2 through September 25, 2012.

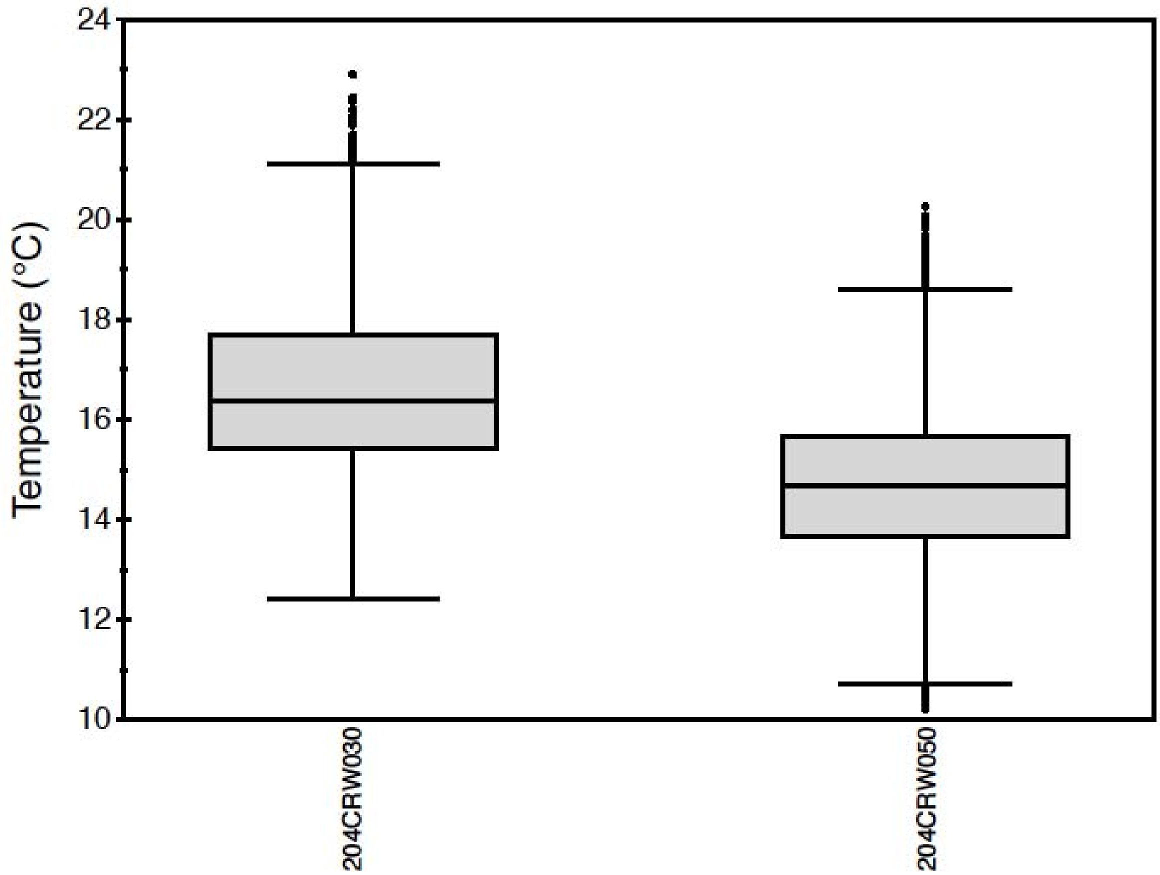

Figure 4-2. Temperature Box Plot at Crow Creek, May 2 through September 25, 2012.

4.2.1.2 Sausal Creek

Continuous monitoring was conducted at six locations within the Sausal Creek sub-watershed (SAU035, SAU070, SAU090, SAU100, SAU110 and SAU200). Monitoring was conducted between April 30 and September 25, 2012. Average temperatures ranged between 14.3°C and 15.6°C. The minimum temperature recorded was 10.7°C at sites 204SAU070 and 204SAU110. The maximum temperature recorded was 20.6°C at site 204SAU035.

Figure 4-3 shows the results of the continuous monitoring results for locations within the Sausal Creek sub-watershed. Box plots of the temperature data are shown in Figure 4-4.

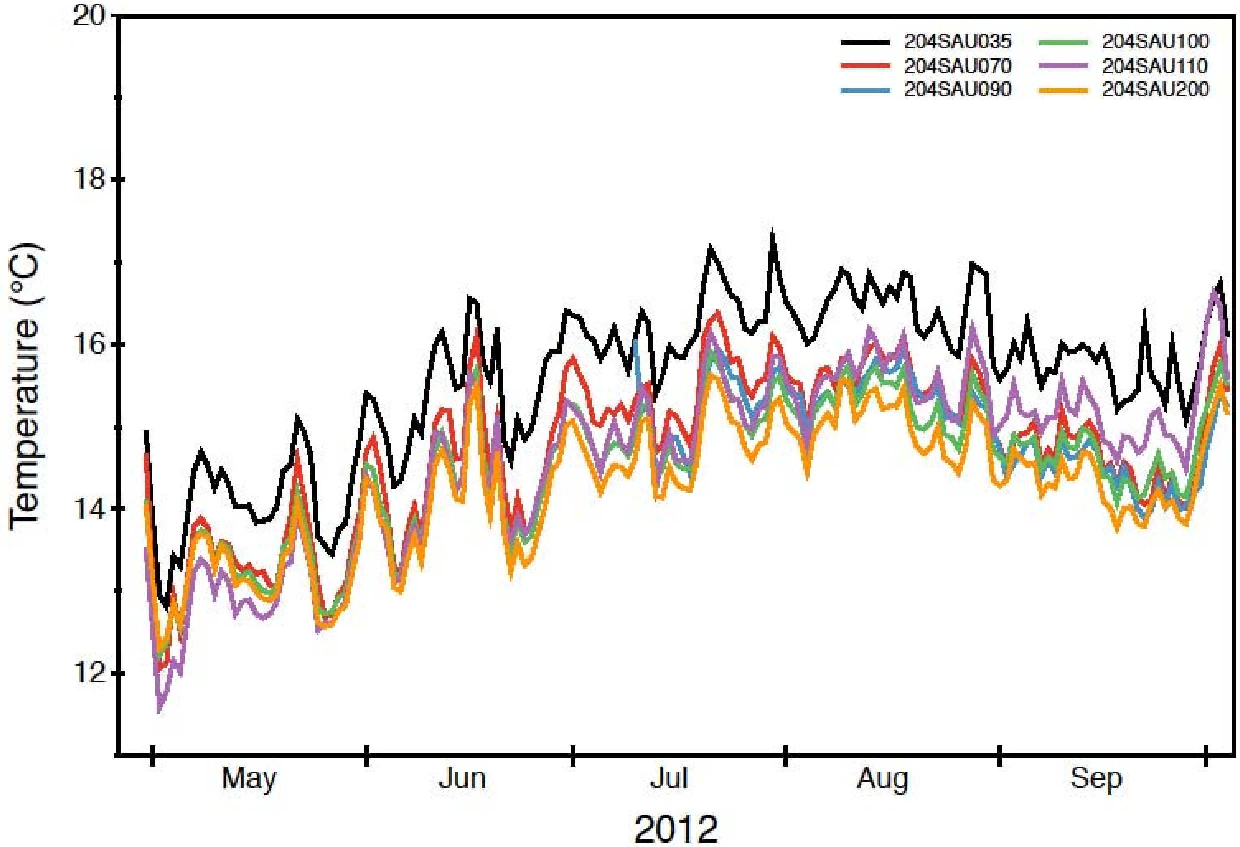

Figure 4-3. Temperature (7 Day Rolling Average Calculated Daily) Line Graph at Sausal Creek, May 6 through September 25, 2012.

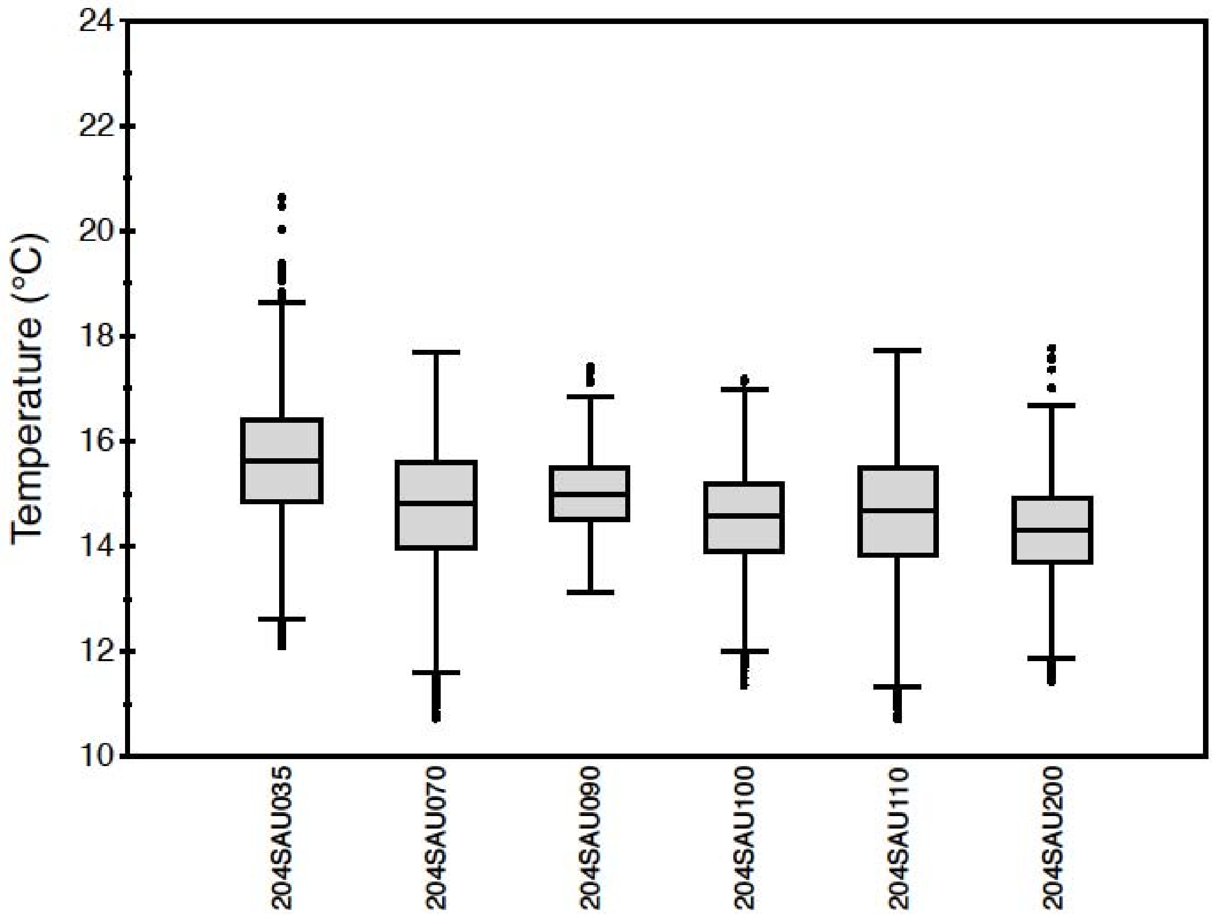

Figure 4-4. Temperature Box Plot at Sausal Creek, May 6 through September 25, 2012.

4.2.2 General Water Quality Measurement

General water quality measurements of temperature, DO, pH and specific conductivity were taken at three locations during both Spring (May and June) and Fall (August and September). These data were collected from:

- 204SLO065 – San Lorenzo Creek above confluence with Castro Valley;
- 204CVY005 – Castro Valley Creek above confluence with San Lorenzo; and
- 204CRW030 – Crow Creek below confluence with Cull Creek.

4.2.2.1 Temperature

Temperature measurements were recorded at fifteen-minute intervals for a seven- to fourteen-day period at three locations. The data presented in this section represent the collation of those measurements.

The box plots in Figure 4-5 illustrate the collated temperature measurements at the three monitoring locations. Spring temperatures were, in general, higher than Fall temperatures. Site 204SLO065 temperatures were, in general, higher than the other two sites, with the highest recorded temperature of 22.2 °C on June 17, 2012. The lowest temperature (13.43 °C) was recorded at Site 204CRW030 on May 27, 2012.

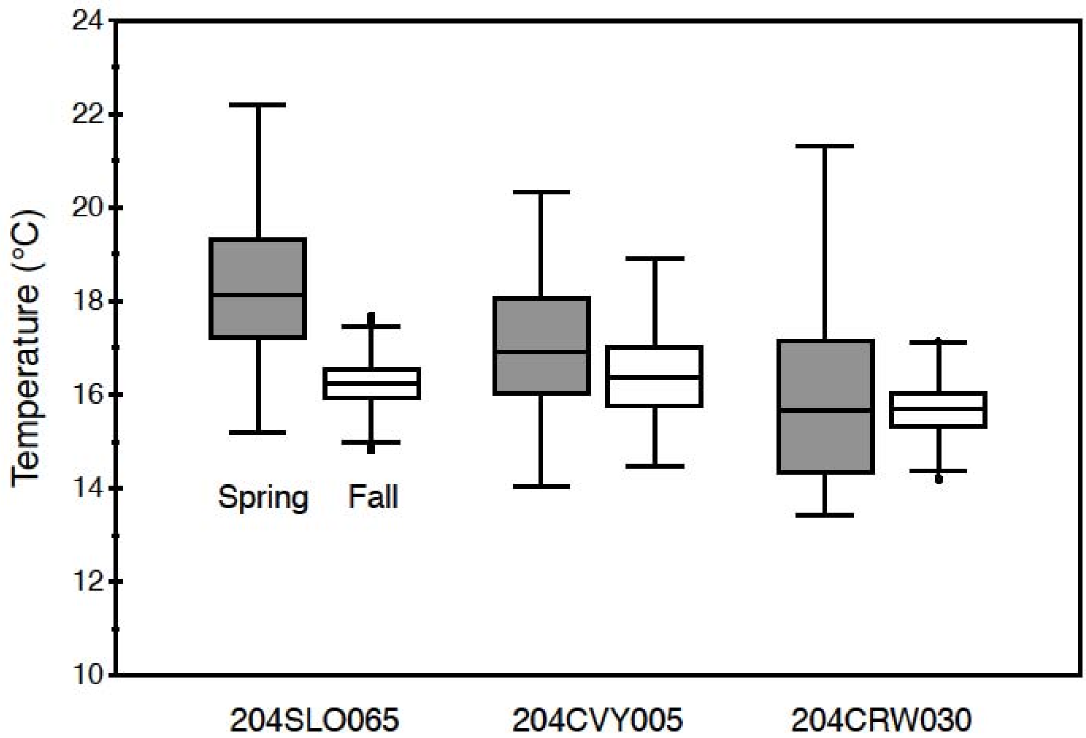

Figure 4-5. Temperature Box Plot for Spring (May and June) and Fall (August and September).

Figure 4-6 presents daily mean temperature (left) and the seven-day rolling mean (right) for the three monitoring locations. The results indicate daily fluctuations of up to approximately two degrees per day with the greatest fluctuations occurring in Spring. Fluctuations in temperature were less pronounced in Fall at all three sites. The rolling means generally suggest increasing temperatures in Spring and decreasing temperatures in Fall.

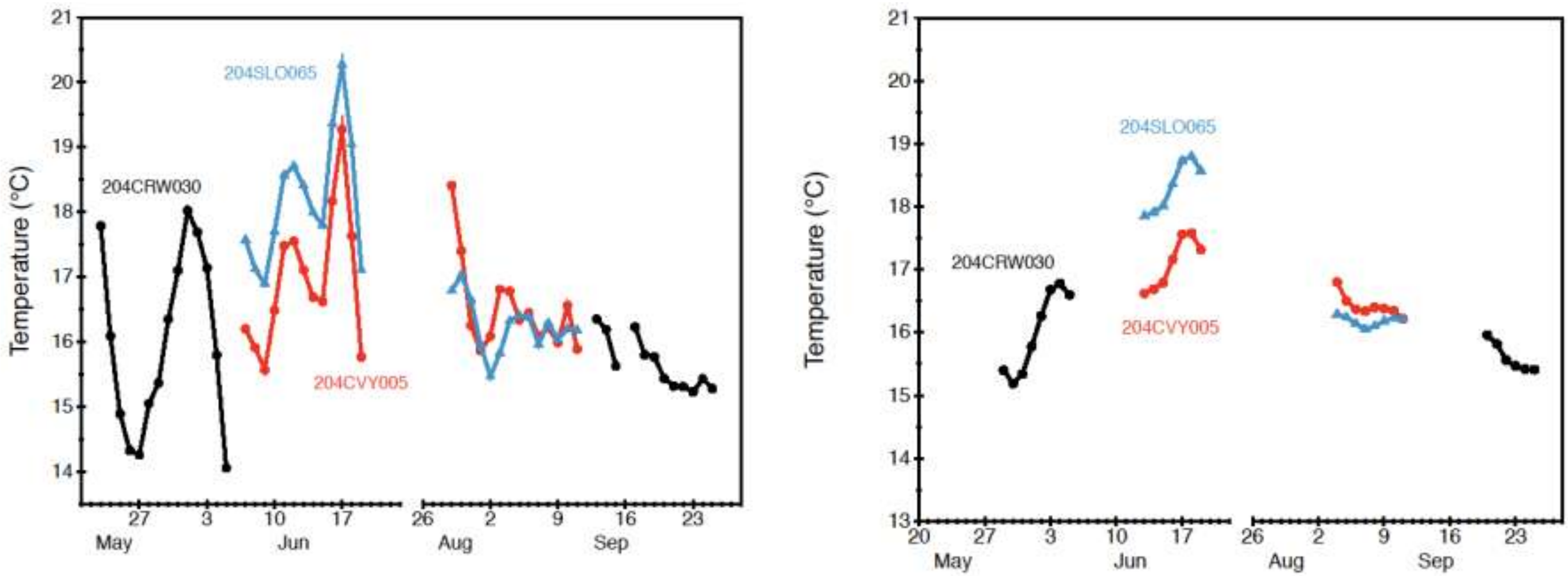

Figure 4-6. Temperature Line Graph of Daily Mean (left) and 7-Day Rolling Mean (right) in Spring (May and June) and Fall (August and September).

4.2.2.2 Dissolved Oxygen

Dissolved oxygen measurements for each site are provided as box plots in Figure 4-7.[6] The data suggest that, in general, DO ranged from 7mg/L to 10mg/L. The highest DO measurement of 11.8mg/L was recorded on May 27, 2012 at Site 204CRW030. This site also recorded the lowest DO measurement of 1.86mg/L, on September 22, 2012.

The daily mean and seven-day rolling mean results are provided in Figure 4-8. These data show that all Spring daily mean DO concentrations were above 7mg/L. Fall daily mean data at Site 204CRW030 were consistently lower than 8mg/L but above 5mg/L.

The fluctuating DO results from Site 204CRW030 can be explained in part by the site location since Site 204CRW030 is located directly downstream of an artificial reservoir, Cull Reservoir. It may be assumed that discharges or impeded flow from this reservoir impacts algal growth and associated DO concentrations in the downstream creek.

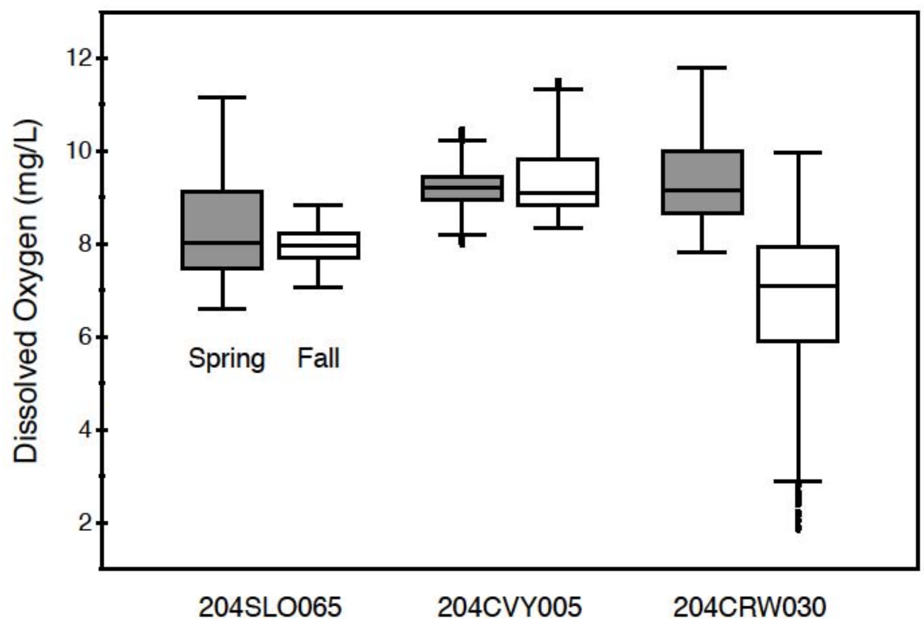

Figure 4-7. Dissolved Oxygen Box Plot for Spring (May and June) and Fall (August and September)

[6] Intermittent power failure (due to a leaking battery) for the YSI deployed in the fall at site 204CRW030 recording General Water Quality measurements prevented a complete record over the deployment period. Post-deployment calibration and drift checks passed all checks, therefore recorded data is viewed as compliant with QAPP DQOs.

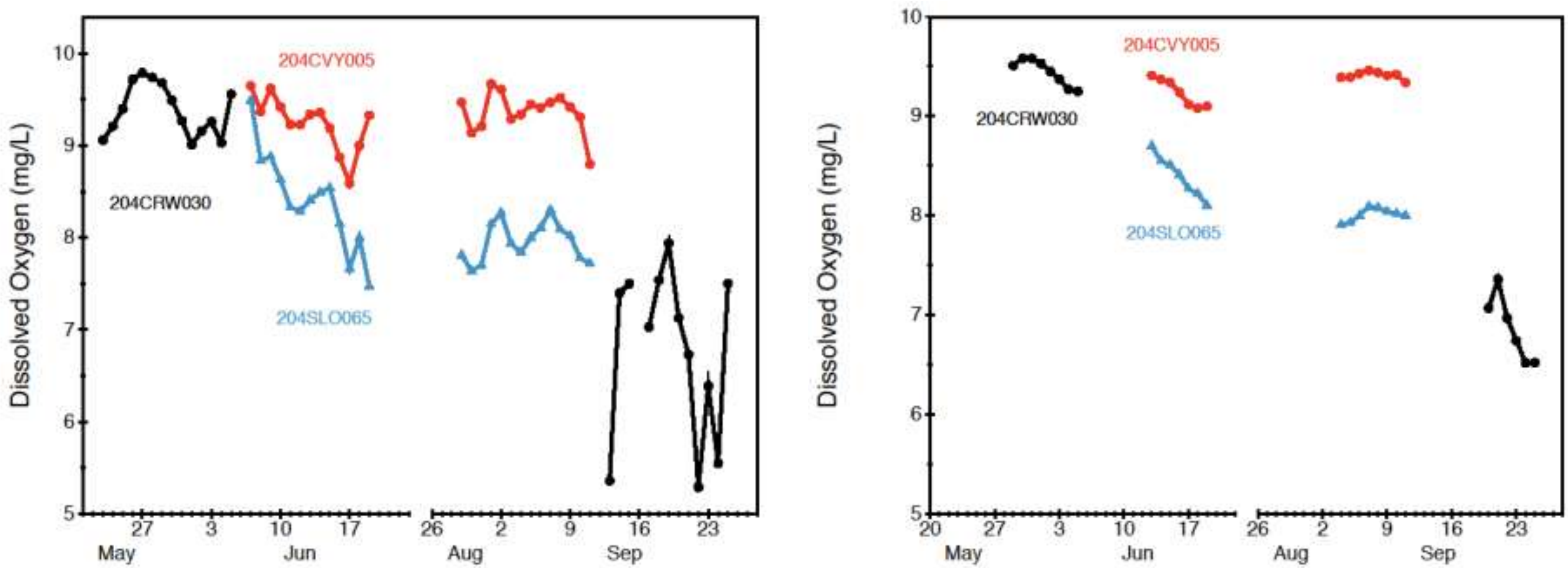

Figure 4-8. Dissolved Oxygen Line Graph of Daily Mean (left) and 7-Day Rolling Mean (right Results in Spring (May and June) and Fall (August and September).

4.2.2.3 pH

pH results are provided as box plots in Figure 4-9 with daily mean and seven-day rolling mean results provided in Figure 4-10. The results indicate that most pH measurements were within the range of 7.8 and 8.4. However, a number of data collected at Site 204CVY005 suggest fluctuating pH levels ranging up to 9.34.

The lowest pH measurement, of 7.87, was found at Site SLO065 on August 30, 2012. The highest pH measurement, of 9.34, was found at Site 204CVY005 on June 14, 2012.

Site SLO065 consistently displayed the lowest pH levels of the three sites. With the exception of some outliers found at Site 204CVY005, Site 204CRW030 had the highest average pH levels of the three sites.

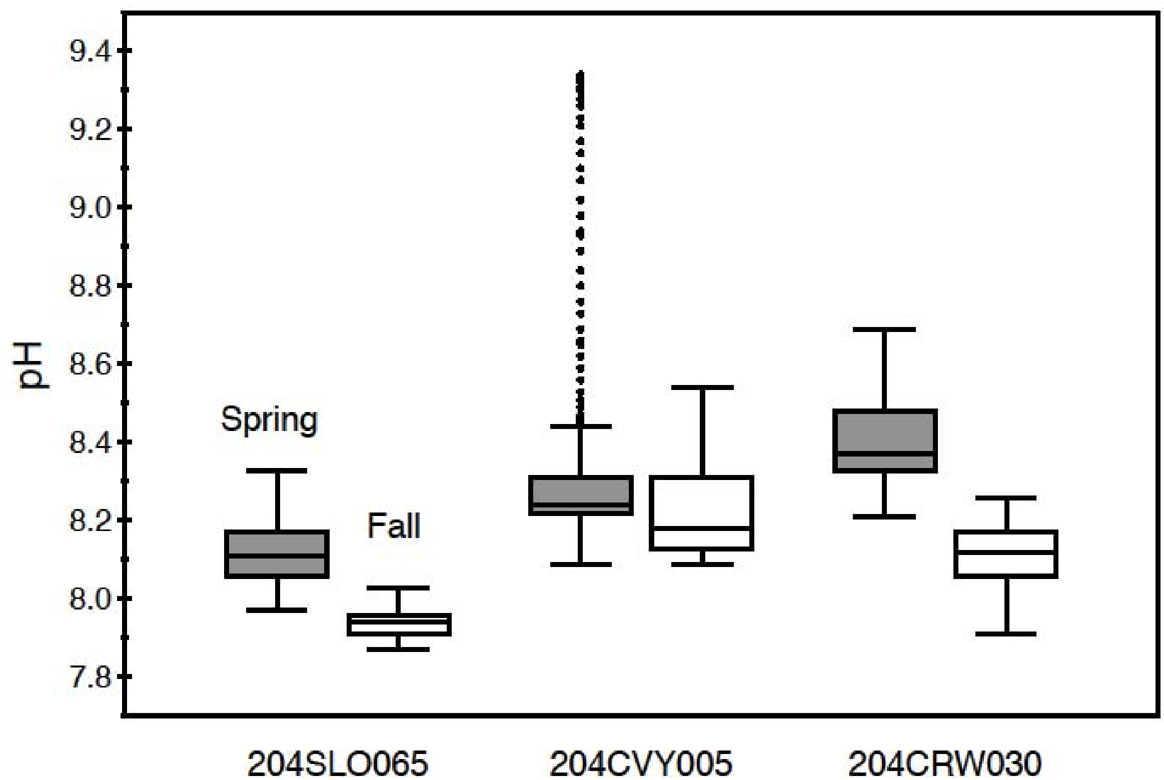

Figure 4-9. pH Box Plot for Spring (May and June) and Fall (August and September).

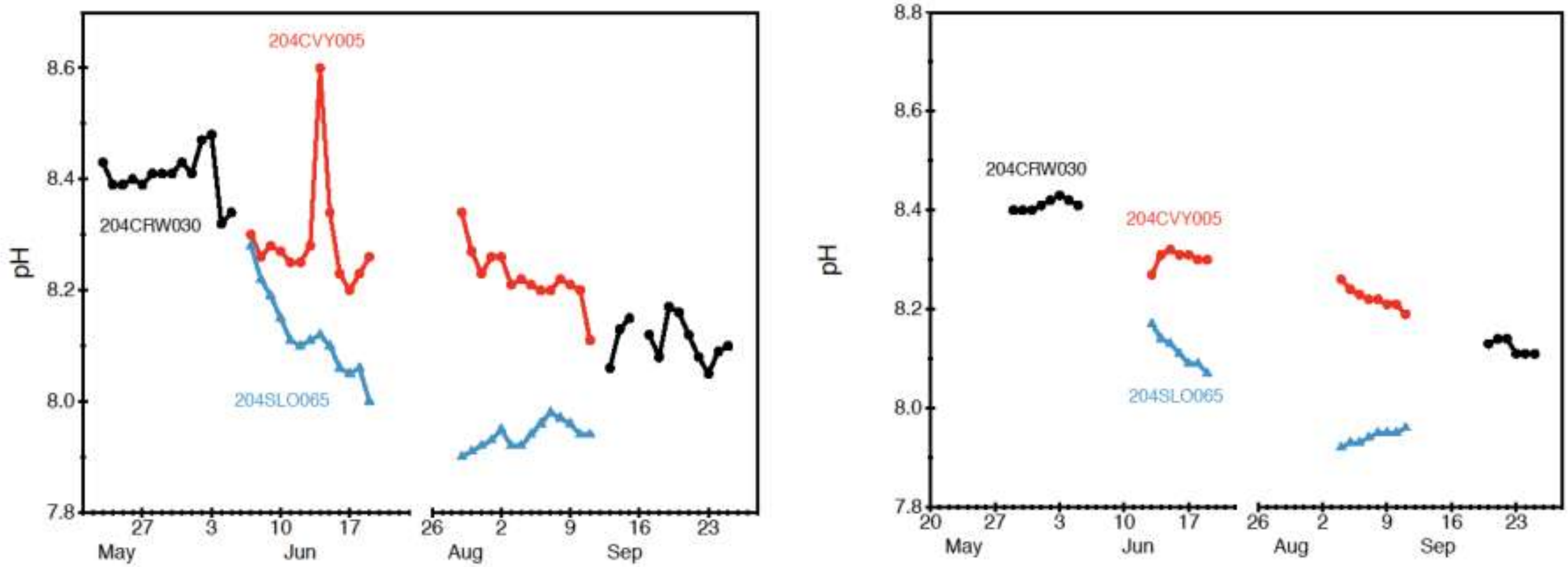

Figure 4-10. pH Line Graph of Daily Mean (left) and 7-Day Rolling Mean (right) in Spring (May and June) and Fall (August and September).

4.2.2.4 Specific Conductivity

Specific conductivity results, displayed as box plots, are shown in Figure 4-11 while daily mean and seven-day rolling mean data are provided in Figure 4-12. Specific conductivity was lowest at Site 204CVY005, on June 14, 2012 with 322µs/cm. Other outliers during the same Spring period were between 300 and 600µs/cm. The highest specific conductivity, of 1196µs/cm was measured at Site 204CRW030 on September 23, 2012 during Fall monitoring.

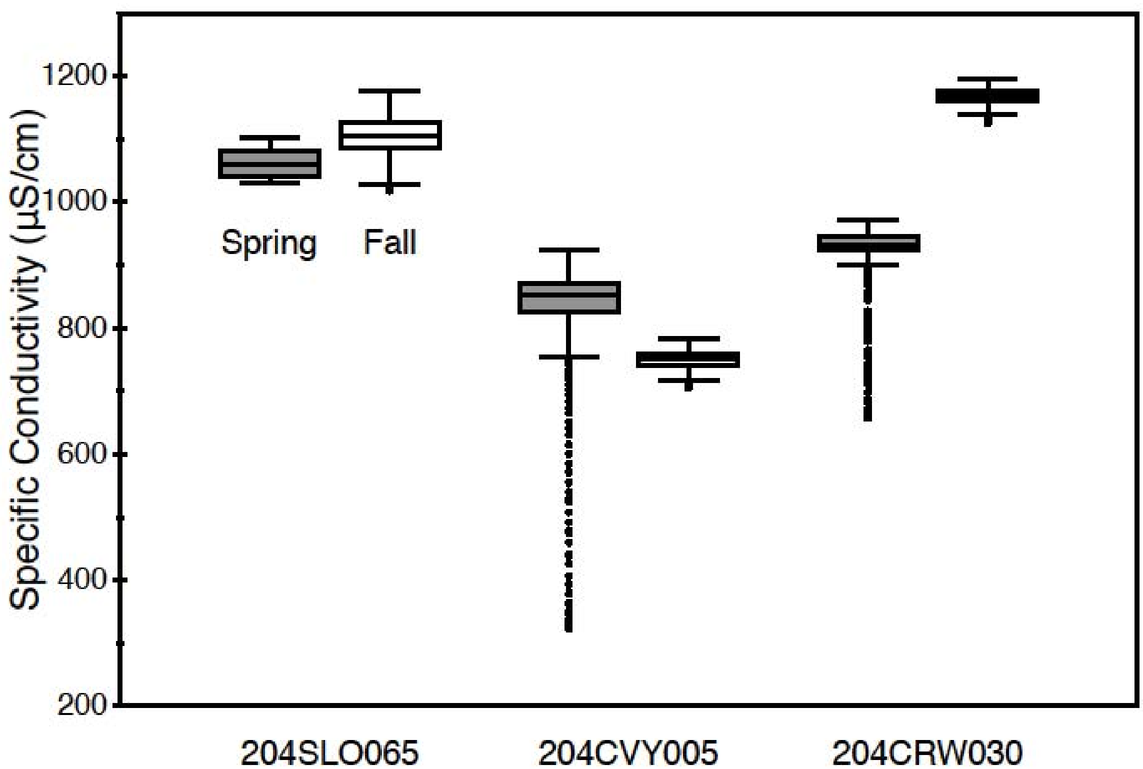

Figure 4-11. Specific Conductivity Box Plot for Spring (May and June) and Fall (August and September)

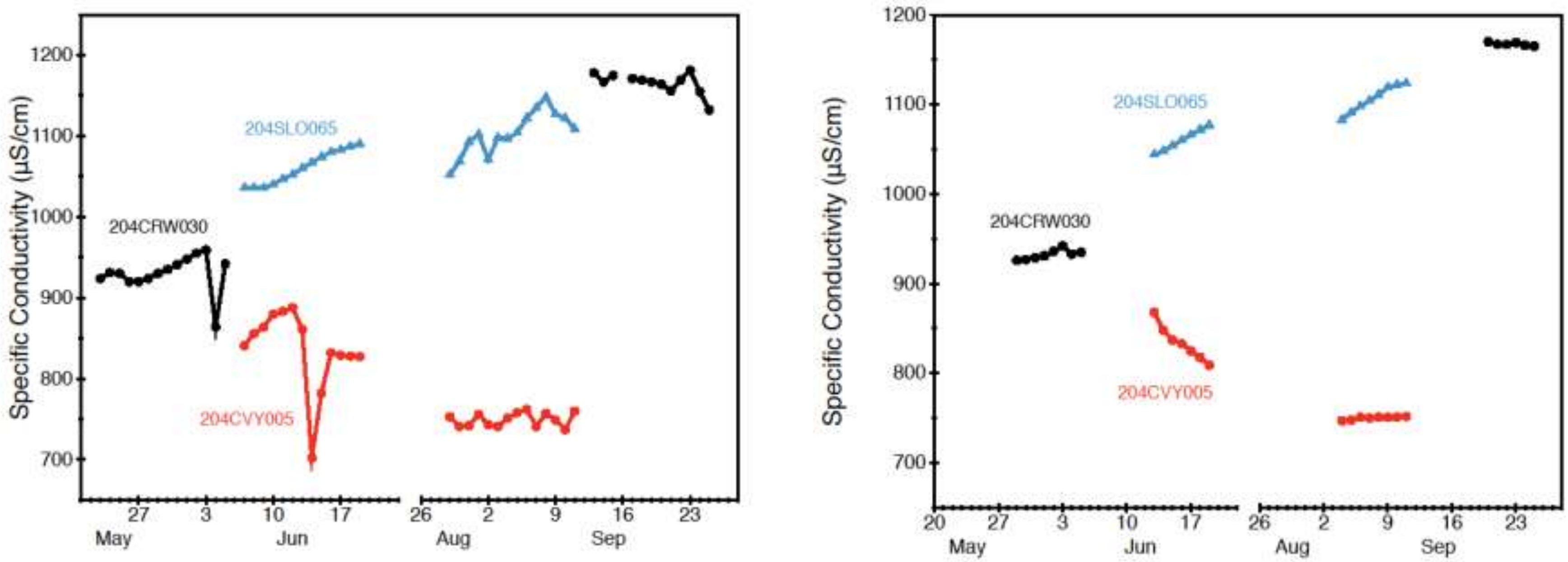

Figure 4-12. Specific Conductivity Line Graph of Daily Mean (left) and 7-Day Rolling Mean (right) in Spring (May and June) and Fall (August and September).

4.2.3 Pathogen Indicators

Grab water samples for pathogen indicators were taken at five locations in the Castro Valley Creek watershed on July 11, 2012. *E. coli* and fecal coliform were enumerated as individual grab samples as presented in Table 4-1. With the exception of one sample, the bacteria concentrations at each of the sampling sites were greater than or equal to 900MPN/100mL.

Elevated fecal indicator bacteria concentrations were found site 204CVY140 (greater than or equal to 16,000MPN/100mL). These results were 800m upstream of Site 204CVY120 where elevated bacteria concentrations were also found (1,700MPN/100mL). Because the concentrations of fecal indicator bacteria at Site 204CVY140 were outside the reporting limits of the dilution series used for enumeration, it is not possible to know the magnitude of the elevated values.

Table 4-1. Fecal coliform and *E. coli* enumerations at San Lorenzo Creek Watershed Monitoring Sites.

Site ID	Site Description	Creek Name	Fecal Coliform (MPN*/100mL)	*E. coli* (MPN*/100 mL)
204CVY020	Chabot Creek at Carlos Bee Park	Castro Valley	900	900
204CVY080	Castro Valley Creek above confluence with Chabot Creek	Castro Valley	900	900
204CVY120	CV Creek Park at Castro Valley Library	Castro Valley	1,700	1,700
204CVY140	Castro Valley Creek North side of Berdina Rd	Castro Valley	>/= 16,000	>/= 16,000
204CVY150	Castro Valley Creek North side of Heyer Ave	Castro Valley	500	500

*Most Probable Number

4.2.4 Stream Survey

The following section provides a summary of the Stream Survey portion of the compliance monitoring (AMS, 2013). The section is comprised of summary stream assessment data for:

- San Lorenzo Creek (Figure 4-13);
- Castro Valley Creek (Figure 4-15); and
- Chabot Creek (Figure 4-17).

4.2.4.1 San Lorenzo Creek

Stream survey assessment in mainstem San Lorenzo Creek was conducted between September 26 and 28, 2012, with a total assessed reach length of 24,147 feet or 4.57 miles. The general characteristics of the surveyed creek are presented in Table 4-2. The majority of the creek is comprised of concrete vertical channel with an average valley slope of 0.3%. It is anticipated that in Water Year 2013 further investigation of the inland reaches will occur. The focus of these reach surveys will encompass those areas with urban impact only. The stream assessment scores are provided in Table 4-3 and illustrated in Figure 4-14. The average score for the stream assessment within these reaches was 30.6, with Reach A having the highest score of 37 and Reaches D and I having the lowest score of 26. The San Lorenzo impact assessment summary is provided in Table 4-4. Slope failure was observed in Reach C and some trash was observed during assessment (including diapers, large electronics and some spray and chemical bottles). The majority of trash was found in Reaches B, E, and I.

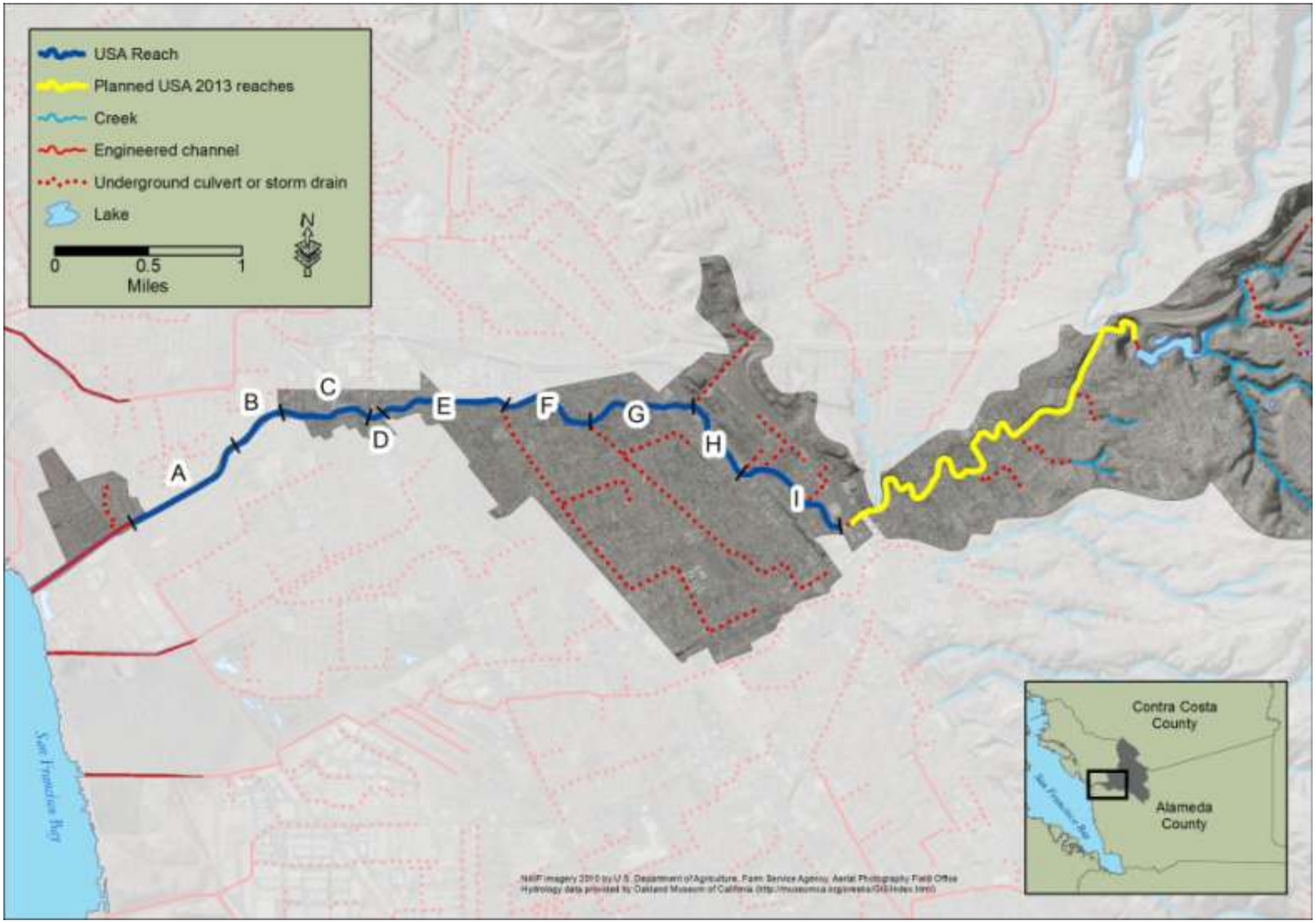

Figure 4-13. San Lorenzo Creek Subwatershed and USA Reaches (limited to areas of urban influence).

Table 4-2. Surveyed Reaches, San Lorenzo Creek

Reach	Geographic Extent	Reach Length (ft)	Valley Slope (%)	General Characteristics
A	Beginning to end of trapezoidal concrete channel.	3,787	0.1%	Concrete trapezoidal channel
B	Beginning of concrete vertical channel to east side of Via Alamitos.	1,680	0.3%	Concrete vertical channel
C	East side of Via Alamitos to the west side of Hesperian Blvd.	2,625	0.4%	Concrete vertical channel
D	West side of Hesperian Blvd. to the north east of Nimitz Freeway.	464	0.3%	Concrete vertical channel
E	North east side of Nimitz Freeway to the east of Meekland Ave.	3,612	0.3%	Concrete vertical channel
F	East side of Meekland Ave. to west side of train tracks.	2,761	0.4%	Concrete vertical channel
G	West side of train tracks to approx. 450 ft east of Mission Blvd.	3,172	0.4%	Concrete vertical channel
H	Approx. 450 feet E of Mission Blvd. to east of Grove Way.	2,445	0.4%	Concrete vertical channel
I	East of Grove Way to west of City Center Drive.	3,603	0.4%	Concrete vertical channel
K	East of Mission Blvd to confluence with Castro Valley Creek	--	--	Natural Chanel - Not surveyed due to water depth and safety issues.

Table 4-3. San Lorenzo Creek Unified Stream Assessment Scores for Each Reach by Assessment Parameter, Subtotals for Instream Condition and Floodplain/Buffer Condition and Total Reach Score.

Reach Number	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Overall Stream Condition									
Instream Habitat	5	1	1	0	1	1	1	1	1
Vegetative Protection (LB)	0	1	1	0	1	1	1	1	0
Vegetative Protection (RB)	0	1	1	0	1	1	1	1	0
Bank Erosion (LB)	10	10	10	10	10	10	10	10	9
Bank Erosion (RB)	10	10	9	10	10	10	10	10	9
Floodplain Connection	2	1	1	1	1	1	1	1	1
Instream Habitat Total Score	27	24	23	21	24	24	24	24	20
Overall Buffer and Floodplain Condition									
Vegetative Buffer Width (LB)	1	1	2	1	2	1	3	1	2
Vegetative Buffer Width (RB)	1	1	1	1	2	1	3	1	1
Floodplain Vegetation	4	2	2	1	1	2	3	2	1
Floodplain Habitat	2	1	1	1	1	1	1	1	1
Floodplain Encroachment	2	1	1	1	1	1	2	1	1
Floodplain and Buffer Total Score	10	6	7	5	7	6	12	6	6
Reach Assessment Total Score	**37**	**30**	**30**	**26**	**31**	**30**	**36**	**30**	**26**

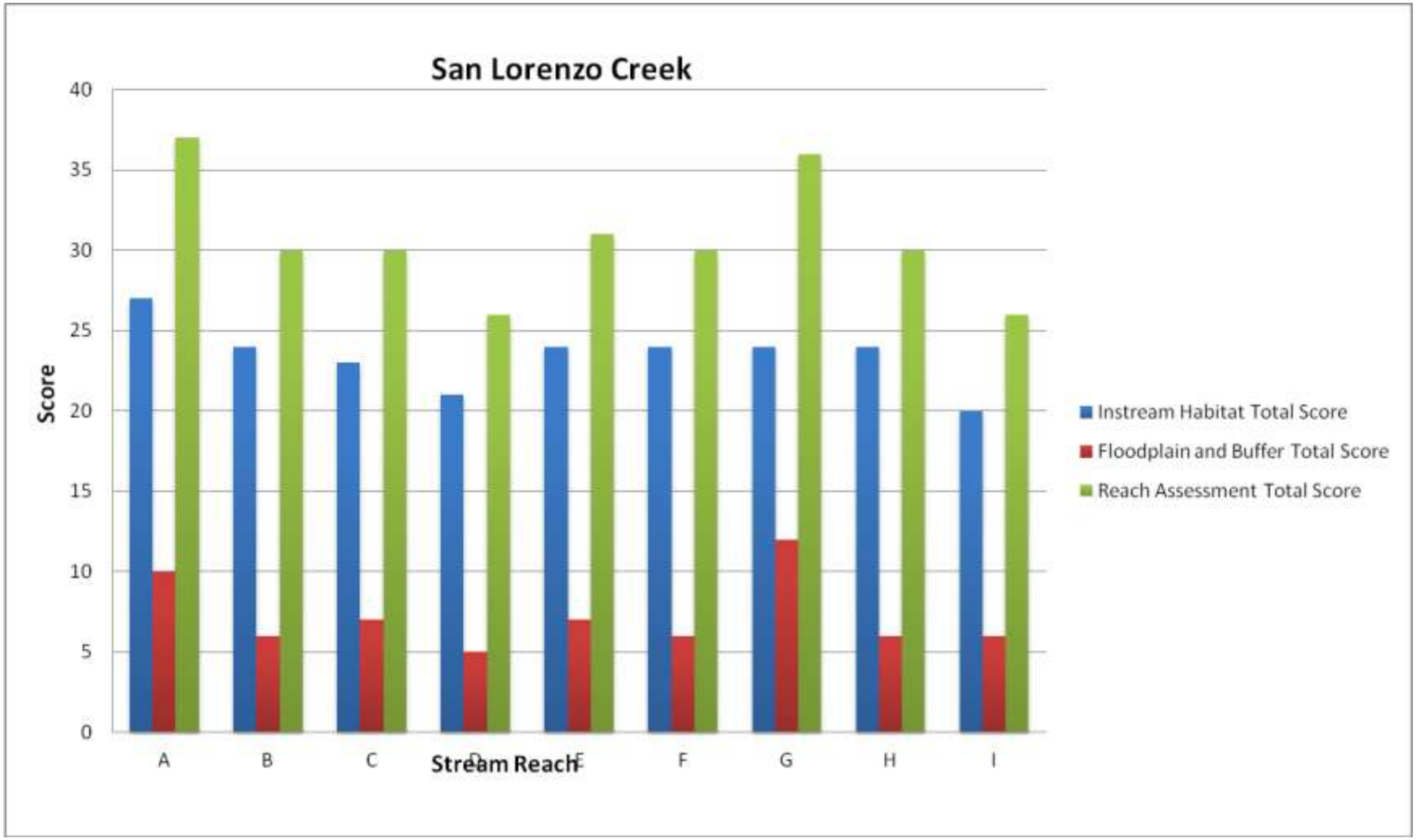

Figure 4-14. Bar Graph (3 bars/reach) of San Lorenzo Creek Unified Stream Assessment Scores: Total Reach Assessment, Instream Habitat Condition, Buffer and Floodplain Condition.

Table 4-4. San Lorenzo Creek Impact Assessment Summary of the Unified Stream Assessment Survey.

Reach Number	A	B	C	D	E	F	G	H	I
Reach Length (ft)	3,787	1,680	2,625	464	3,612	2,761	3,172	2,445	3,603
Outfalls									
Storm Drain Outfalls (8-24 inch diameter)	1	2	6	7	13	12	6	7	17
Other Outfalls (1-6 inch diameter)	0	0	0	0	1	0	0	0	0
Total Outfalls	1	2	6	7	14	12	6	7	17
Total per mile	1	6	12	80	20	23	10	15	25
Total Outfalls with dry weather flow	1	1	0	0	1	0	0	0	0
Channel Modification									
Channelization	X	X	X	X	X	X	X	X	X
Bank_Armoring	X	X	X	X	X	X	X	X	X
Hardened Bed	X	X	X	X	X	X	X	X	X
Drop Structure									
Total Length Modified	3787	1680	2625	464	3612	2761	3172	2445	3603
Percent Reach Modified	100	100	100	100	100	100	100	100	100
Erosion									
Downcutting									
Widening									
Slope Failure			X						
Aggrading									
Total Length	0	0	100	0	0	0	0	0	0
Percent Reach Eroded (%)	0	0	0	0	0	0	0	0	0
Stream Crossings									
Grade Control									
Fish Barrier (T-total; P-partial)									
Total Number of Crossings	1	1	1	3	3	1	3	1	1
Total Length Crossing	9	77	76	337	116	10	400	42	41
Percent Reach Crossing	0%	5%	3%	73%	3%	0%	13%	2%	1%
Trash									
Total Number of Trash Sites	0	1	0	0	1	0	0	0	1
Source: L-Litter; ID-Illegal Dumping; A-Accumulation	NA	L	NA	NA	L	NA	NA	NA	L
Recreation									
Total Number of Rec Sites	0	0	0	0	0	0	0	0	0
Access: Pub- Public; Pvt-Private									
Swimming Potential: Hi; Med; Low									

4.2.4.2 Castro Valley Creek

Stream survey assessment in Castro Valley Creek was conducted between October 3 and 13, 2012 with a total assessed reach length of 13,126 feet or 2.49 miles (Figure 4-15). Details of the surveyed reaches in Castro Valley are provided in Table 4-5. The majority of the creek is comprised of trapezoidal concrete channel, with some natural channel. The average valley slope was determined to be 1.8%. The stream assessment scores are provided in Table 4-6 and illustrated in Figure 4-16. The highest stream assessment score (86) was observed in Reach I. The lowest stream assessment score of 31 was observed in Reach C. The impact assessment summary for Castro Valley streams is provided in Table 4-7. Channel modification is prevalent throughout the reaches with slope failure noted in Reach A. Reach A was also noted as having potential recreational use.

Table 4-5. Surveyed Reaches, Castro Valley Creek

Reach	Geographic Extent	Reach Length (ft)	Valley Slope (%)	General Characteristics
A	Confluence of San Lorenzo and Castro Valley Creek south of City Center Drive to confluence with Chabot Creek east of North 3rd St. and Knox St.	1,384	1.7%	Natural channel
B	Confluence with Chabot Creek to south side of Grove Way	--	--	Natural channel. Not surveyed in 2012 due to access issues.
C	North of Grove Way to East of Redwood Rd	968	0.6%	Trapezoidal concrete channel
E	North east of Redwood Rd to southwest of Watson St	769	0.2%	Trapezoidal concrete channel
H	North of 580 Freeway to southwest of Norbridge Ave.	500	0.8%	Trapezoidal concrete channel
I	North of Norbridge Ave to southwest of Castro Valley Blvd	933	0.2%	Trapezoidal concrete channel
K	121 ft northeast of Castro Valley Blvd to 108 ft south of Catalina Dr.	328	1.4%	Natural channel
M	East of Meadowlark Ct to south of Heyer Ave	2,478	0.1%	Concrete channel
N	South of Heyer Ave to south of Seven Hills Rd	2,068	3.4%	Concrete channel / natural channel
O	South of Seven Hills Rd to south of Seaview Ave	1,066	3.0%	Concrete channel
P	South of Seaview Ave to 518 ft north of Seaview Ave	822	3.0%	Concrete channel
Q	18457 Madison Ave to 17823 Madison Ave	871	2.4%	Natural channel
R	18457 Madison Ave to 17580 Commons Rd	940	4.5%	Natural channel

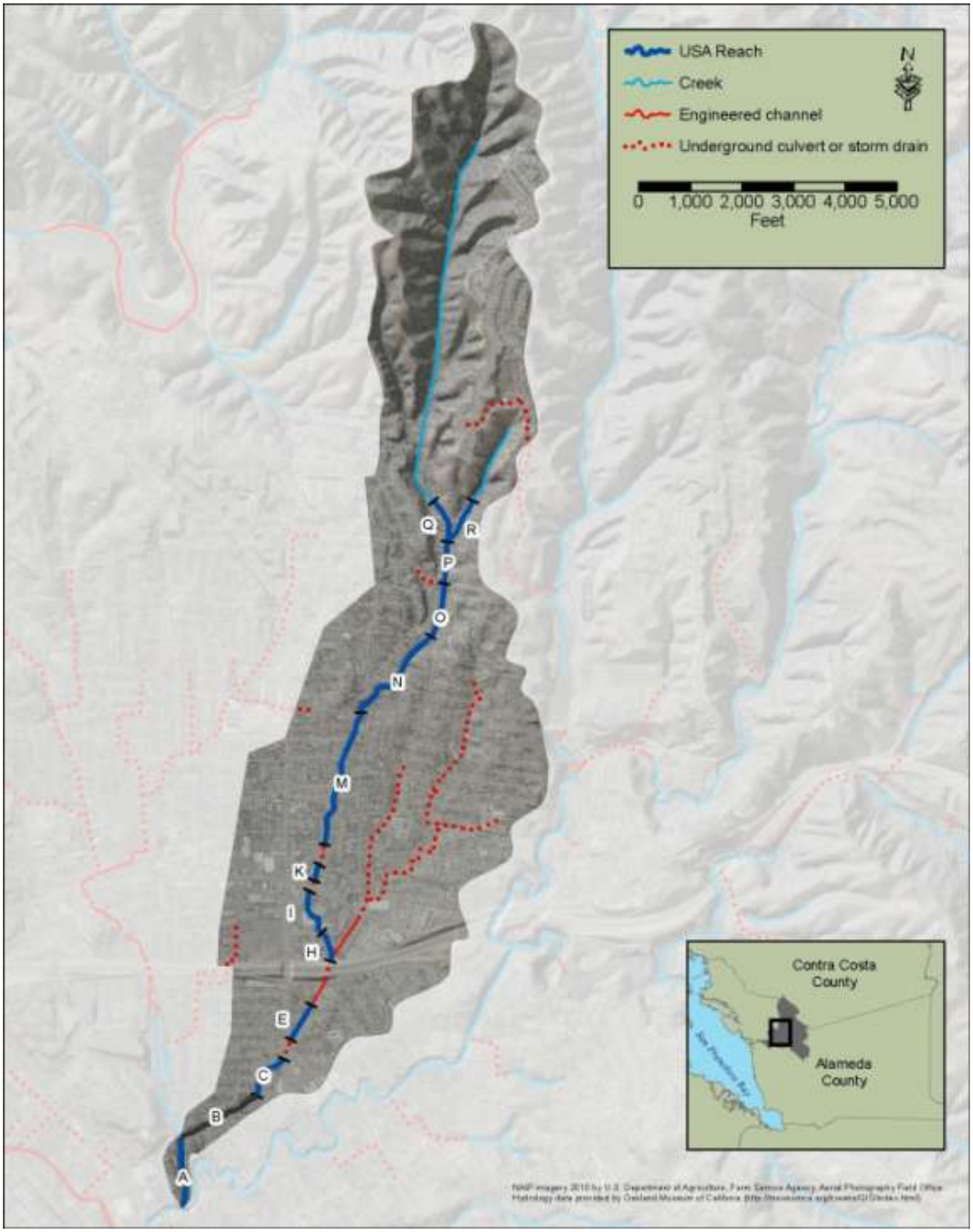

Figure 4-15. Castro Valley Subwatershed USA Assessment Reaches.

Table 4-6. Castro Valley Creek Unified Stream Assessment Scores for Each Reach by Assessment Parameter, Subtotals for Instream Condition and Floodplain/Buffer Condition and Total Reach Score.

Reach Number	**A**	**C**	**E**	**H**	**I**	**K**	**M**	**N**	**O**	**P**	**Q**	**R**
Overall Stream Condition												
Instream Habitat	13	1	2	2	14	2	8	10	3	12	8	12
Vegetative Protection (LB)	4	1	1	0	8	1	4	2	2	7	3	6
Vegetative Protection (RB)	4	1	1	0	8	1	4	2	2	5	2	5
Bank Erosion (LB)	8	10	9	10	7	9	8	9	9	8	7	7
Bank Erosion (RB)	8	10	9	10	7	9	7	9	9	8	7	7
Floodplain Connection	9	3	4	3	15	4	10	13	11	17	19	14
Instream Habitat Total Score	46	26	26	25	59	26	41	45	36	57	46	51
Overall Buffer and Floodplain Condition												
Vegetative Buffer Width (LB)	4	1	1	1	4	1	4	4	2	4	2	5
Vegetative Buffer Width (RB)	4	1	1	1	5	1	5	4	2	4	4	5
Floodplain Vegetation	3	1	2	1	7	2	3	6	3	4	3	5
Floodplain Habitat	1	1	2	1	6	1	2	3	2	2	2	3
Floodplain Encroachment	6	1	1	1	5	1	4	5	3	5	4	5
Floodplain and Buffer Total Score	18	5	7	5	27	6	18	22	12	19	15	23
Reach Assessment Total Score	**64**	**31**	**33**	**30**	**86**	**32**	**59**	**67**	**48**	**76**	**61**	**74**

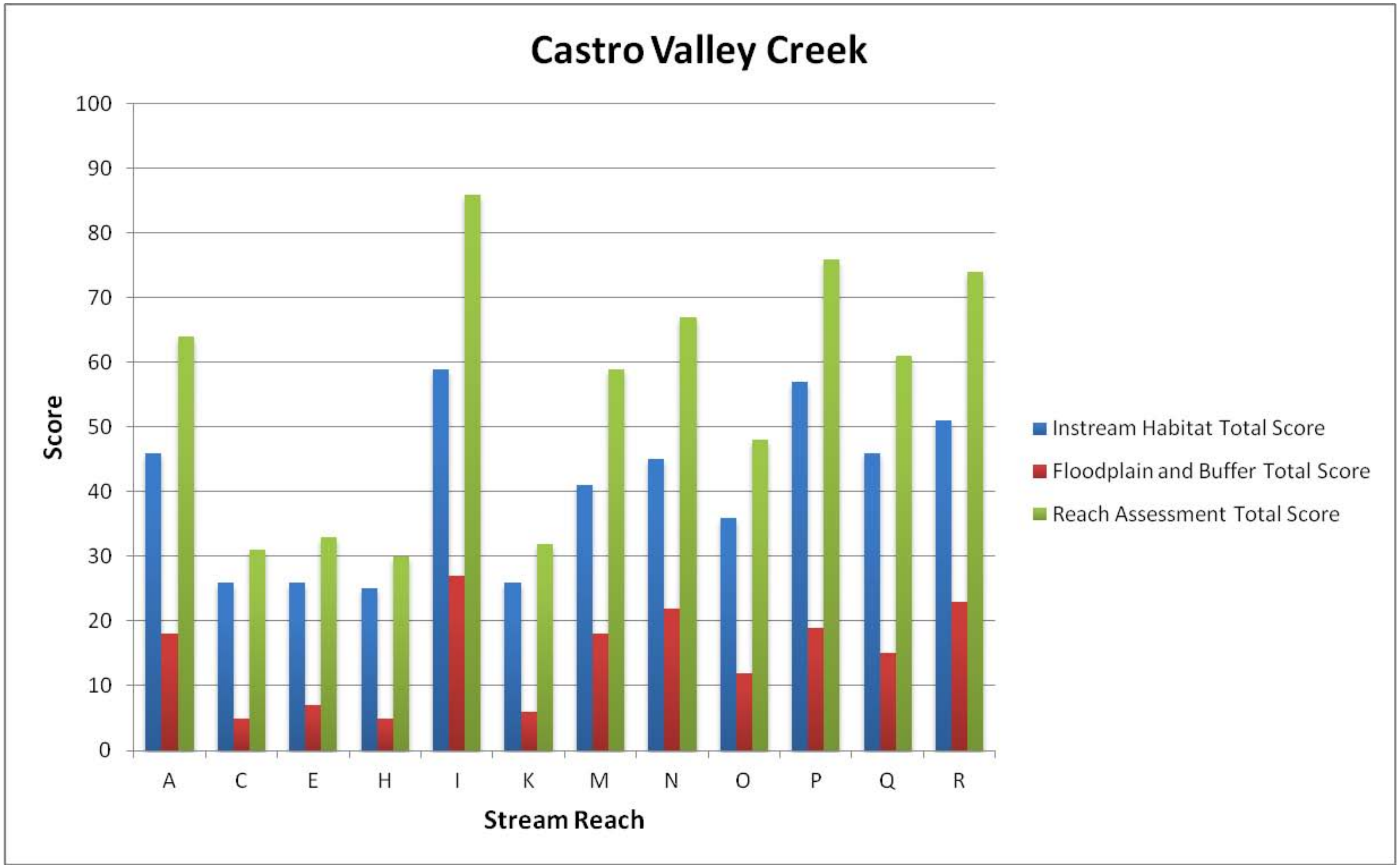

Figure 4-16. Bar Graph (3 bars/reach) of Castro Valley Creek Unified Stream Assessment Scores: total reach assessment, instream habitat condition, buffer and floodplain condition.

Table 4-7. Castro Valley Creek Impact Assessment Summary of the Unified Stream Assessment Survey.

Reach Number	**A**	**C**	**E**	**H**	**I**	**K**	**M**	**N**	**O**	**P**	**Q**	**R**
Reach Length (ft)	1384	968	769	500	933	328	2478	2068	1066	822	871	940
Outfalls												
Storm Drain Outfalls (8-24 inch diameter)	1	6	2	2	6	1	10	5	2	1	3	0
Other Outfalls (1-6 inch diameter)	0	0	0	0	0	0	0	0	0	0	2	0
Total Outfalls	1	6	2	2	6	1	10	5	2	1	5	0
Total per mile	4	33	14	21	34	16	21	13	10	6	30	0
Total Outfalls with dry weather flow	0	1	0	0	0	0	0	0	0	0	1	0
Channel Modification												
Channelization	X	X	X	X		X	X	X	X		X	
Bank_Armoring	X	X	X	X		X	X	X	X		X	
Hardened Bed		X	X	X		X			X			
Drop Structure							X					
Total Length Modified	NR	968	769	500	0	328	1283	2068	1066	0	35	0
Percent Reach Modified (%)	NA	100	100	100	0	100	52	100	100	0	4	0
Erosion												
Downcutting												
Widening												
Slope Failure	X											
Aggrading												
Total Length	99	0	0	0	0	0	0	0	0	0	0	0
Percent Reach Eroded	7	0	0	0	0	0	0	0	0	0	0	0
Stream Crossings												
Grade Control												
Fish Barrier (T-total; P-partial)												
Total Number of Crossings	1	3	1	3	2	1	3	3	3	0	5	5
Total Length Crossing	8	438	29	186	140	40	91	129	94	0	65	81
Percent Reach Crossing	1	45	4	37	15	12	4	6	9	0	7	9
Trash												
Total Number of Trash Sites	0	0	0	0	0	0	0	0	0	0	0	0
Source: L-Litter; ID-Illegal Dumping; A-Accumulation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recreation												
Total Number of Rec Sites	1	0	0	0	0	0	0	0	0	0	0	0
Access: Pub- Public; Pvt-Private	Pub											
Swimming Potential: Hi; Med; Low	Med											

4.2.4.3 Chabot Creek

Stream survey assessment in Chabot Creek was conducted between October 3 and 13, 2012, with a total assessed reach length of 6,395 feet or 1.21 miles (Figure 4-17). Half the surveyed reaches were natural channel and half were trapezoidal concrete channel. The average valley slope was determined to be 0.6%. Details of the surveyed reaches in Chabot Creek are provided in Table 4-8. The stream assessment scores are provided in Table 4-9 and illustrated in Figure 4-18. The highest score (59) was attributed to Reach B, while the lowest score (32) was found in Reaches G and E.

The impact assessment summary for Castro Valley streams is provided in Table 4-10. The creek was found to have approximately 30 outfalls per mile. Public access was found in Reach A with medium swimming potential. Slope failure was observed in Reaches A, B and C with much of the creek channelized.

Table 4-8. Surveyed Reaches, Chabot Creek

Reach	Geographic Extent	Reach Length (ft)	Valley Slope (%)	General Characteristics
A	East of North 3rd St. and Knox St. to 60 ft. south of Grove Way	995	1.4%	Natural channel
B	Approx. 122 ft south of Grove Way to approx. 197 ft north of Meg Ct.	1,443	0.0%	Natural channel to concrete channel
C	Approx. 197 ft north of Meg Ct. to south of Strobridge Ave.	764	0.7%	Natural / concrete channel
E	South of Strobridge Ave. to southwest of Castro Valley Blvd.	1,544	0.5%	Trapezoidal concrete channel
G	Southwest of Castro Valley Blvd. to 103 ft northeast of Lake Chabot Rd	548	0.6%	Trapezoidal concrete channel
H	103 ft northeast of Lake Chabot Rd to west of Anita Ave.	1,101	0.5%	Trapezoidal concrete channel

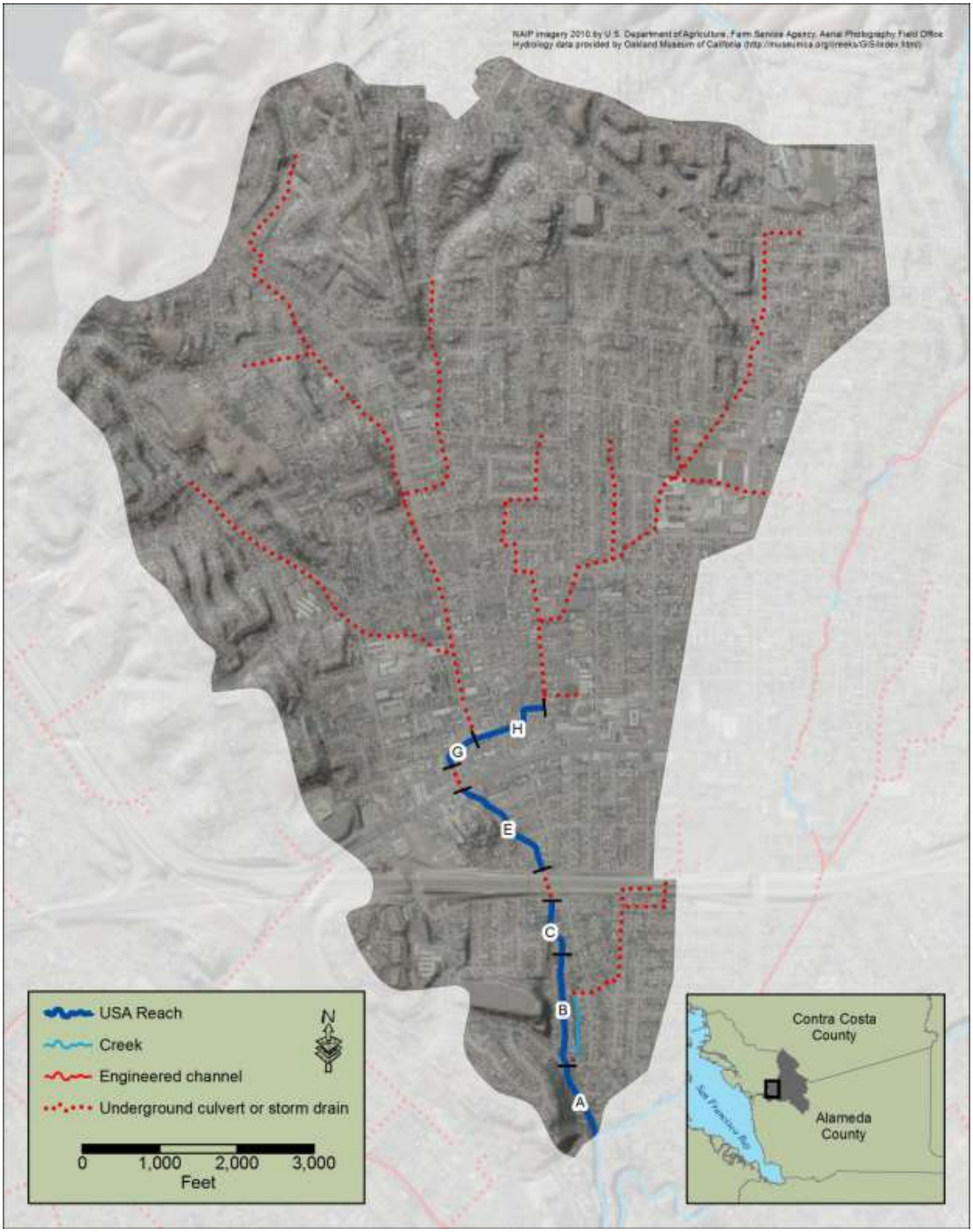

Figure 4-17. Chabot Creek Subwatershed USA Assessment Reaches

Table 4-9. Chabot Creek Unified Stream Assessment Scores for Each Reach by Assessment Parameter, Subtotals for Instream Condition and Floodplain/Buffer Condition and Total Reach Score.

Reach Number	**A**	**B**	**C**	**E**	**G**	**H**
Overall Stream Condition						
Instream Habitat	14	13	10	1	2	3
Vegetative Protection (LB)	3	5	4	1	1	1
Vegetative Protection (RB)	3	4	4	1	1	1
Bank Erosion (LB)	5	7	7	10	10	10
Bank Erosion (RB)	6	6	6	10	10	10
Floodplain Connection	10	7	5	2	2	5
Instream Habitat Total Score	41	42	36	25	26	30
Overall Buffer and Floodplain Condition						
Vegetative Buffer Width (LB)	3	4	4	1	1	2
Vegetative Buffer Width (RB)	3	4	4	1	1	2
Floodplain Vegetation	3	2	3	2	2	2
Floodplain Habitat	1	2	3	1	1	3
Floodplain Encroachment	6	5	5	2	1	2
Floodplain and Buffer Total Score	16	17	19	7	6	11
Reach Assessment Total Score	**57**	**59**	**55**	**32**	**32**	**41**

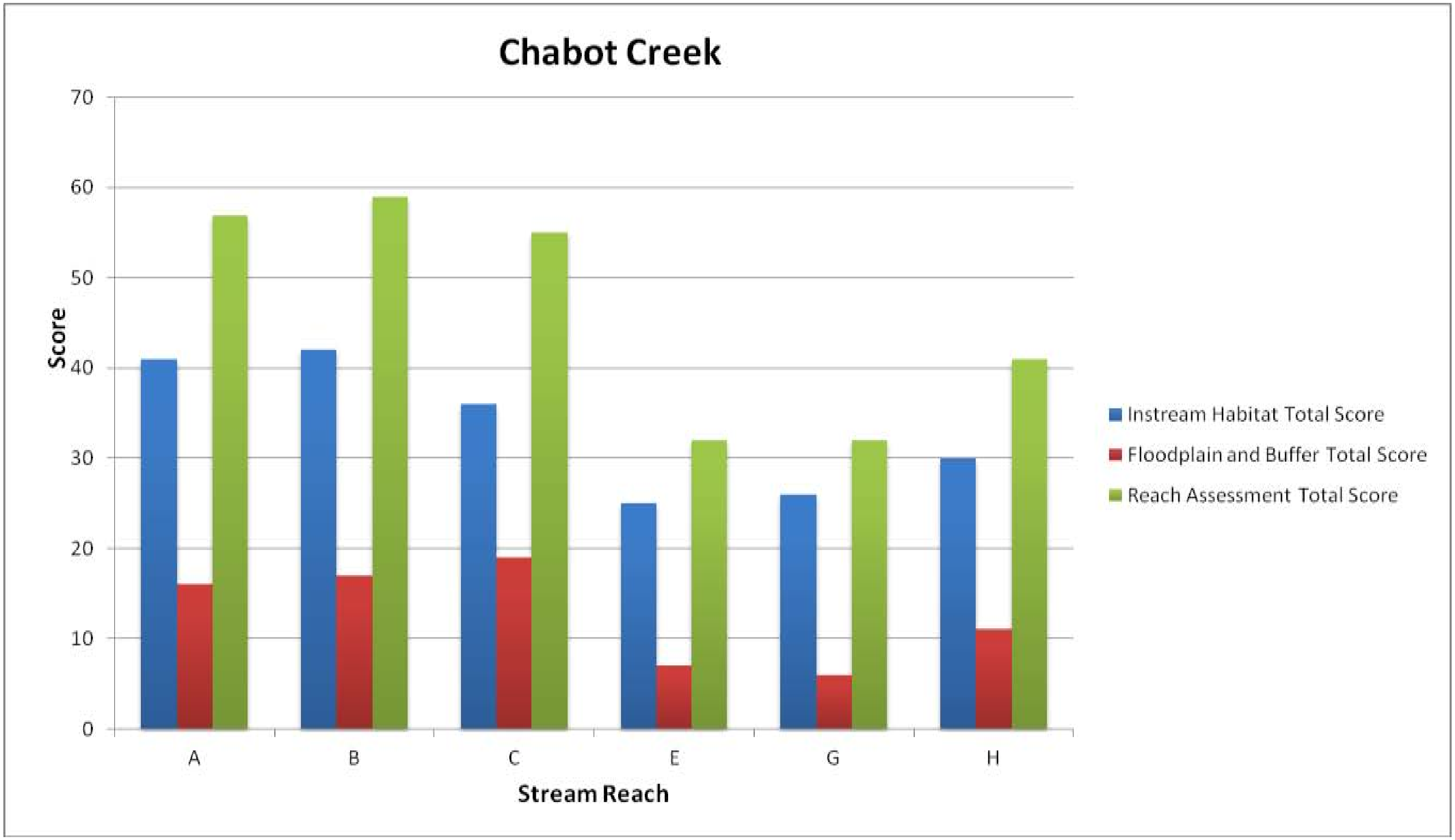

Figure 4-18. Bar Graph (3 bars/reach) of Chabot Creek Unified Stream Assessment Scores: total reach assessment, instream habitat condition, buffer and floodplain condition.

Table 4-10. Chabot Creek Impact Assessment Summary of the Unified Stream Assessment Survey.

Reach Number	A	B	C	E	G	H
Reach Length (ft)	995	1443	764	1544	548	1101
Outfalls						
Storm Drain Outfalls (8-24 inch diameter)	4	5	1	14	4	8
Other Outfalls (1-6 inch diameter)	0	0	0	0	0	0
Total Outfalls	4	5	1	14	4	8
Total per mile	21	18	7	48	39	38
Total Outfalls with dry weather flow	1	1	0	0	1	0
Channel Modification						
Channelization	X	X	X	X	X	X
Bank Armoring	X	X	X	X	X	X
Hardened Bed			X	X	X	X
Drop Structure	X	X	X			
Total Length Modified (ft)	50	263	60	1544	548	1101
Percent Reach Modified (%)	5	18	79	100	100	100
Erosion						
Downcutting						
Widening						
Slope Failure	X	X	X			
Aggrading						
Total Length	241	539	6	0	0	0
Percent Reach Eroded	24	37	1	0	0	0
Stream Crossings						
Grade Control						
Fish Barrier (T-total; P-partial)						
Total Number of Crossings	2	11	0	4	1	1
Total Length Crossing (ft)	50	139	0	487	120	64
Percent Reach Crossing (%)	5	10	0	32	22	6
Trash						
Total Number of Trash Sites	0	0	0	0	0	0
Source: L-Litter; ID-Illegal Dumping; A-Accumulation	NA	NA	NA	NA	NA	NA
Recreation						
Total Number of Rec Sites	1	0	0	0	0	0
Access: Pub- Public; Pvt-Private	Pub					
Swimming Potential: Hi; Med; Low	Med					

4.2.4.4 Reach Assessment Summary

The overall reach assessment scores ranged from 26 to 86. Castro Valley Creek had the highest average score of 55, with a more complex instream habitat, vegetated banks and less floodplain encroachment. Chabot Creek had the second highest average score of 46, with a mix of concrete and natural channels in both residential and urban areas. San Lorenzo Creek had the lowest average score of 31, with 100% of concrete channel reaches in urban areas with significant floodplain encroachment.

4.2.4.5 Impact Assessment Summary

The following impacts were noted during the stream surveys:

Outfalls: The largest number of outfalls per mile occurred in Chabot Creek (approximately 30 per mile), while San Lorenzo Creek and Castro Valley Creek each had approximately 16 outfalls per mile. The majority of outfalls were classified as storm drains. Over 99% of the outfalls had no dry weather flow, and the remaining outfalls had very low or moderate flow. No discharge of odor or oily substances was observed.

Channel modification: All reaches in San Lorenzo Creek were 100% modified, and comprised concrete channels. In the Castro Valley Creek just over 50% of reaches were modified primarily by concrete retaining walls and check dams. The Chabot Creek reaches were over 60% modified, primarily by bank hardening and one weir.

Erosion: A minimal amount of bank erosion / bank failure was found in the reaches surveyed. The observed bank erosion was likely from historical channel incision that resulted in steeper channel gradients and steeper bank slopes, as well as storm damage to banks that were sparsely vegetated.

Stream Crossings: Castro Valley Creek had the greatest total length of stream crossings, followed by San Lorenzo Creek, and then Chabot Creek. Most stream crossings were vehicle overpasses, footbridges, or driveways. None of the stream crossings encountered was fish barriers or performed grade control.

Trash: There was little accumulated trash observed during the surveys. The only notable trash found was in San Lorenzo Creek in reaches B, E, and I. The types of trash found included diapers, chemical bottles, spray cans, and large electronics.

Recreation: The only recreational sites observed were in Reach A of Castro Valley Creek and Reach A of Chabot Creek. Both of these sites have little flow in the summer, making the creeks less likely to experience heavy swimming pressure. No recreational sites were observed in San Lorenzo Creek.

Utilities: Both Castro Valley Creek and Chabot Creek had 13 utility impacts observed in the surveyed reaches, while San Lorenzo Creek only had one observed utility. All impacts were utility pipes with the exception of an Alameda County gaging station in Reach E of Chabot Creek. None of the utility pipes had any observed discharge or were fish barriers.

Miscellaneous: Both San Lorenzo Creek and Chabot creek had five miscellaneous impacts observed in the surveyed reaches, and Castro Valley Creek had six impacts. Some of the impacts were safety concerns, such as a downed / abandoned electrical line in Reach B of Chabot Creek and a broken access ladder in Reach C of San Lorenzo Creek.

5 Stressor Assessment

This section is a preliminary review of targeted monitoring data to identify samples with results that meet the “trigger” conditions for potential further investigation according to Table 8.1 of the MRP (see Table 5-1).

Table 5-1. Description of Triggers for Creek Status Targeted Parameters.

Monitoring Parameter	Trigger Description
General Water Quality	20% of results in one water body exceed one or more water quality standards or established thresholds: • Dissolved Oxygen for WARM is 5.0 mg/l: 3-month median for DO shall not be less than 80 percent of the DO content at saturation. • Dissolved Oxygen Coldwater Beneficial Use: 7.0 mg/l • Water Temperature Warmwater Beneficial Use: see below • Water Temperature Coldwater Beneficial Use: see below • Conductivity: NA • pH: > 6.5 and <8.5; and controllable water quality factors shall not cause changes greater than 0.5 units in normal ambient pH levels.
Temperature	20% of results in one water body exceed applicable temperature thresholds: • The temperature of any cold or warm freshwater habitat shall not be increased by more than 5°F (2.8°C) above natural receiving water temperature; for designated COLD reaches, the maximum 7-day mean temperature should not exceed 26°C and should not exhibit spikes with no obvious natural explanation observed.
Pathogen Indicators	Fecal coliform < 200 organisms/100 ml or < 400 organisms/100 ml for 90% of sample[7] (SFRWQCB 2011) *E. coli:* Moderately used area: < 298 colonies per 100 ml Lightly used area: < 406 colonies per 100 ml Infrequently used area: < 576 colonies per 100 ml (USEPA 1986)
Stream Survey	NA

[7] Water Quality Objectives listed in the Basin Plan for fecal coliform are based on five consecutive samples that are collected over an equally spaced 30-day period. The WQOs for Water Contact Recreation include concentrations for the calculated geometric mean (< 200 MPN/100ml) and the 90th percentile (< 400 MPN/100ml).

5.1 Continuous Temperature

Continuous temperature 7-day averages were compared to two criteria established by USEPA (Brungs and Jones, 1977) for juvenile rainbow trout (*Onchrhynchus mykiss*)[8]:

- Maximum weekly average temperature (MWAT) for juvenile growth - 19°C
- Maximum short-term temperature for juvenile survival - 24°C

While the above thresholds were derived mainly from laboratory studies, they are reasonable in light of habitat characteristics for similar Bay Area salmonid populations (Leidy et al., 2005)[9]. No temperature triggers were observed during ACCWP monitoring in Water Year 2012. The close matching of diurnal temperature changes from upstream to downstream locations indicates that runoff inputs were not causing significant elevation of ambient stream temperatures.

5.2 General Water Quality

Water quality triggers were compared against the results obtained during general water quality monitoring undertaken during Water Year 2012. Table 5-2 provides details of the one site that met water trigger conditions. Site 204CRW030 was found to have lower than recommended DO concentrations. This site is located directly below an artificial reservoir and receives sporadic flows. These DO concentrations may have a detrimental impact on aquatic life.

[8] This species, in either the anadromous (steelhead) or resident (rainbow trout) form, is the only salmonid species that naturally occurs in the San Lorenzo and Sausal watersheds.

[9] Sullivan et al. (2000) is referenced in Table 8.1 of the MRP as a potential source for applicable thresholds to use for evaluating water temperature data for creeks that have salmonid fish communities, and illustrates the risk-based approach to evaluating temperature effects on salmonid communities in terms of relative reductions in growth at temperatures other than optimum. However, that study established its MWAT thresholds using data from salmonid populations in the Pacific Northwest and is likely overly conservative for steelhead in central California. Since fish growth is a function of both temperature and available food, optimum temperature and the incremental effect of temperature shifts on growth are ration-dependent and affected by other ecosystem factors, (for example see reviews in Myrick and Cech, 2001 and Atkinson et al., 2011). Streams in the Bay Area and Central California in general tend to be higher-nutrient systems than the glacially-derived geology of the Pacific Northwest, and can thus deliver the larger food supplies to support salmonid growth at warmer temperatures.

Table 5-2. Comparison of Continuous Water Temperature Monitored to Water Quality Objectives and Triggers.

		pH		DO	Temperature		
Site ID	**Creek Name**	**% results <6.5**	**% results >8.5**	**<7mg/L**	**% 7-day daily max. temp >19°C**	**# of temperature spikes**	**% "temp metric" above natural temp**
204CRW030	Crow Creek	NA	NA	67% of 7-day rolling averages (4 of 6) were below 7mg/L target for cold water habitat	NA	NA	NA

5.3 Pathogen Indicators

Table 5-1 presents the USEPA criteria for ambient water quality bacteria concentrations as stipulated in Provision C.8 of the MRP. The USEPA basis for assessment of public health risk assumes multiple sampling at recreational bathing beaches and derives a statistical probability of illness from those assumptions. Under the provisions of the MRP, permittees collect single samples, once at each sampling location within the Water Year. As such, the monitoring frequency stipulated within the MRP is not consistent with the sampling requirements of the USEPA WQOs. In addition, comparison of data from urban creeks to WQOs derived for recreational beaches is questionable. These criteria are, however, used to establish potential trigger exceedances. Consequently, as the indicated EPA multiple sampling for assessment of public health risk was not required in the MRP, the results of the monitoring are not an accurate indication of the risk to public health but may be used to derive some estimate of potential fecal pollution sources in watersheds.

Table 5-3 presents the results of the pathogen indicator enumeration with comparison against the USEPA criteria. All sites were found to have bacterial concentrations above the recommended thresholds for lightly and moderately used recreational areas. It should be noted that recreational usage, as defined by the EPA, cannot be directly reflected in appropriate usage within Castro Valley Creek. The Castro Valley Creek is designated for both contact (REC-1) and non-contact (REC-2) recreation, although much of the creek system is inaccessible to the public. Two of the monitoring locations (204CVY020 and 204CVY120) do provide public access through parks and trails but there is little option for immersive swimming or contact recreation. Therefore actual recreational contact in this small creek is extremely limited and is not encouraged. Site 204CVY150, if assessed as an infrequently used site, would not be meet the trigger criterion for *E. coli*.

Of note was Site 204CVY140, where greater than or equal to 16,000MPN/100mL of both fecal coliforms and *E. coli* were found.

Table 5-3: Comparison of Pathogen Indicators to Water Quality Objectives and Triggers. BOLD font indicates result meets trigger conditions.

Site ID	Site Name	Creek Name	Fecal Coliform:	*E. coli**
204CVY020	Chabot Creek at Carlos Bee Park	Castro Valley	**900**	**900**
204CVY080	Castro Valley Creek above confluence with Chabot Creek	Castro Valley	**900**	**900**
204CVY120	CV Creek Park at Castro Valley Library	Castro Valley	**1,700**	**1,700**
204CVY140	Castro Valley Creek North side of Berdina Rd	Castro Valley	**>/= 16,000**	**>/= 16,000**
204CVY150	Castro Valley Creek North side of Heyer Ave	Castro Valley	**500**	500**

*based on USEPA criteria
** only meets trigger criteria for moderately or lightly used.

6 Next Steps

All sites identified in Table 5-2 and Table 5-3 as meeting trigger conditions will be discussed by the RMC in Spring 2013 to determine follow-up actions pursuant to MRP Provision C.8.d.i, Stressor/Source Identification (SSID). SSID projects developed through the RMC process would begin in FY2013-14. Where triggers or potential trigger conditions have been identified in 2012 results, ACCWP will also work with local stormwater managers to identify appropriate follow-up activities, which may be outside the scope of Creek Status Monitoring for the MRP.

ACCWP's Creek Status Monitoring for targeted parameters will rotate to a new watershed in 2013 for continuous temperature, general water quality and pathogen indicator monitoring. Stream surveys will be completed for at least four linear stream miles in the unsurveyed portion of Castro Valley Creek and urban-influenced portions of San Lorenzo and Crow Creeks; an additional five stream miles will be surveyed in two to four new watersheds.

7 References

Applied Marine Sciences (AMS), 2013. ACCWP Creek Status Monitoring, 2012 Unified Stream Assessments Conducted with San Lorenzo Watershed, Draft. Prepared for the Alameda Countywide Clean Water Program. January 31, 2013.

Atkinson, K., Fuller, J., Hanon, C. and B. Trush. 2011. Evaluating Water Temperature and Turbidity Effects on Steelhead Life History Tactics in Alameda Creek Watershed. Prepared for Alameda Creek Fisheries Restoration Workgroup. Technical memorandum, March, 2011.

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United States Environmental Protection Agency (USEPA). 1986. Ambient Water Quality Criteria for Bacteria. January 1986

Attachment A.

Electronic Data Submittal Transmittal Letter dated January 15, 2013 with attached file list and preliminary evaluation relative to applicable Water Quality Standards.

Protecting Alameda County Creeks, Wetlands & the Bay

clean water PROGRAM

399 Elmhurst St.
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94544
p. 510-670-5543

January 15, 2013

Bruce Wolfe
Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

SUBJECT: Electronic Data Submittal - ACCWP Creek Status Monitoring from October 2011through September 2012 Pursuant to Provision C.8.g

Dear Mr. Wolfe:

The member agency Permittees of the Alameda Countywide Clean Water Program (Program) through their Management Committee, and in conformance with the Memorandum of Agreement signed by their governing bodies, have authorized and directed me to prepare and submit certain reports as part of their compliance with Monitoring requirements of the Municipal Regional Stormwater NPDES Permit (MRP, Order No. R2-2009-0074, CAS612008).

With this letter I am submitting a CD-ROM containing the Program's Creek Status Monitoring data collected between October 1, 2011 and September 30, 2012 pursuant to Provision C.8.c of the MRP. These data are provided in Microsoft Excel files listed in Attachment A, which are formatted according to templates compatible with data management requirements of the Surface Water Ambient Monitoring Program (SWAMP). The Program is submitting these data to the Regional Water Board by January 15, 2013 as specified in Provision C.8.g.ii of the MRP. Other data addressing the requirements of MRP Provision C.8.e, but not through the efforts of the Program, will be submitted through the entities responsible for Quality Assurance in a time schedule consistent with the Provisions of the MRP[1].

By signing this letter on behalf of the program, I certify under penalty of law that this document and all attachments are 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 managed 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 fine and imprisonment for knowing violations. [40CFR 122.22(d)].

[1] Data collection in Alameda County, and data management and Quality Assurance for all sites, of the alternative approach to Pollutants of Concern Loads Monitoring were performed by the San Francisco Estuary Institute through a collaboration between BASMAA and the RMP. Data collection and reporting for Long Term Trends Monitoring are the responsibility of the SWAMP Sediment Pollution Trends (SPoT) program.

The quality of all Creek Status Monitoring data was evaluated through data collection and evaluation methods consistent with the Standard Operating Procedures and Quality Assurance Project Plan developed through the BASMAA Regional Monitoring Coalition (RMC), a regional collaborative that includes all ACCWP member Permittees. These documents have been reviewed by Region 2 SWAMP staff for SWAMP-comparability where applicable, as provided in MRP C.8.h,

In conformance with MRP Provision C.8.g.ii, the Program has participated in the RMC's development of a regional information management system that supports electronic transfer of data to the Regional Data Center of the California Environmental Data Exchange Network (CEDEN). As requested by Water Board staff on August 5, 2011, concurrent with this submission the Program is transferring the subject monitoring data directly to CEDEN. As required in MRP Provision C.8.g.vii, the Program will notify stakeholders and members of the public of the availability of electronically submitted data and monitoring reports through its website and via other communications as appropriate.

We are in the process of identifying potential persistent water quality issues that would warrant a programmatic response as required by the MRP. Attachment A presents preliminary highlights of some of these issues. It should be emphasized that this water quality data review is preliminary and does not constitute a determination of whether water quality objectives were exceeded and/or if stormwater runoff or dry weather discharges are or may be causing or contributing to exceedances, if any. The Program is in the process of determining whether these data represent persistent exceedances in receiving waters; if it is determined that discharges under this permit are causing or contributing to persistent exceedances of the applicable water quality objectives, the Permittees will follow up as required by MRP Provision C.1. Where results meet trigger criteria for individual parameters as noted in Table 8.1 or Attachment H of the MRP, the Program will implement follow up Monitoring Project actions pursuant to MRP Provision C.8.d.

Please contact me if you have any questions or comments.

Sincerely,

James Scanlin
Program Manager

Attachment: CD ROM
Attachment A: list of datafiles on CD-ROM

Copy via email: Alameda Countywide Clean Water Program Management Committee Representatives

Attachment A

Data files for ACCWP Creek Status Monitoring
October 1, 2011-September 30, 2012

Sources of templates for data files (see file ACCWP-EDS_ToC_WY2012.xlsx for details):
SWAMP v2.5 Database references at http://swamp.mpsl.mlml.calstate.edu/
Kevin Lunde, SFRWQCB SWAMP Program (Continuous Monitoring)
EOA, Inc. (Stream Survey using Urban Streams Assessment)

Sample Purpose	Filename, including site ID	Evaluation of Water Quality[a]
WaterChem	SWAMP_WQ_ACCWP_205R00535 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_205R00430 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_205R00110 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00647 _WET_chem.xls	6/18/12 Dissolved Oxygen was less than 5 mg/L for WARM Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00639 _WET_chem.xls	6/19/12 pH exceeded 8.0 and electrical conductivity exceeded 900 us/cm for MUN Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00596 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00583 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00455 _WET_chem.xls	6/13/12 Dissolved Oxygen was less than 5 mg/L for WARM Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00391 _WET_chem.xls	6/6/12 Dissolved Oxygen was kess than 5 mg/L
WaterChem	SWAMP_WQ_ACCWP_204R00383 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00367 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00356 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00068 _WET_chem.xls	6/4/12 total residual chloride exceeded 250 mg/L for MUN Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00340 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00319 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00303 _WET_chem.xls	6/14/12 Dissolved Oxygen was less than 7 mg/L for COLD Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00191 _WET_chem.xls	5/29/12 Dissolved Oxygen was less than 7 mg/L for COLD Beneficial Use
WaterChem	SWAMP_WQ_ACCWP_204R00100 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00084 _WET_chem.xls	No exceedance
WaterChem	SWAMP_WQ_ACCWP_204R00047 _WET_chem.xls	6/6/12 Dissolved Oxygen was less than 7 mg/L and pH exceeded 8.5 for COLD Beneficial Use

Data files for ACCWP Creek Status Monitoring October 1, 2011-September 30, 2012

Sample Purpose	Filename, including site ID	Evaluation of Water Quality[a]
WaterTox	SWAMP_WQ_ACCWP_204R00100_WET_tox.xls	No significant toxicity
WaterTox	SWAMP_WQ_ACCWP_204R00084_WET_tox.xls	No significant toxicity
WaterTox	SWAMP_WQ_ACCWP_204R00047_WET_tox.xls	3/14/12 *Hyallela azteca* survival was less than 50% of Control (No re-sample/re-test was performed in spring)
SedChem	SWAMP_WQ_ACCWP_204R00100_DRY_chem.xls	No significant toxicity
SedChem	SWAMP_WQ_ACCWP_204R00084_DRY_chem.xls	No significant toxicity
SedChem	SWAMP_WQ_ACCWP_204R00047_DRY_chem.xls	No significant toxicity
WaterTox, SedTox	SWAMP_WQ_ACCWP_204R00047_DRY_tox.xls	No significant toxicity
WaterTox, SedTox	SWAMP_WQ_ACCWP_204R00100_DRY_tox.xls	No significant toxicity
WaterTox, SedTox	SWAMP_WQ_ACCWP_204R00084_DRY_tox.xls	No significant toxicity
WaterChem (Pathogens)	SWAMP_WQ_ACCWP_CVY150_DRY_pathogens.xls	No significant toxicity
WaterChem (Pathogens)	SWAMP_WQ_ACCWP_CVY140_DRY_pathogens.xls	7/11/12 *E. coli* exceeded Basin Plan Table 3.2 criterion for infrequently used area in REC-1 Beneficial Use
WaterChem (Pathogens)	SWAMP_WQ_ACCWP_CVY120_DRY_pathogens.xls	7/11/12 *E. coli* exceeded Basin Plan Table 3.2 criterion for moderately used area in REC-1 Beneficial Use.
WaterChem (Pathogens)	SWAMP_WQ_ACCWP_CVY080_DRY_pathogens.xls	7/11/12 *E. coli* exceeded Basin Plan Table 3.2 criterion for moderately used area in REC-1 Beneficial Use.
WaterChem (Pathogens)	SWAMP_WQ_ACCWP_CVY020_DRY_pathogens.xls	7/11/12 *E. coli* exceeded Basin Plan Table 3.2 criterion for moderately used area in REC-1 Beneficial Use.
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00391_merged_rev.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00596_merged_rev.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00191_merged_rev.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00583_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00340_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00319_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00303_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00100_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00084_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00068_merged.xls	No exceedance

Data files for ACCWP Creek Status Monitoring October 1, 2011-September 30, 2012

Sample Purpose	Filename, including site ID	Evaluation of Water Quality[a]
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00047_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00356_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00367_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00383_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00455_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00639_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_204R00647_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_205R00110_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_205R00430_merged.xls	No exceedance
Benthics, Algae, FieldMeasure, Habitat	SWAMP_BA_ACCWP_205R00535_merged.xls	No exceedance
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_CRW030_2012_dry.xls	September 2012 Dissolved Oxygen concentrations were below the 7 mg/L level for COLD Beneficial Use for a majority of readings.
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_CRW030_2012_wet.xls	No exceedance
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_CVY005_2012_dry.xls	No exceedance
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_CVY005_2012_wet.xls	No exceedance
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_SLO065_2012_dry.xls	No exceedance
ContinuousMonitoring (GenWQ)	CM_ACCWP_YSI_SLO065_2012_wet.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_CRW030_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_CRW050_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU035_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU070_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU0090_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU0100_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU0110_2012.xls	No exceedance
ContinuousMonitoring (Temp)	CM_ACCWP_Hobo_SAU0200_2012.xls	No exceedance

Data files for ACCWP Creek Status Monitoring October 1, 2011-September 30, 2012

Sample Purpose	Filename, including site ID	Evaluation of Water Quality[a]
StreamSurvey	USA_ACCWP_Chabot_2012.xls	N/A
StreamSurvey	USA_ACCWP_CVC_2012.xls	N/A
StreamSurvey	USA_ACCWP_SLZ_2012.xls	N/A

[a] Based on preliminary review of water quality standards; these notes do not constitute a determination of whether water quality objectives were exceeded and/or if stormwater runoff or dry weather discharges are or may be causing or contributing to exceedances, Numeric water quality objectives for most data parameters have not been adopted to-date.

B2

Contra Costa Clean Water Program

CONTRA COSTA
CLEAN WATER
PROGRAM

Local Urban Creeks Monitoring Report Water Year 2012 (Oct 2011 – Sept 2012)

Submitted in Compliance with Provisions C.8.g.iii

NPDES Permit No. CAS612008

and

NPDES Permit No. CAS083313

March 12, 2013

A Program of Incorporated Cities/Towns and
the Contra Costa Flood & Water Conservation District

This report is submitted by the participating agencies of the

CONTRA COSTA CLEAN WATER PROGRAM

Program Participants:

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

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Executive Summary

This Local Urban Creeks Monitoring Report documents the results of targeted monitoring activities performed by Contra Costa Clean Water Program (CCCWP) during Water Year 2012; together with the Creek Status monitoring data reported in the Regional Report, this submittal completes reporting requirements for Table 8.1 monitoring specified contained in Provisions C.8.c of the both the Municipal Regional Permit for Urban Stormwater issued by the San Francisco Bay Regional Water Quality Control Board (MRP, Order No. R2-2011-0083) and the East Contra Costa County Municipal NPDES Permit issued by the Central Valley Regional Water Quality Control Board (Central Valley Permit, Order No. R5-2010-0102). Reporting requirements for Table 8.1 constituents established in provision C.8.g.iii of both permits.

CCCWP's targeted monitoring parameters were water temperature, general water quality, pathogen indicators and riparian assessments. Hourly water temperature measurements were recorded using HOBO ® dataloggers (HOBOs ®) at deployed at four creeks on April 27, 2012 at Alhambra Creek and Wildcat Creek, Marsh Creek on May 2, 2012 and at Walnut Creek on May 11, 2012, Retrieval of the HOBOs ® at Marsh Creek on September 18, 2012, Alhambra Creek on September 24, 2012, and Walnut Creek on September 25, 2012. General water quality monitoring (temperature, dissolved oxygen, pH and specific conductivity) was conducted using YSI continuous water quality equipment (Sondes) at two creeks in Contra Costa County during two time periods at each creek as follows: Walnut Creek - once during spring (May 23-June 4), and once during summer (August 1-13); and, Marsh Creek - once during spring (May 8-May 18) and once during summer (August 1-13). Walnut Creek was prioritized for this type of water quality monitoring because: 1) it is within an urbanized area; 2) it supports a coldwater biological community; and 3) RWQCB Region 2 is interested in the data and can utilize it to further develop and/or implement watershed management plans.

The Contra Costa Flood Control and Water Conservation District (FC District) performed a pilot study in June 2012, to compare the effectiveness of grazing with goats and sheep versus the traditional use of herbicides for vegetation management and assess potential impact s to water quality from each maintenance practice. Water quality samples were collected by FC District staff at eight sites along the reach (upstream to downstream) where the livestock were grazing and were analyzed for fecal coliform during each day of the twelve-day grazing period from June 12–June 23. To augment this pilot study, and to meet MRP and Region 5 Permit Provision C.8.g. requirements, another set of pathogen indicator samples were collected by ADH Environmental (ADH) staff on July 12, 2012, at five sites along the same reach of Walnut Creek and were analyzed for fecal coliform and *E. coli*.

In lieu of a stream assessment either the California Rapid Assessment Method (CRAM), or the Unified Stream Assessment (USA) method, for Water Year 2012 CCCWP proposes to submit an assessment of Wildcat Creek that was funded in part by CCCWP and provides comparable information[1]. The MRP allows recent stream surveys and studies to be submitted in lieu of the required six miles of stream survey specified in Table 8.1 Biological assessments were conducted at 10 locations (and reach lengths) that were monitored under the RMC probabilistic design including physical habitat assessments, nutrients and physical-chemical water quality.

[1] The most recent use of this information (http://www.urbancreeks.org/WildcatWRAP.html) was published as the Wildcat Creek Restoration Action Plan (WRAP) by the Wildcat-San Pablo Watershed Council (Watershed Council). Participants of the Watershed Council include permittees City of Richmond and City of San Pablo. Funding for the original studies supporting the WRAP (see http://legacy.sfei.org/watersheds/wildcatreport/cover-V.pdf.) was provided by CCCWP as well.

Targeted monitoring data gathered were evaluated against numeric Water Quality Objectives (WQOs) or other applicable criteria, as described in Table 8.1 in the MRP and Region 5 Permit. The results are summarized below:

- Temperature: A maximum weekly average temperature (MWAT) of 20.5°C was used as the applicable criterion to evaluate temperature data. Temperature results for all four monitoring sites exceeded this MWAT value, but two of the four lower watershed sites exceeded it more than 20% of the monitoring period.

- Dissolved Oxygen (DO): WQOs for DO in non-tidal waters are applied as follows: 7.0 mg/L minimum for waters designated as cold habitat (COLD) and 5.0 mg/L minimum for waters designated as warm water habitat (WARM) were used to define thresholds for evaluating dissolved oxygen (DO) data for Walnut Creek and Marsh Creek, respectively. DO concentrations measured below the respective COLD and WARM thresholds at Walnut Creek and Marsh Creek respectively during the two week summer deployment only.

- pH: Measured above the 8.5 (applicable WQO of 6.5 - 8.5) threshold at Walnut Creek and Mash Creek during certain portions of each two week deployment at each site.

- Pathogen Indicator Organisms: Single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFRWQCB 2011) and 576 MPN/100ml *E. coli* (USEPA 1986) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. A fecal coliform single sample maximum concentration of 4,000 MPN/100ml was used as a Non-water Contact Recreation evaluation criterion. In addition, EPA 2012 Recreational Water Quality Criteria (RWQC; EPA 2012), Standard Threshold Value (STV) for Recommendation levels 1 and 2 were also used to evaluate these data. Only one of the five samples collected slightly exceeded the EPA single sample maximum fecal coliform concentration and both of the *E. coli* RWQC STV Recommended levels; no other applicable EPA criterion for either pathogen was exceeded.

CCWP will work with the RMC to plan and implement appropriate stressor/source identification projects that follow-up on Water Year 2012 creek status monitoring data, per the requirements of Provision C.8.d.i of the MRP and Region 5 Permit.

List of Acronyms

7DADM	Seven-day average of the daily maxima
ACCWP	Alameda County Clean Water Program
ADH	ADH Environmental
BASMAA	Bay Area Stormwater Management Agencies Association
BOD	Biochemical Oxygen Demand
CDFG	California Department of Fish and Game
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
CRAM	California Rapid Assessment Method
CVRWQB	Water Quality Control Board, Central Valley Region
DO	Dissolved Oxygen
DPS	Distinct Population Segment
FC District	Contra Costa Flood Control and Water Conservation District
FSURMP	Fairfield Suisun Urban Runoff Management Program
HSI	Habitat Suitability Indices
MRP	Municipal Regional Permit
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollution Discharge Elimination System
QAPP	Quality Assurance Project Plan
RWQC	Recreational Water Quality Criteria
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RWQCB	Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SFBRWQB	San Francisco Bay Regional Water Quality Control Board
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	Standard Operating Protocol
SWAMP	Surface Water Ambient Monitoring Program
TRPA	Tomas R. Payne & Associates
USA	Unified Stream Assessment
USEPA	United States Environmental Protection Agency
WQO	Water Quality Objective

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A. Sites from the Probabilistic Monitoring Design that could not be sampled
B. Data Quality Review Details
C. BMI Metric Values: all RMC Monitoring Sites for Water Year 2012
D. Stressor Evaluation Results

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1.0 Introduction

This Local Urban Creeks Monitoring Report documents the results of targeted monitoring activities performed by CCCWP during Water Year 2012; together with the Creek Status monitoring data reported in the Regional Report, this submittal completes reporting requirements for Table 8.1 monitoring specified contained in Provisions C.8.c of the both the Municipal Regional Permit for Urban Stormwater issued by the San Francisco Bay Regional Water Quality Control Board (MRP, Order No. R2-2011-0083) and the East Contra Costa County Municipal NPDES Permit issued by the Central Valley Regional Water Quality Control Board (Central Valley Permit, Order No. R5-2010-0102). Reporting requirements for Table 8.1 constituents established in provision C.8.g.iii of both permits.

The MRP encourages compliance with monitoring provisions through regional collaboration with other countywide stormwater programs by allowing a one year schedule extension in consideration of the time needed to develop a region-wide approach. The Bay Area Stormwater Management Agencies Association (BASMAA) formed the Regional Monitoring Coalition (RMC) to implement monitoring provisions found in C.8 of the MRP. RMC members are:

- Contra Costa Clean Water Program (CCCWP)
- Alameda Countywide Clean Water Program (ACCWP)
- Fairfield Suisun Urban Runoff Management Program (FSURMP)
- San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)
- Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)

The BASMAA RMC has developed monitoring protocols, sampling and analysis plans (SAPs), data quality objectives (DQOs), standard operating procedures (SOPS), data management tools, and reporting templates and guidelines. Costs for these activities have been 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. The RMC protocols for Creek Status and POC monitoring were developed to include CCCWP's monitoring requirements established by the Central Valley Permit; analysis and reporting of results required in the Central Valley Permit is the sole responsibility of CCCWP. The RMC addresses the scope of sub-provisions specified in MRP Provision C.8 (Table 1.1). This report focuses on the Creek Status and Long-Term Trends Monitoring activities that were conducted to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (Table 1.2).

The remainder of this report describes the study area and monitoring design (Section 2.0), monitoring methods (Section 3.0), results (Section 4.0), and conclusions and next steps (Section 5.0).

Table 1.1 Municipal Regional Permit Provisions addressed by the Regional Monitoring Coalition

MRP C.8 Sub-provision Number	MRP C.8 Sub-provision Title	Reporting Documents
C.8.a	Compliance Options	Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan (BAASMA 2011)
C.8.b	San Francisco Bay Estuary Monitoring	Regional Monitoring Plan Annual Monitoring Results (www.sfei.org/rmp)
C.8.c	Creek Status and Long-Term Trends Monitoring	Regional Urban Creeks Monitoring Report; Local Urban Creeks Monitoring Report
C.8.d	Monitoring Projects: • Stressor/source identification • BMP effectiveness investigation • Geomorphic project	• Stressor/source identification report(s) • BMP effectiveness report • Integrated monitoring report
C.8.e	Pollutants of Concern (Loads) Monitoring	Integrated Monitoring Report
C.8.f	Citizen Monitoring and Participation	Annual Urban Creeks Monitoring Report Water Year 2012
C.8.g	Data Analysis and Reporting	Per each reporting document as described above

Table 1.2 Creek Status Monitoring Parameters monitored in compliance with MRP Provision C.8.c. and the associated reporting format

Monitoring Elements of MRP Provision C.8.c	Monitoring Design		Reporting	
	Regional Ambient (Probabilistic)	Local (Targeted)	Regional	Local
Bioassessment & Physical Habitat Assessment	X		X	
Chlorine	X		X	
Nutrients	X		X	
Water Toxicity	X		X	
Sediment Toxicity	X		X	
Sediment Chemistry	X		X	
General Water Quality		X		X
Temperature		X		X
Bacteria		X		X
Stream Survey	X			X

2.0 Study Area and Design

2.1 RMC Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes the portions of the five participating counties that fall within the SFRWQCB's jurisdiction and the eastern portion of Contra Costa County that drains to the CVRWQB's region (Figure 2.1). Status and trends monitoring is being conducted in flowing water bodies (i.e., creeks, streams and rivers) interspersed among the RMC area), including perennial and non-perennial creeks and rivers that run through both urban and non-urban areas.

2.2 Monitoring Locations

During Water Year 2012 (October 1, 2011 - September 30, 2012) water temperature, general water quality and pathogen indicators were monitored at the targeted locations listed in Table 2.1 and Figure 2.2. Site locations were identified using a targeted monitoring design based on the directed principle[2] to address the following management questions:

1. What is the spatial and temporal variability in water quality conditions during the spring and summer season?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. Do pathogen indicator organism concentrations indicate potential impacts to recreational beneficial uses at creek sites where there is potential for water contact recreation to occur?
4. What are the riparian conditions at sampling stations? Are riparian assessments good indicators for condition of aquatic life use? Can they help identify stressors to aquatic life uses?

[2] 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."

Figure 2.1 State Water Resources Control Board Region 2 and 5 Boundaries
(Source Map: CVRWQB 2010)

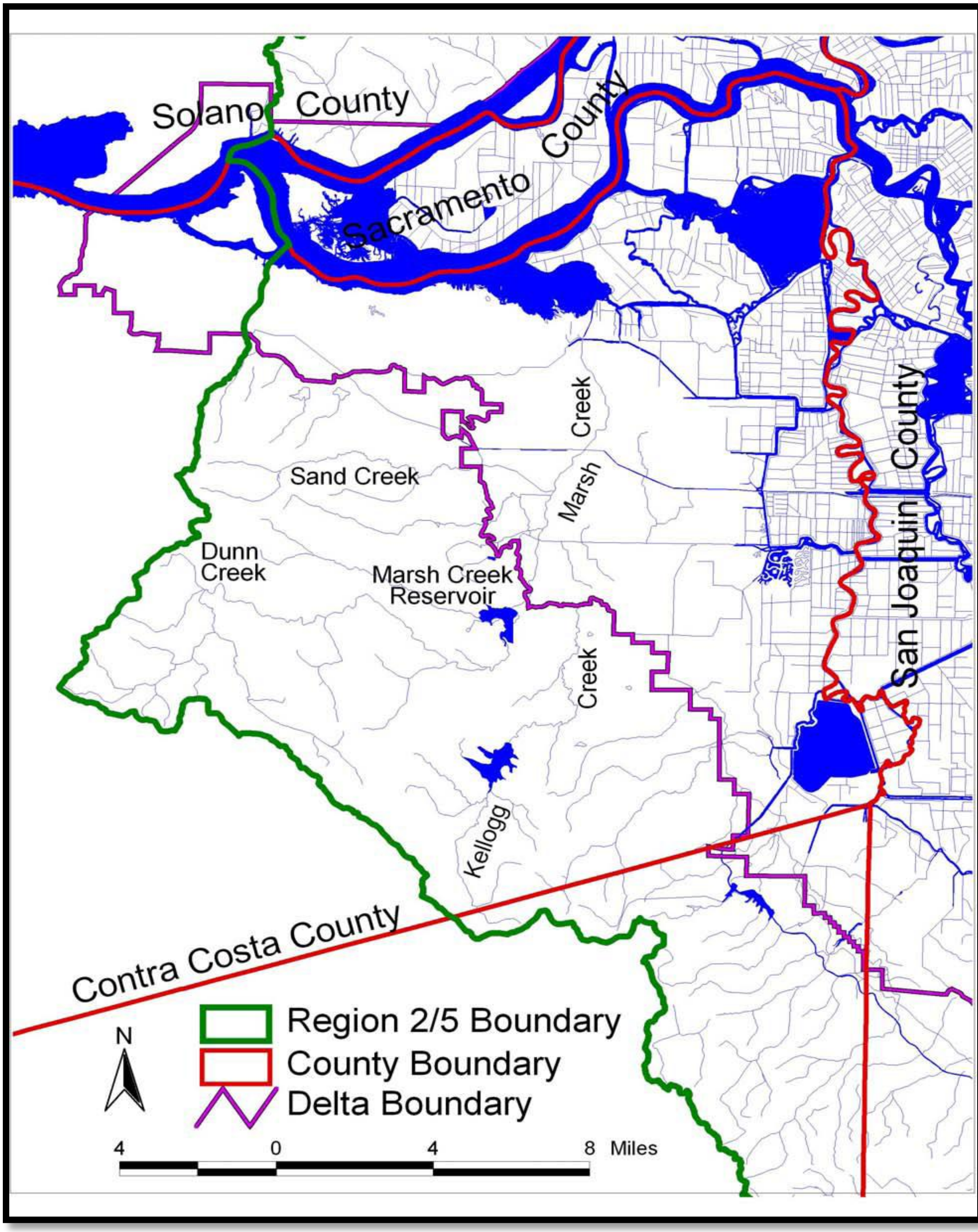


Figure 2.2 Map of BASMAA RMC area, including county boundaries and major creeks

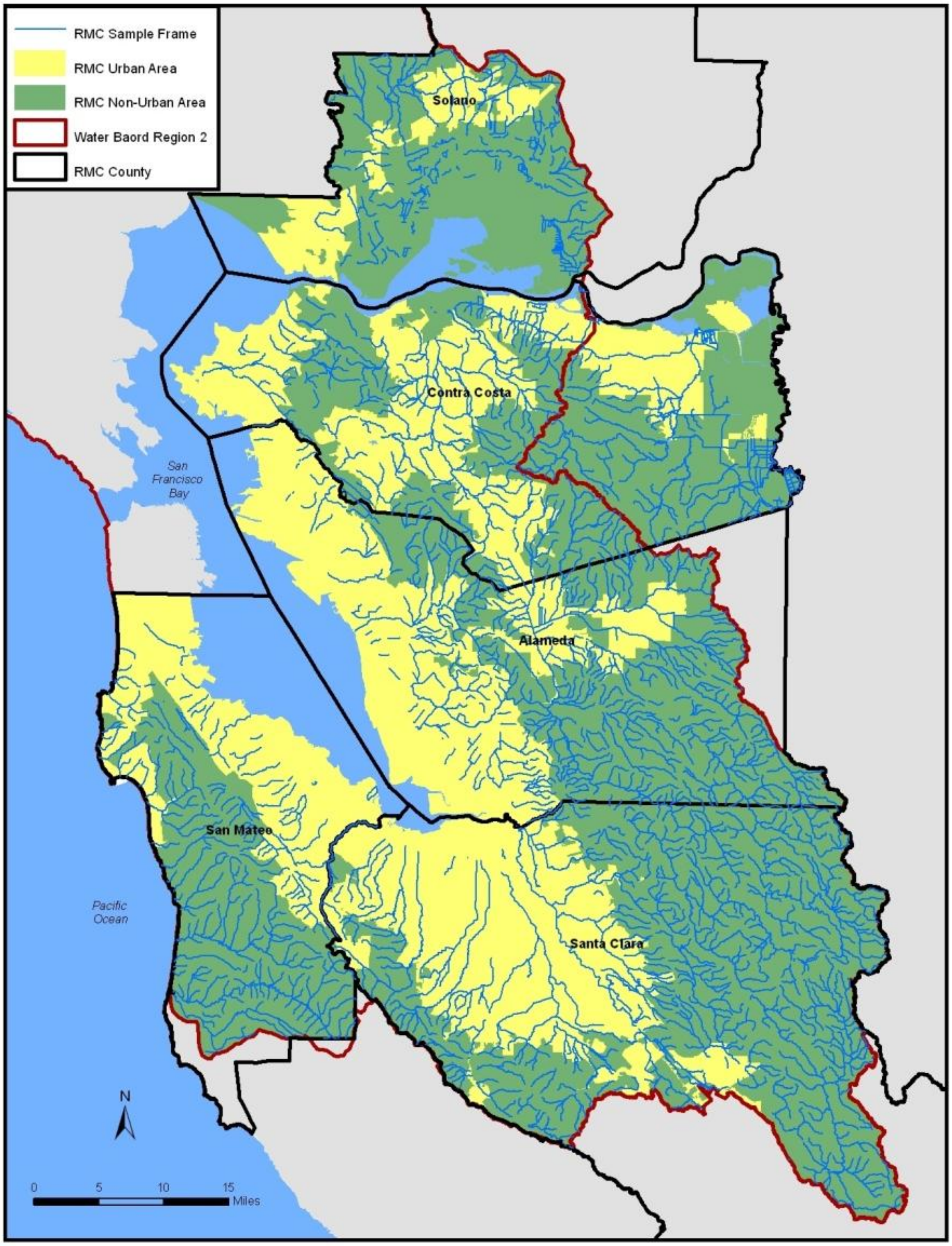


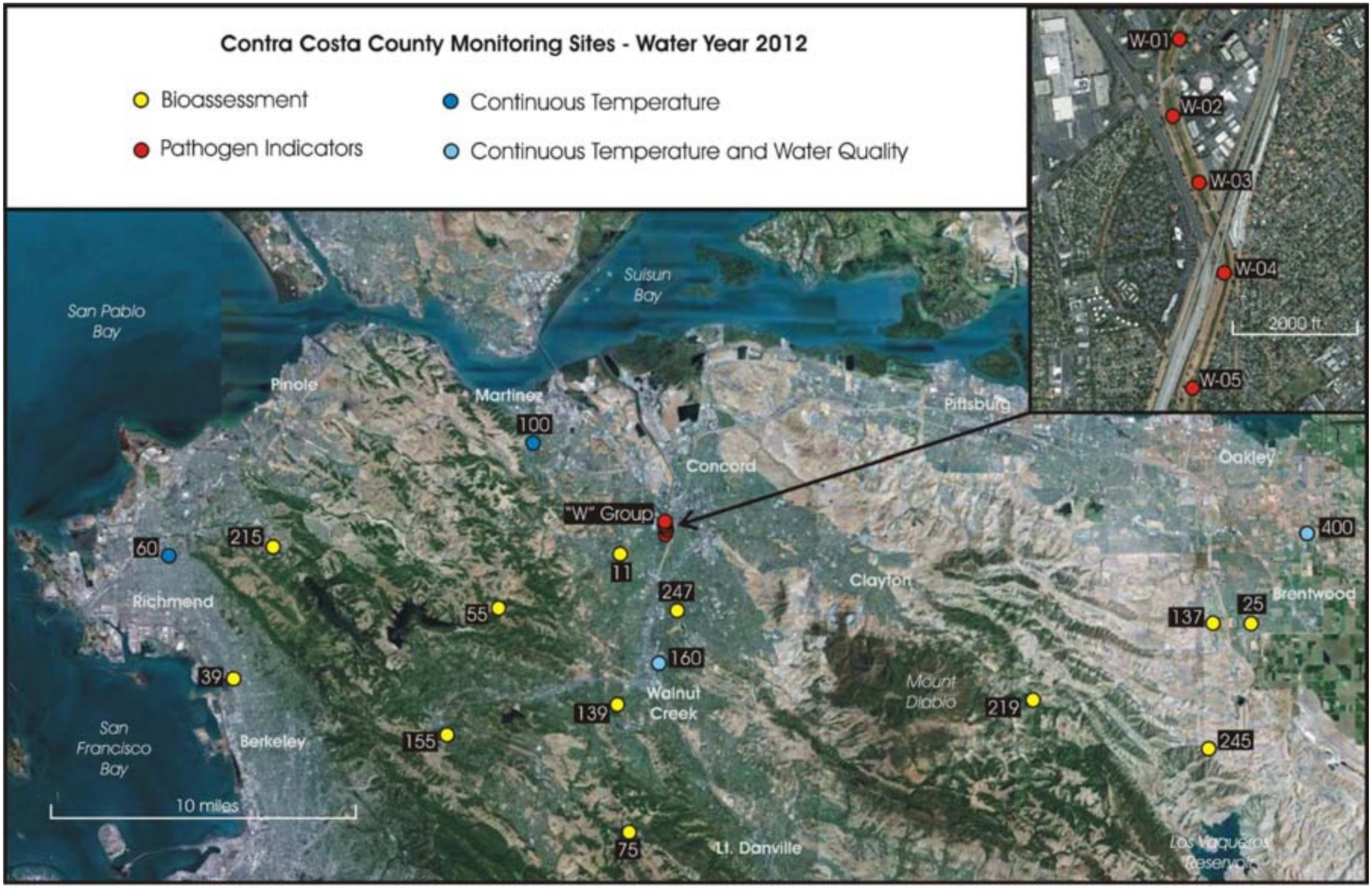
Table 2.1 Sites and local reporting parameters monitored in Water Year 2012 in Contra Costa County

Map ID	Site Code	Creek Name	Latitude	Longitude	Bioassessment	Continuous Temperature	Water Quality	Pathogen Indicators
11	207R00011	Grayson	37.95427	-122.07869	X			
25	544R00025	NA	37.92297	-121.71890	X			
39	203R00039	Cerrito	37.89830	-122.30085	X			
55	206R00055[1]	Bear	37.92998	-122.14887	X			
75	207R00075[1]	Las Trampas	37.82957	-122.07430	X			
137	543R00137	Deer	37.92211	-121.74002	X			
139	207R00139	Las Trampas	37.88658	-122.08098	X			
155	206R00155	San Pablo	37.87286	-122.17865	X			
215	206R00215	San Pablo	37.95807	-122.27814	X			
219	543R00219[1]	Marsh	37.88850	-121.84499	X			
245	543R00245[1]	Marsh	37.86669	-121.74377	X			
247	207R00247	Walnut	37.92925	-122.04751	X			
60	206WIL060	Wildcat	37.95321	-122.33835		X		
100	207ALH100	Alhambra	38.00383	-122.12969		X		
160	207WAL160	Walnut	37.90495	-122.05793		X	X	
400	544MRC400	Marsh	37.96278	-121.68639		X	X	
W-01	207WAL W-01	Walnut	37.96900	-122.05413				X
W-02	207WAL W-02	Walnut	37.96560	-122.05441				X
W-03	207WAL W-03	Walnut	37.96241	-122.05262				X
W-04	207WAL W-04	Walnut	37.95838	-122.05117				X
W-05	207WAL W-05	Walnut	37.95323	-122.05318				X

Explanation

[1] Non-urban probabilistic site

Figure 2.3 Probabilistic and targeted sites monitored by CCCWP in 2012



3.0 Monitoring Methods

Targeted monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2012a) and BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2012b). Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[3], and were submitted in SWAMP-compatible format by CCCWP to the SFBRWQCB and the CVRWQCB on behalf of Contra Costa County permittees and pursuant to Provision C.8.g.

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 2012b) and associated QAPP (BASMAA 2012a). These documents are updated as needed to maintain their currency and optimal applicability. The SOPs were developed using a standard format that describes health and safety precautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples.

The monitoring locations for general water quality parameter [Dissolved Oxygen (DO), specific conductivity, pH, and temperature] were located in Marsh Creek and Walnut Creek for this initial monitoring year because they are the two largest watersheds in Contra Costa County and are located in the Central Valley (Marsh Creek) an San Francisco Bay (Walnut Creek) regions. Additionally, the Friends of Marsh Creek watershed group is interested in the data for the associated fish ladder project. Alhambra Creek and Wildcat Creek were selected for temperature monitoring because they are urbanized watersheds that are listed for the beneficial use of cold water fisheries habitat (COLD), and provide geographic coverage to the west of Marsh Creek and Walnut Creek.

3.1.1 General Water Quality Measurements

Water quality monitoring equipment (YSI 6600 data Sondes) was deployed at one site each in Walnut Creek and Marsh Creek. General water quality parameters (DO, specific conductivity, pH, and temperature) were recorded at fifteen minute intervals for approximately two week intervals. The equipment was deployed for two time periods at each creek as follows:

- Walnut Creek - once during spring (May 23-June 4) and once during summer (August 1-13).
- Marsh Creek - once during spring (May 8-May 18) and once during summer (August 1-13).

Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2012b).

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

3.1.2 Continuous Temperature Monitoring

In 2012, the CCCWP monitored water temperature and other water quality parameters at one location on each of the following creeks: Marsh Creek between Brentwood and Knightsen; Walnut Creek in the City of Walnut Creek; Alhambra Creek in Martinez; and Wildcat Creek in San Pablo. Digital temperature loggers (Onset HOBO ® Water Temp Pro V2) were deployed at each site. Hourly temperature measurements were recorded at each respective site as follows;

- Walnut Creek - once during summer into early fall (June 20–September 30)
- Alhambra Creek – once from mid-spring through early fall (April 17–September 30)
- Wildcat Creek - once from mid-spring through mid-summer (April 17–July 31)
- Marsh Creek - once during mid-spring through early fall (April 25–September 18)

Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2012b).

3.1.3 Pathogen Indicators Sampling

The Contra Costa Flood Control and Water Conservation District (FC District) performed a pilot study in June 2012, to compare the effectiveness of grazing with goats and sheep versus the traditional use of herbicides for vegetation management and assess potential impacts to water quality from each maintenance practice. Water quality samples were collected by FC District staff at eight sites along the reach (upstream to downstream) where the livestock were grazing and were analyzed for fecal coliform during each day of the twelve-day grazing period from June 12th – June 23rd. To augment this pilot study, and to meet MRP and Region 5 Permit Provision C.8.g. requirements, another set of pathogen indicator samples were collected by ADH Environmental (ADH) staff on July 12, 2012, at five sites along the same reach of Walnut Creek and were analyzed for fecal coliform and *E. coli*.

Sampling techniques by the County and ADH 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 by ADH are described in RMC SOP FS-2 (BASMAA 2012b).

3.1.4 Stream Survey Assessment

In lieu of a stream assessment either the California Rapid Assessment Method (CRAM), or the Unified Stream Assessment (USA) method, for Water Year 2012 CCCWP proposes to submit an assessment of Wildcat Creek that was funded in part by CCCWP and provides comparable information[4]. The MRP allows recent stream surveys and studies to be submitted in lieu of the required six miles of stream survey specified in Table 8.1.

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[4] The most recent use of this information (http://www.urbancreeks.org/WildcatWRAP.html) was published as the Wildcat Creek Restoration Action Plan (WRAP) by the Wildcat-San Pablo Watershed Council (Watershed Council). Participants of the Watershed Council include permittees City of Richmond and City of San Pablo. Funding for the original studies supporting the WRAP (see http://legacy.sfei.org/watersheds/wildcatreport/cover-V.pdf.) was provided by CCCWP as well.

3.2 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012a). Data Quality Objectives (DQOs) were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-survey field training and an in-situ field audit were conducted by the California Department of Fish and Game (CDFG).

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

3.3 Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the local Program Quality Assurance Officer, and compared both against the methods and protocols specified in the SOPs and QAPP. The findings and results then were evaluated against the relevant DQOs 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 3.1. The data quality assessment consisted of the following elements:

- Conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.
- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples.
- Temperature data were checked for accuracy by comparing measurements taken by HOBOs ® with NIST thermometer readings in room temperature water and ice water.
- General 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 and precision (i.e., lab duplicates, lab blanks) were not implemented for pathogen samples collected this year, but will be in subsequent years.

Table 3.1 Data quality steps implemented for temperature and general water quality monitoring

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

3.4 Data Analysis and Interpretation

Continuous temperature and general water quality data were plotted as box and whisker plots for each site during each deployment. The middle line of the box represents the median value (50^{th} percentile), and top and bottom edge of the box indicate the 75^{th} and 25^{th} percentile, respectively. The upper whisker represents the 90^{th} percentile, while the bottom whisker represents the 10^{th} percentile. All data that do not fall between the 10^{th} and 90^{th} percentile are plotted as points outside of the whiskers.

The hourly water temperature measurements were calculated as daily arithmetic means over a 24-hour period from midnight to 11:00 PM. Seven-day “rolling” weekly average stream temperatures were calculated by averaging each daily temperature with the previous six daily average temperatures.

Targeted monitoring data were evaluated against WQOs or other applicable thresholds, as described in Table 8.1 in the MRP. Table 3.2 defines thresholds used for selected targeted monitoring parameters. The subsections below provide details on thresholds selected and the underlying rationale.

3.4.1 Dissolved Oxygen

The Basin Plan (SFRWQCB 2011) lists WQOs for DO in non-tidal waters as follows: 5.0 mg/L minimum for waters designated as warm water habitat (WARM) and 7.0 mg/L minimum for waters designated as COLD. Although these WQOs are suitable criteria for an initial evaluation of water quality impacts, further evaluation may be needed to determine the overall extent and degree that COLD and/or WARM beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a water body that may not support salmonid spawning or rearing habitat, but may be important for upstream or downstream fish migration. In these cases, DO data will be evaluated for the salmonid life stage and/or fish community that is expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

Table 3.2 Description of water quality thresholds for Municipal Regional Permit and Region 5 Permit Provision C.8.c parameters monitored using a targeted design

Monitoring Parameter	Threshold Description

Temperature	20% of results for the deployment period at each monitoring site exceed one or more of the following applicable temperature thresholds:
	• For a water body designated as COLD and/or supports steelhead trout population (USEPA 1977):
	  o 7-day Mean Temperature should not exceed 19° C
	• For a water body designated as COLD or WARM (SFRWQCB 2011):
	  o The temperature shall not be increased by more than 2.8˚ C above natural receiving water temperature.

General Water Quality	20% of results for the deployment period at each monitoring site exceed one or more water quality standards or established thresholds: • Water Temperature: see above • Dissolved Oxygen: for WARM < 5.0 mg/L and for COLD < 7.0 mg/L (SFRWQCB 2011) • pH: > 6.5 and < 8.5[1] (SFRWQCB 2011) • Conductivity: NA
Pathogen Indicators	Single sample result meets one or more of the following criteria: • Fecal coliform: ≥ 400 MPN/100 ml (based on SFRWQCB 2011) • E. coli: ≥ 576 MPN/100 ml (based on USEPA 1986, infrequently used area)

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

3.4.2 pH

Water Quality Objectives for pH in surface waters are stated in the Basin Plan (SFRWQCB 2011) 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.

3.4.3 Pathogen Indicators

The Basin Plan (SFRWQCB 2011) includes Water Contact Recreation WQOs of fecal coliform concentrations less than 200 MPN/100ml (geometric mean of data) and less than 400 MPN/100ml (90th percentile of data). For Non-contact Water Recreation, the Basin Plan includes WQOs of fecal coliform concentrations less than 2,000 MPN/100ml (geometric mean of data) and less than 4,000 MPN/100ml (90th percentile of data).It should be noted that in 2012 the EPA released its 2012 Recreational Water Quality Criteria (RWQC) recommendations for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. In the RWQC EPA provides two sets of recommended criteria as shown in Table 3.3. 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 that contains organisms that indicate the presence of fecal contamination. They are not regulations themselves (USEPA 2012).

Table 3.3 EPA 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 (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
Enterococci (marine & fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

The Basin Plan objectives are based on a sampling protocol where a minimum of five consecutive samples are collected equally spaced over a 30-day period. The RMC monitoring design for pathogen indicators was to collect single water samples at individual water bodies, which is not consistent with this sampling protocol. Furthermore, as discussed in Section 3.1.3, CCCWP participated in a goat and sheep grazing pilot study with County of Contra Costa (County) to compare the effectiveness of grazing with goats and sheep versus the traditional use of herbicides for vegetation management. For this study water quality samples were collected by County staff at eight sites along the reach (upstream to downstream) relative to where the livestock were grazing and were analyzed for fecal coliform during each day of the twelve-day grazing period from June 12–June 23. As part of this pilot study, and to meet MRP and Region 5 Permit Provision C.8.g requirements, another set of pathogen indicator samples were collected by ADH Environmental (ADH) staff on July 12, 2012, at five sites along the same reach of Walnut Creek bracketing the grazing plots and were analyzed for fecal coliform and *E. coli*.

For the purposes of this evaluation, fecal coliform maximum concentrations of 400 Most Probable Number (MPN)/100ml and 4,000 MPN/100ml in a single sample were used as a Water Contact Recreation and Non-water Contact Recreation evaluation criteria, respectively. While the Basin Plan does not include WQOs for *E. coli,* the EPA has established a criterion for maximum concentrations of *E. coli* concentrations in fresh water for Water Contact Recreation as 576 MPN/100ml for infrequently used areas (SFRWQCB 2011). The EPA criterion for a single sample maximum was used as the basis for analyzing *E. coli* data to determine which might “trigger” a monitoring project under MRP and Region 5 Permit Provision C.8.d.i. In regard to EPA 2012 RWQC standard threshold values, since the geometric mean cannot be determined from the data collected, the only applicable recommended exceedance is the *E. Coli* Standard Threshold Values of 410 colony forming units (CFU) per 100 ml and 320 CFU/ml, for Recommendation 1 and 2, respectively. For interpretive purpose CFU and MPN are considered equivalent.

3.4.4 Temperature

Temperature is one indicator of the ability of a water body to support either warm water fisheries habitat (WARM) or cold water fisheries habitat (COLD). In California, the beneficial use of COLD is generally associated with suitable spawning habitat and passage for anadromous fish (e.g., salmon). Marsh Creek is listed in the Central Valley Basin Plan as supporting WARM. Walnut Creek is listed in the San Francisco Bay Basin Plan as supporting COLD. In both water bodies, flood control construction in the 1950s and 1960s, and the existing Operations and Maintenance Plan that the FC District must adhere, prohibit the formation of habitat that would support the establishment of anadromous fish (U.S. Army Corps of Engineers 2007)[5]. This physical and regulatory constraint helps prioritize the potential responsive action to the analysis of temperature as it relates to fish habitat in Marsh Creek and Walnut Creek.

A review was conducted of EPA criteria for water temperatures to protect anadromous salmonids, such as steelhead and Chinook salmon, in fresh water streams used by these fish for reproduction and rearing, and address the applicability of EPA criteria to several of the streams in east Contra Costa County that have historically supported steelhead and Chinook salmon. The focus of this analysis is primarily on Marsh Creek, and to a lesser degree, on Walnut Creek.

EPA documents that offer guidance for water temperatures to protect and/or restore fresh water streams for salmonids include: 1) EPA's (2003) *EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*; and 2) Sullivan et al. (2000) *An Analysis of the Effects Of Temperature on Salmonids of the Pacific Northwest With Implications for Selecting Temperature Criteria*. EPA's (1986) *Quality Criteria for Water 1986* was also reviewed but found to be less applicable.

EPA's Region 10 guidance document and Sullivan et al. are both focused on the Pacific Northwest waterways. Those guidance documents may not be applicable locally because of the drier climate of east Contra Costa County and possible temperature tolerances unique to the salmon and steelhead of this region. Although credible Habitat Suitability Indices (HSI) for water temperature and salmonids are not known to have been developed for east Contra Costa County streams, a modified HSI for steelhead in central and southern coastal streams has been developed and applied to steelhead habitat assessments in several streams in this region.

This modification to the Raleigh et al. HSI curves was done by Tomas R. Payne & Associates (TRPA) for several of their projects in central and southern California. The need to modify the Raleigh et al. HSI curves for steelhead water temperatures became apparent when TRPA biologists observed steelhead juveniles appearing unstressed in stream waters with temperatures that the HSI curves gave zero habitat value for this species. These modified HSI curves for steelhead have been used with CDFG approval for assessments of steelhead habitat in the Matilija Creek basin, San Luis Creek, upper Arroyo Grande basin, and for Pole Creek in the Santa Clara River basin, all projects completed between 2004 and 2011 (TRPA 2004, 2007, 2011a&b). Stillwater Sciences (2012) used these HSI curves modified by TRPA for a steelhead habitat suitability assessment of the upper Sisquoc River watershed in Santa Barbara County for CDFG and the Ocean Protection Council.

Sullivan et al. uses a risk-based approach to analyze warm temperature effects on juvenile salmonids. That paper is a primary source of salmonid temperature recommendations; however, that document mostly addresses two salmonid species, steelhead and coho salmon (*Oncorhynchus kisutch*). The paper's rearing temperature recommendations for juvenile coho salmon are not applicable to Chinook salmon, as most coho salmon juveniles rear for a year in their fresh water natal stream and emigrate to the ocean the following March-May (Moyle 2002). Chinook salmon spawn in November and December, their eggs hatch in March or April, and 20 to 30 days later the young juvenile fish typically begin moving downstream toward the estuary and onward to the ocean. This reproductive strategy allows Chinook salmon to utilize coastal streams that would be too warm or dry in which to rear juvenile fish during the summer. For this

[5] complete history of the public deliberation of fish habitat in Walnut Creek can be found on the Contra Costa Flood Control and Water Conservation District's website at: http://ca-contracostacounty.civicplus.com/index.aspx?NID=536

reason, examination of water temperatures in Marsh Creek and Walnut Creek relative to Chinook salmon should focus on the October-November spawning migration of adults, and the outmigration of fry in April-May. Concerns for Chinook salmon spawning and egg incubation are met by focusing on suitable temperatures for similar life stages for steelhead which also utilize these streams. Sullivan et al. shows the similarity in water temperature requirements for Chinook salmon and steelhead in tables 7.1 and 7.2 of their paper.

Summer temperature concerns for rearing juvenile salmonids in Contra Costa County streams should be directed at the steelhead juveniles that spend 1 to 3 years (usually 2 years) in their natal stream before out-migrating in March through April (TRPA 2007). For this reason, Sullivan et al. temperature recommendations for steelhead are assumed here to provide adequate protection for Chinook salmon, as well with the exception of the adult salmon entering the streams in October and November to spawn.

The salmonid water temperature recommendations presented in Tables 3 and 4 of EPA 2003 (page 25) are shown in Table 3.3. As the single temperature recorder for each of the four Contra County streams are located at the lower end of the waterway, it is particularly valuable to look at the EPA 2003 temperature recommendation of adult salmonid migration: 20^0C seven-day average of the daily maxima (7DADM), above which causes migration blockage and delay. Regarding juvenile rearing, this EPA paper recommends an upper threshold of 18^0C 7DADM for low to moderate densities of juveniles where water temperature exceeds optimum conditions.

This EPA guidance publication also recommends using the water temperature metric of the maximum 7DADM. It states:

> *"This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus it reflects an average of maximum temperatures that fish are exposed to over a week-long period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions."*

Regarding unusually warm conditions:

> *EPA believes it is reasonable for a State or Tribe to decide not to apply the numeric temperature criteria during unusually warm conditions for purposes of determining if a waterbody is attaining criteria. One possible way for a State or Tribe to do this would be to ….. determine attainment with the numeric temperature criterion based on the 90^{th} percentile of the yearly maximum 7DADM values calculated from a yearly set of values of 10 years or more. Thus, generally speaking, the numeric criteria would apply 9 out of 10 years, or all but the hottest year.*

This EPA document also suggests that in waterways that have natural background temperatures higher than 20 degrees C, site-specific numeric criteria be developed for different sections of the waterway that reflects its primary salmonid use patterns. For example, waters lower in the drainage that provide migratory passage to upstream waters should not be held to standards for juvenile rearing that primarily occurs in the upper portions of the stream. The temperature criteria for the lower section should reflect the seasonal temperature needs of salmonid migration, not rearing.

Site specific temperature needs have been evaluated for central and southern coastal streams. For three decades, the consulting firm, TRPA of Arcata, California, has specialized in instream habitat and fish population assessment, temperature needs for stream salmonids, and instream flow need determinations. They have an excellent reputation among Federal and State resource agencies.

Table 3.4 Recommended Water Temperatures for Salmonids and HSI Adjustments for Central and Southern California Steelhead Waters

Reference	Fish Species	Life Stage	Recommendation
Sullivan et al. 2000	Steelhead	Juv. Rearing	20.5^{0} C [1,2]
	Salmonids	Juv. Rearing (lethal)	26^{0} C [3]
	Salmonids	Juv. Rearing	$24\text{-}26^{0}$ C [4]
EPA 2003	Salmonids [5]	Spawning	13^{0} C (DADM)
	Salmonids [5]	Egg Incubation & Fry Emerg.	13^{0} C (DADM)
	Salmonids [5]	Low-Mod Density[6] Juv. Rearing	18^{0}C (7DADM)
	Salmonids [5]	Steelhead Smoltification	14^{0} C (7DADM)
	Salmonids [5]	Adult Migration	20^{0}C (7DADM)
Raleigh et al. 1984	Steelhead	Adult Migration HSI	18^{0}C is zero point[8]
TRPA 2007	Steelhead	Adjusted Migration HSI	24^{0}C is zero point[8]
Raleigh et al. 1984	Steelhead	Adult Migration HSI	13.5^{0}C is HOV[9]
TRPA 2007	Steelhead	Adjusted Migration HSI	16.5^{0}C is HOV[9]
Raleigh et al. 1984	Steelhead	Juv. Rearing HSI	25^{0}C is zero point[8]
	Steelhead	Juv. Rearing HSI	18.5^{0}C is HOV[9, 10]
TRPA 2007	Steelhead	Adjusted Juv. Rearing HSI	32^{0}C is zero point[8]
Raleigh et al. 1984	Steelhead	Egg Incubation HSI	20^{0}C is zero point[8]
TRPA 2007	Steelhead	Adjusted Egg Incub. HSI	22^{0}C is zero point[8]
Raleigh et al. 1984	Steelhead	Smolt Outmigration HSI	15^{0}C is zero point[8]
TRPA 2007	Steelhead	Adjusted Smolt Outmig. HSI	24^{0}C is zero point[8]
Raleigh et al. 1984	Steelhead	Smolt Outmigration HSI	10.5^{0}C is HOV[9]
TRPA 2007	Steelhead	Adjusted Smolt Outmig. HSI	12.5^{0}C is HOV[9]

[1] Upper temperature threshold (seven-day maximum temperature) associated with 10% weight reduction.
[2] Found that the average of the maximum 7 consecutive days of the daily mean temperature was best correlated with growth simulations, but the annual maximum and 7-day maximum were also quite suitable.
[3] Annual maximum temperature, indicating imminent risk of direct mortality to salmonids.
[4] Recommend site specific analysis of duration of exposure when annual maximum temperature is in this range.
[5] This applies to anadromous salmon, steelhead, and trout other than bull trout, which have their own recommended temperatures.
[6] EPA 2003 refers to "core" and "non-core" juvenile rearing, the difference being high density (optimal temperatures) versus low-moderate density (higher than optimal temperatures) of juveniles rearing in a stream. As Contra Costa County streams are unlikely to achieve high densities of rearing juvenile salmonids because of higher than optimal temperatures, only the non-core juvenile rearing recommended temperature are presented here.
[7] Applies to both juvenile rearing and adult migration.
[8] Average maximum water temperature.
[9] HOV = highest optimal temperature value on the HSI curve.
[10] TRPA made no adjustment to the HSI curves for the juvenile steelhead rearing HOV.

In conducting studies of several anadromous salmonid streams along the central and southern California coast, TRPA noticed that the salmonids of these streams were more tolerant of high water temperatures than that reported in Raleigh et al. (1984) HSI curves for water temperatures. Apparently unstressed juvenile steelhead trout were frequently observed utilizing instream habitat whose water temperature exceeded the upper tolerance limit shown in the Raleigh HSI curves. Based on similar findings and temperature data from studies on the Ventura River, upper Klamath River at Iron Gate, Topanga Creek, San Luis Obispo Creek, and maximum temperatures reported in Moyle (2002) and Myrick and Cech (2000), TRPA modified some of the Raleigh HSI curves' value given to the upper temperature limits to reflect these observations. The Raleigh HSI upper temperature values and the modifications made by TRPA are shown in Table 3.4.

The reason for bringing attention to these steelhead temperature modifications that reflect the conditions in the warmer parts of California is not to state that they are necessarily more appropriate for east Contra Costa County streams supporting anadromous salmonids, but rather to point out that is generally recognized that such a condition exists. As such, consideration should be given to the possibility that it may be appropriate to use slightly higher temperature criteria for Contra Costa County streams rather than to hold them to standards suitable for a cooler climate.

When referring to the chart of summer water temperatures (seven-day average maximum) in Section 4, it is important to remember that these plotted temperatures for each creek are from a single recording device located at the lower end of each creek. Essentially, these data provides a "worst case" scenario regarding summer water temperatures occurring in these streams. Cooler temperatures during the summer may be found in upsteam segments and tributaries where there is a greater gradient and more riparian shading.

Another concern arises from the San Francisco Bay Basin Plan (RWQCB 2011) requirement that "temperature shall not be increased by more than 5 degrees F (2.8 degrees C) above natural receiving water temperature". Establishing the natural temperature of the receiving water would be needed in order to make this distinction.

For the water temperature criteria for cold water streams supporting salmonids in Contra Costa County streams, the Sullivan et al. (2000) recommendation of an upper temperature threshold of 20.5^0C (seven-day maximum) for juvenile salmonid rearing is favored. This upper temperature threshold assumes a 10 percent growth loss and is believed by Sullivan et al. to be an acceptable risk level. Natural, undammed riverine waters never operate at a constant temperature range suitable for optimum salmonid growth, except possibly certain spring creeks where the vast majority of their flow is from local springs of nearly constant temperature. So a 10 percent growth loss for salmonids from less than optimum water temperature is reasonable. It would also be reasonable to adjust this upper temperature threshold upward 0.5^0C to allow for an apparently greater tolerance of warm temperature for steelhead native to central and southern California.

4.0 Results

4.1 Statement of Data Quality

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

- Temperature data (from HOBOs ®) were collected from four sites. 73% of the expected data were collected for the following reasons:
  - HOBOs ® were deployed on April 27, 2012 at Alhambra Creek and Wildcat Creek, Marsh Creek on May 2, 2012 and at Walnut Creek on May 11, 2012, and not by April 1, 2012.
  - Retrieval of the HOBOs ® at Marsh Creek on September 18, 2012, Alhambra Creek on September 24, 2012, and Walnut Creek on September 25, 2012, and not through September 30, 2012.
  - Additionally, when the HOBO ® was deployed at Walnut Creek on May 11, 2012, the measurement interval was inadvertently set to 30 seconds instead of hourly. As a result the memory reached capacity on May 26, 2012 and the HOBO ® discontinued collecting measurements. This issue was corrected during a site visit on June 19, 2012.
  - Upon retrieval, Wildcat Creek was observed to be dry where the HOBO ® was installed and is believed to be the reason that temperature measurements discontinued on August 11, 2012.
- Continuous water quality data (temperature, pH, DO, conductivity) were collected during spring and summer season resulting in collection of 100% of the expected data.
- Continuous water quality data generally met measurement quality objectives (accuracy) for all parameters with the exception of DO at one site during Event 1 (Table 4.1). Data were flagged but used in the analysis.
- Quality Assurance laboratory procedures were inadvertently not implemented for pathogen indicator analyses this year, thus data quality could not be evaluated. These procedures will be implemented in Water Year 2013.

Table 4.1 Accuracy[1] measurement taken for dissolved oxygen, pH and specific conductivity; bold values exceed the Measurement Quality Objectives

Parameter	Measurement Quality Objectives	Site 207WAL160		Site 544MRC400	
		Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.2 mg/L	**0.22**	0.05	-0.06	**0.27**
pH 7.0	± 0.2	0.12	-0.04	0.08	-0.05
pH 10.0	± 0.2	0.13	0.19	-0.19	0.22
Conductivity (uS/cm)	± 2 uS/cm	-0.01	0.02	-0.09	0.06

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

4.2 Monitoring Results

4.2.1 Water Temperature

Summary statistics for water temperature data collected at the four sampled creeks from April to September 2012 are shown in Table 4.2. Hourly temperature data was collected for approximately 106 consecutive days at Wildcat Creek, 148 days at Marsh Creek, 161 days at Alhambra Creek, and 117 days at Walnut Creek, in two periods of 17 days in May 2012, and 100 days in June-September, 2012. Water temperatures measured at each site, along with the upper temperature threshold of 20.5^{0}C (seven-day maximum) for juvenile salmonid rearing, are illustrated in Figures 4.1 – 4.3.

Table 4.2 Descriptive statistics for continuous water temperature measured at four sites in Contra Costa County, April 19-September 25 (Alhambra Creek and Walnut Creek), April 19-August 1 (Wildcat Creek), and April 25-September 18 (Marsh Creek), 2012

Site	206WIL060	207ALH100	207WAL160	544MRC400
Temperature	Wildcat Creek	Alhambra Creek	Walnut Creek	Marsh Creek
Minimum	11.10	13.23	16.11	11.93
Median	14.52	17.23	19.39	21.82
Mean	14.74	17.31	20.49	23.71
Maximum	24.48	22.08	24.34	32.07
Max 7-day mean	18.65	19.98	23.81	27.56
# Measurements	2494	3813	2718	3502

The minimum and maximum temperature for all sites was 11.10^o C and 32.07^o C, respectively. The median temperature range for all four sites was 14.52^o C to 21.82^o C, and the maximum weekly average temperature (MWAT) range was 18.65^o C to 27.56^o C.

Figure 4.1 Water temperature data collected using HOBOs ® at four sites in Marsh, Walnut, Alhambra, and Wildcat Creeks, from April through September 2012

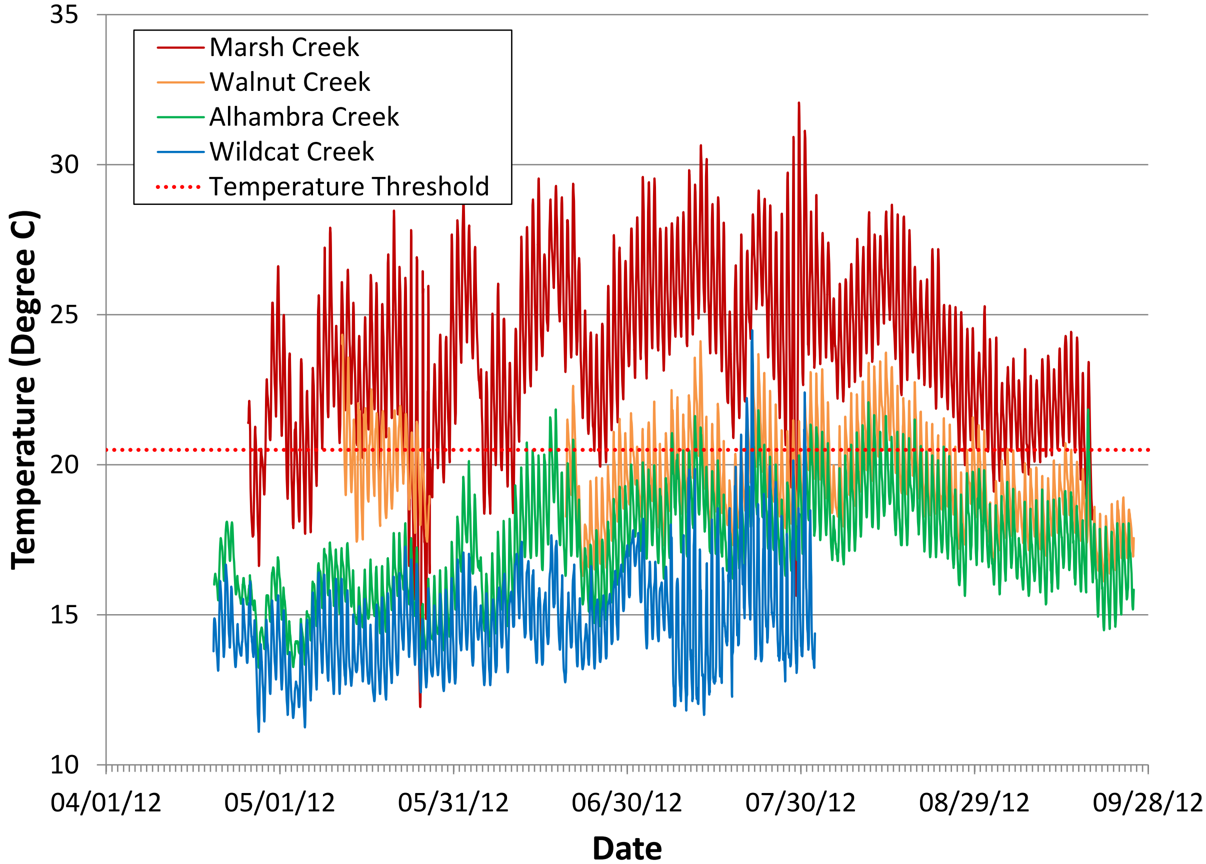


Figure 4.2 Seven-day average maximum daily water temperature (MWAT) data collected using HOBOs ® at four sites in Marsh, Walnut, Alhambra, and Wildcat Creeks, from April through September

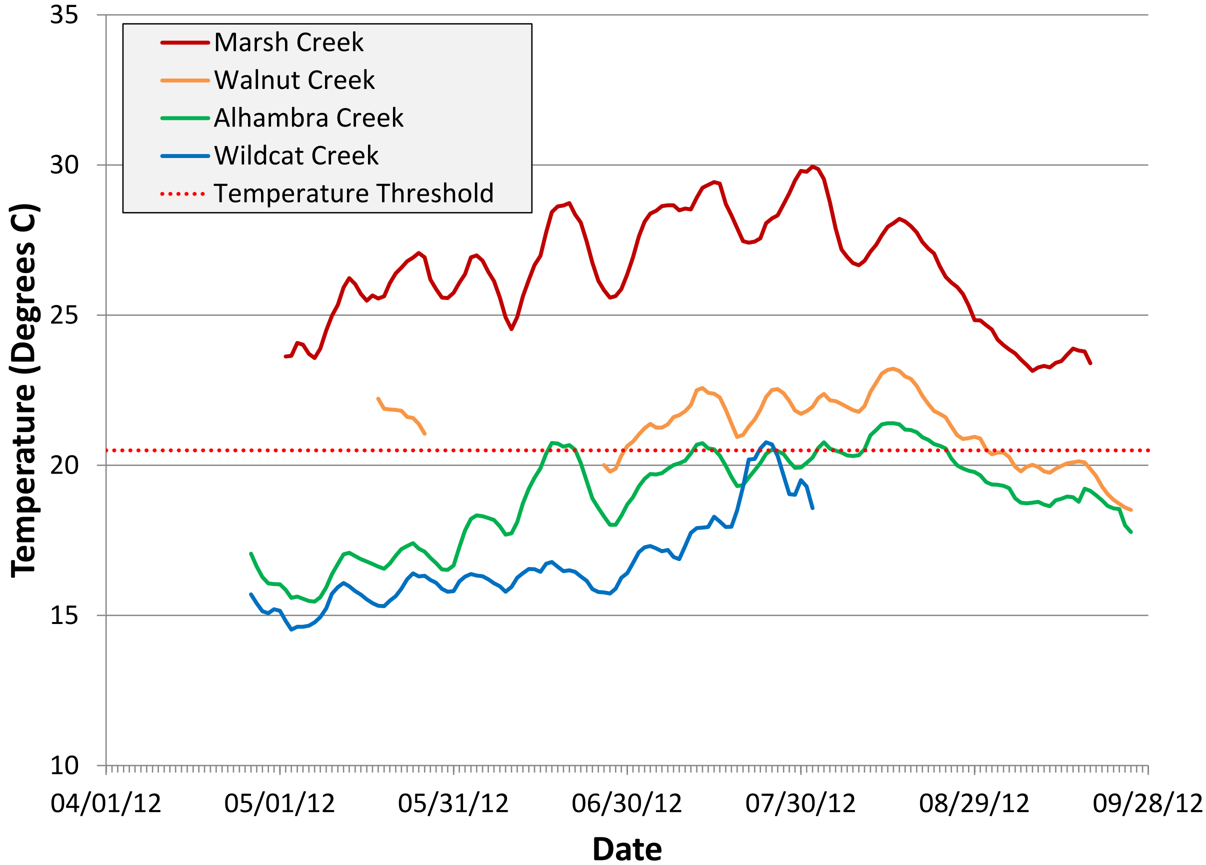
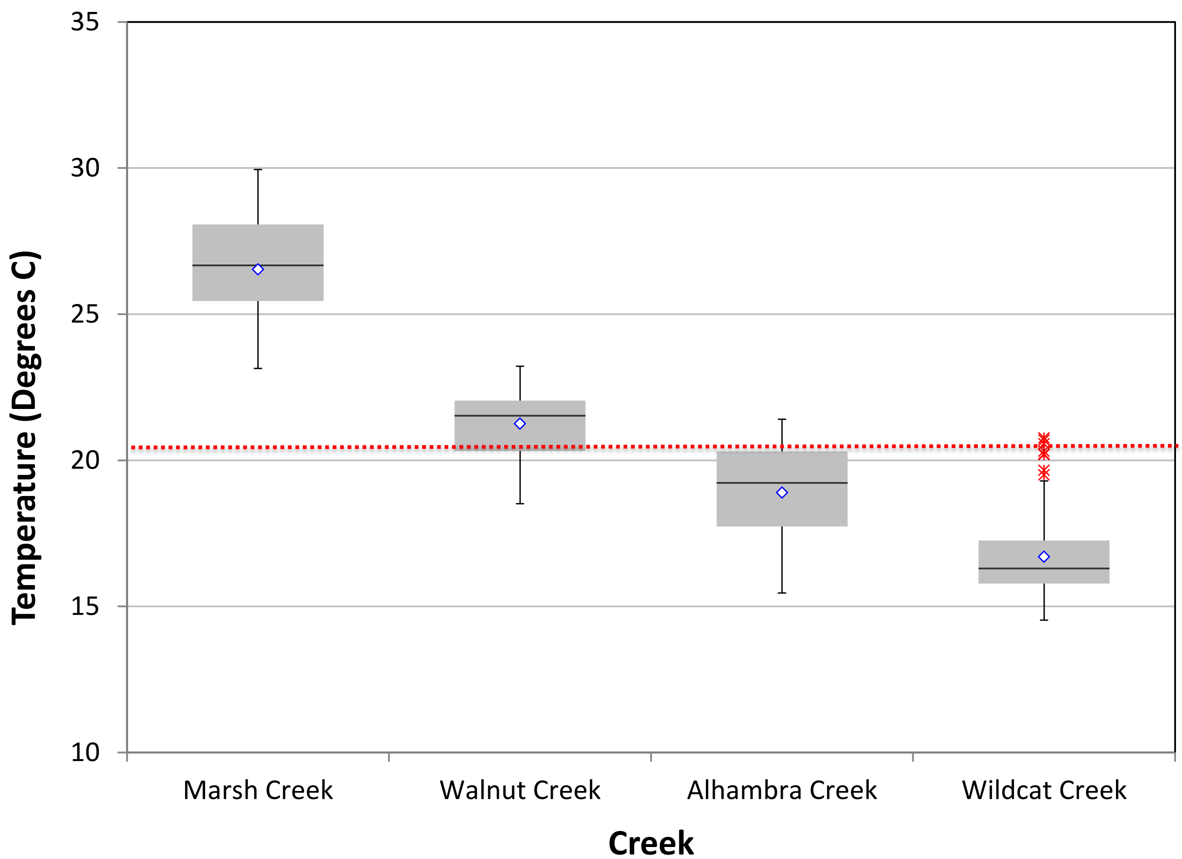


Figure 4.3 Box plots of seven-day average maximum daily water temperature (MWAT) at four sites in Marsh, Walnut, Alhambra, and Wildcat Creeks, from April through September 2012 (The red "X" points are outliers of the Wildcat Creek distribution. These outliers were the result of a rapid temperature rise at Wildcat Creek at the end of the deployment of the station HOBO ® device. Outliers are defined here as any value outside of the range Q1 – 1.5 (Q3 – Q1) and Q3 + 1.5 (Q3 – Q1), were Q3 = 75th quartile point and Q1 = 25th quartile point for each distribution.)



The distribution of seven-day average maximum daily water temperatures measured at the Alhambra Creek and Wildcat Creek stations both less the annual maximum temperature threshold for salmonids (20.5° C) for less than 20% of the time during the sampling period (Table 4.3). The distributions at Marsh Creek and Walnut Creek show 100% and 68% exceedance, respectively. The value at Walnut Creek is somewhat inflated due to the absence of the probably relatively cool water temperatures that were not sampled during the period of May 27, 2012 to June 18, 2012. However, had these temperatures been sampled, it is estimated the lowest the exceedance for Walnut Creek could have been is 55%. These water temperature monitoring results indicate the need for possible follow-up actions at Marsh Creek and Alhambra Creek.

4.2.2 General Water Quality

Summary statistics for general water quality measurements collected at two sites in Marsh Creek and Walnut Creek during two periods in May-June and August, 2012 are shown in Table 4.4. Data collected during both periods along with the required thresholds are plotted in Figures 4.4 and 4.5. The measurements taken during the May-June 2012 period do not co-occur because only one YSI Sonde device was available for deployment at these stations. Because of that, the general water quality measurements for Marsh Creek were taken during May 8, 2012 to May 18, 2012 and those for Walnut Creek were taken May 23, 2012 to June 3, 2012.

Table 4.3 Percent of water temperature data measured at four sites that exceed water quality criteria

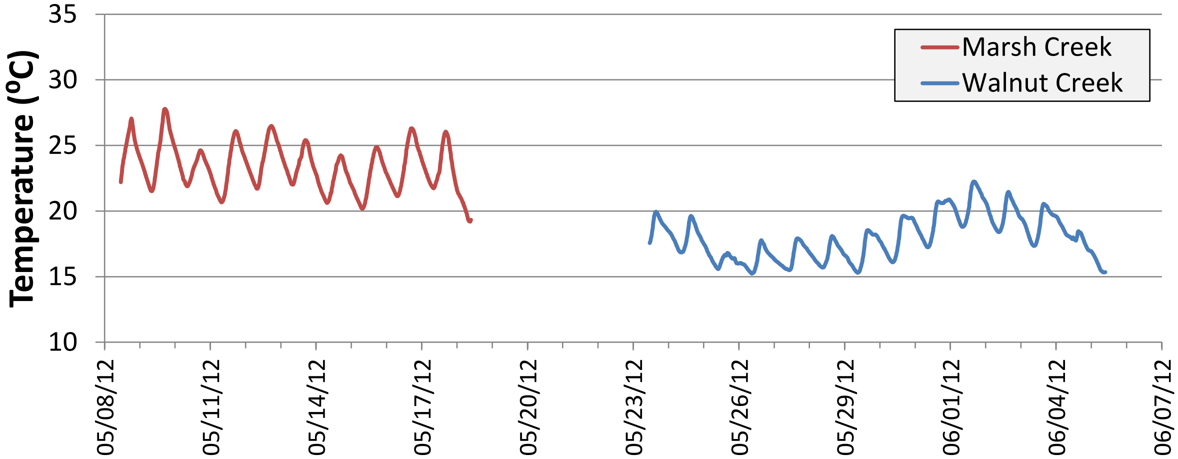
Site ID	Creek Name	Monitoring period	*Temp Percent Results MWAT > 20.5°C*
206WIL060	Wildcat	April 19 – August 1, 2012	3%
207ALH100	Alhambra	April 19 – September 25, 2012	18%
207WAL160	Walnut	April 19 – September 25, 2012	68%
544MRC400	Marsh	April 25 – September 18, 2012	100%

The lowest dissolved oxygen (DO) concentration (4.09 mg/l) occurred at Marsh Creek during August 2012. The lowest DO concentration (6.35 mg/l) also occurred at Walnut Creek during August 2012. The minimum and maximum pH measurements for Marsh Creek during both periods were 7.69 and 9.29, respectively. The minimum and maximum pH measurements for Walnut Creek during both periods were 8.20 and 8.55, respectively.

Table 4.4 Descriptive statistics for daily and monthly continuous water temperature, dissolved oxygen, conductivity, and pH measured at two sites in Contra Costa County, May 23–June 5 (Walnut Creek), May 8–May 18 (Marsh Creek), and August 1–13 (Event 2 both sites), 2012

Parameter		Site 207WAL160		Site 544MRC400	
		May	August	May	August
Temperature (° C)	Min	15.22	17.82	19.2	22.11
	Median	17.82	20.45	23.3	25.05
	Mean	17.96	20.50	23.37	23.71
	Max	22.25	23.53	27.79	28.98
	Max 7-day mean	20.53	21.59	25.06	27.47
Dissolved Oxygen (mg/l)	Min	7.17	6.35	5.03	4.09
	Median	8.72	7.34	10.56	8.96
	Mean	8.84	7.88	10.79	9.15
	Max	10.79	10.71	17.22	14.92
pH	Min	8.2	8.25	7.99	7.69
	Median	8.47	8.37	8.67	8.38
	Mean	8.46	8.38	8.68	8.37
	Max	8.55	8.53	9.28	9.29
Specific Conductivity (µS/cm)	Min	780	757	964	935
	Median	944	853	1347	1180
	Mean	933	847	1352	1189
	Max	980	889	1754	1480

Figure 4.4 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductivity) collected at Marsh and Walnut Creeks, May 8-June 5, 2012



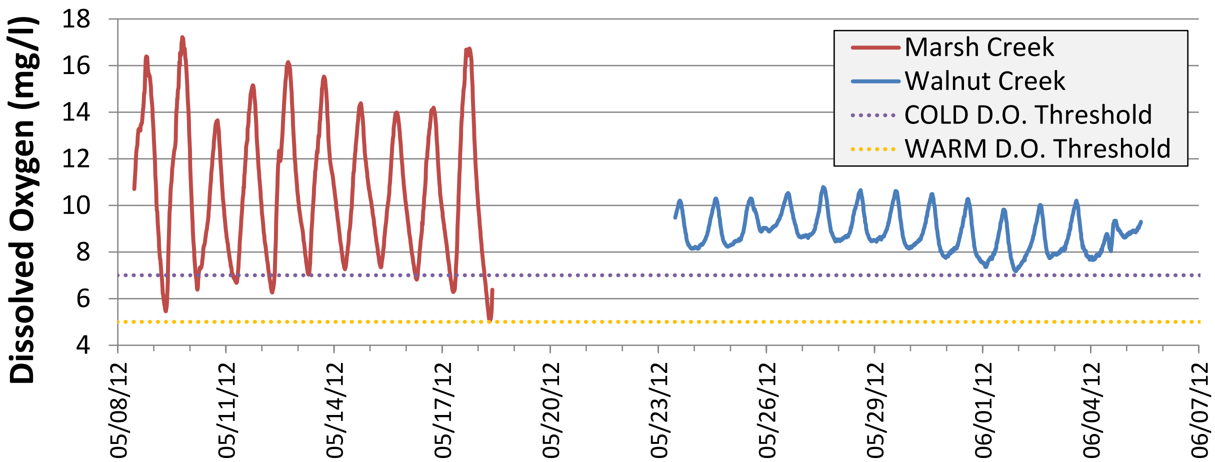
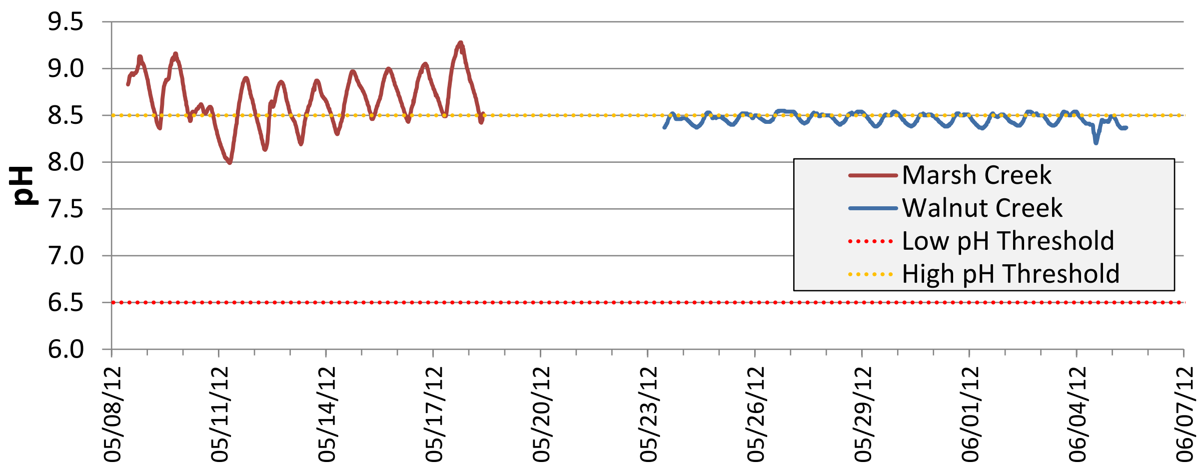


Figure 4.4 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductivity) collected at Marsh and Walnut Creeks, May 8-June 5, 2012 (Continued)



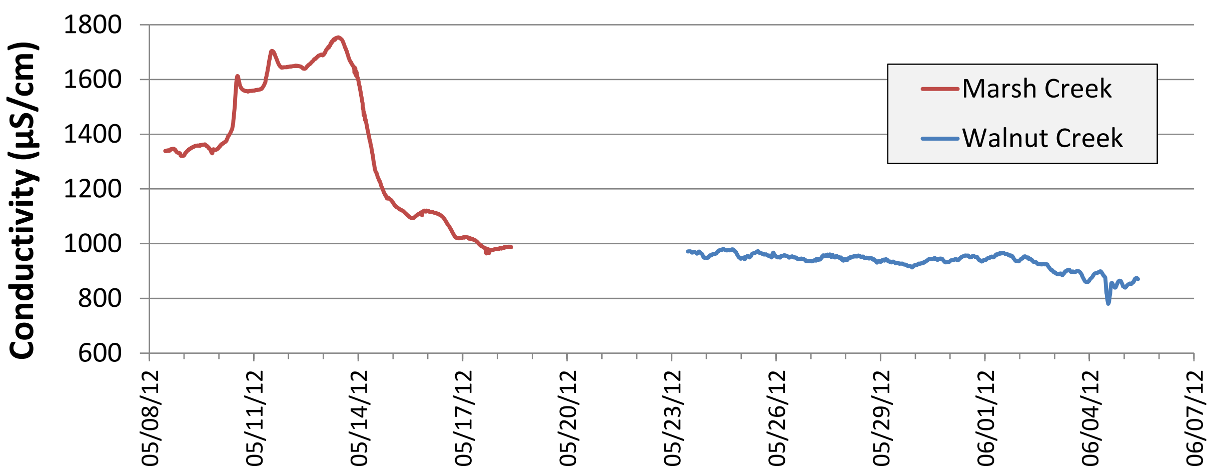


Figure 4.5 Continuous water quality data (temperature, dissolved oxygen, pH, and specific conductivity) for Marsh and Walnut Creeks, August 8-13, 2012

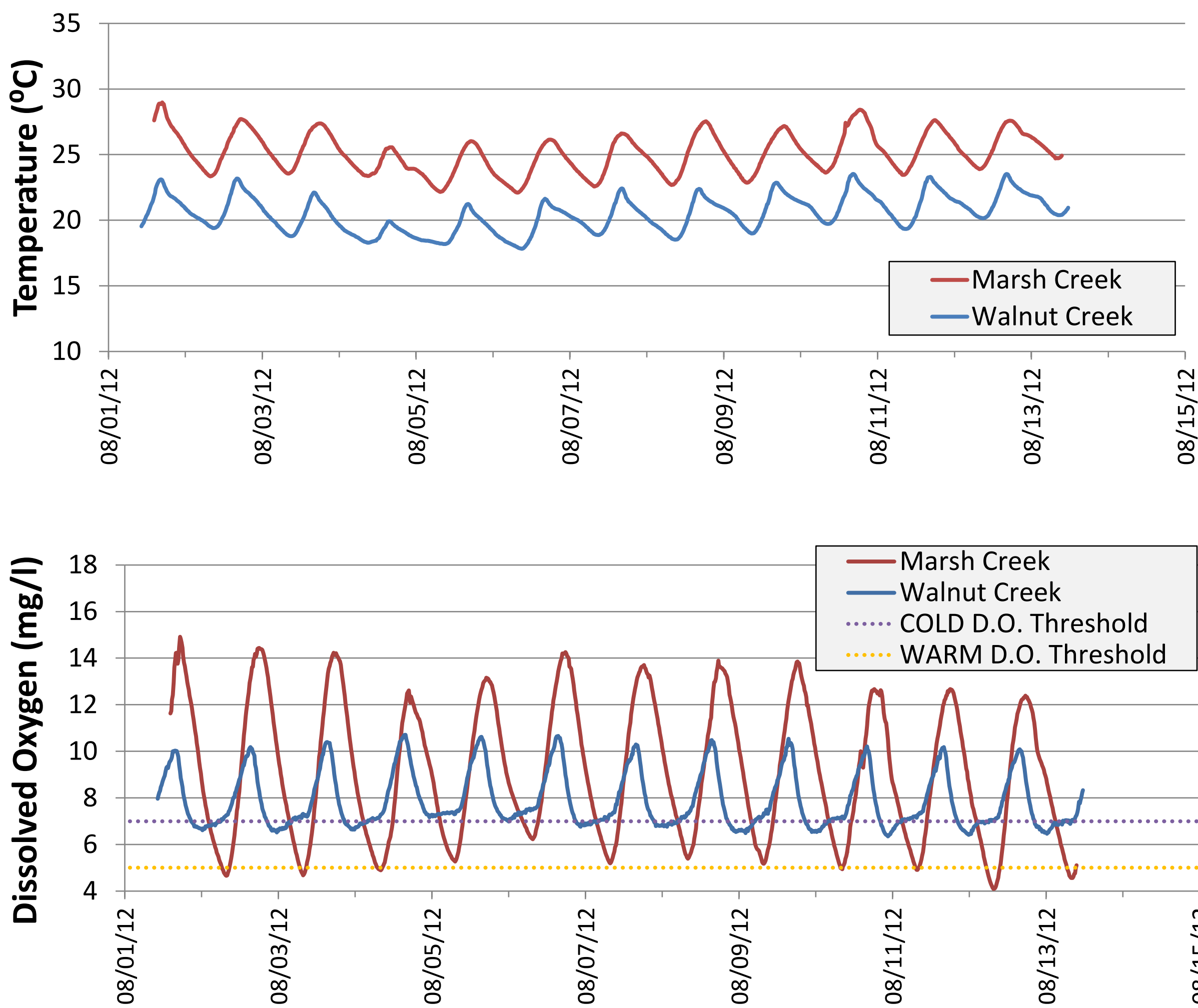
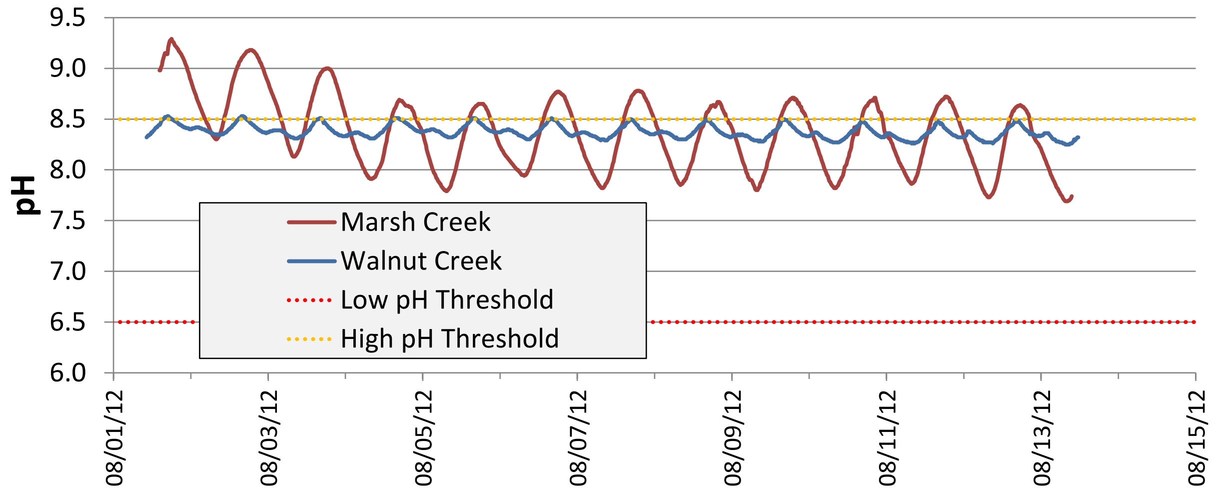


Figure 4.5 Continuous water quality data (temperature, dissolved oxygen, pH, and specific conductivity) for Marsh and Walnut Creeks, August 8-13, 2012 (Continued)



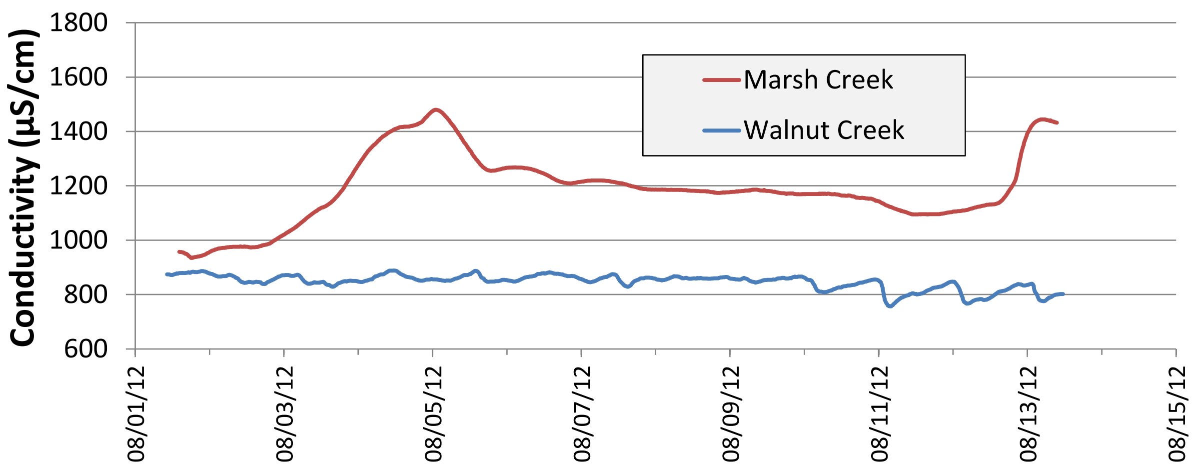


Figure 4.6 compares distributions of seven-day average maximum daily water temperature (MWAT) to the annual maximum temperature threshold for salmonids (20.5o C) at the Marsh Creek and Walnut Creek sites as recorded by the YSI Sonde devices during May-June and August 2012.The results show that only during the May-June deployment was Walnut Creek below the threshold. These results are consistent with those for the longer HOBO-based temperature series at these two stations.

Figure 4.6 Box plots of seven-day average maximum daily water temperature (MWAT) at Marsh and Walnut Creeks, during May-June 2012 and August 2012

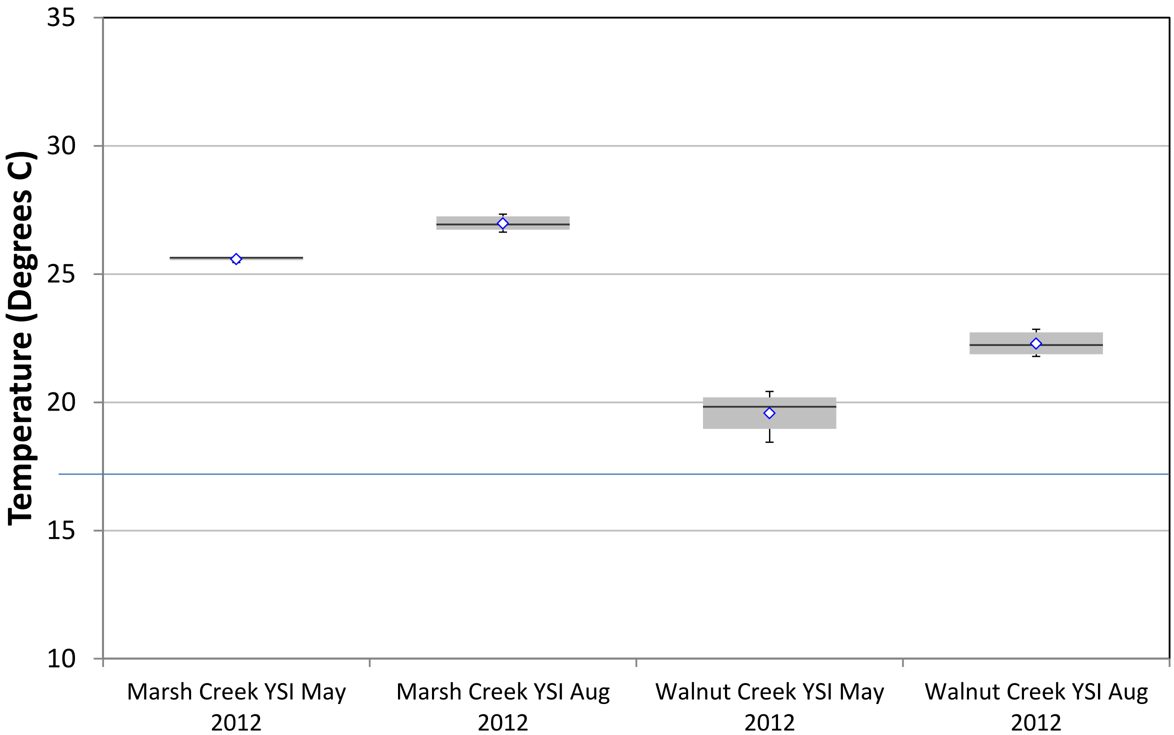


Table 4.5 presents the distribution of continuous water quality data for temperature, dissolved oxygen, and pH measured at Marsh Creek and Walnut Creek during both monitoring periods compared to water quality evaluation criteria specified in Table 8.1 of the MRP and Region 5 Permit (Table 3.2). The following summarizes any exceedances that occurred at either creek as follows:

- Walnut Creek:

    a. During the May-June 2012 deployment, water temperature exceeded the MWAT threshold 100% of the time.
    b. During the August 2012 deployment, DO fell below the COLD threshold 26% of the time.
    c. During the May 2012 deployment, pH exceeded the 8.5 threshold 26% of the time.
    d. During the August 2012 deployment, pH exceeded the 8.5 threshold3% of the time.

- Marsh Creek:

    a. During the May and August 2012 deployments, water temperature exceeded the MWAT threshold 100% of the time.
    b. During the August 2012 deployment, DO fell below the WARM threshold 5% of the time.
    c. During the May 2012 deployment, pH exceeded the 8.5 threshold 75% of the time.
    d. During the August 2012 deployment, pH exceeded the 8.5 threshold 39% of the time.

These monitoring results indicate the need for possible follow-up actions at Marsh Creek and Walnut Creek.

Table 4.5 Percent of dissolved oxygen, water temperature, and pH data measured at two sites for both events that exceed water quality evaluation criteria identified in Table 3.2.

Site ID	Creek Name	Monitoring Period	Temp Percent Results MWAT > 20.5°C	DO Percent Results < 5.0 mg/l (WARM)	DO Percent Results < 7.0 mg/l (COLD)	pH Percent Results < 6.5 or > 8.5
207WAL160	Walnut Creek	May 23 - June 5, 2012	0%	-	0%	26%
		August 1 - 13, 2012	100%	-	28%	3%
544MRC400	Marsh Creek	May 8 - May 18, 2012	100%	0%	-	75%
		August 1 - 13, 2012	100%	5%	-	39%

Previous observation of Marsh Creek and Walnut Creek have shown that slow currents, warm water temperatures, and a high degree of channel exposure to solar radiation result in extensive growth of filamentous algae in the wetted creek channel. When this large amount of algae biomass is living, it begins to produce dissolved oxygen by photosynthesis once the sun rises, particularly as it shines on the water. If there is minimal current and wind rippling the stream channel waters, super saturation of dissolved oxygen is common. During the night, the algae revert to respiration and consume dissolved oxygen, dropping the stream's dissolved oxygen level to its minimum by dawn. Carbon dioxide produced by the algae during the evening's respiration is the major natural factor holding down the pH of the water. When excessive dissolved oxygen is produced in the stream water because of a large volume of living algae or aquatic plant biomass responding to the sunlight, the carbon dioxide in the water is greatly reduced and pH rises. So even long before decomposition of the dying filamentous algae in the fall increases the stream's Biochemical Oxygen Demand (BOD) and lowers levels of dissolved oxygen, the natural cycle of algae photosynthesis during the day and respiration during the night causes large shifts in dissolved oxygen and pH on a diurnal basis.

As these filamentous algae filled lower ends of Marsh Creek and Walnut Creek are not providing summer rearing habitat for juvenile salmonids (too warm, too much fluctuation of dissolved oxygen, not enough shelter), these spring and summer exceedances of dissolved oxygen and pH standards are not impacting any salmonid fisheries which may occur upstream in cooler waters. Relative to salmonids, the October-November levels of dissolved oxygen and pH are a greater concern as Chinook salmon adults attempt to ascend the stream at this time of year, and the lower portions of these two creeks provide migratory passage habitat for these spawning adults. In addition to monitoring temperature, dissolved oxygen, and pH in the lower ends of these creeks during adult Chinook salmon migration in the fall, it might also be worthwhile to monitor the water quality at these locations during the March-April outmigration of steelhead smolts and salmon young-of-the-year. One year's set of water quality monitoring data during these periods and locations may be all that is needed to dismiss concerns for water quality suitability for salmonid passage through the lower portions of these two creeks.

4.2.3 Pathogen Indicators

The Contra Costa Flood Control and Water Conservation District (FC District) performed a pilot study in June 2012, to compare the effectiveness of grazing with goats and sheep versus the traditional use of herbicides for vegetation management and assess potential impacts to water quality from each maintenance practice. Water quality samples were collected by FC District staff at eight sites along the reach (upstream to downstream) where the livestock were grazing and were analyzed for fecal coliform during each day of the twelve-day grazing period from June 12–June 23. To augment this pilot study, and to meet MRP and Region 5 Permit Provision C.8.g. requirements, another set of pathogen indicator samples were collected by ADH Environmental (ADH) staff on July 12, 2012, at five sites along the same reach of Walnut Creek and were analyzed for fecal coliform and *E. coli*. Table 4.6 summarizes the results of analyses of the samples collected on July 12, 2012.

Table 4.6 Fecal coliform and *E. coli* levels measured from water samples collected on July 12, 2012 at five locations creeks in Walnut Creek

Site ID	*Fecal Coliform (MPN/100ml)*	*E. Coli (MPN/100ml)*
207WALW01	**450**[1]	**450**[2]
207WALW02	300	300
207WALW03	240	130
207WALW04	130	34
207WALW05	130	130

Explanation:
[1] Exceeded EPA fecal coliform single sample maximum concentrations of 400 MPN/100ml.
[2] Exceeded *E. coli* EPA RWQC Recommendations 1 and 2 STVs of 410 and 320 MPN/100ml, respectively.

As described previously (Section 3.4.3), single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFRWQCB 2011) and 410 MPN/100ml *E. coli* (USEPA 2012) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. In addition, a fecal coliform single sample maximum concentration of 4,000 MPN/100ml was used as a Non-water Contact Recreation evaluation criterion. And, 2012 Recreational Water Quality Criteria (RWQC) Standard Threshold Values (STV) Recommendations 1 and 2 for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use were also applied.

Total coliform concentrations ranged from 130 to 450 MPN/100 ml; *E. coli* concentrations ranged from 34 to 450 MPN/100 ml. Only one sample collected exceeded any applicable EPA criteria: the sample collected at (upstream) site 207WALW01 exceeded EPA single sample maximum concentrations of 400 MPN/100ml fecal coliform and 2012 RWQC criteria STV for Recommendation levels 1 and 2 for *E. coli* of 410 and 320, respectively at a value of 450 MPN/ml.

A review of the fecal coliform data from the County pilot study and pathogen samples collected by ADH along the reach on Walnut Creek show two noteworthy aspects: 1) pathogen data for fecal coliform and *E. coli* were relatively low; and, 2) there is no correlation of pathogen indicator bacteria increasing in concentration upstream to downstream along the pilot study reach. This would tend to indicate reduced risk of water quality impacts due to goat grazing; however, the FC District intends to continue this study for the next two years.

5.0 Next Steps

During Water Year 2013, CCCWP will continue conducting monitoring for general water quality parameters according to the requirements of Provision C.8 in the MRP and the Region 5 Permit. CCCWP will perform a Stream Survey on a total of 6 miles on a yet-to-be determined water body or water bodies within Contra Costa County using the Unified Stream Assessment (USA), modified method to provide additional data that can be used in the assessment of aquatic life condition in Contra Costa County creeks. Finally, CCWP will work with the RMC and Water Board Region 5 to plan and implement appropriate stressor/source identification projects that follow-up on Water Year 2012 creek status monitoring data, per the requirements of MRP and Region 5 respective Provision C.8.d.i.

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B3

San Mateo Countywide Water Pollution Prevention Program

SAN MATEO COUNTYWIDE
Water Pollution Prevention Program

Local Urban Creeks Monitoring Report Water Year 2012 (Oct 2011 – Sept 2012)

Submitted in Compliance with Provision C.8.g.iii, NPDES Permit No. CAS612008

FINAL

March 8, 2013

A Program of the City/County Association of Governments

Credits

This report is being submitted by the participating agencies in the

Town of Atherton
City of Belmont
City of Brisbane
City of Burlingame
Town of Colma
City of Daly City
City of East Palo Alto
City of Foster City
City of Half Moon Bay
Town of Hillsborough
City of Menlo Park
City of Millbrae
City of Pacifica
Town of Portola Valley
City of Redwood City
City of San Bruno
City of San Carlos
City of San Mateo
County of San Mateo
San Mateo County Flood Control District
City of South San Francisco
Town of Woodside

San Mateo Countywide Water Pollution Prevention Program
555 County Center, Redwood City, California, 94063
A Program of the City/County Association of Governments (C/CAG)

Report Prepared by
EOA, Inc. of Oakland, CA

List of Acronyms

ACCWP	Alameda County Clean Water Program
BASMAA	Bay Area Stormwater Management Agency Association
B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
CRAM	California Rapid Assessment Method
DPS	Distinct Population Segment
FSURMP	Fairfield Suisun Urban Runoff Management Program
HDI	Human Disturbance Index
MRP	Municipal Regional Permit
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollution Discharge Elimination System
QAPP	Quality Assurance Project Plan
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RWQCB	Regional Water Quality Control Board
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SOP	Standard Operating Procedure
SWAMP	Surface Water Ambient Monitoring Program
USEPA	United States Environmental Protection Agency
WQO	Water Quality Objective

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Executive Summary

In early 2010, several members of the Bay Area Stormwater Agencies Association (BASMAA), including the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), joined together to form the Regional Monitoring Coalition (RMC). The RMC was formed to coordinate and oversee water quality monitoring required by the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP) (SFBRWQCB 2009). In compliance with MRP Provision C.8.c, SMCWPPP conducted Creek Status Monitoring during Water Year 2012 (October 1, 2011 to September 30, 2012) using targeted (non-probabilistic) and probabilistic monitoring designs developed through the RMC (BASMAA 2011). This Local Urban Creeks Monitoring Report documents the results of targeted monitoring activities performed by SMCWPPP during Water Year 2012.

SMCWPPP's targeted monitoring parameters were water temperature, general water quality, pathogen indicators and riparian assessments. Hourly water temperature measurements were recorded using digital temperature loggers at five sites in Pilarcitos Creek between April 23rd and September 25th 2012. General water quality monitoring (temperature, dissolved oxygen, pH and specific conductivity) was conducted using continuous water quality probes at two sites in Pilarcitos Creek during two sampling events; once during the spring season (May 29th - June 15th) and once during the summer season (August 14th - 27th). Pilarcitos Creek was prioritized for this type of water quality monitoring because 1) it is within an urbanized area; 2) it supports a coldwater biological community; and 3) a watershed group exists that is interested in the data and can utilize it to further develop and/or implement watershed management plans.

Water samples were collected at one site on each of five separate San Mateo County creeks on July 17, 2012 for analysis of microbial pathogen indicator organisms (*E. coli* and fecal coliform). Indicator organism creek monitoring locations were selected at city parks or trails that were considered to have potential for public access and exposure. It should be noted that at these sites, human exposure appears to be very limited and ingestion of water is highly unlikely.

Riparian assessments were conducted at 10 sites between July 16th and August 23rd using the California Rapid Assessment Method (CRAM). CRAM assessments were conducted at the same locations (and reach lengths) that were monitored under the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physio-chemical water quality).

Targeted monitoring data, with the exception of CRAM and specific conductivity data, were evaluated against applicable criteria, as described in Table 8.1 in the MRP (SFBRWQCB 2009). Overall, the analysis of creek data included in this submittal suggests that water quality conditions in creeks vary substantially among sites and between monitoring events. Temporal and spatial variability adds to the challenge of interpreting and evaluating the data and using it to help identify potential persistent water quality issues warranting a programmatic response. The analysis results are preliminary and do not constitute a determination of whether water quality objectives were exceeded, and/or whether stormwater runoff or dry weather discharges are or may be causing or contributing to exceedances, if any. The results are summarized below:

- Temperature: A maximum weekly average temperature (MWAT) of 19°C was used as the applicable criterion to evaluate temperature data. Temperature results for all five monitoring sites were well below this MWAT value.
- Dissolved Oxygen: WQOs for coldwater aquatic life uses (COLD) (minimum of 7.0 mg/l) were used to define thresholds for evaluating dissolved oxygen (DO) data. None of the sampled DO concentrations measured below the WQO for COLD. Previous studies indicate factors most limiting the steelhead population in the Pilarcitos Creek watershed are low stream flow, abundant fine sediment, and generally low production of insects limiting food availability (Phil Williams and Associates 2008). Water quality was not identified as a factor limiting steelhead production. All of the SMCWPPP water quality monitoring sites occurred in creek reaches downstream of Highway 92 that support upstream and downstream migration of steelhead, but likely do not support steelhead spawning and rearing habitat (Phil Williams and Associates 2008).
- pH: All of the pH measurements in Pilarcitos Creek were measured within the range of the applicable WQO (pH = 6.5 - 8.5).
- Pathogen Indicator Organisms: Single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFBRWQCB 2011) and 576 MPN/100ml *E. coli* (USEPA 1986) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. In addition, a fecal coliform single sample maximum concentration of 4,000 MPN/100ml was used as a Non-water Contact Recreation evaluation criterion. All five creek water samples met the fecal coliform Non-water Contact Recreation evaluation criterion. At three of five locations *E. Coli* concentrations were greater than the water quality evaluation criterion for Water Contact Recreation. At all five locations single sample fecal coliform concentrations were greater than the Water Contact Recreation water quality evaluation criterion. However, comparison of fecal indicator results from local creeks to existing water quality recreational criteria may not be appropriate for a number of reasons related to the sampling and laboratory protocols, the sources of the fecal contamination, and the relatively low level of human exposure in local creeks.

Applicable criteria have not been developed for CRAM, but the results were well-correlated with B-IBI scores for the ten bioassessment sites. The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and additional information are needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

During Water Year 2013, SMCWPPP will continue conducting monitoring for general water quality parameters in another creek(s). SMCWPPP will also continue to monitor for pathogen indicator organisms next year and potentially select sample locations in San Pedro Creek to assist with the ongoing Total Maximum Daily Load (TMDL) water quality restoration program in that watershed. In addition, SMCWPPP plans to perform CRAM assessments at all Water Year 2013 bioassessment locations to provide additional data that can be used in the assessment of aquatic life condition in San Mateo County creeks. Finally, SMCWPPP will work with the RMC to plan and implement appropriate stressor/source identification projects that follow-up on Water Year 2012 creek status monitoring data, per the requirements of MRP Provision C.8.d.i.

1.0 Introduction

In early 2010, several members of the Bay Area Stormwater Agencies Association (BASMAA), including the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), formed the Regional Monitoring Coalition (RMC) (Table 1.1). The RMC facilitates water quality monitoring required by the National Pollutant Discharge Elimination System (NPDES) stormwater permit for Bay Area municipalities referred to as the Municipal Regional Permit (MRP)[1]. The RMC was formed to develop and implement a regionally coordinated water quality monitoring program to improve stormwater management in the region and address water quality monitoring required by the MRP. Implementation of the RMC's Creek Status and Long-Term Trends Monitoring Plan allows Permittees and the SFBRWQCB to modify their existing creek monitoring programs and improve their ability to collectively answer core management questions in a cost-effective and scientifically-rigorous way. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC).

In compliance with MRP Provision C.8.c, SMCWPPP conducted Creek Status Monitoring during Water Year 2012 (October 1, 2011 to September 30, 2012) using targeted (non-probabilistic) and probabilistic monitoring designs developed through the RMC (BASMAA 2011). This Local Urban Creeks Monitoring Report provides results from targeted monitoring activities performed by SMCWPPP during Water Year 2012.

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 County Clean Water Program (ACCWP)	Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City; Alameda County; Alameda County Flood Control and Water Conservation District; and, Zone 7
Contra Costa Clean Water Program (CCCWP)	Cities of Antioch, Brentwood, Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Oakley, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, Walnut Creek, Danville, and Moraga; Contra Costa County; and, Contra Costa County Flood Control and Water Conservation District
San Mateo Countywide Water Pollution Prevention Program (SMCWPPP)	Cities of Atherton, Belmont, Brisbane, Burlingame, Colma, Daly City, East Palo Alto, Foster City, Half Moon Bay, Hillsborough, Menlo Park, Millbrae, Pacifica, Portola Valley, Redwood City, San Bruno, San Carlos, San Mateo, South San Francisco, 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

[1]The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) issued the five-year MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFBRWQCB 2009). 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.

The goals of the RMC are to:

1. Assist Permittees in complying with requirements in MRP Provision C.8 (Water Quality Monitoring);
2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area, through the improved coordination among RMC participants and other agencies (e.g., SFBRWQCB) that share common goals; and
3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining reporting.

The RMC addresses the scope of sub-provisions specified in MRP Provision C.8 (Table 1.2). This report focuses on the Creek Status and Long-Term Trends Monitoring activities that were conducted to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (Table 1.3). Riparian assessments, a targeted monitoring parameter, were conducted at all probabilistic sites to meet the stream survey monitoring element.

Table 1.2 Municipal Regional Permit Provisions addressed by the Regional Monitoring Coalition.

MRP C.8 Sub-provision Number	MRP C.8 Sub-provision Title	Reporting Documents
C.8.a	Compliance Options	Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan (BAASMA 2011)
C.8.b	San Francisco Bay Estuary Monitoring	Regional Monitoring Plan Annual Monitoring Results (www.sfei.org/rmp)
C.8.c	**Creek Status and Long-Term Trends Monitoring**	Regional Urban Creeks Monitoring Report; **Local Urban Creeks Monitoring Report**
C.8.d	Monitoring Projects	
	Stressor/Source Identification;	Stressor/Source Identification Report(s)
	BMP Effectiveness Investigation;	BMP Effectiveness Report
	Geomorphic Project.	Integrated Monitoring Report
C.8.e	Pollutants of Concern (Loads) Monitoring	Integrated Monitoring Report
C.8.f	Citizen Monitoring and Participation	Annual Urban Creeks Monitoring Report Water Year 2012
C.8.g	Data Analysis and Reporting	Per each reporting document as described above

Table 1.3 Creek Status Monitoring Parameters monitored in compliance with MRP Provision C.8.c. and the associated reporting format (Regional denotes the Urban Creeks Status Monitoring Report; Local denotes this report).

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

[1] California Rapid Assessment Method for Riverine Wetlands (CRAM) was used to fulfill the stream survey monitoring element listed in the MRP Table 8.1 (SFBRWQCB 2009).

The remainder of this report describes the study area and monitoring design (Section 2.0), monitoring methods (Section 3.0), results (Section 4.0), and conclusions and next steps (Section 5.0).

2.0 Study Area & Design

2.1 RMC Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes the portions of the five participating counties that fall within the SFBRWQCB's jurisdiction and the eastern portion of Contra Costa County that drains to the Central Valley region (Figure 2.1)[2]. Status and trends monitoring is being conducted in flowing water bodies (i.e., creeks, streams and rivers) interspersed among the RMC area), including perennial and non-perennial creeks and rivers that run through both urban and non-urban areas.

2.2 Monitoring Locations

During Water Year 2012 (October 1, 2011 - September 30, 2012) water temperature, general water quality and pathogen indicators were monitored at the targeted locations listed in Table 2.1 and Figure 2.2. SMCWPPP also conducted riparian assessments at all probabilistic sites. Site locations were identified using a targeted monitoring design based on the directed principle[3] to address the following management questions:

1. What is the spatial and temporal variability in water quality conditions during the spring and summer season?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. Do pathogen indicator organism concentrations indicate potential impacts to recreational beneficial uses at creek sites where there is potential for water contact recreation to occur?
4. What are the riparian conditions at bioassessment sampling stations? Are riparian assessments good indicators for condition of aquatic life use? Can they help identify stressors to aquatic life uses?

[2]GIS layers used to develop Figure 1 are available upon request by contacting Nick Zigler, nzigler@eoainc.com.

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

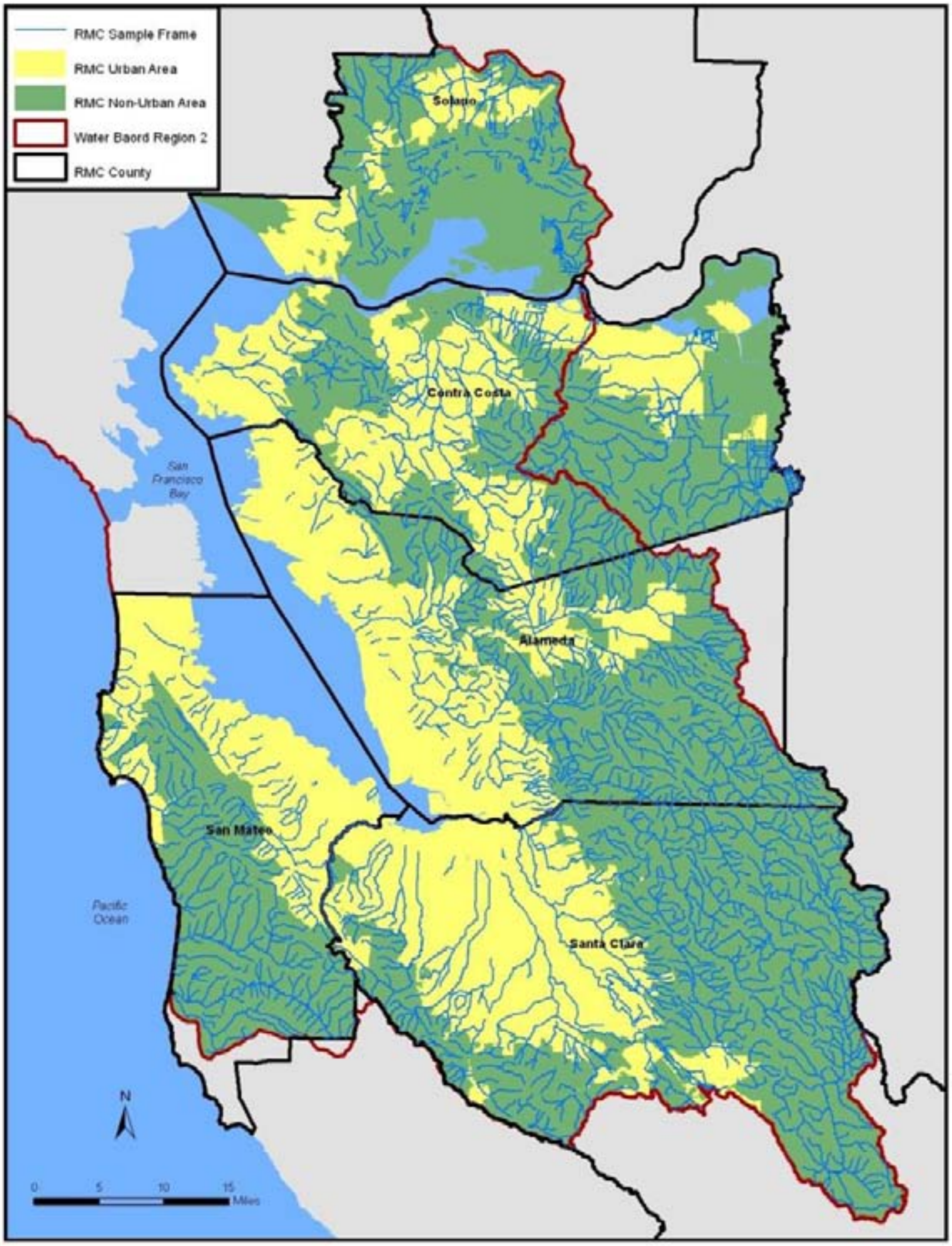

Figure 2.1 Map of BASMAA RMC area, including County boundaries and major creeks.

Table 2.1 Sites and local reporting parameters monitored in Water Year 2012 in San Mateo County.

Map ID	Site Code	Creek Name	Latitude	Longitude	Cont. Temp	Water Quality	Path Indic	CRAM
24	202R00024	Woodhams Creek	37.32468	-122.24666				x
72	202R00072	Pilarcitos Creek	37.51493	-122.38637				x
87	202R00087	Unnamed Tributary	37.64474	-122.48009				x
88	205R00088	Corte Madera Creek	37.37200	-122.21964				x
168	205R00168	Corte Madera Creek	37.39680	-122.23231				x
180	204R00180	Sanchez Creek	37.57313	-122.36934				x
200	204R00200	Polhemus Creek	37.52325	-122.34090				x
232	204R00232	Arroyo Ojo De Agua	37.46109	-122.25504				x
244	204R00244	Unnamed Tributary	37.47147	-122.24532				x
284	202R00284	Denniston Creek	37.50515	-122.48723				x
30	202PIL030	Pilarcitos Creek	37.47195	-122.44399	x	x		
100	202PIL100	Pilarcitos Creek	37.46788	-122.43456	x			
150	202PIL150	Pilarcitos Creek	37.46584	-122.42858	x			
340	202PIL340	Pilarcitos Creek	37.47945	-122.40549	x	x		
650	202PIL650	Pilarcitos Creek	37.49225	-122.38523	x			
160	204BEL160	Belmont Creek	37.51618	-122.27904			x	
60	204SMA060	San Mateo Creek	37.56244	-122.32828			x	
250	204AOA250	Arroyo Ojo de Aqua	37.45563	-122.24808			x	
15	202PIL015	Pilarcitos Creek	37.47282	-122.44616			x	
230	204LAU230	Laurel Creek	37.52658	-122.32298			x	

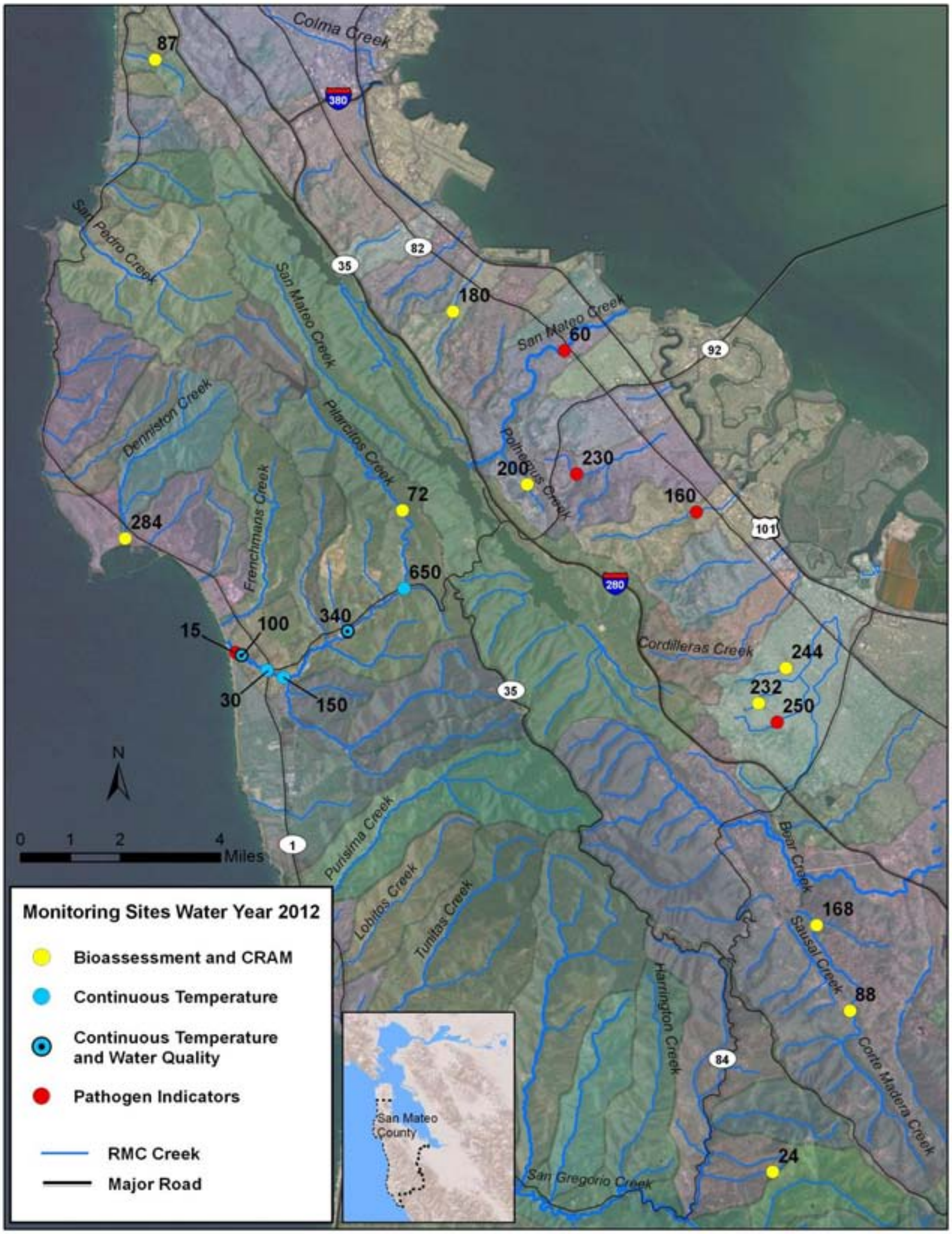

Figure 2.2 Probabilistic and targeted sites monitored by SMCWPPP in 2012.

3.0 Monitoring Methods

In accordance with the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011), targeted monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2012a) and BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2012b). Where applicable, monitoring data were collected using methods comparable to those specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[4], and were submitted in SWAMP-compatible format to the SFBRWQCB.

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 2012b) and associated QAPP (BASMAA 2012a). These documents are updated as needed to maintain their currency and optimal applicability. The SOPs were developed using a standard format that describes health and safety precautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples.

General water quality parameter (dissolved oxygen (DO), specific conductivity, pH, and temperature) monitoring locations were prioritized based on the following criteria: 1) water body is within an urbanized area; 2) water body supports a coldwater biological community; and 3) limited or no water quality data exist for the water body and/or a watershed group exists that is interested in the data and can utilize it to further develop and/or implement watershed management plans. Several locations met the first two criteria: Bay-side were San Mateo Creek and San Francisquito Creek; coast-side were San Pedro Creek and Pilarcitos Creek. The third criterion was met to varying degrees in each of these water bodies. Ultimately, Pilarcitos Creek was selected for water quality monitoring in Water Year 2012 because the Pilarcitos Watershed Workgroup expressed interest in using the data to implement their watershed management plan.

3.1.1 General Water Quality Measurements

Water quality monitoring equipment (YSI 6600 data sondes) was deployed at two sites in Pilarcitos Creek. General water quality parameters (DO, specific conductivity, pH, and temperature) were recorded at fifteen minute intervals for approximately two week intervals. The equipment was deployed for two time periods; once during spring season (May 29th - June 15th) and once during summer season (August 14th - 27th). Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2012b).

3.1.2 Continuous Temperature Monitoring

Digital temperature loggers (Onset HOBO Water Temp Pro V2; hereafter referred to as HOBOs) were deployed at five sites in Pilarcitos Creek. Hourly temperature measurements were recorded from April 23rd through September 25th. Procedures used

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

for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2012b).

3.1.3 Pathogen Indicators Sampling

Field crews collected grab water samples at five sites on July 17, 2012 for analysis of pathogen indicators (*E. coli* and fecal coliform). 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 2012b). Pathogen indicator creek monitoring locations were selected at city parks or trails and were considered to have potential for public access and exposure.

3.1.4 California Rapid Assessment Method for Riverine Wetlands

Field crews conducted assessments at ten sites from July 16th through August 23rd using the California Rapid Assessment Method (CRAM). Assessments were conducted at the same locations (and reach lengths) that were monitored for the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physio-chemical water quality). CRAM includes an assessment of the following four attributes within a defined riparian Assessment Area (AA): 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008).

3.2 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012a). Data Quality Objectives (DQOs) were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity (detection and quantization limits), precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-survey field training and in-situ field assessments were conducted. Field training and inter-calibration exercises were conducted to ensure consistency and quality of CRAM data.

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

3.3 Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the local Program Quality Assurance Officer, and compared both against the methods and protocols specified in the SOPs and QAPP. The findings and results then were evaluated against the relevant DQOs 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 3.1. The data quality assessment consisted of the following elements:

- Conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.
- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples.
- Temperature data were checked for accuracy by comparing measurements taken by HOBOs with NIST thermometer readings in room temperature water and ice water.
- General 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 and precision (i.e., lab duplicates, lab blanks) were not implemented for samples collected this year, but will be in subsequent years.
- Field crews participated in one CRAM training class and two inter-calibration exercises prior to field assessments.

Table 3.1 Data quality steps implemented for temperature and general water quality monitoring.

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

3.4 Data Analysis and Interpretation

Continuous temperature and general water quality data were plotted as box and whisker plots for each site during each deployment. The middle line of the box represents the median value (50^{th} percentile), and top and bottom edge of the box indicate the 75^{th} and 25^{th} percentile, respectively. The upper whisker represents the 90^{th} percentile, while the bottom whisker represents the 10^{th} percentile. All data that do not fall between the 10^{th} and 90^{th} percentile are plotted as points outside of the whiskers.

The hourly water temperature measurements were calculated as daily arithmetic means over a 24-hour period from midnight to 11:00 PM. Seven-Day “rolling” weekly average stream temperatures were calculated by averaging each daily temperature with the previous six daily average temperatures.

Targeted monitoring data were evaluated against Water Quality Objectives or other applicable criteria, as described in Table 8.1 in the MRP. Table 3.2 defines criteria used for selected targeted monitoring parameters. Criteria have not been established for conductivity or CRAM data.

Table 3.2 Description of water quality evaluation criteria for Municipal Regional Permit Provision C.8.c parameters monitored using a targeted design.

Monitoring Parameter	Criteria Description

Temperature	20% of results for the deployment period at each monitoring site exceed one or more of the following applicable temperature thresholds:
	• For a water body designated as COLD and/or supports steelhead trout population (USEPA 1977):
	  o 7-day Mean Temperature should not exceed 19° C
	• For a water body designated as COLD or WARM (SFBRWQCB 2011):
	  o The temperature shall not be increased by more than 2.8˚ C above natural receiving water temperature.

General Water Quality	20% of results for the deployment period at each monitoring site exceed one or more water quality standards or established thresholds: • Water Temperature: see above • Dissolved Oxygen: for WARM < 5.0 mg/L and for COLD < 7.0 mg/L (SFBRWQCB 2011) • pH: > 6.5 and < 8.5[1] (SFBRWQCB 2011) • Conductivity: NA
Pathogen Indicators	Single sample result meets one or more of the following criteria: • Fecal coliform: ≥ 400 MPN/100 ml (based on SFBRWQCB 2011) • *E. coli*: ≥ 576 MPN/100 ml (based on USEPA 1986, infrequently used area)
CRAM	NA

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

The water quality evaluation criteria for each monitoring parameter are discussed briefly below.

3.4.1 Temperature

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

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

The SFBRWQCB is currently applying the temperature thresholds suggested by Sullivan et al. (2000) (i.e., MWAT of 17°C and 14.8°C for steelhead and coho salmon, respectively) to evaluate temperature data for the 303(d) listing process of impaired waterbodies (SFBRWQCB 2011). The SFBRWQCB has also applied these thresholds in evaluating temperature data collected at reference sites in the San Francisco Bay Area (SFBRWQCB 2012).

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

Sullivan et al.'s (2000) risk assessment approach to establishing water temperature thresholds for salmonids focuses on juvenile growth rates. Several studies, however, demonstrate that Central California Coast (CCC) Steelhead Distinct Population Segment (DPS)[5] have adapted feeding behaviors and life history strategies to deal with higher water temperatures characteristic of the southern end of their range. Smith and Li (1983) have observed that juvenile steelhead will tolerate warmer temperatures when food is abundant by moving into riffle habitats to increase feeding success. Steelhead will also move into coastal estuaries to feed during the summer season when stream conditions become stressful to the fish (Moyle 2008). Sogard et al. (2012) determined that steelhead growth rates were higher during winter-spring season compared to summer fall season in Central California coastal creeks, whereas the opposite was true for steelhead in creeks of the Central Valley. Railsback and Rose (1999) concluded that juvenile growth rate during the summer season was more dependent on food availability and consumption than temperature.

These studies demonstrate that the application of temperature thresholds to evaluate steelhead growth and survival is challenging, and may promote management actions that may not improve ecological conditions. In cases where low flow conditions in concert with high temperatures during summer season are impacting steelhead populations, management actions that improve food availability (e.g., increase summer flow) may better address factors that are more critically limiting steelhead production.

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

For monitoring, fish size thresholds at critical life stages such as smolting may be a much better indicator for understanding viability of steelhead populations (Atkinson et al. 2011).

We recommend using thresholds identified in EPA (1977) (i.e., MWAT of 19°C for steelhead and 18°C for coho salmon) for interpretation of temperature data collected during the Creek Status Monitoring Project in 2012. These thresholds are consistent with results from thermal tolerance studies by Myrick and Cech (2000) that demonstrated maximum growth rates for California rainbow trout population to be near 19°C. Myrick (1998) also demonstrated that growth rates for steelhead at 19°C were greatly increased when food ration level was highest.

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

The Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) (SFBRWQCB 2011) contains a water temperature Water Quality Objective that states that “temperature shall not be increased by more than 2.8^{o}C above natural receiving water temperature”. This criterion is difficult to apply to sites where natural receiving water temperature is not known. This criterion may be applicable in situations where temperature is dramatically altered (e.g., imported water) and water temperature data is collected above and below a POTW outfall. In addition, there is no recommended criterion to use for warm water fish communities, which are more adapted to higher temperatures. At this time, SMCWPPP intends to prioritize temperature monitoring at sites that are designated with a coldwater habitat (COLD) beneficial use (SFBRWQCB 2011) or that support salmonid fish communities.

3.4.2 Dissolved Oxygen

The SF Bay Basin Plan(SFBRWQCB 2011) lists Water Quality Objectives for DO in non-tidal waters as follows: 5.0 mg/L minimum for waters designated as warm water habitat (WARM) and 7.0 mg/L minimum for waters designated as COLD. Although these WQOs are suitable criteria for an initial evaluation of water quality impacts, further evaluation may be needed to determine the overall extent and degree that COLD and/or WARM beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a water body that may not support salmonid spawning or rearing habitat, but may be important for upstream or downstream fish migration. In these cases, DO data will be evaluated for the salmonid life stage and/or fish community that is expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

3.4.3 pH

Water Quality Objectives for pH in surface waters are stated in the SF Bay Basin Plan (SFBRWQCB 2011) 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.

3.4.4 Pathogen Indicators

The SF Bay Basin Plan (SFBRWQCB 2011) includes Water Contact Recreation WQOs of fecal coliform concentrations less than 200 MPN/100ml (geometric mean of data) and less than 400 MPN/100ml (90^{th} percentile of data). For Non-contact Water Recreation, the SF Bay Basin Plan includes WQOs of fecal coliform concentrations less than 2,000 MPN/100ml (geometric mean of data) and less than 4,000 MPN/100ml (90^{th} percentile of data).

These objectives are based on a sampling protocol where a minimum of five consecutive samples are collected equally spaced over a 30-day period. However, the RMC monitoring design for pathogen indicators was to collect single water samples at individual water bodies, which is not consistent with this sampling protocol. For the purposes of this evaluation, fecal coliform maximum concentrations of 400 MPN/100ml and 4,000 MPN/100ml in a single sample were used as a Water Contact Recreation and Non-water Contact Recreation evaluation criteria, respectively.

While the SF Bay Basin Plan (SFBRWQCB 2011) does not include adopted WQOs for *E. coli*, EPA has established a criterion for a single sample maximum *E. coli* concentration of 576 MPN/100ml in fresh water for Water Contact Recreation at infrequently used areas (USEPA 1986). This criterion was applied for the purposes of this evaluation.

4.0 Results

4.1 Statement of Data Quality

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

- Temperature data (collected using HOBOs) were collected from five sites (MRP only requires collection from four sites[6]). As a result over 100% of the expected data were collected.
- Continuous water quality data (temperature, pH, DO, specific conductivity) were collected during spring and summer season resulting in collection of 100% of the expected data.
- Continuous water quality data generally met measurement quality objectives (accuracy) for all parameters with the exception of DO at one site during Event 1 (Table 4.1). Data were flagged but used in the analysis.
- Quality Assurance laboratory procedures were inadvertently not implemented for pathogen indicator analyses this year, thus data quality could not be evaluated. These procedures will be implemented in Water Year 2013.
- Total CRAM scores between field crews at two pre-calibration exercises were within 10%.

Table 4.1 Accuracy measurement taken for dissolved oxygen, pH and specific conductivity. Bold values exceed the Measurement Quality Objectives.

Parameter	Measurement Quality Objectives	Site 205PIL030		Site 205PIL340	
		Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.5 mg/L	**-1.16**	0.47	0.00	0.14
pH 7.0	± 0.2	-0.01	0.03	-0.01	0.04
pH 10.0	± .02	-0.01	0.03	-0.03	0.06
Specific Conductance (uS/cm)	± 5%	1.4%	-1.6%	0%	-0.5%

[6] An additional, available HOBO was installed as a precautionary measure to increase the likelihood of collecting all data as required per the MRP, as these devices are sometimes damaged, stolen, or displaced.

4.2 Monitoring Results

4.2.1 Water Temperature

Summary statistics for water temperature data collected in Pilarcitos Creek during April – September 2012 are shown in Table 4.2. Hourly temperature data was collected for approximately 155 consecutive days at all sites. Water temperatures measured at each site, and acute and chronic temperature thresholds, are illustrated in Figures 4.1 – 4.3.

Table 4.2 Descriptive statistics for continuous water temperature measured at five sites in Pilarcitos Creek April 23rd through September 25th, 2012.

Site	205PIL030	205PIL100	205PIL150	205PIL340	205PIL650
Temperature	Pilarcitos Creek				
Minimum	10.12	9.95	10.12	9.98	9.76
Median	13.64	13.47	13.45	13.28	13.23
Mean	13.58	13.42	13.39	13.22	13.11
Maximum	17.63	16.25	16.03	15.94	15.37
Max 7-day mean	14.71	14.53	14.48	14.39	14.36
# Measurements	3716	3716	3716	3717	3717

Temperature was inversely correlated with stream site elevation. The minimum and maximum temperature for all sites was 9.76 and 17.63, respectively. The median temperature range for all five sites was 13.23 – 13.64, and the maximum weekly average temperature (MWAT) range was 14.39 – 14.71.

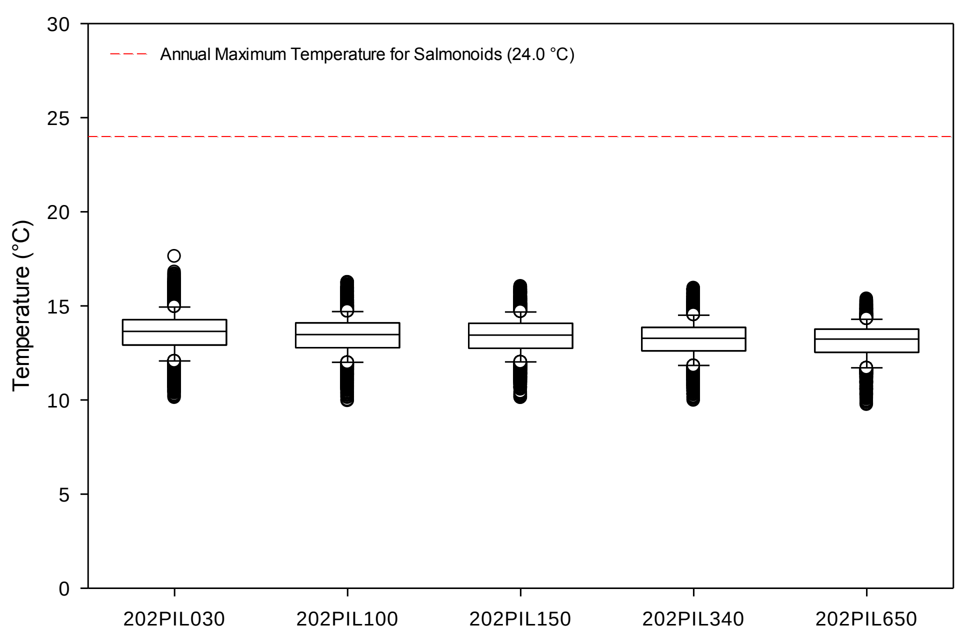

Figure 4.1 Box plots of water temperature data collected at five sites in Pilarcitos Creek, San Mateo County, from April through September 2012.

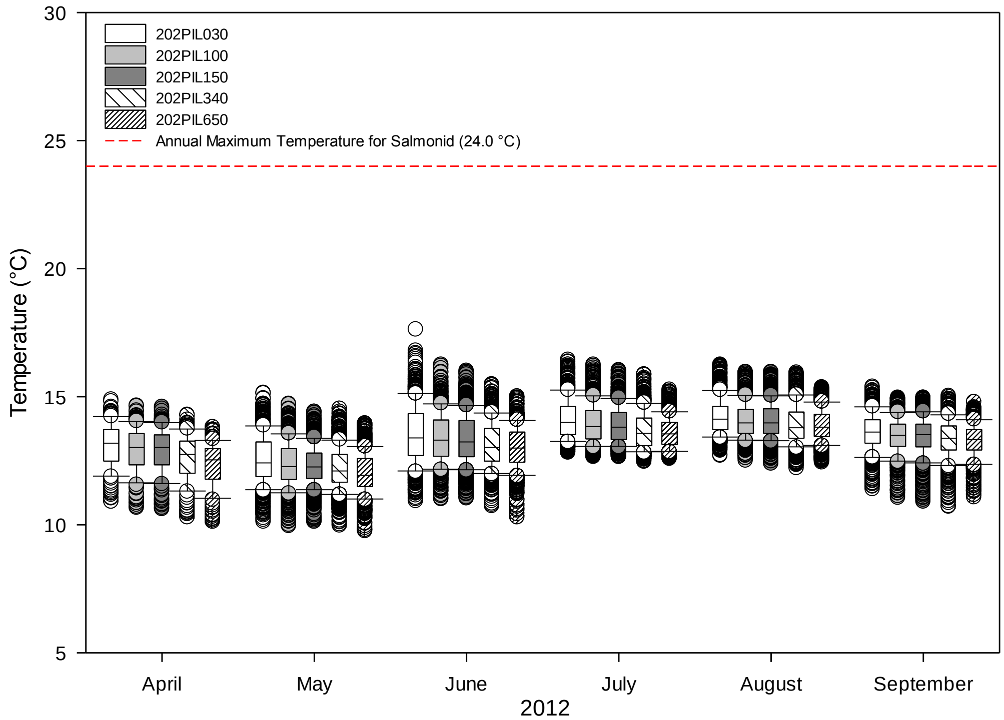

Figure 4.2 Box plots of water temperature data grouped by month, at five sites in Pilarcitos Creek, San Mateo County, from April through September 2012.

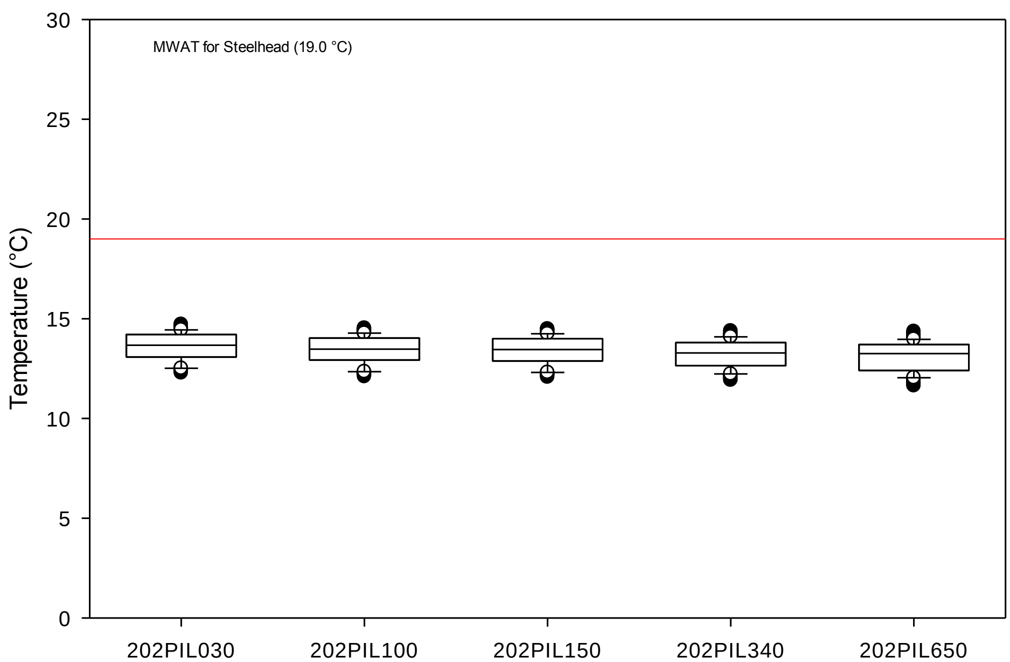

Figure 4.3 Box plots of water temperature data calculated as a rolling 7-day average, at five sites in Pilarcitos Creek, San Mateo County, from April through September 2012.

The entire distribution of water temperatures measured at all five monitoring stations in Pilarcitos Creek was well below both the annual maximum temperature threshold for salmonids (24^{o} C) and the MWAT threshold for steelhead (19^{o} C) (Table 4.3). Therefore these water temperature monitoring results did not suggest the need for any follow-up actions.

Table 4.3 Percent of water temperature data measured at five sites that exceed water quality criteria.

Site ID	Creek Name	Monitoring period	Site Name	*Percentage MWAT for steelhead > 19°*	*Percentage Instantaneous Maximum > 24°C*
202PIL030	Pilarcitos Creek	April 23 - Sept 25, 2012	Treatment Plant	0%	0%
202PIL100			Highway 1	0%	0%
202PIL150			Main Street	0%	0%
202PIL340			Madonna Ranch	0%	0%
202PIL650			Christmas Tree Farm	0%	0%

4.2.2 General Water Quality

Summary statistics for general water quality measurements collected at two sites in Pilarcitos Creek during two sampling events is shown in Table 4.4 Data collected during both events are plotted in Figures 4.4 and 4.5. The lowest DO concentration (7.41 mg/l) occurred at site 205PIL030 during event 1. The median DO range for both sites and events was 9.58 – 10.19 mg/L. The Minimum Weekly Average DO range was 7.94 – 9.83 mg/l. The minimum and maximum pH for both sites and events were 7.63 and 8.07, respectively.

Table 4.4 Descriptive statistics for daily and monthly continuous water temperature, dissolved oxygen, conductivity, and pH measured at two sites in Pilarcitos Creek during May 29th–June 15th (Event 1) and August 14th – 27th (Event 2) in 2012.

Parameter		Site 202PIL030		Site 202PIL340	
		Event 1	Event 2	Event 1	Event 2
Temperature (° C)	Min	9.37	11.17	10.13	12.59
	Median	11.56	12.13	12.66	13.91
	Mean	11.65	12.23	12.77	14.00
	Max	13.75	14.1	15.24	15.82
	Max 7-day mean	11.78	12.53	12.92	14.36
Dissolved Oxygen (mg/l)	Min	7.41	9.57	9.39	9.56
	Median	9.58	10.15	10.09	10.19
	Mean	9.32	10.15	10.09	10.17
	Max	10.73	10.74	10.84	10.51
	Min 7-day mean	7.94	9.70	9.60	9.83
pH	Min	7.63	7.88	7.81	7.86
	Mean	7.82	7.96	7.90	8.00
	Median	7.83	7.96	7.9	7.99
	Max	7.94	8.07	7.98	8.06
Specific Conductivity (µS/cm)	Min	385	417	340	351
	Median	486	447	388	381
	Mean	463	448	388	380
	Max	566	480	432	403
Total Number of Data Points		1626	1239	1632	1239

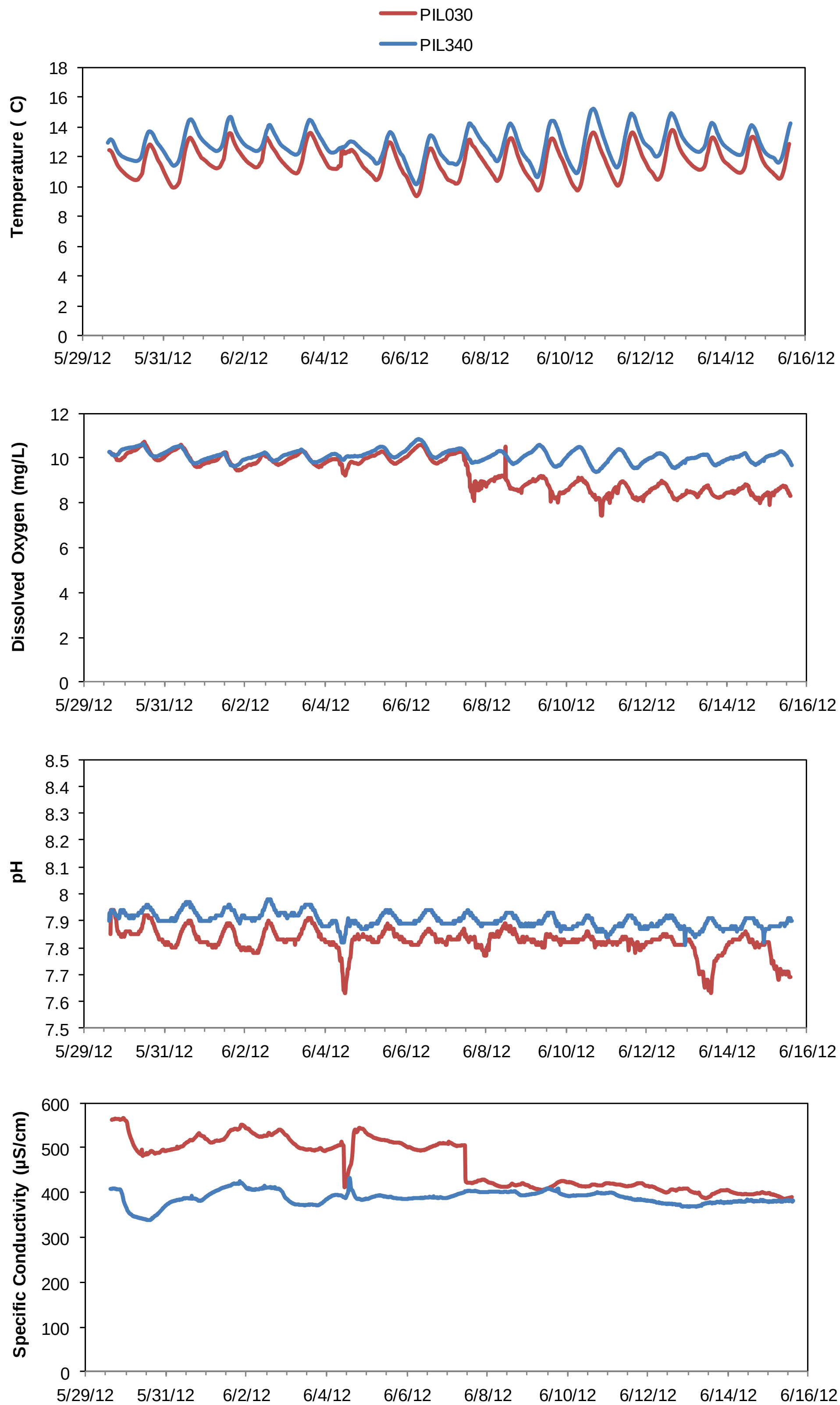

Figure 4.4 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected at two sites in Pilarcitos Creek during May 29-June 15 (Event 1).

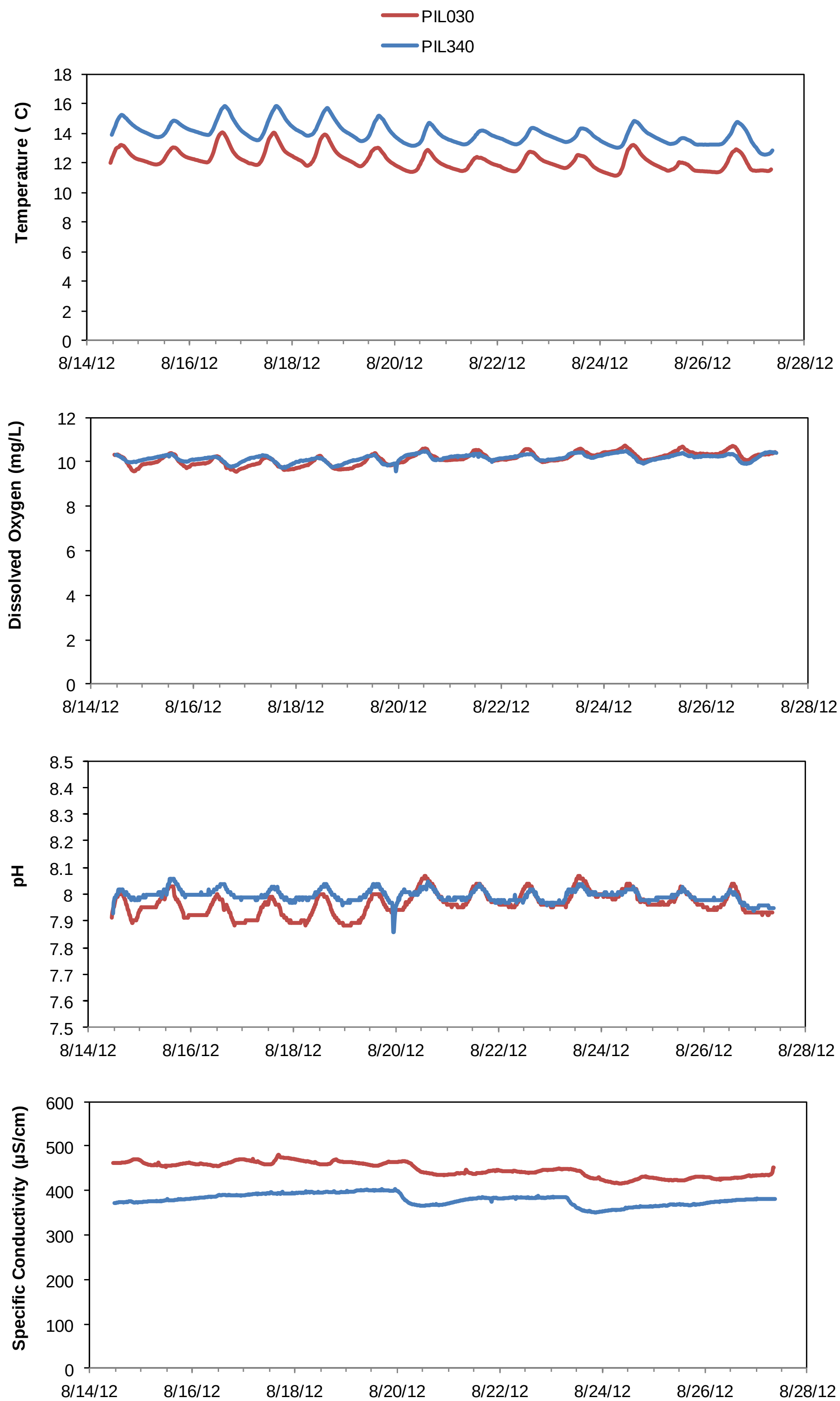

Figure 4.5 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected at two sites in Pilarcitos Creek during August 14th-28th (Event 2).

Figures 4.6 and 4.7 compare continuous temperature measured during the two sampling events at the Pilarcitos Creek monitoring sites to the annual maximum temperature threshold for salmonids (24.0°C) and demonstrate that temperatures during both events at both sites were well below this threshold.

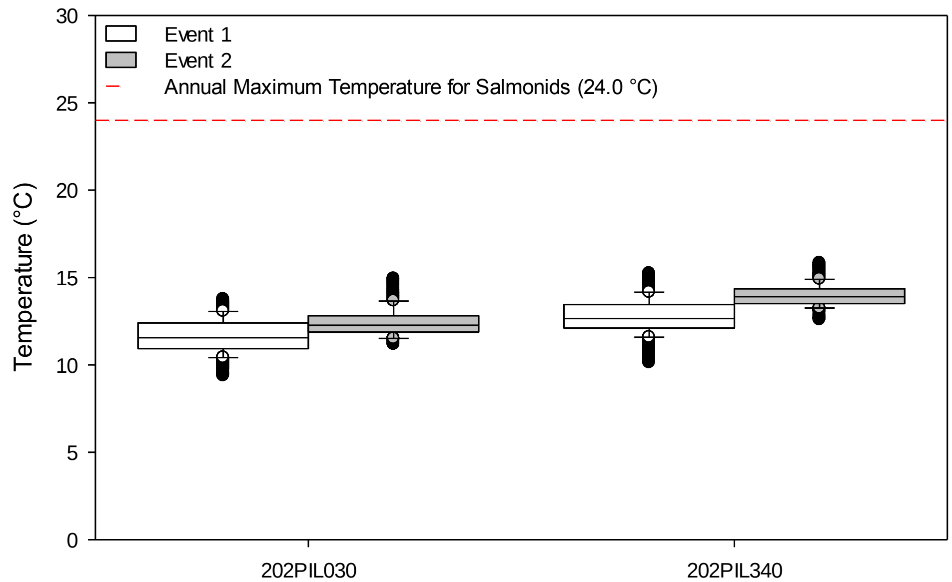

Figure 4.6 Box plots of water temperature data collected during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County.

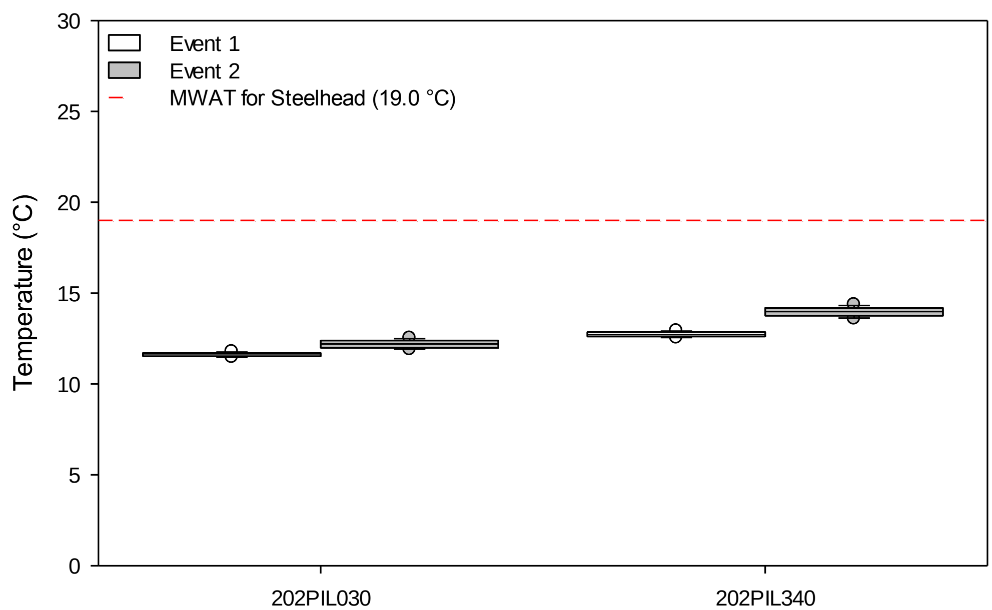

Figure 4.7 Box plots of water temperature data, calculated as a rolling 7-day average, collected during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County.

Figures 4.8 and 4.9 compare DO levels measured during the two sampling events at the Pilarcitos Creek monitoring sites to the SF Bay Basin Plan WQOs for WARM and COLD beneficial uses and demonstrate that levels during both events at both sites were well above the minimum thresholds.

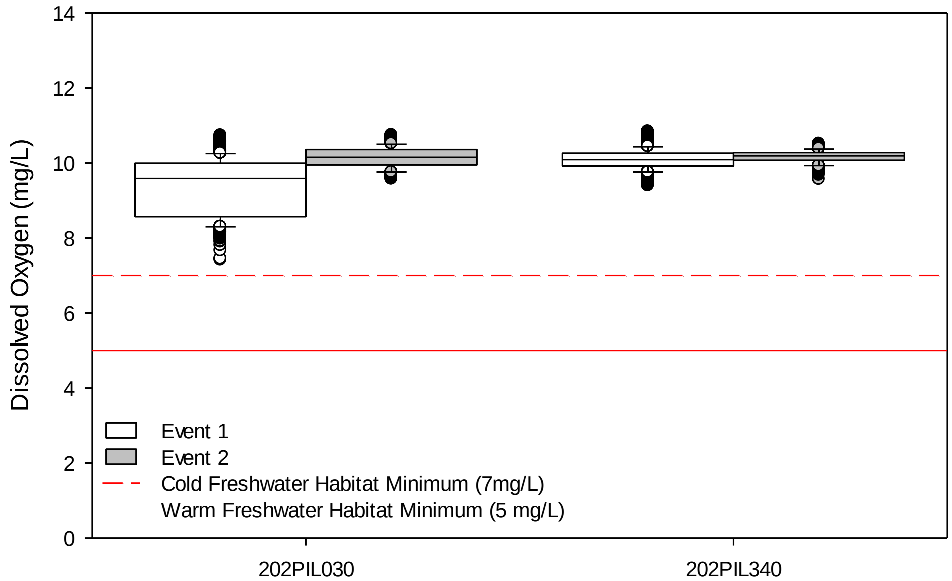

Figure 4.8 Box plots of dissolved oxygen data collected using sondes during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County compared to associated SF Bay Basin Plan Water Quality Objectives.

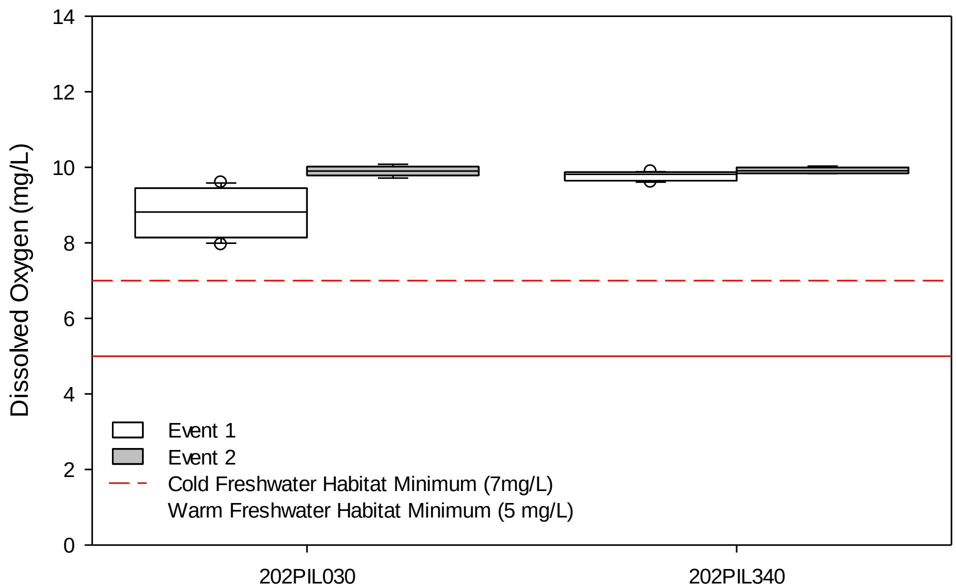

Figure 4.9 Box plots of dissolved oxygen data, calculated as the 7-day average minimum, collected during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County, compared to respective SF Bay Basin Plan Water Quality Objectives for warmwater and coldwater beneficial uses.

Figure 4.10 compares pH levels measured during the two sampling events at the Pilarcitos Creek monitoring sites to the associated SF Bay Basin Plan WQO and demonstrates that pH levels during both events, at both sites, remained within the acceptable range specified by this WQO. The distribution of specific conductivity taken during same time period and at same sites is shown in Figure 4.11. No WQOs are associated with this water quality parameter thus none is depicted in Figure 4.11.

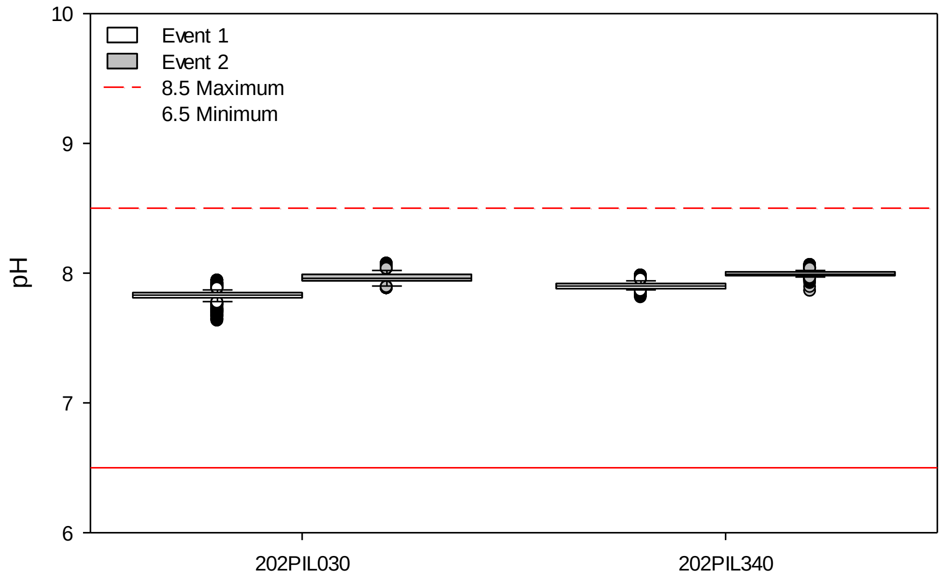

Figure 4.10 Box plots of continuous pH data collected during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County compared to associated SF Bay Basin Plan Water Quality Objectives.

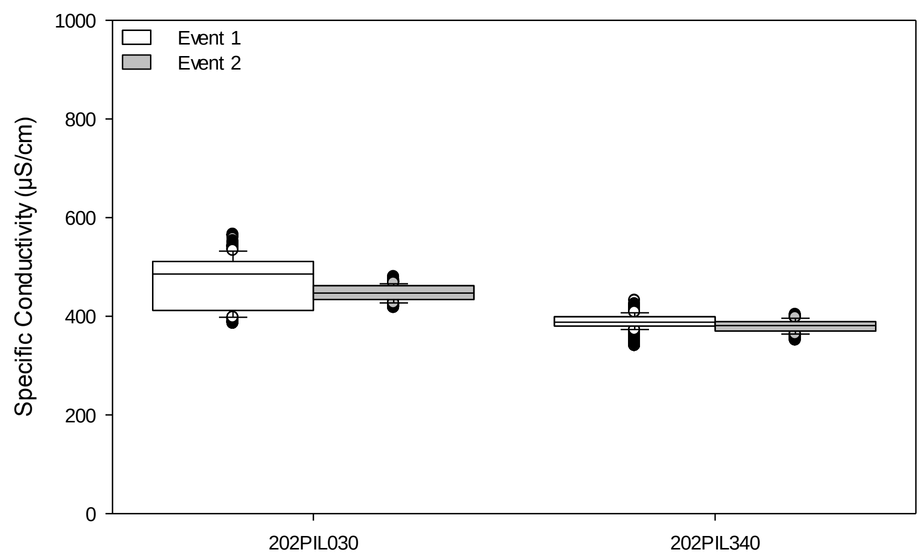

Figure 4.11 Box plots of continuous specific conductivity data collected during two sampling events (Event 1, May 29-June 15; Event 2, August 14-28) at two sites in Pilarcitos Creek, San Mateo County.

Table 4.5 illustrates that the entire distribution of continuous water quality data for temperature, DO and pH measured at the two Pilarcitos Creek sites during both monitoring events were well below the water quality evaluation criteria specified in Table 8.1 of the MRP (Table 3.2).

Table 4.5 Percent of dissolved oxygen, water temperature, and pH data measured at two sites on Pilarcitos Creek for both monitoring events that exceeded water quality evaluation criteria as identified in Table 3.2.

Site ID	Creek Name	Site Name	Monitoring Period	*Temp Percent Results Annual Max > 24°C*	*Temp Percent Results MWAT > 19°C*	*DO Percent Results < 7.0 mg/l*	*pH Percent Results < 6.5 or > 8.5*
202PIL030	Pilarcitos Creek	Treatment Plant	May 29 - June 12, 2012	0%	0%	0%	0%
			August 14 - 28, 2012	0%	0%	0%	0%
202PIL340	Pilarcitos Creek	Madonna Ranch	May 29 - June 12, 2012	0%	0%	0%	0%
			August 14 - 28, 2012	0%	0%	0%	0%

The SF Bay Basin Plan (SFBRWQCB 2011) designates several Beneficial Uses for Pilarcitos Creek associated with aquatic life uses, including COLD, WARM, MIGR, SPWN and RARE. An approximate 7.5-mile section of the Pilarcitos Creek mainstem extending from the mouth upstream to Stone Dam provides potential spawning and rearing habitat for steelhead (Leidy et al. 2005). The best spawning and rearing habitat occurs in a 2.7-mile reach below Stone Dam with an estimated steelhead production of 5,500 individuals (Entrix 2006). The factors identified as most limiting the steelhead population in the Pilarcitos Creek watershed are low stream flow, resulting from water diversions, abundant fine sediment reducing the quality of spawning and rearing habitats, and generally low production of insects limiting food availability (Philip Williams and Associates 2008). Water quality was not identified as a factor limiting steelhead, as water temperatures and DO levels suitable to support steelhead populations exist for a majority of the watershed (Philip Williams and Associates 2008).

Temperature and continuous water quality data collected by SMCWPPP in 2012 are consistent with the habitat quality assessment conducted by Philip Williams and Associates (2008), indicating that these water quality conditions do not appear to have degraded since that time. Water temperatures and DO concentrations measured between April and September, 2012 were suitable to support juvenile steelhead populations that may be present in the Pilarcitos Creek mainstem. The majority of steelhead juveniles, however, typically migrate downstream in early spring and summer (PWA 2008), so if present in the Pilarcitos Creek mainstem they may have been primarily in a migratory phase of life during the 2012 sampling period.

4.2.3 Pathogen Indicators

A single water sample was collected at one site on each of five separate San Mateo County creeks on July 17, 2012 for analysis of microbial pathogen indicator organisms (*E. coli* and fecal coliform). Table 4.6 summarizes the results and indicates upstream land uses and potential pathogen indicator sources based on discussions with municipal staff and review of aerial imagery and the California State Water Resource Control Board Sanitary Sewer Overflow Reduction program website (SWRCB 2013). Figure 2-2 illustrates the pathogen indicator monitoring locations, referencing a shortened site ID for improved visual display (only the last numeric portion of the site ID). Table 4-7 describes the median values for fecal coliform by land use[7] from the National Pollutant Discharge Elimination System database for stormwater outfall data collected through mid-December 2002 (3,757 events from 66 agencies and municipalities from 17 states) (Pitt et al. 2003). The information in Tables 4-6 and 4-7 illustrates that the levels of fecal coliform detected at the five receiving water (creek) sites in San Mateo County during Water Year 2012 are considerably lower than the levels found nationally in outfall samples (Pitt et al. 2003). However, creek sample results are not directly comparable to undiluted outfall sample results.

Table 4.6 Fecal coliform and *E. coli* levels measured from water samples collected on July 17, 2012 at five creeks in San Mateo County.

Site ID	Creek Name	Site Name, Municipality	Fecal Coliform (MPN/ 100ml)	E. Coli (MPN/ 100ml)	Upstream Land Use	Potential Upstream Sources		
						Wildlife	Domestic Animals	Sanitary Sewer Overflows[1]
204LAU230	Laurel Creek	Laurelwood Park, City of San Mateo	400	400	Open Space; moderate density residential	Yes	Yes	No
204BEL160	Belmont Creek	Twin Pines Park, City of Belmont	500	500	Residential; open space; minimal commercial	Yes	Yes	No*
204SMA060	San Mateo Creek	De Anza Historical Park, City of San Mateo	1,300	1,300	Residential; open space.	Yes	Yes	No*
204AOA250	Arroyo Ojo de Aqua	Stulsaft Park, Redwood City	1,500	5,000	Residential; open space	Yes	Yes	No[2]
202PIL015	Pilarcitos Creek	Half Moon Bay Coastal Trail, Half Moon Bay	1,700	1,700	Open space; industrial; agricultural; residential	Yes	Yes	No

[1]Source: http://www.waterboards.ca.gov/water_issues/programs/sso/sso_map/sso_pub.shtml; April 17, 2012 through July 17, 2012. "No" entries indicate that overflows were not reported three months before sampling unless further footnoted.
* A reported overflow was contained and cleaned up with no material reaching a storm drain inlet.
[2] No sanitary sewer overflows were reported three months prior to sampling, however, upstream septic leach fields are potential sources of contamination based on discussions with municipal staff.

[7] The authors note that due to lack of space in their report, they did not include median fecal coliform values for all land uses, including open space.

Table 4-7. Median Fecal Coliform values from NPDES MS4 Outfall National Database (Pitt et al. 2003)

Land Use	All Data (n=3,757)	Residential (n=983)	Mixed Residential (n=584)	Commercial (n=464)	Industrial (n=471)	Freeways (n=185)
Fecal Coliform (MPN/100 ml)	5,000	7,750	110,000	3,000	2,400	1,700

All five creeks monitored for pathogen indicators are designated for both contact (REC-1) and non-contact (REC-2) recreational beneficial uses. Monitoring locations at each creek were selected at city parks or trails and were considered to have potential for public access and exposure. The potential for public access and exposure appeared to be very low in the remaining non-sampled areas of all five creeks.

As described previously (Section 3.4.4), single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFBRWQCB 2011) and 576 MPN/100ml *E. coli* (USEPA 1986) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. In addition, a fecal coliform single sample maximum concentration of 4,000 MPN/100ml was used as a Non-water Contact Recreation evaluation criterion.

All five creek water samples met the fecal coliform Non-water Contact Recreation evaluation criterion (REC-2). At three of five locations *E. Coli* concentrations were greater than the water quality evaluation criterion for Water Contact Recreation (REC-1). At all five locations single sample fecal coliform concentrations were greater than the Water Contact Recreation water quality evaluation criterion (REC-1).

However, comparison of fecal indicator results from local creeks to existing water quality recreational criteria may not be appropriate and such comparisons should be made only with several caveats:

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

4.2.4 CRAM

Total CRAM scores for ten sites assessed in San Mateo County in Water Year 2012 are shown in Table 4.7. CRAM scores ranged from 20 - 89 based on a 0 - 100 scale, and were ranked by quartiles. Seven of the ten sites ranked as either good or excellent. The remaining three sites ranked as either fair or poor. The CRAM sampling locations and ranking scores are depicted in Figure 4.12.

Table 4.8 Metric and total CRAM scores applied to 10 bioassessment monitoring sites in San Mateo County in summer, 2012.

Station Code	Buffer	Hydrology	Physical	Biotic	Total CRAM Score	Condition Ranking
202R00072	91.7	83.3	87.5	91.7	89	Excellent
205R00088	79.2	66.7	62.5	97.2	77	Good
202R00024	100.0	66.7	50.0	72.2	76	Good
205R00168	91.7	50.0	62.5	91.7	74	Good
202R00087	100.0	50.0	50.0	91.7	73	Good
204R00200	87.5	58.3	75.0	69.4	73	Good
202R00284	79.2	58.3	75.0	61.1	71	Good
204R00232	41.7	58.3	75.0	38.9	54	Fair
204R00180	25.0	58.3	50.0	58.3	51	Fair
204R00244	25.0	33.3	25.0	33.3	29	Poor

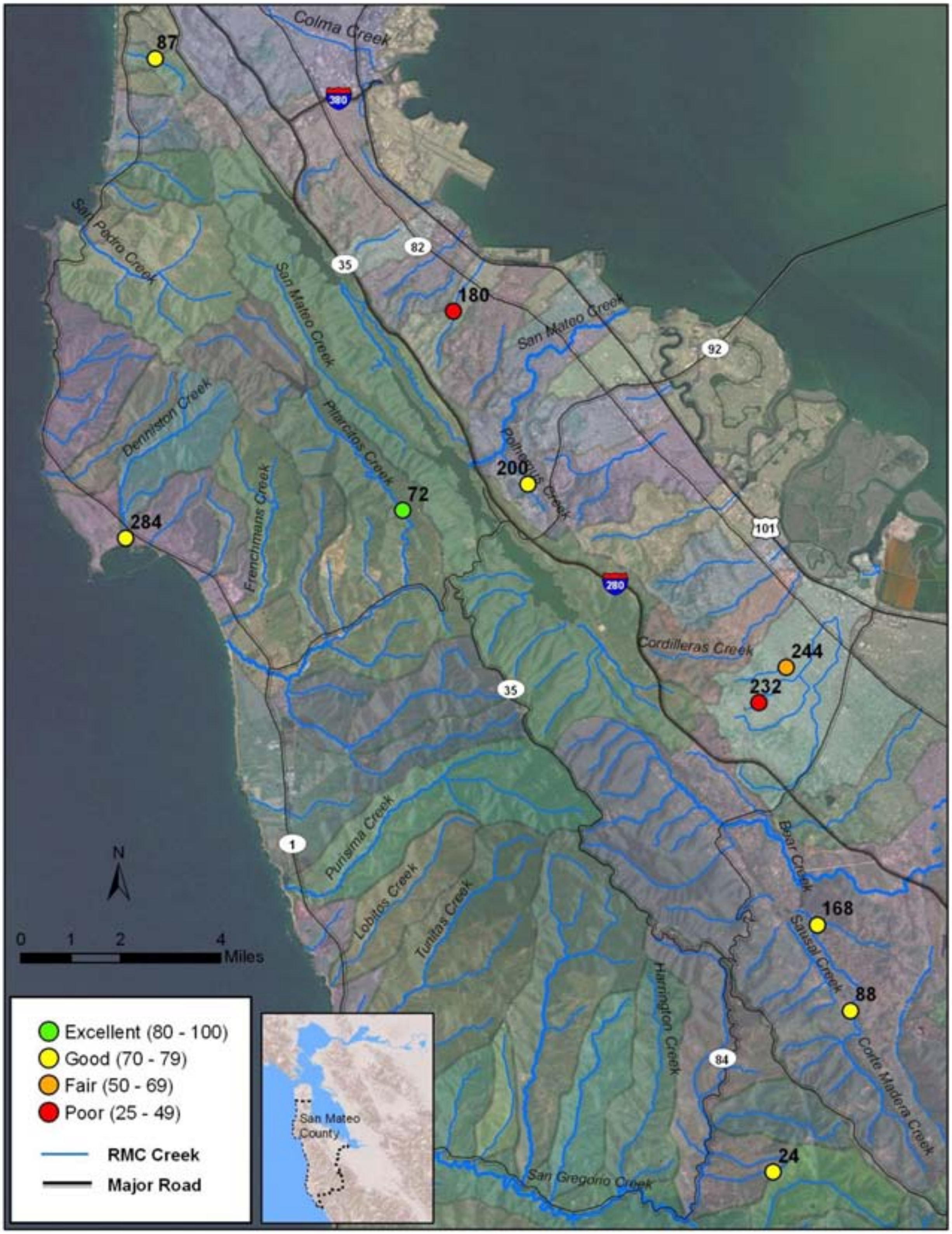

Figure 4.12 CRAM ranking scores for 10 sites assessed in 2012 in San Mateo County.

CRAM assessments were conducted at the same sites, identified through a probabilistic monitoring design, where bioassessments were conducted to address the following questions:

- What is the range of stream ecosystem conditions in San Mateo County?
- Are CRAM indicators useful for understanding aquatic life use conditions?
- Are CRAM results useful for identifying potential stressors or sources of stress to aquatic life?

CRAM data has been used to assess the overall condition of health of stream ecosystem resources and to develop hypotheses regarding the causes of their observed conditions (SCVWD 2011). When collected at bioassessments sites, as done here, it provides a broader and more complete suite of indicators to use to evaluate the conditions of aquatic life uses. Previous studies in a Southern California watershed demonstrated a high correlation between benthic macro-invertebrate communities (as measured by a B-IBI) and CRAM scores (Solek et al. 2011).

CRAM scores were compared to B-IBI scores, calculated using the Southern California IBI (Ode et al. 2005), for ten bioassessment sites in San Mateo County. Although sample size was small, the CRAM scores were well-correlated with B-IBI scores (R^2 = 0.644, $p < 0.01$) (Figure 4.13).

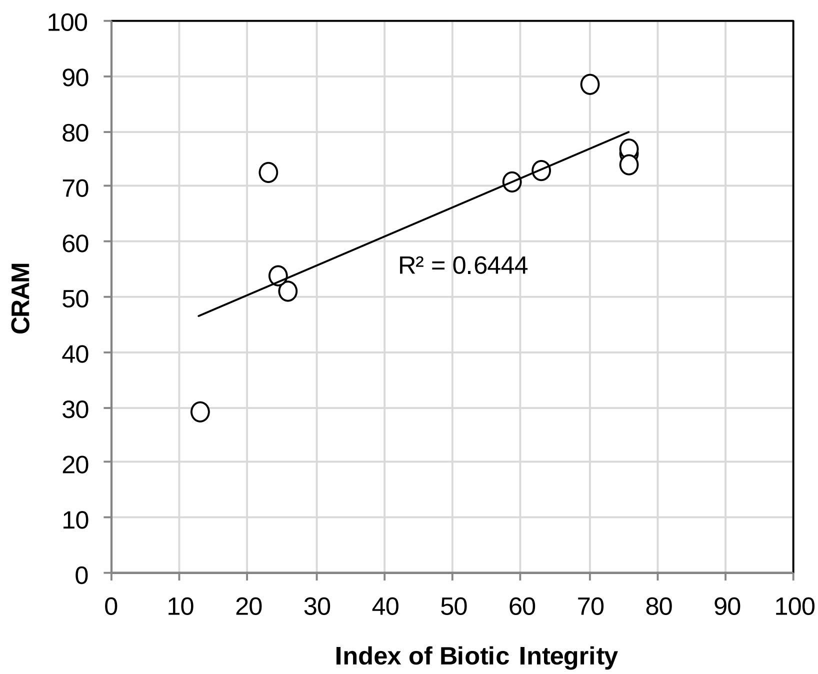

Figure 4.13 Correlation between scores from the California Rapid Assessment Method and the Southern California Benthic Index of Biotic Integrity at 10 bioassessment sites in San Mateo County sampled in spring, 2012.

The CRAM attribute scores (buffer, hydrology, physical and biotic) were also compared to the B-IBI scores. The buffer and biotic attributes were most strongly correlated with the B-IBI scores (Figure 4.14), indicating that buffer condition and riparian plant community integrity and structure are important indicators to consider when assessing aquatic biota condition.

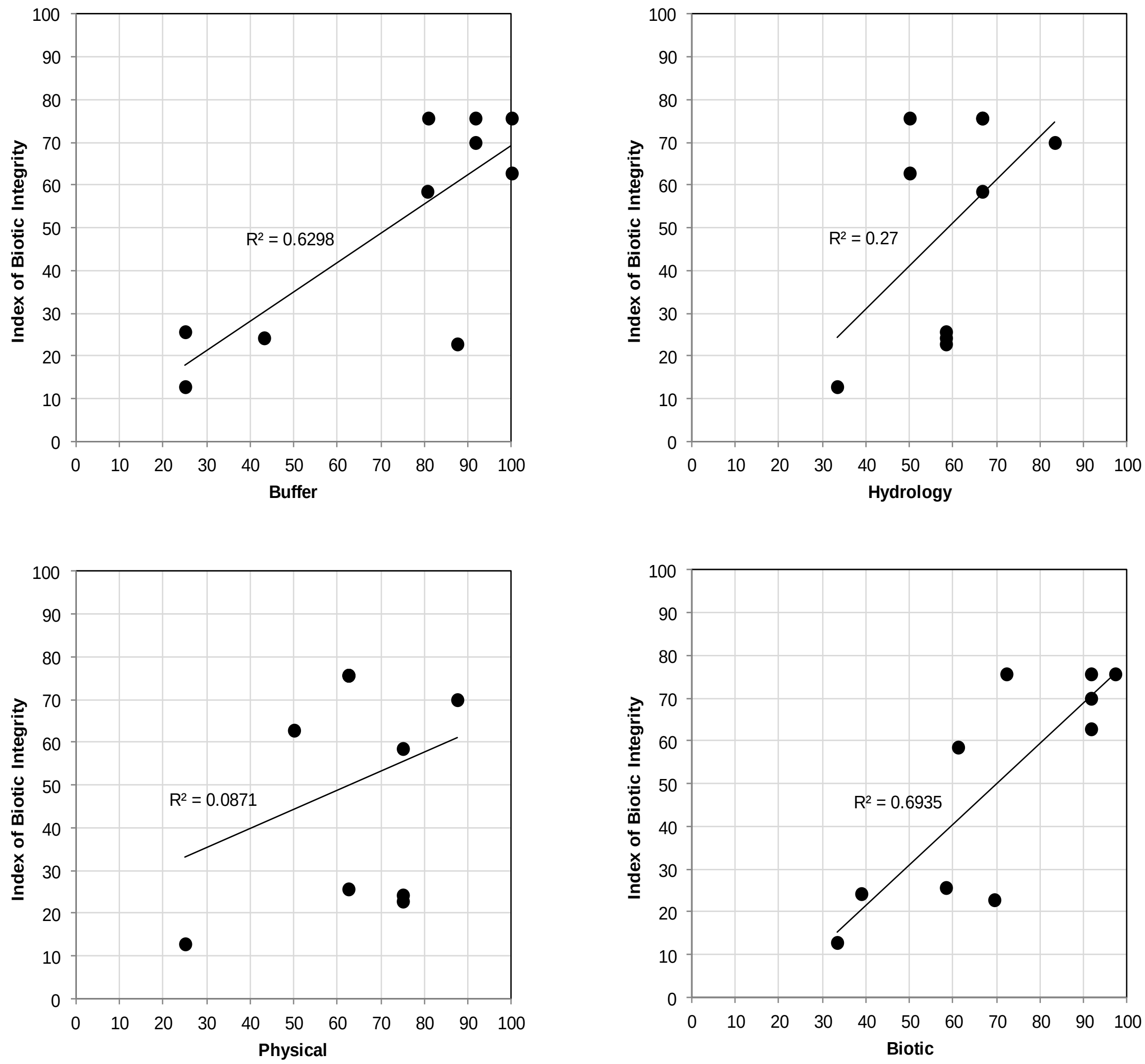

Figure 4.14 Scores from the Southern California Benthic Index of Biotic Integrity compared to California Rapid Assessment Method attribute scores.

The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and new information is needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

The Human Disturbance Index (HDI) is the one of the qualitative assessments that is conducted during the Physical Habitat (PHAB) component of each bioassessment. The HDI identifies the range of anthropogenic stressors (e.g., channel structures, buildings, roads, and trash) that are present in the channel, and on the lower and upper banks of an assessment reach. These scores are weighted and summed as a total score. The

HDI scores for bioassessment sites were moderately correlated with the CRAM scores for the ten bioassessment sites (R^2 = 0.476, $p < 0.05$) (Figure 4.15).

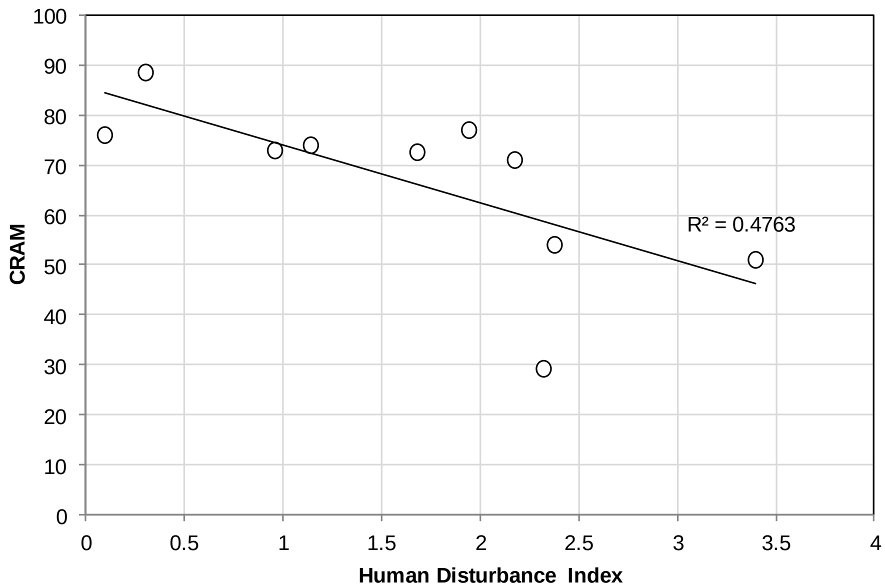

Figure 4.15 Correlation between scores from implementing the California Rapid Assessment Method and the Human Disturbance Index Method at ten sites in San Mateo County in 2012.

5.0 Discussion and Next Steps

Targeted monitoring data, with the exception of CRAM and specific conductivity data, were evaluated against applicable criteria, as described in Table 8.1 in the MRP. Overall, the analysis of creek data included in this submittal suggests that water quality conditions in creeks vary substantially among sites and between monitoring events. Temporal and spatial variability adds to the challenge of interpreting and evaluating the data and using it to help identify potential persistent water quality issues warranting a programmatic response. The analysis results are preliminary and do not constitute a determination of whether water quality objectives were exceeded, and/or whether stormwater runoff or dry weather discharges are or may be causing or contributing to exceedances, if any. The results are summarized below:

- Temperature: A maximum weekly average temperature (MWAT) of 19°C was used as the applicable criterion to evaluate temperature data. Temperature results for all five monitoring sites were well below this MWAT value.
- Dissolved Oxygen: WQOs for coldwater aquatic life uses (COLD) (minimum of 7.0 mg/l) were used to define thresholds for evaluating dissolved oxygen (DO) data. None of the sampled DO concentrations measured below the WQO for COLD. Previous studies indicate factors most limiting the steelhead population in the Pilarcitos Creek watershed are low stream flow, abundant fine sediment, and generally low production of insects limiting food availability (Philip Williams and Associates 2008). Water quality was not identified as a factor limiting steelhead production. All of the SMCWPPP water quality monitoring sites occurred in creek reaches downstream of Highway 92 that support upstream and downstream migration of steelhead, but likely do not support steelhead spawning and rearing habitat (Philip Williams and Associates 2008).
- pH: All of the pH measurements in Pilarcitos Creek were measured within the range of the applicable WQO (pH = 6.5 - 8.5).
- Pathogen Indicator Organisms: Single sample maximum concentrations of 400 MPN/100ml fecal coliform (SFBRWQCB 2011) and 576 MPN/100ml *E. coli* (USEPA 1986) were used as Water Contact Recreation evaluation criteria for the purposes of this evaluation. In addition, a fecal coliform single sample maximum concentration of 4,000 MPN/100ml in was used as a Non-water Contact Recreation evaluation criterion. All five creek water samples met the fecal coliform Non-water Contact Recreation evaluation criterion. At three of five locations *E. Coli* concentrations were greater than the water quality evaluation criterion for Water Contact Recreation. At all five locations single sample fecal coliform concentrations were greater than the Water Contact Recreation water quality evaluation criterion. However, comparison of fecal indicator results from local creeks to existing water quality recreational criteria may not be appropriate for a number of reasons related to the sampling and laboratory protocols, the sources of the fecal contamination, and the relatively low level of human exposure in local creeks.

Applicable criteria have not been developed for CRAM, but the results were well-correlated with B-IBI scores for the ten bioassessment sites. The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and additional information are needed to comprehensively evaluate the utility of CRAM data for assessing stream ecosystem health and aquatic life uses.

During Water Year 2012, SMCWPPP conducted monitoring for general water quality parameters (temperature, dissolved oxygen, pH and specific conductivity) in Pilarcitos Creek. SMCWPPP will continue conducting this type of monitoring in another creek(s) during Water Year 2013. SMCWPPP will also continue to monitor for pathogen indicator organisms next year and potentially select sample locations in San Pedro Creek to assist with the ongoing Total Maximum Daily Load (TMDL) water quality restoration program in that watershed. In addition, SMCWPPP plans to perform CRAM assessments at all Water Year 2013 bioassessment locations to provide additional data that can be used in the assessment of aquatic life conditions in San Mateo County creeks. Finally, SMCWPPP will work with the RMC to plan and implement appropriate stressor/source identification projects that follow up on Water Year 2012 creek status monitoring data, per the requirements of MRP Provision C.8.d.i.

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B4

Santa Clara Valley Urban Runoff Pollution Prevention Program

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Local Urban Creeks Status Monitoring Report

Water Year 2012 (October 2011 – September 2012)

Submitted in compliance with Provision C.8g(iii) of NPDES Permit # CAS612008

FINAL

March 15, 2013

PREFACE

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

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

This Local Urban Creeks Monitoring Report complies with the MRP Reporting Provision C.8.g for Status Monitoring data (MRP Provision C.8.c) collected in Water Year 2012 (October 1, 2011 and September 30, 2012). Data presented in this report were produced under the direction of the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) using a targeted (non-probabilistic) monitoring design as described herein.

In accordance with the RMC Creek Status and Long-Term Trends Monitoring Plan (BASMAA 2011), targeted monitoring data were collected in accordance with the BASMAA RMC Quality Assurance Program Plan (QAPP; BASMAA, 2012a) and BASMAA RMC Standard Operating Procedures (SOPs; BASMAA, 2012b). Where applicable, monitoring data were derived using methods comparable with methods specified by the California Surface Water Ambient Monitoring Program (SWAMP) QAPP[2]. Data presented in this report were also submitted in electronic SWAMP-comparable formats by SCVURPPP to the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) on behalf of Santa Clara County Co-permittees and pursuant to Provision C.8.g.

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[1] The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) issued the MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFBRWQCB 2009). The BASMAA programs supporting MRP Regional Projects include all MRP Permittees as well as the cities of Antioch, Brentwood, and Oakley, which are not named as Permittees under the MRP but have voluntarily elected to participate in MRP-related regional activities.
[2] The current SWAMP QAPP is available at:
http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/qapp/swamp_qapp_master090108a.pdf

LIST OF ACRONYMS

ACCWP	Alameda County Clean Water Program
ARP	Alum Rock Park
BASMAA	Bay Area Stormwater Management Agency Association
B-IBI	Benthic Macroinvertebrate Index of Biological Integrity
CCCWP	Contra Costa Clean Water Program
CEDEN	California Environmental Data Exchange Network
CRAM	California Rapid Assessment Method
DPS	Distinct Population Segment
EMAF	Ecological Monitoring and Assessment Framework
FSURMP	Fairfield Suisun Urban Runoff Management Program
HDI	Human Disturbance Index
MRP	Municipal Regional Permit
MWAT	Maximum Weekly Average Temperature
NPDES	National Pollution Discharge Elimination System
QAPP	Quality Assurance Project Plan
RMC	Regional Monitoring Coalition
RMP	Regional Monitoring Program
RWQCB	Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SFEI	San Francisco Estuary Institute
SMCWPPP	San Mateo County Water Pollution Prevention Program
SOP	Standard Operating Protocol
SWAMP	Surface Water Ambient Monitoring Program
USEPA US	Environmental Protection Agency
WQO	Water Quality Objective

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EXECUTIVE SUMMARY

In early 2010, several members of the Bay Area Stormwater Agencies Association (BASMAA), including the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), joined together to form the Regional Monitoring Coalition (RMC). The RMC was formed to coordinate and oversee water quality monitoring required by the Municipal Regional National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (MRP). In compliance with MRP Provision C.8.c, the SCVURPPP conducted Creek Status Monitoring during Water Year 2012 (October 1, 2011 to September 30, 2012) using a targeted (non-probabilistic) and probabilistic monitoring design developed for the RMC. This Local Urban Creeks Monitoring Report provides results from targeted monitoring activities performed by SCVURPPP in 2012.

The SCVURPPP targeted monitoring parameters consisted of water temperature, general water quality, pathogen indicators and riparian assessments. Hourly water temperature measurements were recorded using HOBO® temperature data loggers at four sites in Upper Penitencia Creek and three sites in Saratoga Creek between April 23rd and September 25th 2012. General water quality monitoring (temperature, dissolved oxygen, pH and specific conductivity) was conducted using YSI continuous water quality equipment (sondes) at three sites in Coyote Creek during two sampling events; once during spring season (May 10th - 24th) and once during summer season (September 4th - 18th). Water samples were collected at five sites on July 17, 2012 for analysis of pathogen indicators (*E. coli* and fecal coliform). Riparian assessments were conducted at 20 sites between July 16th and August 23rd using the California Rapid Assessment Method (CRAM). Assessments were conducted at the same locations (and reach lengths) that were monitored for the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physio-chemical water quality).

Targeted monitoring data, with the exception of CRAM data, were evaluated against numeric Water Quality Objectives (WQOs) or other applicable thresholds, as described in Table 8.1 of the MRP, to determine whether results “trigger” a potential stressor/source identification monitoring project (per MRP Provision C.8.d.i). A trigger for temperature, dissolved oxygen and/or pH was identified when greater than 20% of the data collected at a single site exceeded the WQOs or applicable thresholds. Maximum weekly average temperature (MWAT) of 19 °C was used as the applicable threshold to evaluate triggers for temperature data. Numeric dissolved oxygen WQOs for WARM (5.0 mg/l) and/or COLD (7.0 mg/l) beneficial uses, and lower and upper levels of 6.5 to 8.5 for pH were used. Pathogen indicator data triggers were identified as a single sample exceeding a WQO or applicable criterion. Triggers were not evaluated for riparian assessment data (i.e., CRAM).

Of the seven sites monitored, the temperature trigger (i.e., MWAT) was exceeded greater than 20% of the time at three sites: two in Upper Penitencia Creek (sites 205COY105 and 205COY130) and one in Saratoga Creek (site 205SAR050). The temperatures observed at the lowest elevation sites in both creeks were likely influenced by imported water releases that are managed for groundwater percolation. Existing information suggests that juvenile steelhead spawning and rearing habitat is not supported at either site, and therefore current water temperatures are likely not impacting cold water fisheries at these sites. Although steelhead spawning and rearing habitat is supported at site 205COY130 in Alum Rock Park, based on existing information, low summer flow and food availability are likely more important limiting factors affecting steelhead production at this site. The low precipitation during the water year of 2011-2012 was also likely exacerbating the naturally occurring low flow conditions at this site.

Of the three sites monitored for continuous water quality, dissolved oxygen concentrations exceeded triggers for COLD beneficial uses (5.0 mg/L) at one site in Coyote Creek (site 205COY235) during both sampling events, and triggers for COLD beneficial uses (7.0 mg/L) at all three sites in Coyote Creek during both sampling events. Existing information indicates the habitat at all three sites does not support juvenile steelhead spawning and rearing habitat, but may support upstream and downstream migration for coldwater fish (i.e., steelhead). The low DO concentrations at Watson Park (site 205COY235) was identified in previous studies and although data collection continues at this site, preliminary evidence suggests channel morphology and physical habitat condition may be important factors influencing the oxygen demand at this site. All sites in Coyote Creek exhibited pH levels within numeric WQOs and no triggers were exceeded. Pathogen indicator triggers were exceeded at one of five sites monitored (Los Gatos Creek - 205LGA400).[3]

CRAM results and B-IBI scores were not well correlated at the twenty bioassessment sites monitored by SCVURPPP in Water Year 2012. However, these results may have been influenced by biological conditions unique to larger river systems (i.e., poor habitat for BMI community but intact and diverse riparian habitat). Further evaluation of CRAM data in combination with a larger sample size of sites may show better relationships between these indicators in the future.

In preparation for monitoring in Water Year 2013, SCVURPPP is considering additional temperature monitoring in Upper Penitencia Creek as part of MRP creek status monitoring. Temperature data may be collected at sites monitored in Water Year 2012 to evaluate inter-annual variability. Additional temperature monitoring in Saratoga Creek may be also be considered at creek sites upstream of the City of Saratoga that support rainbow trout rearing and spawning habitat.

In addition to creek status monitoring, SCVURPPP is currently implementing a stressor/source identification project in Coyote Creek[4]. Investigation will include additional continuous water quality monitoring in Water Year 2013 to determine extent and magnitude of low dissolved oxygen concentrations. Potential sources of low DO conditions will be investigated, as well as possible management actions to control these sources/stresses.

[3] Indicator organism abundance at this site was marginally above the triggers and within 95% confidence interval of the laboratory methodology, suggesting that minimal (if any) risk associated with waterborne pathogens is present at this site.
[4] The SCVURPPP is also conducting a stressor/source identification project evaluating low dissolved oxygen concentrations in Guadalupe River and Alviso Slough (Appendix C2).

1.0 INTRODUCTION

This SCVURPPP Local Urban Creeks Monitoring Report complies with MRP Reporting Provision C.8.g for Creek Status Monitoring data collected in Water Year 2012 (October 1, 2011 to September 30, 2012) in compliance with MRP Provision C.8.c. Data presented in this report were developed using a targeted (non-probabilistic) monitoring design and the probabilistic monitoring design developed for the RMC (see below).

The RMC was formed in early 2010 as a collaboration among a number of BASMAA members and MRP Permittees (Table 1.1) to develop and implement a regionally coordinated water quality monitoring program to improve stormwater management in the region and address water quality monitoring required by the MRP[5]. Implementation of the RMC's Creek Status and Long-Term Trends Monitoring Plan allows Permittees and the Water Board to modify their existing creek monitoring programs, and improve their ability to collectively answer core management questions in a cost-effective and scientifically-rigorous way. Participation in the RMC is facilitated through the BASMAA Monitoring and Pollutants of Concern Committee (MPC).

Table 1.1 Regional Monitoring Coalition participants.

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

[5] The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) issued the five-year MRP to 76 cities, counties and flood control districts (i.e., Permittees) in the Bay Area on October 14, 2009 (SFRWQCB 2009). 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.

The goals of the RMC are to:

1. Assist Permittees in complying with requirements in MRP Provision C.8 (Water Quality Monitoring);
2. Develop and implement regionally consistent creek monitoring approaches and designs in the Bay Area, through the improved coordination among RMC participants and other agencies (e.g., Water Board) that share common goals; and
3. Stabilize the costs of creek monitoring by reducing duplication of effort and streamlining reporting.

Participants in the RMC collectively address the scope of sub-provisions specified in MRP Provision C.8 (Table 1.2). This report focuses on the Creek Status and Long-Term Trends Monitoring activities that were conducted to comply with Provision C.8.c using a targeted (non-probabilistic) monitoring design (Table 1.3). In addition, riparian assessments, a targeted monitoring parameter, are addressed in the report, but were conducted at all probabilistic sites to satisfy stream survey monitoring requirement in MRP Table 8.1.

Table 1.2 Municipal Regional Permit Provisions addressed by the Regional Monitoring Coalition.

Sub-Provision	Subprovision Title	Reporting Document
C.8.a	Compliance Options	• Regional Monitoring Coalition Creek Status & Long-Term Trends Monitoring Plan (BASMAA 2011)
C.8.b	San Francisco Bay Estuary Monitoring	• Regional Monitoring Program Annual Monitoring Results (www.sfei/rmp.org)
C.8.c	Creek Status Monitoring	• Regional Urban Creeks Status Monitoring Report • Local Urban Creeks Status Monitoring Reports
C.8.d	Monitoring Projects	
	• Stressor/Source Identification	• Stressor/Source Identification Reports
	• BMP Effectiveness Investigation	• BMP Effectiveness Reports
	• Geomorphic Project.	• Integrated Monitoring Report
C.8.e	Pollutants of Concern (Loads) and Long-Term Trends Monitoring	• Small Tributaries Loading Strategy (STLS) Multi-Year Monitoring Plan (Version 2013A) • Pollutants of concern (POC) loads monitoring data progress report (Water Year 2012)
C.8.f	Citizen Monitoring and Participation	• Urban Creeks Monitoring Report (Main Body)
C.8.g	Data Analysis and Reporting	• Urban Creeks Monitoring Report (Main Body) • Individual Monitoring Reports

Table 1.3 Creek Status Monitoring Parameters monitored in compliance with MRP Provision C.8.c. and the associated reporting format.

Monitoring Elements of MRP Provision C.8.c	Monitoring Design		Reporting	
	Regional Ambient Probabilistic	Local Targeted	Regional	Local
Bioassessment & Physical Habitat Assessment	X		X	
Chlorine	X		X	
Nutrients	X		X	
Water Toxicity	X		X	
Sediment Toxicity	X		X	
Sediment Chemistry	X		X	
General Water Quality		X		X
Temperature		X		X
Bacteria		X		X
Stream Survey[1]		X		X

[1] California Rapid Assessment Method for Riverine Wetlands (CRAM) was used to fulfill the stream survey monitoring element listed in the MRP Table 8.1.

The remainder of this report describes the study area and monitoring design (Section 2.0), the monitoring methods (Section 3.0), the results and discussion (Section 4.0), and the conclusions and next steps (Section 5.0).

2.0 STUDY AREA & DESIGN

2.1 RMC Area

The RMC area encompasses 3,407 square miles of land in the San Francisco Bay Area. This includes the portions of the five participating counties that fall within the San Francisco Bay Region Water Quality Control Board boundary, as well as the eastern portion of Contra Costa County that drains to the Central Valley region (Figure 2.1)[6]. Status and trends monitoring is being conducted in flowing water bodies (i.e., creeks, streams and rivers) interspersed among the RMC area), including perennial and non-perennial creeks and rivers that run through both urban and non-urban areas. Sites monitored during Water Year 2012 in Santa Clara County are shown on Figure 2.2.

2.2 Targeted Monitoring Design

During Water Year 2012 (October 1, 2011 - September 30, 2012) water temperature, general water quality and pathogen indicators were monitored at the targeted locations presented in Table 2.1 and Figure 2.2. SCVURPPP also conducted riparian assessments at all probabilistic sites, where bioassessments were conducted. Site locations were identified using a targeted monitoring design based on the directed principle[7] to address the following management questions:

1. What is the spatial and temporal variability in water quality conditions during the spring and summer season?
2. Do general water quality measurements indicate potential impacts to aquatic life?
3. What are the pathogen indicator concentrations at creek sites where there is potential for water contact recreation to occur?
4. What are the riparian conditions at bioassessment sampling stations? Are riparian assessments good indicators for condition of aquatic life use? Can they help identify stressors to aquatic life uses?

[6] GIS layers used to develop Figure 1 are available upon request by contacting Nick Zigler, nzigler@eoainc.com.
[7] 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."

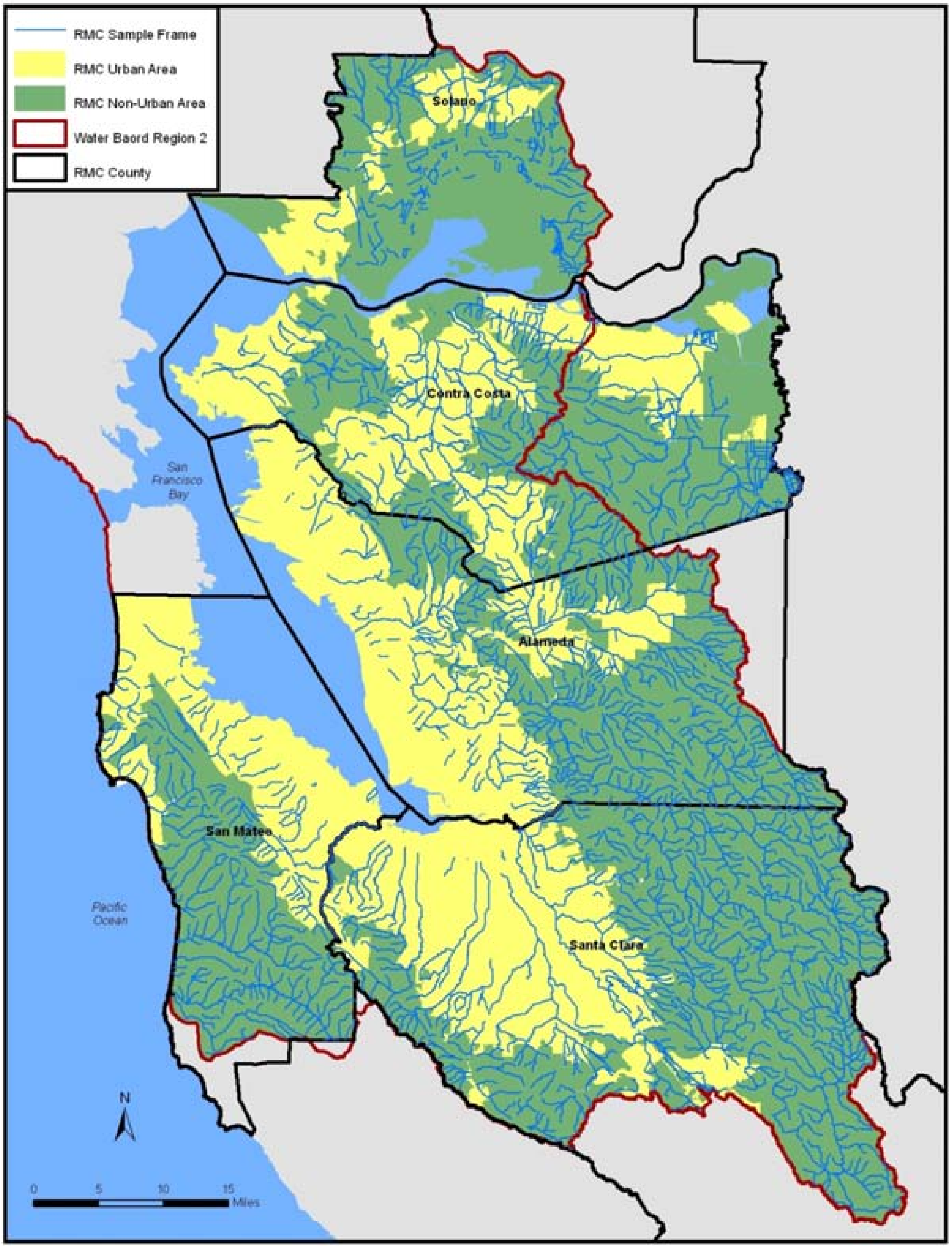

Figure 2.1 Map of BASMAA RMC area, major creeks, transportation features.

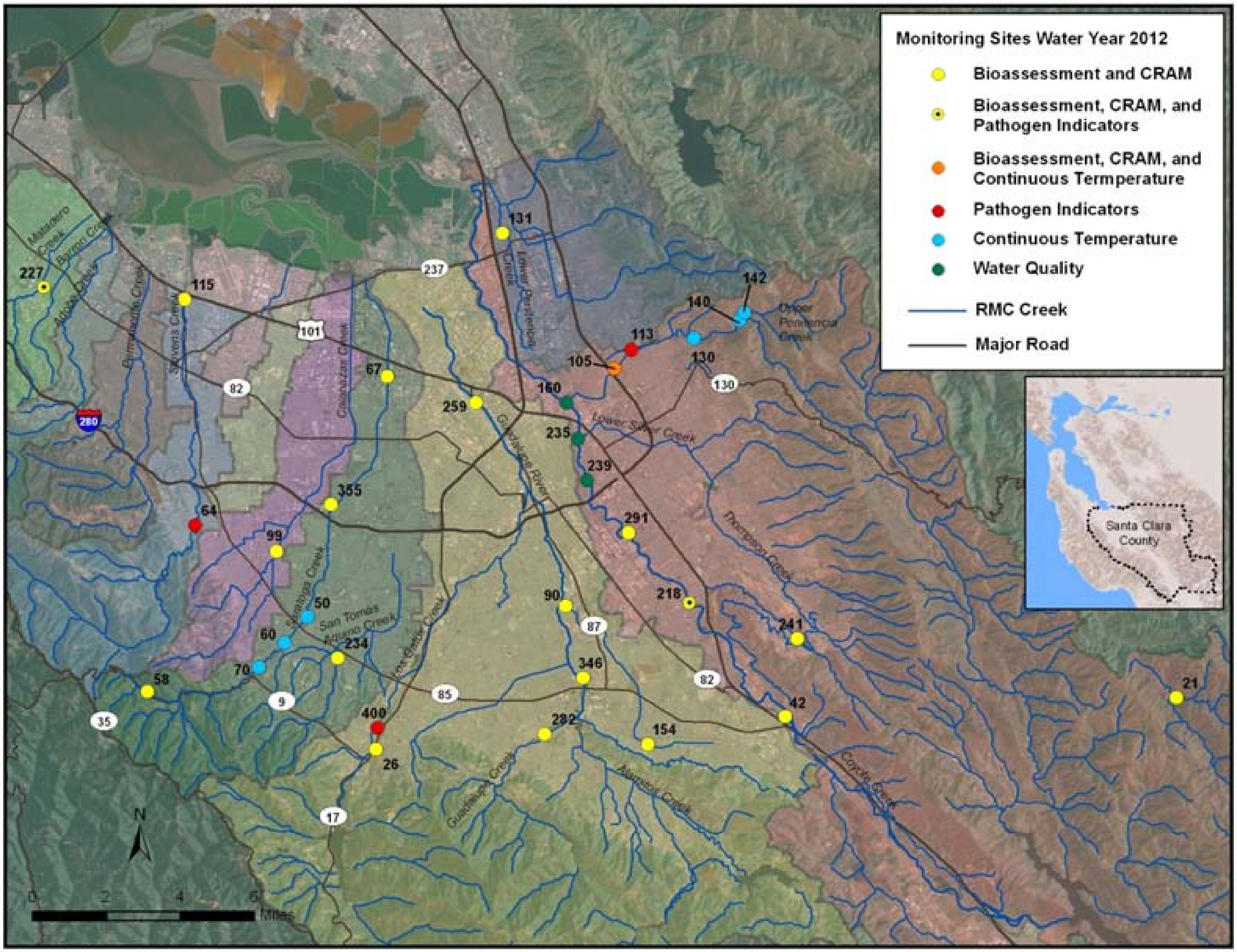

Figure 2.2 Map of SCVURPPP Program Area, major creeks and sites monitored in Water Year 2012 Refer to Table 2.1 for description of sites.

Table 2.1 Sites and parameters monitored in Water Year 2012 in Santa Clara County. Monitoring sites that did not record data due to loss of equipment are indicated as NR (not recorded) and are not depicted in Figure 2.2.

Map Number	Station Number	Creek Name	Latitude	Longitude	CRAM	Temp[1]	Water Quality	Pathogen Indicator
99	205R00099	Calabazas Creek	37.30773	-122.02170	x			
90	205R00090	Canoas Creek	37.28807	-121.87920	x			
154	205R00154	Canoas Creek	37.23400	-121.83759	x			
42	205R00042	Coyote Creek	37.24578	-121.77020	x			
330	205COY330	Coyote Creek	37.29000	-121.81804				x
218	205R00218	Coyote Creek	37.29000	-121.81804	x			
291	205R00291	Coyote Creek	37.31718	-121.84857	x			
160	205COY160	Coyote Creek	37.36765	-121.88019			x	
235	205COY235	Coyote Creek	37.3536	-121.87417			x	
239	205COY239	Coyote Creek	37.33722	-121.86953			x	
282	205R00282	Guadalupe Creek	37.23760	-121.88840	x			
259	205R00259	Guadalupe River	37.36723	-121.92477	x			
346	205R00346	Guadalupe River	37.25973	-121.87010	x			
26	205R00026	Los Gatos Creek	37.23057	-121.97137	x			
400	205LGA400	Los Gatos Creek	37.23889	-121.97054				x
131	205R00131	Lower Penitencia Creek	37.43404	-121.91280	x			
30	205MAT030	Matadero Creek	37.40990	-122.13831				x
227	205R00227	Matadero Creek	37.40990	-122.13831	x			
21	205R00021	MF Coyote Creek	37.25513	-121.57811	x			
67	205R00067	San Tomas Aquino	37.37693	-121.96857	x			
234	205R00234	San Tomas Aquino	37.26620	-121.99081	x			
58	205R00058	Saratoga Creek	37.25170	-122.08407	x			
355	205R00355	Saratoga Creek	37.32668	-121.99539	x			
50	205SAR050	Saratoga Creek	37.28223	-122.00623		x		
60	205SAR060	Saratoga Creek	37.27185	-122.01716		x		
70	205SAR070	Saratoga Creek	37.26199	-122.02933		x		
-	205SAR080	Saratoga Creek	37.25341	-122.04233		NR		
115	205R00115	Stevens Creek	37.40586	-122.06906	x			
64	205STE064	Stevens Creek	37.31735	-122.06182				x
35	205R00035	Upper Penitencia Creek	37.38145	-121.85669	x			
105	205COY105	Upper Penitencia Creek	37.38145	-121.85669		x		
113	205COY113	Upper Penitencia Creek	37.38889	-121.84864				x
-	205COY120	Upper Penitencia Creek	37.39303	-121.83330		NR		
130	205COY130	Upper Penitencia Creek	37.39362	-121.81783		x		
140	205COY140	Upper Penitencia Creek	37.40113	-121.79541		x		
142	205COY142	Upper Penitencia Creek	37.40418	-121.79317		x		
241	205R00241	Upper Silver Creek	37.27642	-121.76496	x			
Total Sites					20	7	3	5

[1] Monitoring equipment at one site in Upper Penitencia and one site in Saratoga was lost and therefore data were not retrieved for these sites.

3.0 MONITORING METHODS

3.1 Data Collection Methods

Water quality data were collected in accordance with SWAMP-comparable methods and procedures described in the BASMAA RMC Standard Operating Procedures (BASMAA 2012b) and associated Quality Assurance Project Plan (BASMAA 2012a). These documents are updated as needed to maintain their currency and optimal applicability. The SOPs were developed using a standard format that describes health and safety cautions and considerations, relevant training, site selection, and sampling methods/procedures, including pre-fieldwork mobilization activities to prepare equipment, sample collection, and de-mobilization activities to preserve and transport samples.

3.1.1 General Water Quality Measurements

Water quality monitoring equipment (YSI 6600 data sondes) were deployed at three sites in Coyote Creek, previously monitored by SCVURPPP, and found to have low dissolved oxygen concentrations during the late summer/fall season in 2010. These sites are also being monitoring by SCVURPPP in 2012 as part of a Stressor/Source Identification Project (Appendix C1). General water quality parameters (dissolved oxygen, specific conductivity, pH, and temperature) were recorded at fifteen minute intervals during two, two-week periods; once during spring season (May 10th - 24th) and once during summer season (September 4th - 18th). Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-4 (BASMAA 2012b).

3.1.2 Continuous Temperature Monitoring

Digital temperature loggers (Onset HOBO Water Temp Pro V2) were deployed at five sites in Upper Penitencia Creek and four sites in Saratoga Creek. Three of the five sites in Upper Penitencia Creek were located in Alum Rock Park in areas known to support juvenile steelhead rearing habitat. The remaining two sites in Upper Penitencia Creek were located at existing monitoring locations within the urbanized section of the valley floor. One of these sites (205COY105) was a site selected as part of the probabilistic monitoring design in 2012, and the remaining site (205COY120) was a creek location for a citizen monitoring program that is supported by the City of San Jose.

Three of the Saratoga Creek sites were selected at sites that SCVURPPP previously conducted bioassessments and fish surveys in 2004 and 2005. One of these sites (205SAR080) was located above the City of Saratoga in areas known to support rainbow trout rearing habitat. The remaining sites were located in urban reaches on the valley floor. Hourly temperature measurements were recorded from April 23rd through September 25th. At two of the nine sites, the monitoring devices were missing during retrieval and thus data were only collected at seven of the sites. Procedures used for calibrating, deploying, programming and downloading data are described in RMC SOP FS-5 (BASMAA 2012b).

3.1.3 Pathogen Indicators Sampling

Field crews collected water samples at five sites on July 17, 2012 for analysis of pathogen indicators (*E. coli* and fecal coliform). All five sites occurred in municipal or county owned parks in areas with good public access to creeks and potential for recreational contact to waterbody. 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 2012b).

3.1.4 California Rapid Assessment Method for Riverine Wetlands (CRAM)

Field crews conducted assessments at 20 sites between July 16th and August 23rd using the California Rapid Assessment Method (CRAM). Assessments were conducted at the same locations (and reach lengths) that were monitored for the RMC probabilistic design (i.e., biological and physical habitat assessments, nutrients and physical chemical water quality). CRAM was conducted at bioassessment locations to determine if CRAM data can be useful for explaining condition of aquatic biological condition. CRAM is performed within a defined riparian Assessment Area (AA) and is composed of the following subcategories: 1) buffer and landscape context; 2) hydrology; 3) physical structure; and 4) biotic structure. Procedures describing methods for scoring riparian attributes are described in Collins et al. (2008).

3.2 Quality Assurance/Quality Control

Data quality assessment and quality control procedures are described in detail in the BASMAA RMC QAPP (BASMAA 2012a). Data Quality Objectives (DQOs) were established to ensure that data collected are of adequate quality and sufficient for the intended uses. DQOs address both quantitative and qualitative assessment of the acceptability of data. The qualitative goals include representativeness and comparability. The quantitative goals include specifications for completeness, sensitivity, precision, accuracy, and contamination. To ensure consistent and comparable field techniques, pre-survey field training and in-situ field assessments were conducted. Field training and inter-calibration exercises were most applicable to ensure high quality CRAM data.

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

3.3 Data Quality Assessment Procedures

Following completion of the field and laboratory work, the field data sheets and laboratory reports were reviewed by the local Program Quality Assurance Officer, and compared both against the methods and protocols specified in the SOPs and QAPP. The findings and results then were evaluated against the relevant DQOs to provide the basis for an assessment of programmatic data quality. Summary of data quality steps associated with water quality measurements is shown in Table 3.1. The data quality assessment consisted of5 the following elements:

- Conformance with field and laboratory methods as specified in SOPs and QAPP, including sample collection and analytical methods, sample preservation, sample holding times, etc.
- Numbers of measurements/samples/analyses completed vs. planned, and identification of reasons for any missed samples.
- Temperature data was checked for accuracy by comparing measurements taken by HOBOs with NIST thermometer readings in room temperature water and ice water.
- General water quality data was checked for accuracy by comparing measurements taken before and after deployment with measurements taken in standard solutions to evaluate potential drift in readings.
- Quality assessment laboratory procedures for accuracy and precision (i.e., lab duplicates, lab blanks) were not implemented for samples collected this year, but will be in subsequent years.
- Field crews participated in one CRAM training class and two inter-calibration exercises prior to field assessments.

Table 3.1 Data quality steps implemented for temperature and general water quality monitoring.

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

3.4 Data Analysis and Interpretation

Continuous temperature and general water quality data were plotted as box and whisker plots for each site during each deployment. The middle line of the box represents the median value (50^{th} percentile), and top and bottom edge of the box indicate the 75^{th} and 25^{th} percentile, respectively. The upper whisker represents the 90^{th} percentile, while the bottom whisker represents the 10^{th} percentile. All points that do not lie within the 10^{th} and 90^{th} percentile are plotted as dots outside of the whiskers.

The hourly water temperature measurements were calculated as daily arithmetic means over a 24-hour period from midnight to 11:00 PM. Seven-Day “rolling” weekly average stream temperatures were calculated by averaging each daily temperature with the previous six daily average temperatures.

Targeted monitoring data were evaluated against Water Quality Objectives or other applicable thresholds, as described in Table 8.1 of the MRP, to determine whether results may “trigger” a potential stressor/source identification monitoring project (per MRP Provision C.8.d.i). Table 3.2 lists the definitions for trigger thresholds used by SCVURPPP for selected targeted monitoring parameters. Sites that exceed triggers for one or more parameters may be eligible for consideration as a Stressor/Source Identification project per MRP Provision C.8.d.i. No trigger thresholds have been established for CRAM data.

Table 3.2 Description of triggers for Municipal Regional Permit Provision C.8.c monitoring parameters monitored using a targeted monitoring design.

Monitoring Parameter	Trigger Description
Temperature	20% of results for the deployment period at each monitoring site exceed one or more of the following applicable temperature thresholds: • For a waterbody designated as COLD and/or supports steelhead trout population (USEPA 1977): o 7-day Mean Temperature should not exceed 19˚ C • For a waterbody designated as COLD or WARM (Water Board 2011): o The temperature shall not be increased by more than 2.8˚ C above natural receiving water temperature.
General Water Quality	20% of results for the deployment period at each monitoring site exceed one or more water quality standards or established thresholds: • Water Temperature : see above • Dissolved Oxygen for WARM < 5.0 mg/L and/or COLD: < 7.0 mg/L (Water Board 2011) • pH: > 6.5 and < 8.5[1] (Water Board 2011) • Conductivity: NA
Pathogen Indicators	Single sample maximum at each site exceed one or more water quality standards or established criteria: • Fecal coliform: $\geq$ 400 MPN/100 ml (Water Board 2011) • E. coli: $\geq$ 576 MPN/100 ml (USEPA 1986)
CRAM	NA

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

The thresholds used to evaluate triggers for each monitoring parameter are discussed briefly below.

3.4.1 Temperature

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

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

The San Francisco Bay Region Water Quality Control Board (Water Board) is currently applying the temperature thresholds suggested by Sullivan et al. (2000) (i.e., MWAT of 17°C and 14.8°C for steelhead and coho salmon, respectively) to evaluate temperature data for the 303(d) listing process of impaired waterbodies (SFRWQCB 2011). The Water Board has also applied these thresholds in evaluating temperature data collected at reference sites in the San Francisco Bay Area (SFRWQCB 2012).

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

Sullivan et al.'s (2000) risk assessment approach to establishing water temperature thresholds for salmonids focuses on juvenile growth rates. Several studies, however, demonstrate that Central California Coast (CCC) Steelhead Distinct Population Segment (DPS)[8] have adapted feeding behaviors and life history strategies to deal with higher water temperatures characteristic of the southern end of their range. Smith and Li (1983) have observed that juvenile steelhead will tolerate warmer temperatures when food is abundant by moving into riffle habitats to increase feeding success. Steelhead will also move into coastal estuaries to feed during the summer season when stream conditions become stressful to the fish (Moyle 2008). Sogard et al. (2012) determined that steelhead growth rates were higher during winter-spring season compared to summer fall season in Central California coastal creeks, whereas the opposite was true for steelhead in creeks of the Central Valley. Railsback and Rose (1999) concluded that juvenile growth rate during the summer season was more dependent on food availability and consumption than temperature.

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

We recommend using thresholds identified in EPA (1977) (i.e., MWAT of 19°C for steelhead and 18°C for coho salmon) for interpretation of temperature data collected during the Creek Status Monitoring Project in 2012. These thresholds are consistent with results from thermal tolerance studies by Myrick and Cech (2000) that demonstrated maximum growth rates for California rainbow trout population to be near 19°C. Myrick (1998) also demonstrated that growth rates for steelhead at 19°C were greatly increased when food ration level was highest.

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

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

analysis that assumes optimal growth rates for salmonids using data that are likely not applicable to local watershed conditions.

The Basin Plan's water temperature Water Quality Objective states that "temperature shall not be increased by more than 2.8^{o}C above natural receiving water temperature". This criterion is difficult to apply to sites where natural receiving water temperature is not known. This criterion may be applicable in situations where temperature is dramatically altered (e.g., imported water) and water temperature data is collected above and below a POTW outfall. In addition, there is no recommended criterion to use for warm water fish communities, which are more adapted to higher temperatures. At this time, SCVURPPP intends to prioritize temperature monitoring at sites that are designated with a cold water habitat (COLD) beneficial use (SFBRWQCB 2011) or that support salmonid fish communities.

3.4.2 Dissolved Oxygen

The Basin Plan (SFBRWQCB 2011) lists Water Quality Objectives for dissolved oxygen in non-tidal waters as follows: 5.0 mg/L minimum for waters designated as warm water habitat (WARM) and 7.0 mg/L minimum for waters designated as COLD. Although these WQOs provide suitable thresholds to evaluate triggers, further evaluation may be needed to determine the overall extent and degree that COLD and/or WARM beneficial uses are supported at a site. For example, further analyses may be necessary at sites in lower reaches of a waterbody that may not support salmonid spawning or rearing habitat, but may be important for upstream or downstream fish migration. In these cases, dissolved oxygen data will be evaluated for the salmonid life stage and/or fish community that is expected to be present during the monitoring period. Such evaluations of both historical and current ecological conditions will be made, where possible, when evaluating water quality information.

3.4.3 pH

Water Quality Objectives for pH in surface waters are stated in the Basin Plan as follows: the pH shall not be depressed below 6.5 nor raised above 8.5. The range of values above or below these thresholds will be used for the trigger analysis.

3.4.4 Pathogen Indicators

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

While the Basin Plan does not include WQOs for *E. coli*, the EPA has established a criterion for *E. coli* in fresh water for Water Contact Recreation as 576 MPN/100ml for infrequently used areas (SFRWQCB 2011). The EPA criterion for a single sample maximum was used as the basis for evaluating *E. coli* results which might "trigger" a monitoring project under MRP Provision C.8.d.i.

Two important issues should be considered when evaluating bacterial indicator organisms: 1) the imperfect correlation between bacterial indicator organisms and pathogens of public health concern; and 2) potential for human exposure to the water bodies of interest. Water Quality Objectives and Criteria for indicators were derived from epidemiological studies of people recreating at bathing beaches that received bacteriological contamination via treated human wastewater. Therefore, applying these thresholds to data collected from creeks where exposure via recreation is infrequent and ingestion of the water is highly unlikely, is highly questionable. Additionally, sources of fecal indicators in the watershed are likely non-human given the understanding of watershed sources. Recent research indicates that the source of fecal contamination is critical to understanding the human health risk associated with recreational waters and that the risk in recreational waters varies with various fecal sources (*EPA Draft Recreational Water Quality Criteria*, *December 2011*). Thus, comparison of fecal indicator results in Santa Clara Valley creeks to WQOs and criteria, may not be appropriate and should be interpreted cautiously.

4.0 RESULTS AND DISCUSSION

4.1 Statement of Data Quality

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

- Temperature data (from HOBOs) was collected from seven of the required eight sites due to loss of equipment at two sites. As a result, approximately 88% of the expected data was captured.
- Continuous water quality data (temperature, pH, dissolved oxygen, specific conductivity) was collected during spring and summer season resulting in over 100% of the expected data results.
- Continuous water quality data generally met measurement quality objectives (accuracy) for all parameters with the exception of dissolved oxygen at two sites during Event 1 (Table 4.1). Data was flagged but used in the analysis.
- Quality Assurance laboratory procedures were not implemented for pathogen indicator concentrations this year, thus data quality could not be evaluated.
- Total CRAM scores between field crews at two pre-calibration exercises were within 10%.

Table 4.1 Accuracy measurement taken for dissolved oxygen, pH and specific conductivity. Bold values exceeded established Measurement Quality Objectives (MQOs).

Parameter	Measurement Quality Objectives	205COY160		205COY235		205COY239	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Dissolved Oxygen (mg/l)	± 0.5 mg/L	1.2	0.14	0.14	-0.17	0.94	-0.02
pH 7.0	± 0.2	0.04	-0.12	0.13	-0.05	0	0.02
pH 10.0	± 0.2	-0.06	0.15	-0.06	0.05	-0.03	-0.02
Specific Conductance (uS/cm)	± 0.5 %	-0.5%	1.2%	-0.6%	0.3%	-0.2%	1.6%

4.2 Temperature

Summary statistics for water temperature data collected in Upper Penitencia and Saratoga Creeks during April – September 2012 are shown in Table 4.2. Hourly temperature data was collected for approximately 152 consecutive days at all sites, with the exception of site 205COY142, which was retrieved after 118 days due to dry channel conditions. Box plots showing the distribution of temperatures measured at each site are shown in Figures 4.1 – 4.4. Acute and chronic temperature thresholds are shown in all the figures.

Table 4.2 Descriptive statistics for continuous water temperature measured at four sites in Upper Penitencia Creek and three sites in Saratoga Creek April 27th through September 26th, 2012.

Site	205COY105	205COY130	205COY140	205COY142	205SAR050	205SAR060	205SAR070
Creek Name	Upper Penitencia Creek				Saratoga Creek		
Min	14.91	10.66	9.63	8.99	15.01	11.01	10.61
Median	21.20	17.46	15.29	15.61	20.58	16.34	16.08
Mean	21.07	17.50	15.16	16.03	19.83	16.36	15.99
Max	25.82	23.64	18.53	25.14	23.74	21.49	20.77
Max 7-day mean	23.93	19.78	17.11	19.41	22.73	18.65	18.41
n	3652	3651	3650	2831	3644	3644	3645

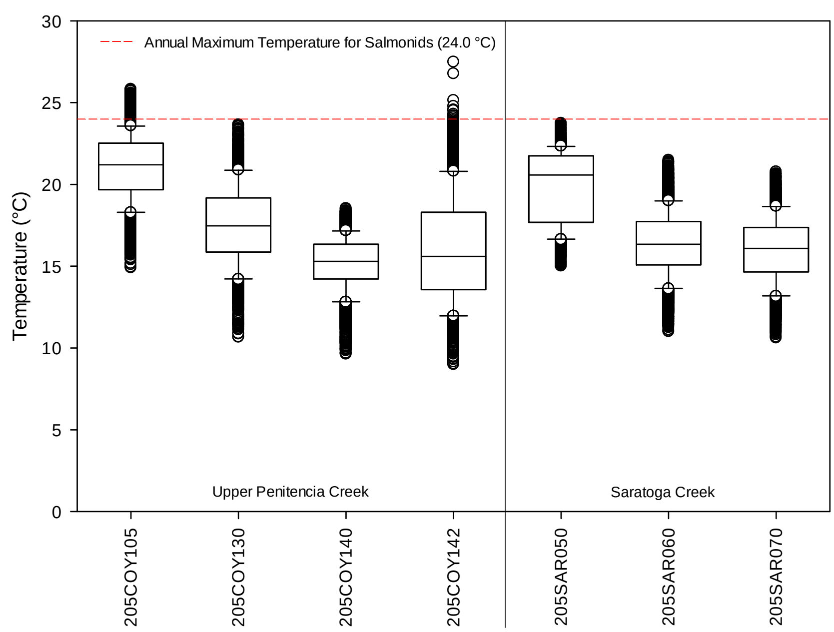

Figure 4.1 Box plots of water temperature data collected at seven stream locations in Upper Penitencia Creek and Saratoga Creek, Santa Clara County, from April through September 2012.

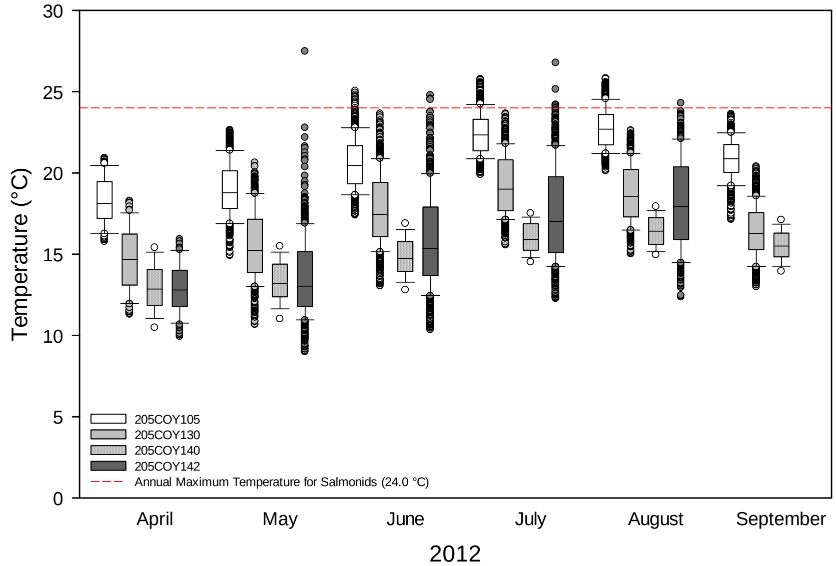

Figure 4.2 Box plots of water temperature, grouped by month, collected at four creek sites on Upper Penitencia Creek, Santa Clara County, from April through September 2012.

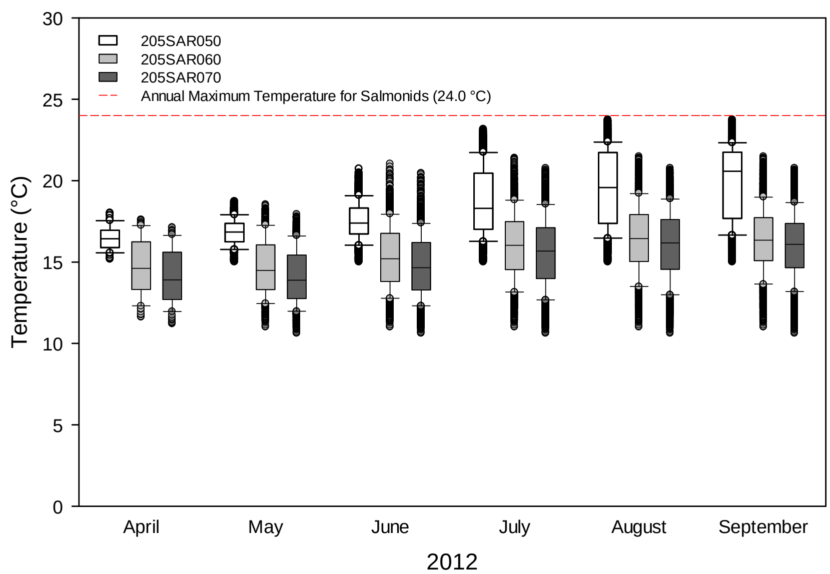

Figure 4.3 Box plots of water temperature, grouped by month, collected at three creek sites on Saratoga Creek, Santa Clara County, from April through September 2012.

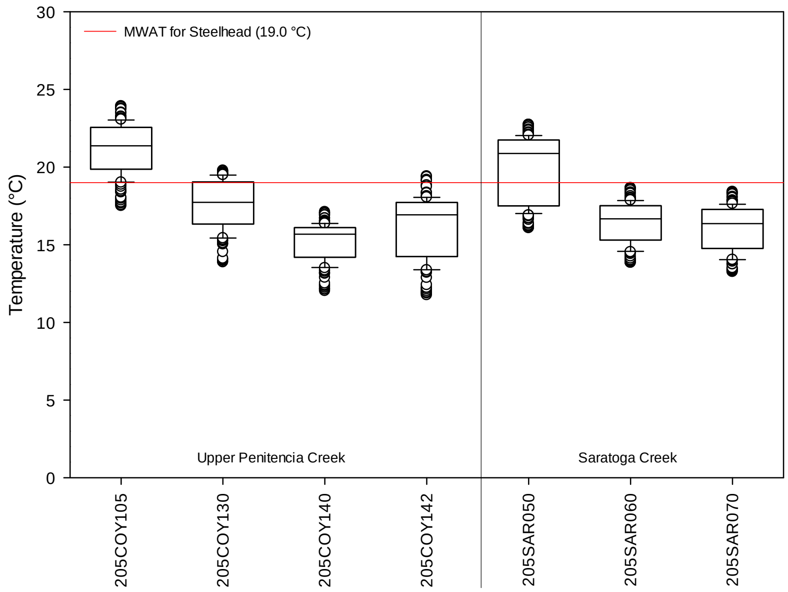

Figure 4.4 Box plots of water temperature data, calculated as the 7-day mean, collected at seven stream locations in Upper Penitencia Creek and Saratoga Creek, Santa Clara County, from April through September 2012.

The monitoring results in Upper Penitencia Creek indicate that water temperatures generally increased at sites with decreasing elevation. The percent of water temperature data measured at the seven sites that exceed the MWAT threshold (19 °C) is shown in Table 4.3.Temperatures were not problematic at the upper two sites, with exceedences in the MWAT threshold only occurring for only 4% of the data results at site 205COY142 (Table 4.3). Site 205COY130, located further downstream, did exceed the MWAT for 26% of the data results. All three sites described above are located in Alum Rock Park (ARP), which is the primary reach of Upper Penitencia Creek where steelhead has historically been observed (Leidy et al. 1995) and contains the best quality steelhead spawning and juvenile rearing habitat (Stillwater 2006).

The furthest downstream site (205COY105) exceeded the MWAT threshold for 91% of the data results (see Table 4.3). This site is located much farther downstream of the ARP and is within the urbanized valley reach of Upper Penitencia Creek. The valley reach does not currently support spawning or rearing habitat, but is an important migration corridor for steelhead (Stillwater 2006).

Table 4.3 Percent of water temperature data measured between April 27th – September 26th, 2012 at seven sites that exceeded MWAT maximum threshold value (19 °C).

Site ID	Creek Name	Site Name	*Percentage results MWAT > 19°*
205COY105	Upper Penitencia Creek	N. Capital Ave	91%
205COY130		Quail Hollow in ARP	26%
205COY140		Live Oak in ARP	0%
205COY142		Below Arroyo Aguague confl. in ARP	4%
205SAR050	Saratoga Creek	Cox Ave	61%
205SAR060		Crestbrook Rd	0%
205SAR070		Walnut Ave	0%

Historically, the valley reach of Upper Penitencia Creek did not likely support a cold water fish community due to naturally low or dry season flow conditions. Portions of this reach now contain a more perennial hydrology sustained by releases from Cherry Flat Dam and imported water (Beller et al 2012). Periodic flow augmentation downstream of the dam is believed to have increased the extent and duration of wetted channel in ARP (SCVURPPP 2003). Water imported from the South Bay Aqueduct, is released into off channel percolation ponds for groundwater percolation, and diverted back into the main channel near Piedmont Avenue (Buchan et al. 1999). Site 205COY120, located at Nobel Avenue just upstream of the percolation pond outfall, exhibited dry channel conditions during an equipment check in July (note: device was not recovered during field check, likely due to visibility from the exposure and subsequent removal by unidentified party).

Periodic instances of high maximum daily temperatures (24-27 °C) were observed at the upper site (205COY142) during summer (May – August) (Figure 4.2). These peak temperatures typically occurred during the afternoon, which might have been caused by a short period of direct exposure of sunlight to the temperature device. There were no known discharges in the upper reaches of ARP that were suspected of causing the peak temperatures. The upper site was also the only site that exhibited dry channel conditions (resulting in early retrieval of the device in August).

Low total precipitation during the 2011/2012 Water Year likely resulted in lower than normal stream flow at all the sites in ARP. Intermittent, low flows are typical for sections of Alum Rock Park during the late summer. Low flow conditions affecting food availability and outmigration were identified as one of the primary limiting factors for juvenile steelhead production in Upper Penitencia Creek (Stillwater 2006).

The monitoring results suggest water temperatures during late summer/fall season generally support juvenile steelhead populations for much of the upstream areas in ARP, even during a dry year. Warmer temperatures exhibited at the lowest elevation site in ARP suggest adequate flow and connectivity to upstream refugia, as well as adequate food sources, may be critical for juvenile rearing steelhead, especially in the summer period of dry years. Future monitoring at sites in ARP would be useful to evaluate the inter-annual variability of water temperatures for both wet and dry years.

Similar to Upper Penitencia Creek sites, water temperatures increased in Saratoga Creek with decreasing elevation. The MWAT was never exceeded at the upper two sites, but did exceed 61% of the data results at site 205SAR050. Median temperature at the lowest elevation site was four degrees higher than the two sites further upstream. It is not clear what might be causing the temperature increase, however, site 205SAR050 is located downstream of the outfall pipe that SCVWD operates to release water from the South Bay Aquaduct to Saratoga Creek for instream percolation during the summer season.

The three Saratoga Creek sites are located within a reach that has been classified as a native warm water fish community supporting mostly Sacramento sucker and California roach and low numbers of rainbow trout (Smith 2001). The cold water trout zone was classified in the reach of Saratoga Creek upstream of Highway 9, which is just upstream of site 205SAR070. This classification is supported by data collected by SCVURPPP (2007) which identified multiple age classes of juvenile trout and suitable rearing habitat occurring upstream of the City of Saratoga in Saratoga Creek and within the tributaries of Bonjetti, San Andreas and Sanborn Creeks (SCVURPPP 2007).

Temperatures do not appear to be problematic at the upper two sites, located just downstream of the rainbow trout zone, with no exceedences of the MWAT threshold (see Table 4.3). No applicable thresholds for native warm water fish community have been identified to evaluate the temperature data collected at site 205SAR050. However, the temperatures exhibited at this site are well within the range for native warm water fish community (Moyle 2000).

To better evaluate cold water fish populations, temperature monitoring should be conducted in Saratoga Creek upstream of the City of Saratoga. For 2012 study, a temperature device was deployed in Saratoga Creek near Hakone Gardens but data was not obtained due to loss of equipment.

4.3 General Water Quality

Summary statistics for general water quality measurements collected at three sites in Coyote Creek during two sampling events is shown in Table 4.4. Sampling Event 1 occurred May 10-24, 2012 and Event 2 occurred during September 4-18, 2012. Distribution of data during both events is plotted in Figure 4.5 and Figure 4.6.

Table 4.4 Descriptive statistics for daily and monthly continuous water temperature, dissolved oxygen, conductivity, and pH measured at three sites in Coyote Creek during two sampling events in 2012.

Parameter	Data Type	205COY160		205COY235		205COY239	
		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2
Temp (° C)	Min	16.42	18.05	16.56	17.18	15.86	14.00
	Median	17.81	19.39	17.64	18.12	17.54	15.7
	Mean	17.95	19.47	17.66	18.15	17.63	15.79
	Max	19.98	21.19	18.72	19.18	19.77	17.61
	Max 7-day Mean	18.04	19.52	17.82	18.32	17.72	15.99
Dissolved Oxygen (mg/l)	Min	4.64	5.23	1.85	2.33	5.74	5.59
	Median	5.93	5.97	2.53	3.22	6.38	6.26
	Mean	6.09	6.15	2.55	3.19	6.49	6.44
	Max	7.76	7.36	3.26	3.83	7.68	7.83
	7-day Avg. Min	4.92	5.32	2.08	2.74	5.97	5.85
pH	Min	7.77	7.53	7.5	7.57	7.53	7.39
	Median	7.85	7.94	7.55	7.61	7.63	7.48
	Mean	7.86	7.95	7.56	7.61	7.63	7.51
	Max	7.96	8.11	7.59	7.68	7.76	7.76
Specific Conductance (uS/cm)	Min	1325	1315	1098	1064	997	1001
	Median	1364	1358	1156	1170	1044	1113
	Mean	1366	1357	1156	1155	1056	1118
	Max	1419	1388	1207	1218	1114	1181
Total number data points (n)		1363	1338	1365	1335	1368	1333

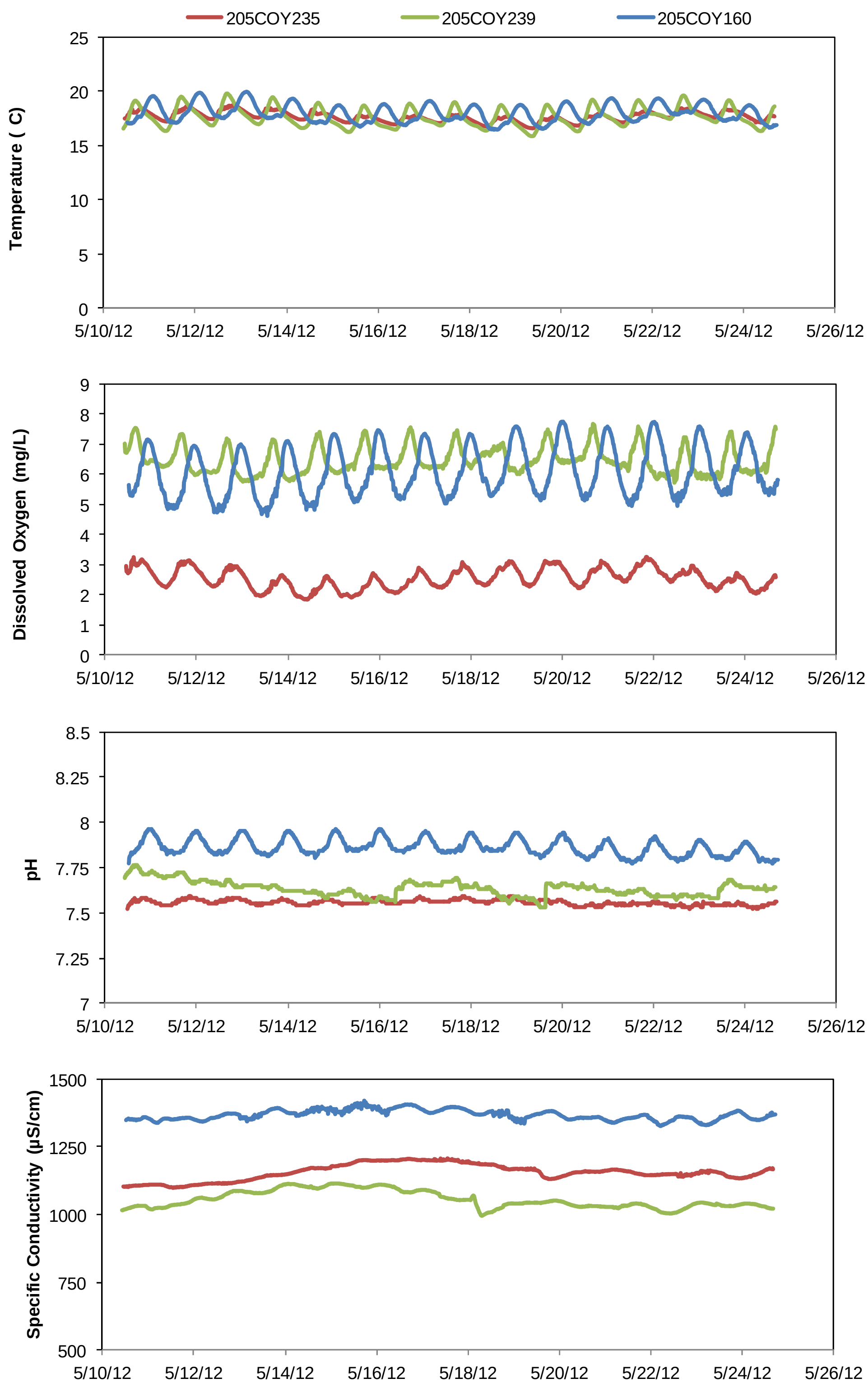

Figure 4.5 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected using sondes at three sites in Coyote Creek during sampling event 1.

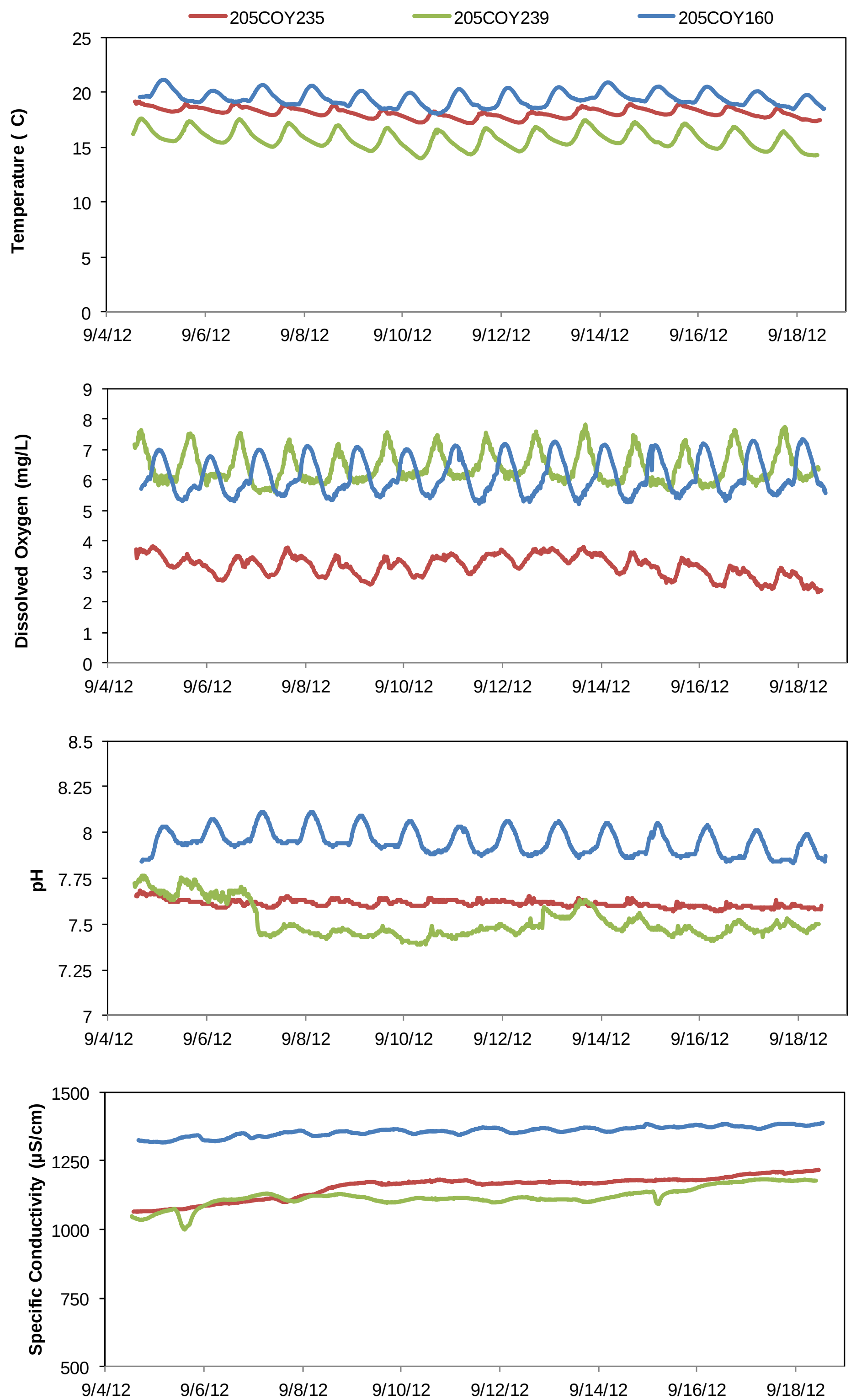

Figure 4.6 Continuous water quality data (temperature, dissolved oxygen, pH and specific conductance) collected using sondes at three sites in Coyote Creek during sampling event 2.

4.3.1 Temperature

Box plot showing the distribution of continuous temperature data taken during the two sampling events at three sites in Coyote Creek are shown in Figure 4.7. Distribution of temperature data, calculated as weekly averages, taken during same time period and at same sites are shown in Figure 4.8.

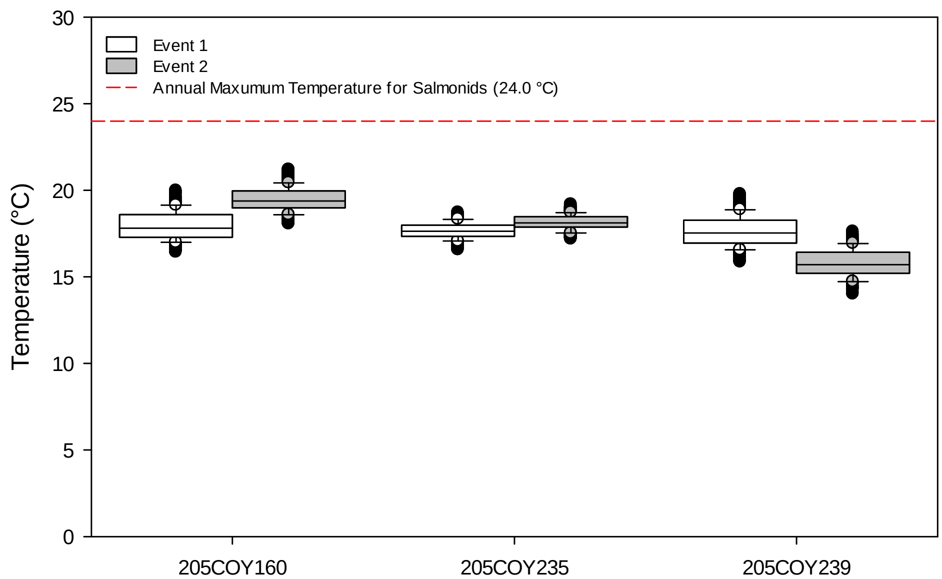

Figure 4.7 Box plots of continuous temperature data collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012.

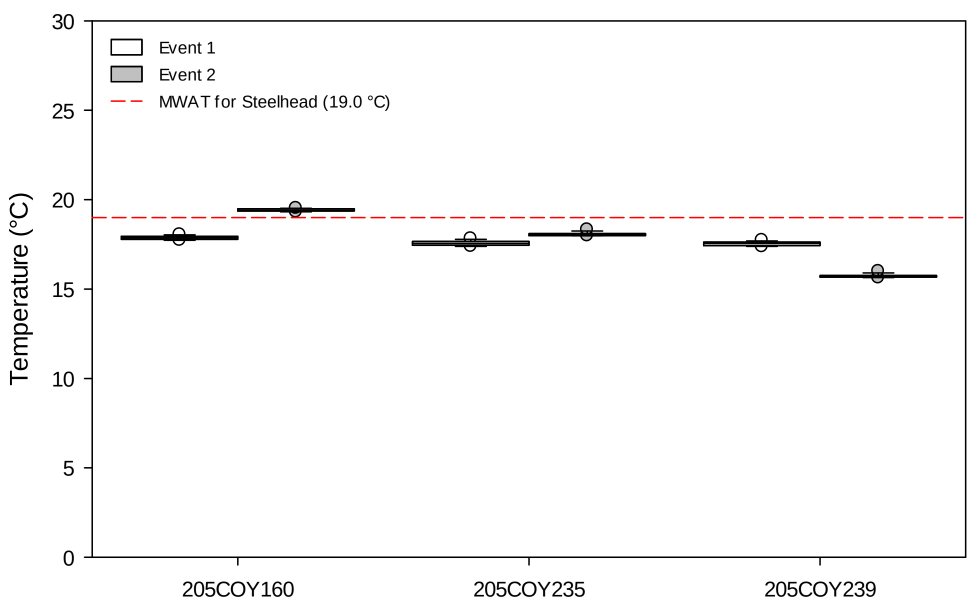

Figure 4.8 Box plots of continuous temperature data, calculated as the 7-day mean, collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012.

The MWAT did not exceed the chronic threshold (19°C) at any of the sites for both events, with the exception of site 205COY160 during Event 2, which 100% of the data was above the trigger (Table 4.5).

Table 4.5 Percent of water temperature data measured at two sites for both events that exceed trigger values identified in Table 3.2.

Site ID	Creek Name	Site	Monitoring Event	*Percent results MWAT > 19º*
205COY160	Coyote Creek	Flea Market	1	0%
			2	100%
205COY235		Watson Park	1	0%
			2	0%
205COY239		William St Park	1	0%
			2	0%

Although MWAT thresholds were exceeded at site 205COY160 during the late summer monitoring event, it is not likely to impact steelhead migration since fish are moving through the system quickly and can migrate during cooler periods of the night. Majority of steelhead in the watershed utilize spawning and rearing habitat in Upper Penitencia Creek, which is downstream of all three continuous water quality monitoring sites in Coyote Creek.

4.3.2 Dissolved Oxygen

Box plot showing the distribution of dissolved oxygen concentrations taken during the two sampling events at three sites in Coyote Creek are shown in 4.9. Distribution of dissolved oxygen data, calculated as weekly average of minimum concentrations, taken during same time period and at same sites are shown in Figure 4.10.

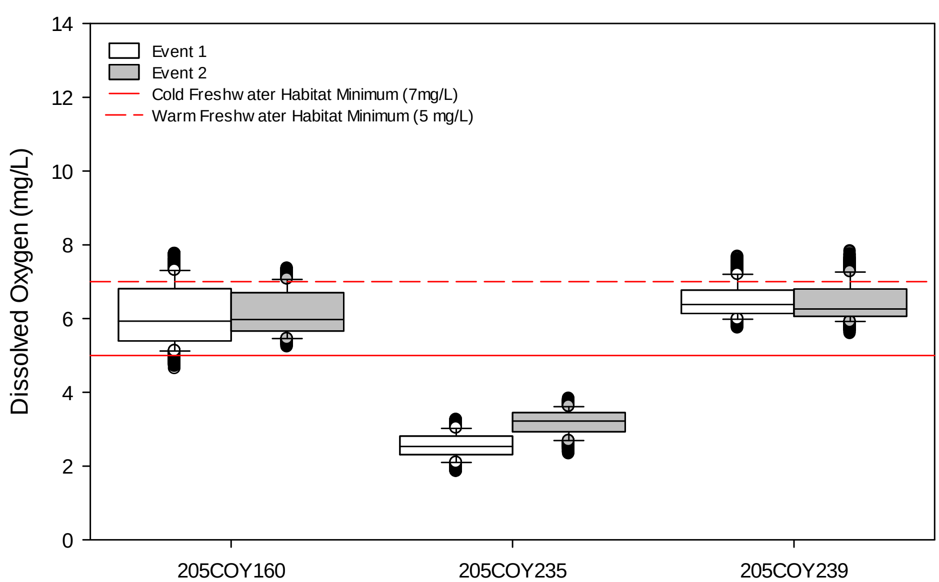

Figure 4.9 Box plots of continuous dissolved oxygen data collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012. Basin Plan Water Quality Objectives for DO are indicated on the plot.

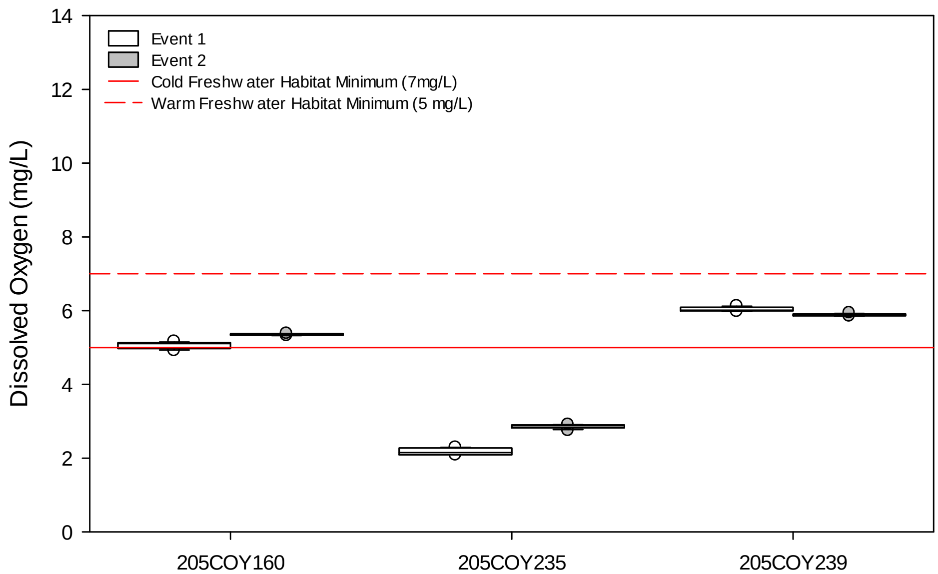

Figure 4.10 Box plots of continuous dissolved oxygen data, calculated as the 7-day average minimum, collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012. Basin Plan Water Quality Objectives for DO are indicated on the plot.

The Water Quality Objectives for both COLD (7.0 mg/L) and WARM (5.0 mg/L) were exceeded for 100% of the data results at site 205COY235 for both events (Table 4.6). The WQO for COLD was exceeded for 81-87% of the data results collected at the remaining two sites during both events. The WQO for WARM was not exceeded at the other sites, with the exception of 6% of the results at site 205COY160 during Event 1.

Table 4.6 Percent of dissolved oxygen data measured at two sites for both events that exceed trigger values identified in Table 5.1.

Site ID	Creek Name	Site	Monitoring Event	*Percent Results DO < 5.0 mg/L*	*Percent Results DO < 7.0 mg/L*
205COY160	Coyote Creek	Flea Market	1	6%	81%
			2	0%	87%
205COY235		Watson Park	1	100%	100%
			2	100%	100%
205COY239		William St Park	1	0%	83%
			2	0%	81%

The three Coyote Creek sites selected for continuous water quality monitoring were located between Upper Penitencia Creek confluence and William Street Park (about 0.5 mile downstream I-280). Previous water quality monitoring in 2010 showed these locations had consistently low dissolved oxygen concentrations, with the site at Watson Park recording the lowest DO readings (median concentrations ranging from 2.2 to 3.3 mg/L). Data collected during the current study showed similar results, indicating a persistent low DO problem in this reach of Coyote Creek. Fish survey data collected between the confluence of Upper Penitencia Creek and I-280 indicate a warm water fish population resides in this reach, but in relatively low abundance and primarily consists of non-native species (SCVWD 2008).

Although the WQO for COLD was exceeded 81-100% of the time at all sites for both events, existing information suggest these sites do not support juvenile steelhead spawning or rearing habitat. Adult and juvenile steelhead occurrences in entire Coyote Creek mainstem are extremely rare, with habitat limited to an area between a series of instream percolation ponds (Metcalf Ponds) upstream to Anderson Dam (Leidy et al 2005). Recent fish surveys in 2008 conducted in the Mid-Coyote Creek reach (defined as Montague Expressway upstream to I-280) reported 13 steelhead/trout individuals at two monitoring sites downstream of Upper Penitencia Creek (SCVWD 2008). There were no trout recorded in the remaining 11 survey sites in 2008 or at any of the same 13 monitoring sites in 2007 or 2009 (Melissa Moore, SCVWD, personal communication, 2013).

Fish habitat surveys conducted between the Upper Penitencia Creek confluence and I-280 showed greater than 95% pool habitat; predominantly mid-channel pools (SCVWD 2006). Historically, the Mid-Coyote Creek reach was an entrenched channel that became increasingly incised over time due to land use changes as well as ground subsidence caused by excessive groundwater withdrawals in the 1930's (Grossinger et al. 2006). The resultant combination of deep pools, high fine sediment deposition, low water velocity and poor water quality would not be conducive to supporting a cold water fish community.

SCVURPPP conducted additional water quality monitoring during September – December 2012 at six sites in Coyote Creek, including the three sites previously sampled for MRP Creek Status Monitoring. The water quality results show the reach of reduced oxygen extends from the site at Watson Park upstream to the site near Julian Street Bridge, a distance of approximately 0.5 mile. Further monitoring is needed to evaluate the water quality between the Julian and Williams sites and between the Watson site and the confluence of Lower Silver Creek. The Coyote Creek Stressor/Source Identification Project will follow a process to define the area of water quality impacts and identify the stressors/sources for oxygen depletion in that area.

4.3.3 pH

Box plot showing the distribution of pH measurements taken during the two sampling events at three sites in Coyote Creek are shown in figure 4.11. pH measurements never exceeded Water Quality Objectives and thus, did not result in any triggers at any of the sites.

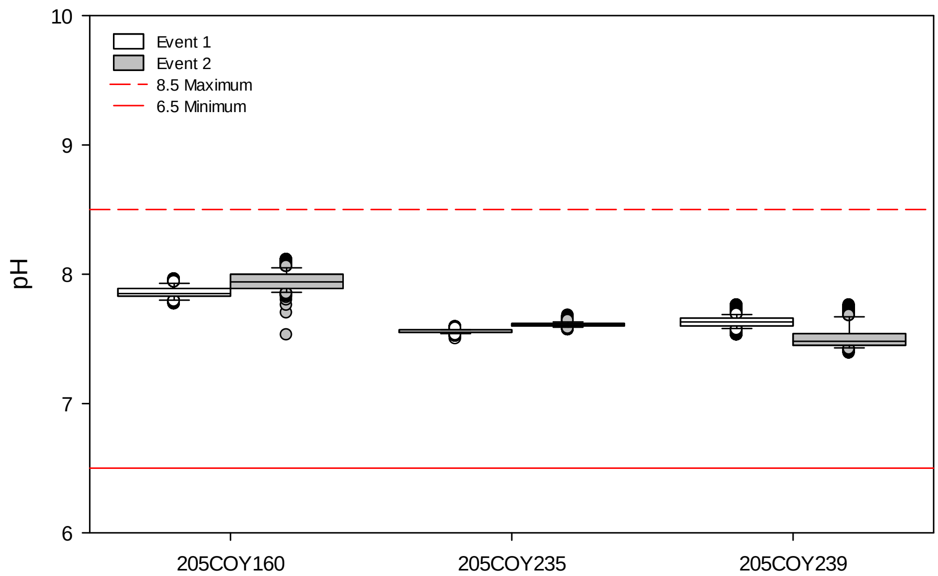

Figure 4.11 Box plots of continuous pH data collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012. Basin Plan Water Quality Objectives for pH are indicated on the plot.

4.3.4 Specific Conductivity

Box plot showing the distribution of specific conductivity measurements taken during the two sampling events at three sites in Coyote Creek are shown in 4.12. There are no water quality objectives or thresholds for this parameter, so an evaluation of trigger exceedence was not conducted.

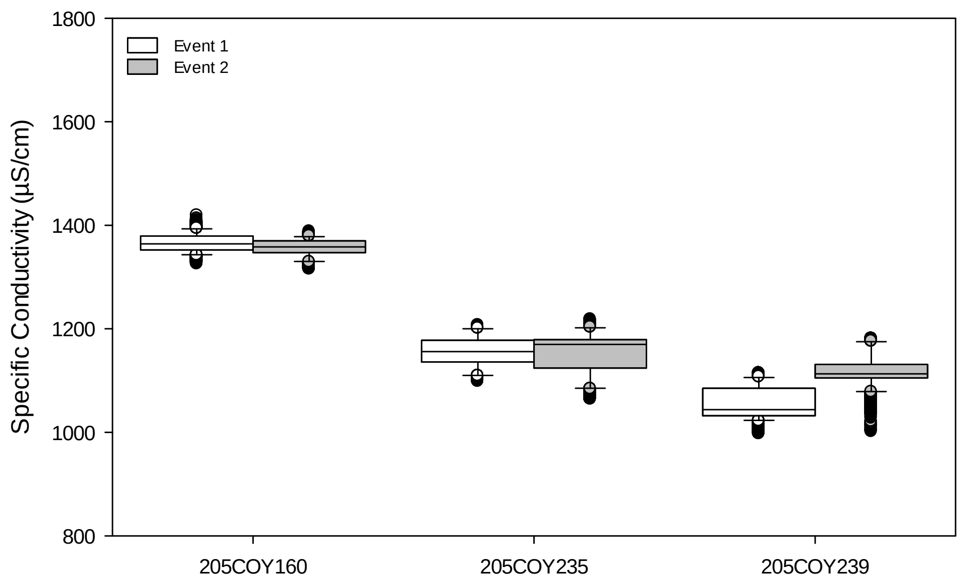

Figure 4.12 Box plots of continuous specific conductance data collected using sondes at three stream locations in Coyote Creek, Santa Clara County, for two sampling events in 2012.

4.4 Pathogen Indicators

Pathogen indicator concentrations measured in water samples collected at five monitoring locations are shown in Table 4.7. The site on Los Gatos Creek (site 205LGA400) at Vasona Park had the highest concentrations of fecal coliform and *E. coli* (800 MPN/100ml) among all the sites and was the only site to exceed the triggers for both indicators defined in Table 3.2.

Table 4.7 Fecal coliform and E. coli levels observed at five sites on five creeks in Santa Clara Valley during July 17, 2012.

Site ID	Creek Name	Site Name	*Fecal Coliform (MPN/100ml)*	*E. Coli (MPN/100ml)*
205COY330	Coyote Creek	Hellyer Park	30	30
205LGA400	Los Gatos Creek	Vasona Park	800	800
205MAT030	Matadero Creek	Bol Park	130	130
205STE064	Stevens Creek	Blackberry Farm	80	80
205COY113	Upper Penitencia Creek	Penitencia Park	300	300

All five creeks monitored for pathogen indicators are designated for both contact (REC-1) and non-contact (REC-2) recreation. Monitoring locations at each creek were selected at city parks or trails that were considered to exhibit high potential for public access. Data collected in 2012 exceeded the trigger threshold for fecal coliform and for E. coli concentrations at one site in Los Gatos Creek (205LGA400). Additional investigations relative to characterizing exposure would be needed to better understand the waterborne pathogen-related risk at all five sites. Public access and exposure risk appear to be very low in the remaining areas for all five creeks.

4.5 CRAM

The individual metric and overall CRAM scores and ranking for twenty sites assessed in Santa Clara County during Water Year 2012 are shown in Table 4.8. CRAM scores ranged from scores of 42-90. Fifty percent of the sites scored excellent or good and the remaining sites scored as fair or poor. The CRAM sampling locations and ranking scores are shown in Figure 4.13.

Table 4.8 Metric and total CRAM scores applied to 20 bioassessment monitoring sites in Santa Clara County in 2012.

Station Code	Buffer	Hydrology	Physical	Biotic	Overall CRAM Score	CRAM Rank
205R00042	91.7	83.3	100.0	83.3	90	Excellent
205R00021	100.0	83.3	75.0	75.0	83	Excellent
205R00259	75.0	83.3	87.5	86.1	83	Excellent
205R00241	75.0	83.3	87.5	83.3	82	Excellent
205R00291	79.2	83.3	100.0	66.7	82	Excellent
205R00218	79.2	75.0	87.5	86.1	82	Excellent
205R00346	83.3	75.0	87.5	77.8	81	Excellent
205R00058	91.7	83.3	75.0	72.2	81	Excellent
205R00026	79.2	75.0	75.0	66.7	74	Good
205R00282	83.3	75.0	50.0	77.8	72	Good
205R00035	50.0	58.3	75.0	80.6	66	Fair
205R00227	70.8	58.3	50.0	69.4	62	Fair
205R00099	66.7	41.7	50.0	77.8	59	Fair
205R00115	29.2	66.7	62.5	66.7	56	Fair
205R00355	25.0	58.3	50.0	61.1	49	Poor
205R00154	66.7	41.7	37.5	47.2	48	Poor
205R00234	50.0	58.3	37.5	44.4	48	Poor
205R00067	37.5	66.7	37.5	47.2	47	Poor
205R00131	66.7	58.3	25.0	33.3	46	Poor
205R00090	54.2	41.7	37.5	33.3	42	Poor

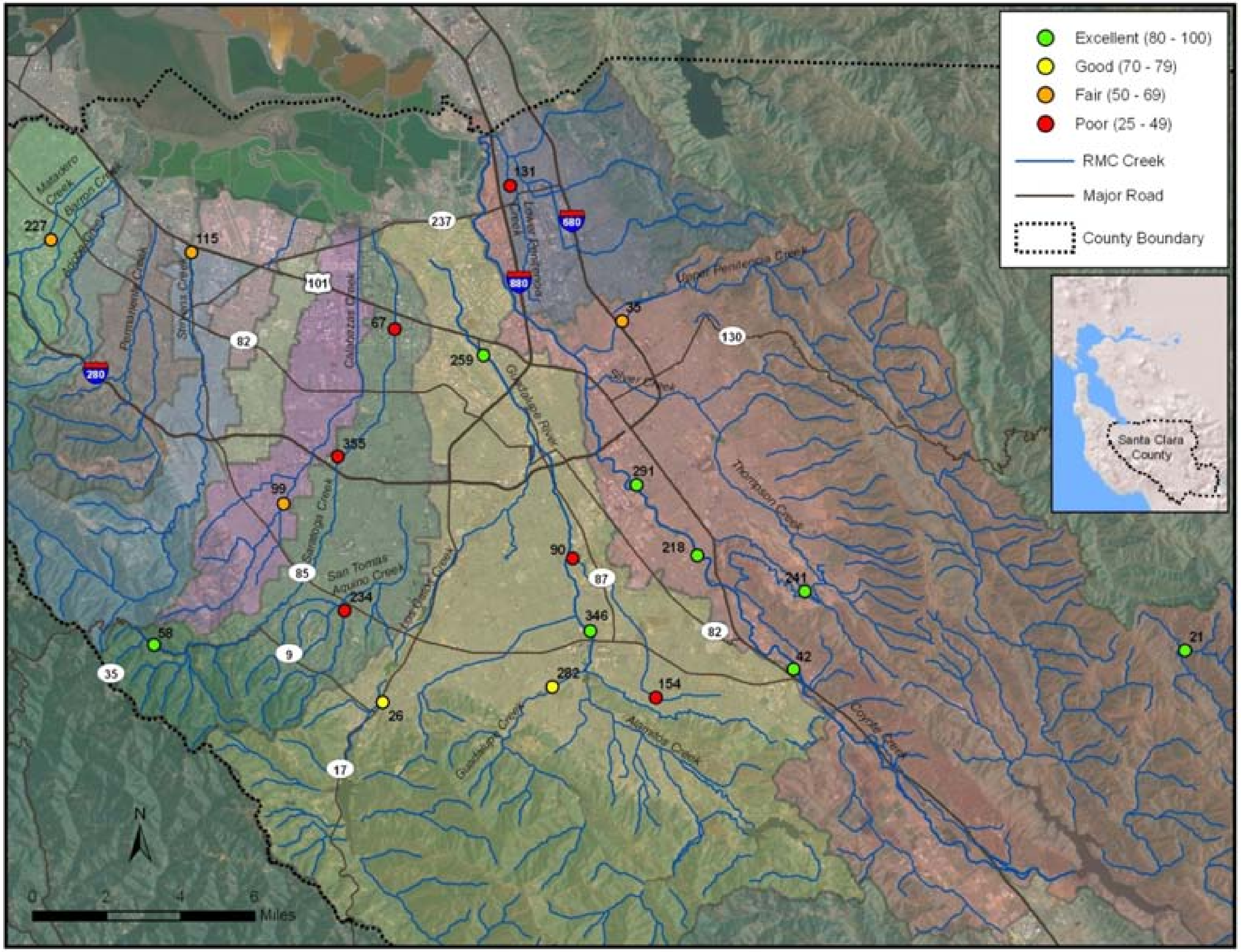

Figure 4.13 CRAM scoring rank for 20 sites assessed in Santa Clara County in 2012.

CRAM assessments were conducted at bioassessment locations to address the following objectives:

- What is the range of conditions of riparian plant community at probabilistic sites?
- Is riparian condition a good indicator for aquatic life use?
- Can CRAM results be useful for identifying potential stressors/sources of aquatic life use condition?

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

CRAM scores were compared to B-IBI scores, calculated using the Southern California IBI (Ode et al. 2005), for twenty bioassessment sites in Santa Clara County. As a population, the CRAM scores were poorly correlated with B-IBI scores ($R^2 = 0.1053$, $p < 0.2$) (Figure 4.14). Similar lack of correlation was found comparing CRAM attribute scores (i.e., riparian buffer, hydrology, physical structure and biotic structure) and B-IBI scores. In general, the riparian assessment condition was generally higher than BMI community condition, indicating that riparian condition is not the primary driver for biological health at many of the sites. The lack of correlation, however, may be due to the small population size and disproportionate number of sites occurring in large creeks. Five of the seven highest CRAM scores (ranging 81 - 90) were in either Coyote Creek or Guadalupe River, which had low B-IBI scores (ranging 10 - 21) (Figure 4.14).

Additional CRAM and BMI data collected across a wider range of sites in Santa Clara Valley watersheds are needed to better evaluate the relationship between riparian and biological condition. Other local data can also be evaluated to the extent possible, such as the CRAM data previously collected by SCVWD in the Coyote Creek and Guadalupe River watersheds as part of the Ecosystem Monitoring & Assessment Framework (EMAF) project (SCVWD 2011).

The Human Disturbance Index (HDI) is the one of the qualitative assessments that is conducted during the PHAB component of each bioassessment. The HDI identifies the range of anthropogenic stressors (e.g., channel structures, buildings, roads, trash, etc.) that are present in the channel and within 50 meters of the channel along the assessment reach. These scores are weighted and summed as a total score. The HDI score for bioassessment sites was moderately correlated (R^2=0.3615, $p < 0.005$) with the CRAM scores for the twenty sites (Figure 4.15). Additional physical habitat measurements taken during bioassessments (e.g., cobble embeddedness, percent fines) did not correlate well with CRAM scores.

The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results should be considered preliminary. Further analysis of existing data and new information is needed before assessing the utility of CRAM data for assessing ecosystem health.

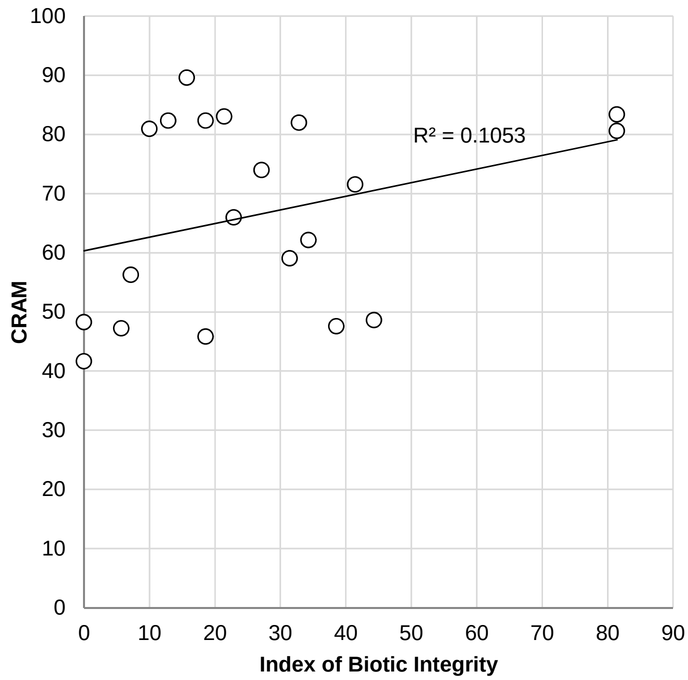

Figure 4.14 CRAM scores plotted with IBI scores for twenty bioassessment sites in Santa Clara County. Solid circles are sites in larger river systems (i.e., Coyote Creek or Guadalupe River).

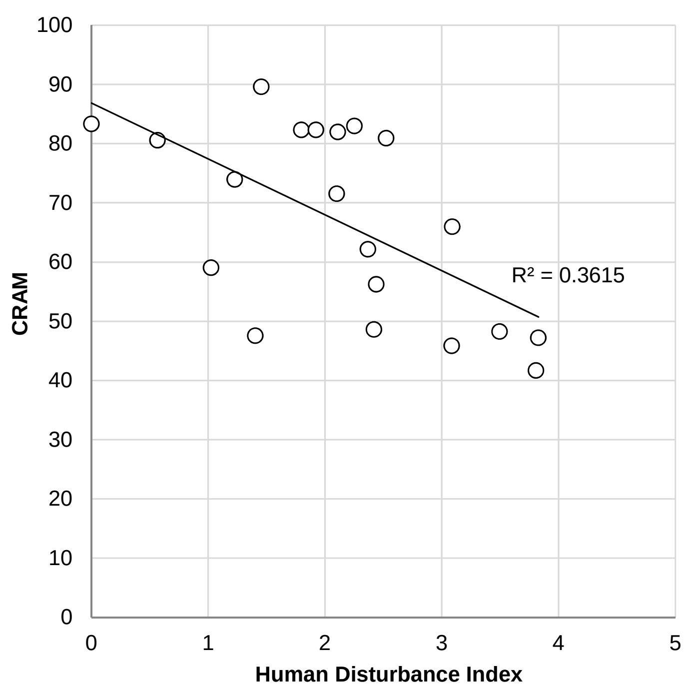

Figure 4.15 CRAM scores plotted with Human Disturbance Index scores for twenty bioassessment sites in Santa Clara County.

5.0 CONCLUSIONS & NEXT STEPS

5.1 Summary of Stressor Results

The following conclusions are based on the management questions presented in Section 2.2 and the evaluation of targeted monitoring data results with respect to triggers as defined in Table 3.2 (page 19):

Spatial and Temporal Variability of Water Quality Conditions

- Temperature data collected in Water Year 2012 was inversely correlated with elevation across sites in both Upper Penitencia and Saratoga Creeks. The lowest elevation sites for both creeks were located in an urbanized reach on the valley floor and downstream of an outfall for imported water releases managed for groundwater percolation. The Upper Penitencia Creek sites in Alum Rock Park showed both spatial and temporal variability, which was likely correlated with progressively reduced stream flows over the summer season.

- Dissolved oxygen concentrations at the Watson Park site on Coyote Creek were lower (median < 3.0 mg/l) compared to sites directly upstream (Williams) and downstream (Flea Market) (median > 5.0 mg/l). The patterns in DO levels were consistent between the spring and summer sampling events.

Potential Impacts to Aquatic Life

- There were no or limited exceedences of the Mean Weekly Average Temperature (MWAT) threshold at the two upper elevation sites in Upper Penitencia Creek, suggesting that temperatures are present at levels needed to support juvenile steelhead at these reaches. The MWAT threshold was never exceeded in the upper two elevation sites in Saratoga Creek; however, existing information suggests these sites are located downstream of the primary spawning and rearing habitat areas for rainbow trout.

- The downstream site on Upper Penitencia Creek within Alum Rock Park (205COY130) exceeded the MWAT threshold trigger 26% of the time. Although steelhead spawning and rearing habitat is supported in Alum Rock Park, limiting factors analyses previously conducted by the program indicate that low summer flow and food availability are likely more important factors affecting steelhead production than periodic high temperatures.

- Temperature data results exceeded trigger thresholds (61 - 91% of the time) at the lowest elevation site in both Upper Penitencia and Saratoga Creeks. However, these results are do not appear to be a high priority concern since existing information suggests that juvenile steelhead spawning and rearing habitat is not supported at either site.

- Dissolved oxygen concentrations at all three sites monitored in Coyote Creek exceeded trigger thresholds for COLD habitat use (81%-100% of the time). However, existing information indicates the mid-Coyote Creek reach does not support juvenile steelhead spawning and rearing habitat, but does support upstream and downstream migration use. Therefore, further evaluation of water quality data in the context of steelhead migration should be conducted.

- Dissolved oxygen data collected at Watson Park (site 205COY330) in Water Year 2012 confirmed that low DO at this site appears to be a water quality concern. Additionally, based on the initial analyses conducted by the Program and described in the Program's *Interim Monitoring Project Report* (see Appendices C1 and C2 of the RMC Water Year 2012 Urban Creeks Monitoring Report), existing information suggests that low gradient deep water habitat in this reach acts as a depositional zone, trapping organic material that results in a high biological oxygen demand.[9]

- Values for pH were within Water Quality Objectives at Coyote Creek sites monitored in Water Year 2012.

Potential Impacts to Water Contact Recreation

- Pathogen indicator results were greater than threshold triggers for fecal coliform and for *E. coli* at site 205LGA400 (Vasona Park). However, applying thresholds that were based on human recreation at beaches receiving bacteriological contamination for human wastewater (see section 3.4.4) may not be applicable to conditions found in urban creeks. As a result, the comparison of pathogen indicator results to water quality objectives and criteria for full body contact recreation, may not be appropriate and should be interpreted cautiously.

Riparian Condition Assessment

- Riparian assessment (i.e., CRAM) results were not well correlated with biological condition (i.e., B-IBI scores) for the twenty bioassessment sites monitored in Water Year 2012. However, these results may have been influenced by a small sample size and the fact that a disproportionate number of monitoring sites in Water Year 2012 occurred in larger riverine systems that have intact and diverse riparian habitat (i.e., high CRAM scores), but provide poor habitat for BMI communities (i.e., low B-IB scores).
- Human Disturbance Index (HDI) scores measured during bioassessments were moderately correlated with CRAM scores, suggesting that CRAM and HDI may provide similar information at a macro level.
- The application of CRAM in urban creeks of the San Francisco Bay Region is relatively recent and results and conclusions should be considered preliminary. Further analysis of existing data and new information is needed before assessing the use of CRAM data in causal analyses that attempt to explain the stressors governing biological condition scores.

5.2 Next Steps

The following next steps are planned for monitoring in Water Year 2013:

Temperature

- As part of MRP creek status monitoring in Water Year 2013, continue monitoring temperature at subset of locations in Upper Penitencia Creek that were sampled in Water Year 2012. Continued monitoring at these sites will assist the Program in evaluating inter-annual variability of temperatures at these sites, and provide a more robust dataset to evaluate whether temperatures appear to impacting beneficial uses.

[9] The Program is in the process of making a determination of whether municipal stormwater discharges are causing or contributing to low dissolved oxygen in this reach of Coyote Creek. Through this process, hypotheses are currently under development and will be tested in accordance with timeline described in Appendix C2 of the RMC Water Year 2012 Urban Creeks Monitoring Report.

Dissolved Oxygen

- As part of MRP creek status monitoring in Water Year 2013, continue investigating low dissolved oxygen concentrations in the reach of Coyote Creek near Watson Park. The Program plans to conduct this monitoring in coordination with the ongoing stressor/source identification project underway.

Pathogen Indicators

- As part of selecting stressor/source identification projects in Water Year 2013, evaluate Water Year 2012 pathogen indicator results within the context of other creek status monitoring data collected locally and regionally.

Riparian Assessments

- As part of MRP creek status monitoring in Water Year 2013 and in coordination with the Santa Clara Valley Water District's Environmental Monitoring and Assessment Program (EMAP), conduct riparian assessments using the CRAM methodology at all Water Year 2013 bioassessment locations. Additional CRAM data will provide information that can be used in the continued assessment of the biological condition of Santa Clara Valley creeks and the conditions associated with physical habitat at these sites.

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Appendix C

Stressor/Source Identification Project Reports (Provision C.8.d.i)

C1 - Interim Monitoring Project Report - Coyote Creek

C2 - Letter to Water Board Staff from SCVURPPP on Stressor/Source ID Project Next Steps and Time Schedule

C3 - Interim Monitoring Project Report – Guadalupe River

C1

Interim Monitoring Project Report - Coyote Creek

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Interim Monitoring Project Report

Stressor/Source Identification Project (Coyote Creek)

Conducted in compliance with Provision C.8.d(i) of Order R2-2009-0074

September 15, 2012

EOA inc.

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1.0 INTRODUCTION

This project was conducted in compliance with provision C.8.d(i) of the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074). This MRP provision requires Permittees to conduct monitoring projects to identify and isolate the sources and/or stressors associated with potential water quality impacts. Permittees are complying with this requirement via Program-led monitoring in coordination with the Bay Area Stormwater Management Agencies Association's (BASMAA) Regional Monitoring Coalition (RMC).[1] This interim report serves as a demonstration of progress made toward complying with Provision C.8.d (i). The project was included and is consistent with monitoring tasks described in the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) Fiscal Year 10-11 and 11-12 Work Plans.

The Coyote Creek Stressor/Source Identification Project was triggered by creek status/condition data previously collected by the Program and Permittees that suggested that urban sections of Coyote Creek have reduced biological integrity and poor water quality conditions, specifically related to low dissolved oxygen. This monitoring project was intended to answer the following questions related to water quality, with a focus on dissolved oxygen concentrations in Coyote Creek mainstem during late summer season:

1. What is the temporal and diurnal variability of dissolved oxygen concentrations?
2. Are there water quality impacts following the first rainfall event of the season?
3. Do monitoring results inform us in identifying and prioritizing potential stressors or sources?

The monitoring project was implemented by the Program, City of San José and Santa Clara Valley Water District (SCVWD) beginning late summer through fall of 2010.

1.1 Background

Previous water quality studies and biological assessments conducted in the Coyote Creek mainstem suggest that both fish and benthic macroinvertebrate communities are in relatively poor condition in selected urban reaches of Coyote Creek. The SCVWD conducted water quality and fisheries monitoring during the summer season from 2007 to 2009 in Coyote Creek watershed to obtain pre-project baseline data for the Mid-Coyote Flood Protection Project (SCVWD 2008, 2009). Fish abundance was highly variable between the 22 sites sampled in 2007 and 2008 (Figure 1-1). Low abundance of native fish and high abundance of non-native fish were characteristic of SCVWD sample sites 9 – 13, which correspond to a section of Coyote Creek between Mabury Road and Interstate 280. Native fish become much more abundant at sites located in the Coyote Creek mainstem downstream of Lower Silver Creek and Upper Penitencia Creeks.

[1] All water quality monitoring activities required by Provision C.8 are coordinated regionally through the BASMAA Regional Monitoring Coalition (RMC). In a November 2, 2010 letter to Permittees, the Water Board's Assistant Executive Officer (Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through the RMC.

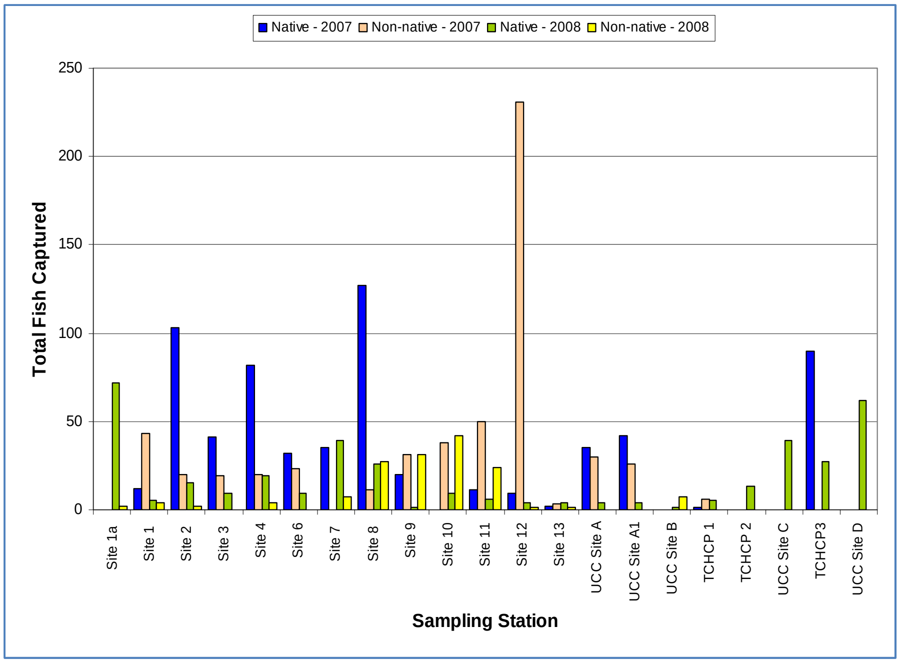

Figure 1. Fish abundance recorded at 22 sites in Coyote Creek during the summer of 2007 and 2008 (SCVWD).

The Program conducted benthic macroinvertebrate bioassessments in Coyote Creek during 2007 and 2008. Benthic Index for Biological Integrity (B-IBI) scores for 13 bioassessment sites assessed during 2008 is shown in Figure 2. B-IBI scores for the six lowest elevation sites on Coyote Creek (between Montague Expressway and Kelley Park) were all ranked in “poor” category. The IBI scores typically increased with increasing elevation, with the exception of sites COY240 and COY250, which had lower scores than the three sites directly downstream (Figure 2). These sites were located at William Street Park and Kelley Park.

The City of San Jose, as part of the Stream Augmentation Project, collected monthly water samples at several stream locations between May and October during 2000 and 2001 (San Jose 2000, 2001). Monitoring results showed that dissolved oxygen concentrations at selected locations during summer months were relatively low. Mean DO concentrations for both years showed DO concentrations were below 5 mg/L at three sites; Municipal Golf Course and Upper and Lower Watson Park Sites.

The Program collected continuous general water quality data in Coyote Creek during 1999 as part of the Stormwater Environmental Indicator Demonstration Project (SEIDP) (SCVURPPP 1999). Water temperature, dissolved oxygen, pH, and conductivity were continuously measured between June and September 1999 at five locations in Coyote Creek mainstem. Mean daily dissolved oxygen concentrations recorded at four of the five monitoring stations[2] during the sampling period are shown in Figure 3. Station 1, located approximately one mile upstream of Kelley Park, was the only station among the SEIDP monitoring sites that had a mean daily DO concentration below 5 mg/L.

[2] DO probe malfunctioned at Station 4 and as a result, data was not shown in Figure 1 for this station.

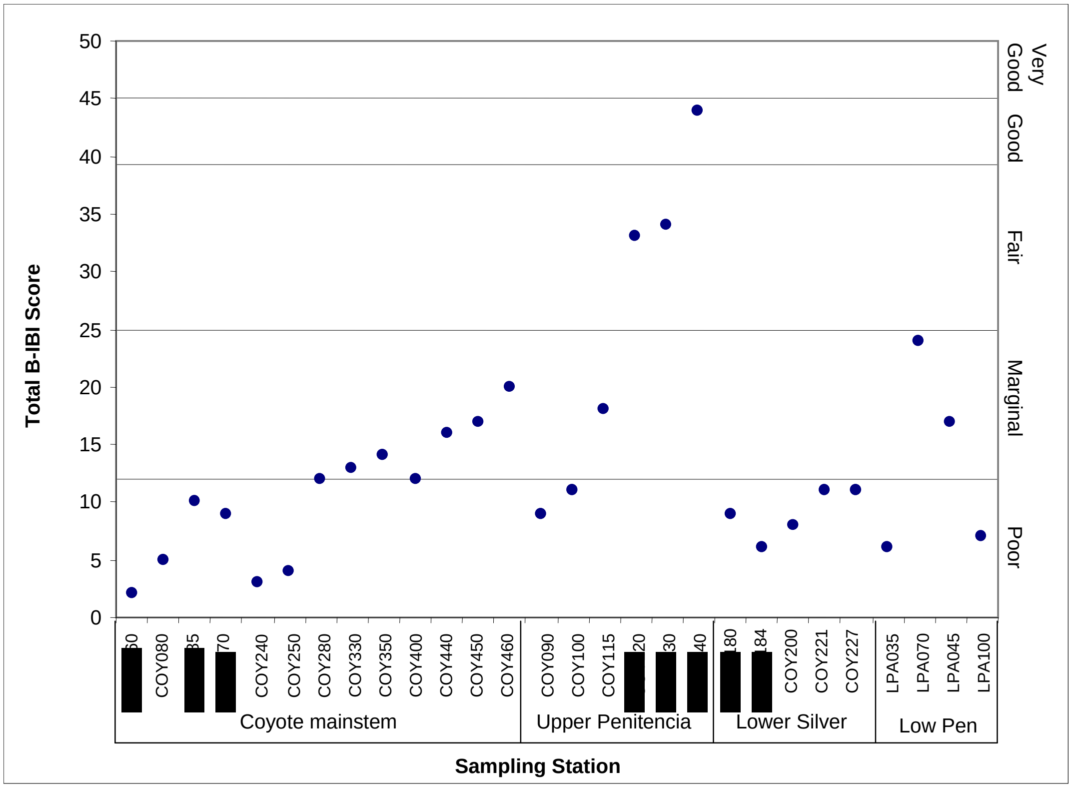

Figure 2. Benthic Index of Biotic Integrity (B-IBI) scores for sites in Coyote Creek and Lower Penitencia Creek watersheds (SCVURPPP 2008).

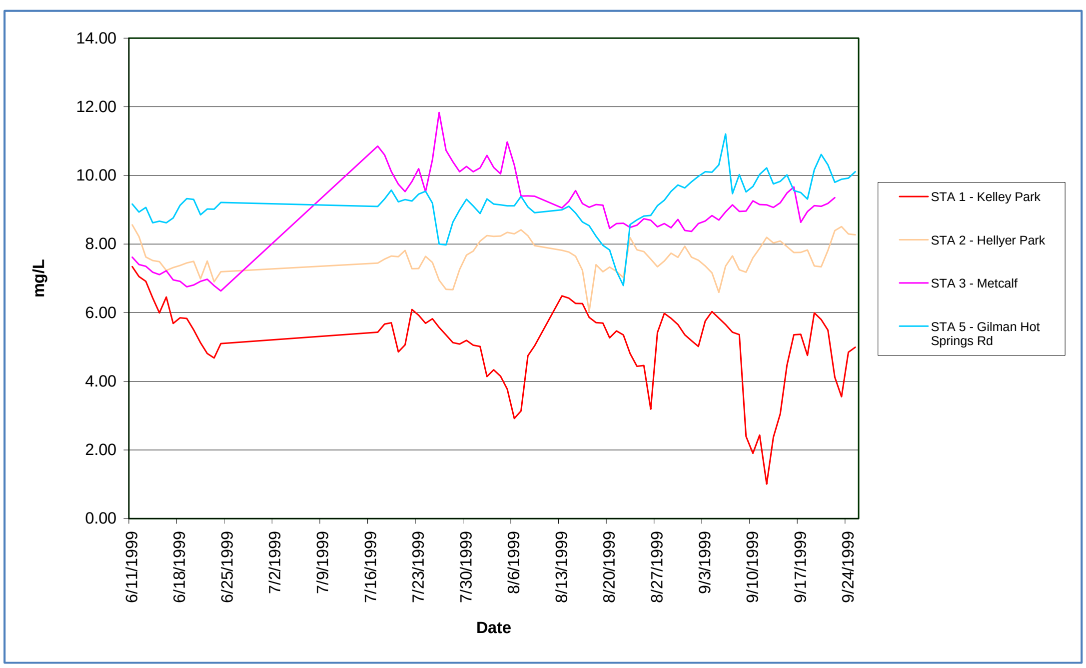

Figure 3. Daily mean dissolved oxygen concentrations measured at five stations in Coyote Creek mainstem from June to September 1999 (SCVURPPP 1999).

2.0 METHODS

The Program, City of San Jose and SCVWD coordinated continuous water quality monitoring field activities and equipment calibration, while water quality data were retrieved, compiled and summarized by Program staff.

2.1 Sample Sites and Study Area

Each program/agency deployed and retrieved continuous monitoring equipment at three stream locations for a total of nine monitoring sites. Specific locations for equipment deployment were identified during field reconnaissance conducted on July 2, 2010. The name and location of the selected monitoring sites, land use characteristics and the agency responsible for conducting the monitoring are provided in Table , ordered from downstream to upstream (south to north). Monitoring locations are also shown in Figure .

Table 1. Monitoring site locations and agencies leading monitoring.

Site Name	Location	Land Use	Responsible Agency
Montague	Montague Expressway	Urban	SCVURPPP
O'Toole	O'Toole Ave	Urban	SCVURPPP
Flea Market	San Jose Flea Market upstream Upper Penitencia Creek confluence	Urban	SCVURPPP
Watson	Watson Park upstream Lower Silver Creek confluence	Urban	San Jose
Williams	Coyote Classroom site downstream Williams Street Park	Urban	San Jose
Kelley	Kelley Park	Urban	San Jose
Hellyer	Hellyer County Park near Velodrome	Rural	SCVWD
Silver Creek	Silver Creek Valley Rd	Rural	SCVWD
Metcalf	South of Metcalf Rd near PG&E substation	Rural	SCVWD

The three upstream sites, Metcalf, Silver Creek and Hellyer have adjacent land uses that are predominately rural while the remaining sites receiving drainage from predominantly urban land uses. There are three tributaries to the Coyote Creek mainstem within the study area, these include: 1) Upper Silver Creek (5.5 square mile drainage area) confluence is about 1 miles downstream of the Hellyer site; 2) Lower Silver Creek (43.4 square mile area) confluence is located just downstream of the Watson site; and 3) Upper Penitencia Creek (23.4 square mile area) confluence is just downstream the Flea Market site. The Metcalf percolation ponds are located just downstream the Metcalf site. Additionally, two reservoirs, Anderson and Coyote Reservoirs, are located on Coyote mainstem upstream of the study area.

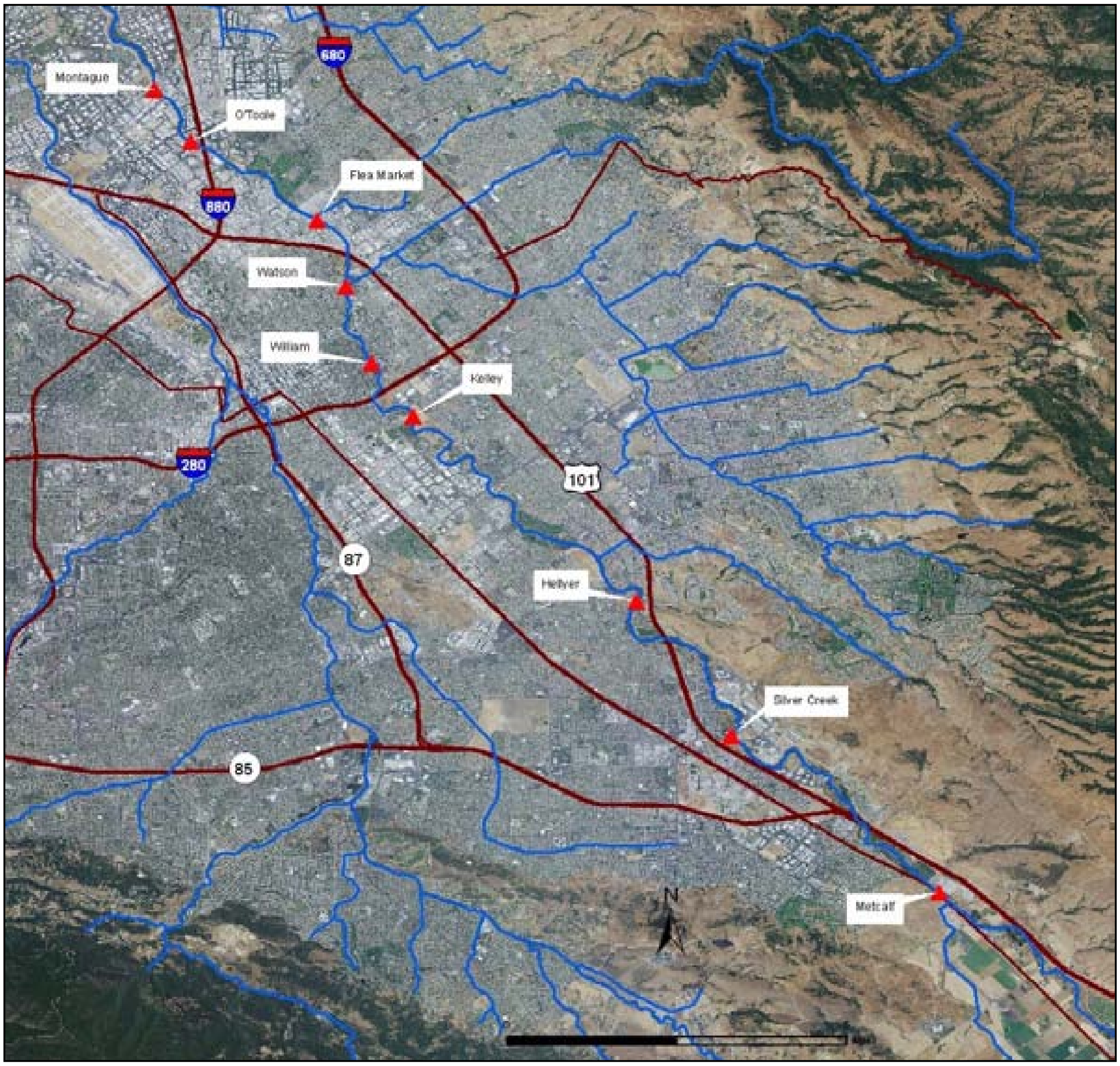

Figure 4. Monitoring site locations in Coyote Creek.

2.2 Sample Timing and Frequency

Continuous monitoring equipment was deployed during three events, each for an approximately 2-week period. The first two sampling events occurred during the dry season and the third event occurred during the first rainfall event of the season (Table 2). For this study, the definition used for the targeted rainfall event was a storm predicted to result in at least 0.25 inches of rain in a 24-hour period. As a result, monitoring equipment was not deployed during a smaller rain event (< 0.1 inches) that occurred about 3 days prior to the targeted rainfall event. Two storm events, including the targeted event, occurred during the wet season monitoring event (Figure 5). Rainfall data was retrieved from the ALERT (Automated Local Evaluation in Real Time) system rain gauge located at Downtown San Jose (Station #131) that is operated by the SCVWD.

Table 2. Monitoring and rain event timing and duration.

Event	Start Date	End Date	Duration
1 (Dry)	August 11, 2010	August 24, 2010	14 days
2 (Dry)	September 8, 2010	September 22, 2010	15 days
3 (Wet)	October 20, 2010	November 5, 2010	17 days

Though the small rain event prior to Event 3 only lasted two hours, it had a major impact on Coyote Creek's discharge, which was collected from the United States Geological Survey (USGS) flow gauge on Coyote Creek at Highway 237. Figure 2-2 shows the mean daily discharge at Highway 237, downstream of all the sample sites, and total daily rainfall for the entire study period. The three sampling events are also included in the figure.

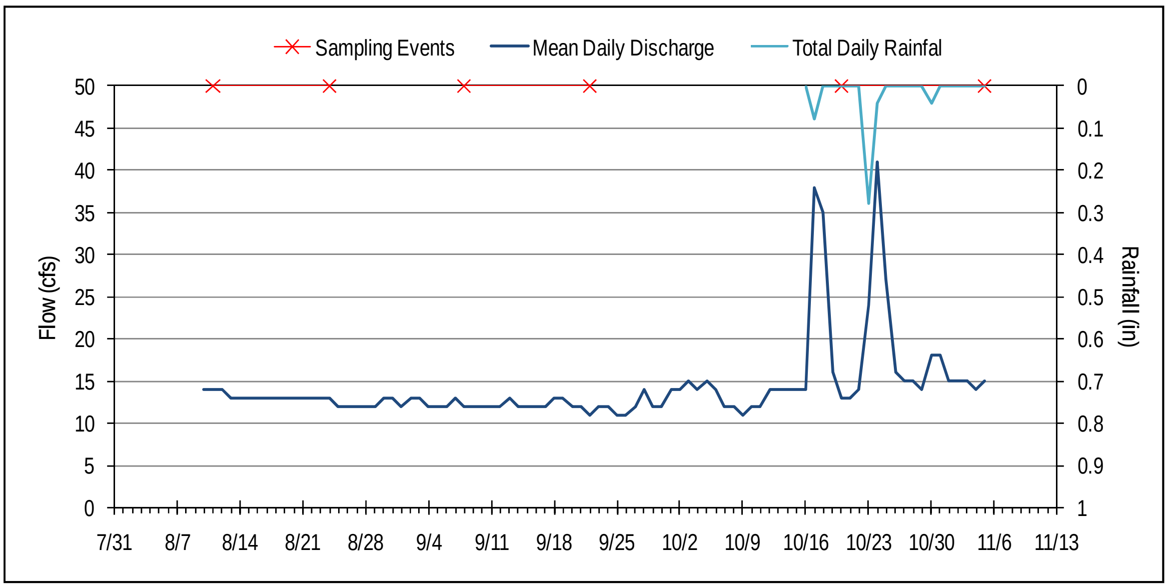

Figure 5. Mean daily discharge in Coyote Creek at Highway 237, total rainfall at Downtown San Jose, and start and end dates for three sampling events.

2.3 Monitoring Equipment and Methods

Multi-probe water quality data sondes (YSI 6600 V2) were utilized during this study at all sites. Sondes were programmed to collect temperature, dissolved oxygen (DO), specific conductivity, pH and turbidity at 15-minute intervals. Turbidity was not measured at some of the sites during each of the monitoring events due to changes in the availability of monitoring equipment over the course of the study. The distribution of turbidity sensors among the nine sites is shown in Table 3.

Table 3. Monitoring sites where turbidity measurements were collected.

	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Event 1	X	X	X	X	X	X		X	X
Event 2	X	X	X	X	X	X		X	X
Event 3	X		X	X	X	X			X

At each monitoring site, the deployment location was established to limit access and visibility of equipment to reduce potential for vandalism or theft. Sites were selected to ensure that sondes were continually submerged during any anticipated change in flow stage. Sondes were attached to metal cages – constructed with heavy gage 3/8 inch metal tubing – with weights attached to the base (Figure 6). The sonde is attached to the metal cage using hose clamps. The metal cage can be placed in deepest part of the channel and anchored to a fixed location on the bank (e.g., tree) using stainless steel cables and key locks. The cage protects the equipment and keeps sensors about 6 inches off the stream bottom to reduce potential for fouling by fine sediment.

Figure 6. Water quality data sonde secured to a metal cage used during monitoring.

During the third sampling event, metal cages were unavailable at two of the sites and an alternative deployment method was applied. Monitoring equipment was placed inside a section of 4-inch diameter PVC pipe modified with holes to allow water to flow around the probes. Screw caps containing eyebolts were secured at each end. Steel cables and key locks were used to attach the PVC pipe (at eyebolt) to a fixed location on the bank, which was either an existing tree or metal rebar pounded into streambed. PVC tubing was secured about one foot above streambed elevation.

Prior to installation, the sondes were programmed and the transport/calibration cup was then replaced with the probe guard. Water quality grab samples were collected prior to deployment and recorded on field sheets. Channel dimensions and other relevant sampling event information were recorded on the standard field sheet during installation.

2.4 Sampling Protocols

The Program coordinated with the City of San Jose and the SCVWD on the timing of each sampling event through email communication and conference calls. The pre-event sampling preparation included the calibration of all sensors, programming of monitoring equipment, and preparing water quality sampling gear and field data forms. Post sampling protocol included cleaning equipment, downloading data from sondes to a computer, calibrating all sensors, and proper transportation and storage of equipment in a secure location.

2.5 Data Quality Assurance and Quality Control

All sondes were calibrated at the City of San Jose's Department of Environmental Science Department Laboratory or SCVWD's laboratory within 12 hours of deployment and retrieval. Calibration followed Standard Operating Procedures (SOPs) and results were recorded on the Calibration Worksheet, included in Appendix A. All Calibration Worksheets were compiled in a single binder and entered into a database, both maintained by the Program.

During calibration, both temperature and barometric pressure were measured and recorded. Dissolved oxygen and specific conductivity were calibrated using a one-point calibration, while pH and turbidity were calibrated using a two-point calibration. The standard solution used for specific conductivity was 1.409 microSiemens per centimeter ($\mu S \cdot cm^{-1}$) for the first event and 1.413 $\mu S \cdot cm^{-1}$ for the second and third event. The pH sensors were calibrated using a ph 7.0 buffer solution followed by a pH 10.0 buffer solution, while turbidity was calibrated for 0 NTU (nephelometric turbidity units) followed by a 126 NTU standard solution.

Dissolved oxygen, conductivity and turbidity calibration results were checked for drift via relative percent error shown in Equation 1.

$$RPE = \frac{(y - x)}{x} \times 100$$

RPE = relative percent error
y = post-deployment measurement
x = pre-deployment measurement

In accordance with YSI 6600 V2 Multiprobe Sondes Standard Operating Procedures, acceptable error was considered less than 10%. For pH, calibrations within 0.3 pH units were considered acceptable. During the study, only one dissolved oxygen sensor had calibration errors and none of the RPEs exceeded the threshold. The one malfunctioning sensor was serviced by YSI technicians. Calibrations results are provided in Appendix A.

3.0 RESULTS AND DISCUSSION

Summary results for temperature, dissolved oxygen, pH, specific conductivity and turbidity measurements collected during the three monitoring events are presented in this section. Discussion of the results for each parameter are provided below, specifically with regards to spatial and temporal (both diurnal and seasonal) variability, potential impacts to water quality associated with first rainfall event of the season, and potential sources for poor water quality conditions. Summary statistics for water quality parameter measurements are included in Appendix C.

3.1 Temperature

Water temperatures for the three monitoring events at each of the nine sites are plotted in Figure 7. The daily maximum and minimum air temperatures and the hourly rainfall totals are also included in the figure. Results show that water temperature had similar trends as the minimum daily air temperature. The distribution of water temperature measurements for each site is shown as box plots in Figure 8.

Median water temperatures were lowest at the three middle elevation sites (Watson, Williams and Kelley) during both summer sampling events, although differences were minimal (less than 2.5 degrees). Median water temperatures were relatively similar across sites during the wet season event. The range of temperatures was greatest at the Silver Creek site and smallest at the Watson site. Water temperature decreased over the study period, with the highest temperatures recorded during the first event in August and the lowest temperatures during the third event in late October.

Figure 9 shows the diurnal pattern of water temperature during Event 1. The diurnal patterns are relatively consistent across sites, with the exception of the Flea Market site (green line in the graph). The water temperature at the Flea Market site peaks in the early morning and drops in the afternoon. In contrast, the other eight sites peak in the early evening and then drop in the morning. This phase shift at Flea Market site was seen for all three monitoring events. Diurnal variability is reduced during the wet season event at most sites.

Physical characteristics have likely had a large influence on the water temperatures observed at the study sites. For example, water depth (i.e., depth of sonde placement) may be an important factor affecting water temperatures. Additionally, the density of riparian canopy cover can affect the level of exposure from solar irradiation. Turbidity concentrations can also affect the penetration of solar irradiation at the site. Water depths, canopy cover and turbidity concentrations are typically higher at urban sites (note: this assessment is based on visual observations and not actual measurements). The urban sites furthest downstream also had higher temperatures compared to upstream sites, which may be influenced from the input of warmer water associated with Lower Silver Creek.

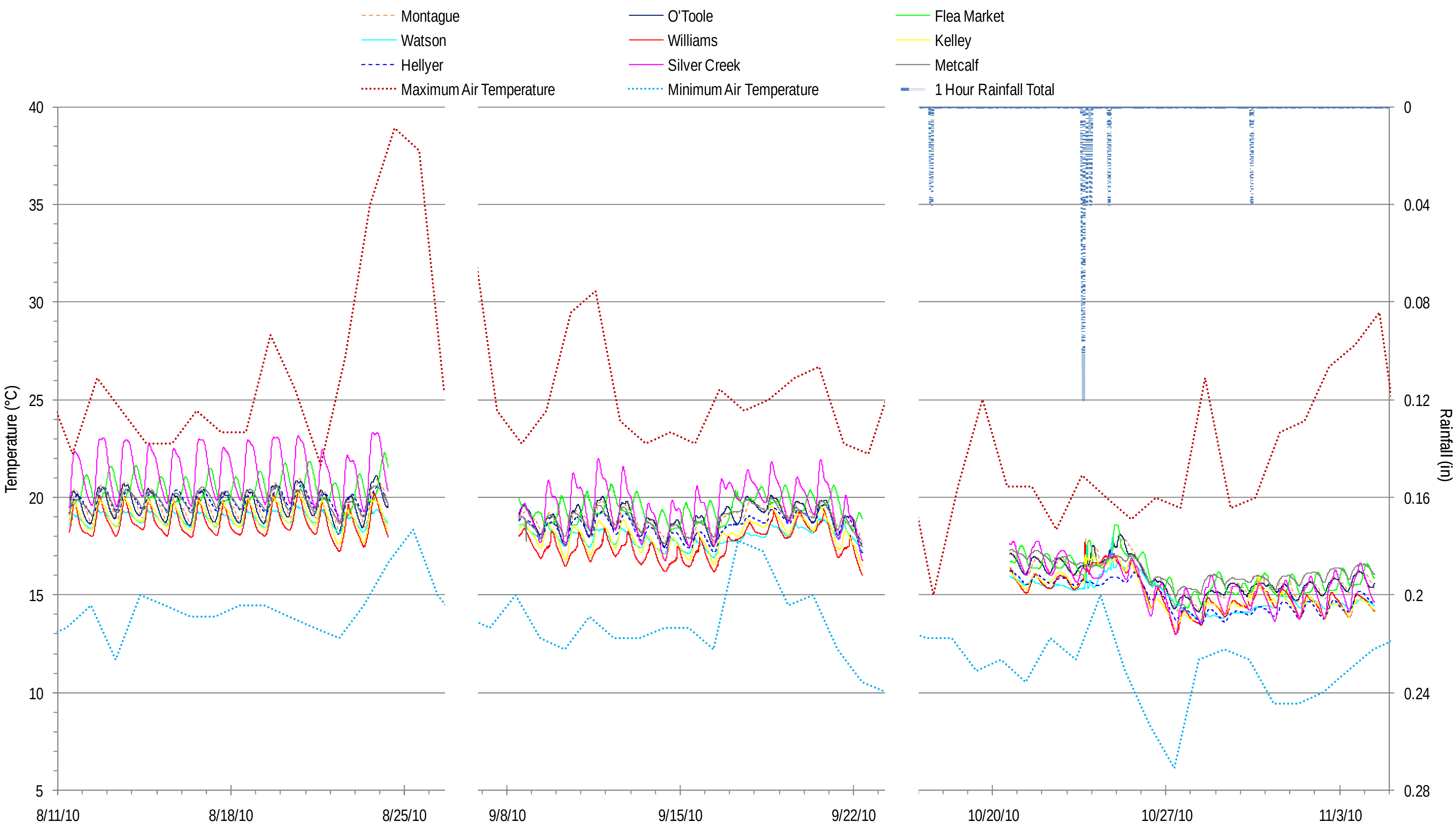

Figure 7. Water temperature measurements collected at the nine stations during three sampling events in 2010. Daily minimum and maximum air temperatures and 1-hour rainfall totals in the general geographical area are also shown.

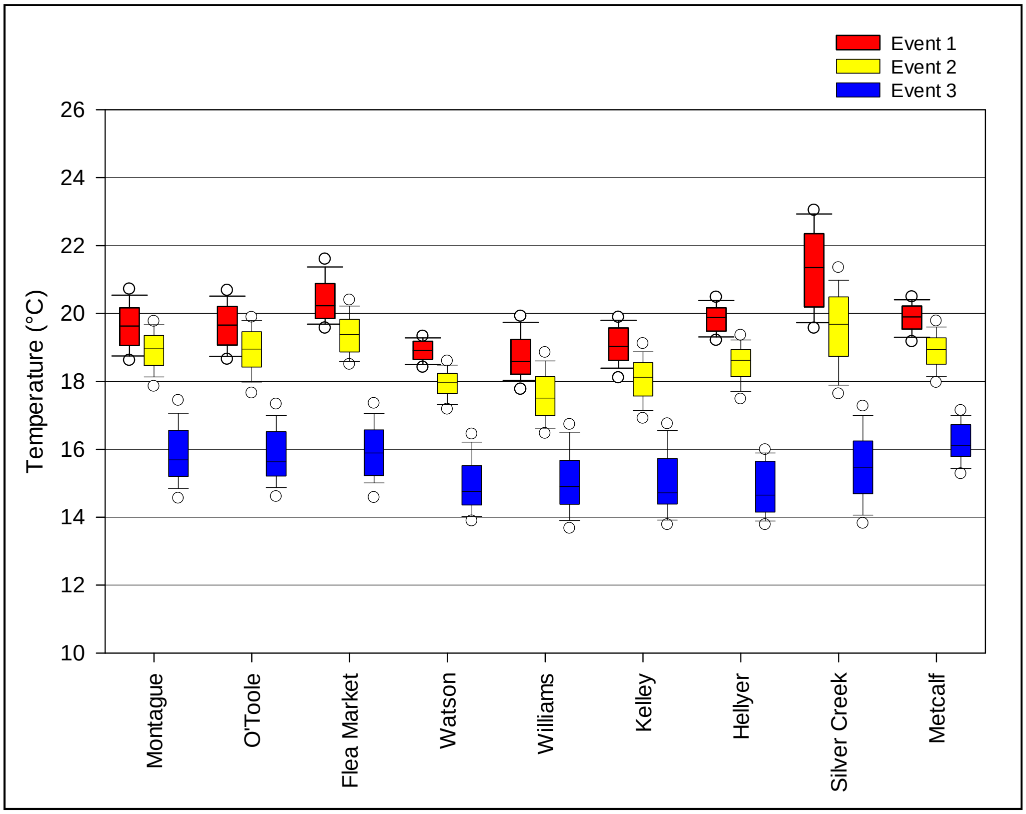

Figure 8. Box plots of water temperature measurements collected at nine sites during all three sampling events. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

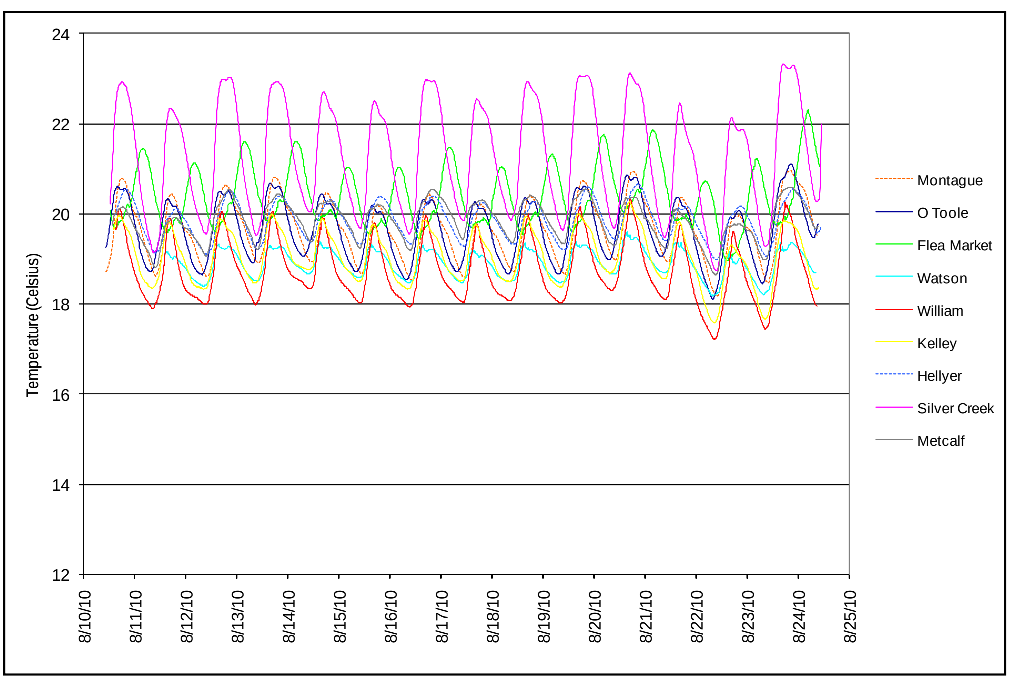

Figure 9. Diurnal pattern of water temperature data recorded at nine sites during Event 1.

3.2 Dissolved Oxygen

The dissolved oxygen (DO) concentrations for the three monitoring events at each of the nine sites[3] are shown in Figure 10. Hourly rainfall totals during the wet season sampling event are also presented in the figure. Over the course of the study, DO concentrations were highly variable across sites and over time, especially between the dry and wet season sampling events. The diurnal pattern of DO concentrations was relatively consistent during the dry season sampling events. In contrast, the wet season event showed large fluctuations in DO at a majority of sites in response to a series of small rainfall events.

The distribution of dissolved oxygen concentrations for each site during the three sampling events are presented as box plots in Figure 11. The water quality objectives listed in the Basin Plan (Water Board 1995) for both warm and cold freshwater habitat, 5 and 7 mg/L, respectively, are also illustrated in the figure. The entire range of DO measurements recorded at the Watson site was below 5 mg/L and the median DO at three sites (Flea Market, Williams and Kelley) was below 7 mg/L for all three sampling events. Median DO concentrations were variable across the sites, with the lowest levels occurring at the Watson site (2.2–3.3 mg/L), moderate concentrations at the Flea Market, Williams and Kelley sites (5.3–6.1 mg/L), and the highest levels occurring at the remaining sites at the upper and lower ends of the study area (6.8–9.1 mg/L) (see Appendix B).

The dissolved oxygen concentrations during the dry season events followed a diurnal pattern similar to water temperature for most sites, with peaks occurring in the middle of the day and valleys occurring in the early morning hours (Figure 12). The diurnal pattern of DO was slightly different at the Flea Market site with peaks occurring around midnight and valleys during the late morning hours. The Watson site also exhibited a slightly different diurnal pattern compared to other sites, with highs and lows occurring about 3 hours earlier than Flea Market site. There was a notable spike in DO at the Hellyer site during Event 2, which may be explained by supersaturation caused by high photosynthetic activity.

The rainfall events had a varied effect on DO concentrations depending upon the location of the site. A decline in DO levels was observed at the four middle sites (Flea Market, Watson, William, and Kelley) following the three rain events that occurred before and during the wet season sampling event. The biggest drop in DO concentration (0-2 mg/L) occurred at the Watson and Flea Market sites following a small rainfall event (< .10 inch) that occurred prior to the wet season event. Following each rainfall event at the four middle sites, DO concentrations initially increased, sharply declined over the next 1-2 days, and then recovered to pre-event levels over the course of 4-5 days. The three upper, rural sites (Metcalf, Silver Creek and Hellyer) had smaller declines following the rain events with minimal changes to the diurnal variation.

[3] Dissolved oxygen was not measured at the Silver Creek site during the second event due to a malfunction of the DO sensor.

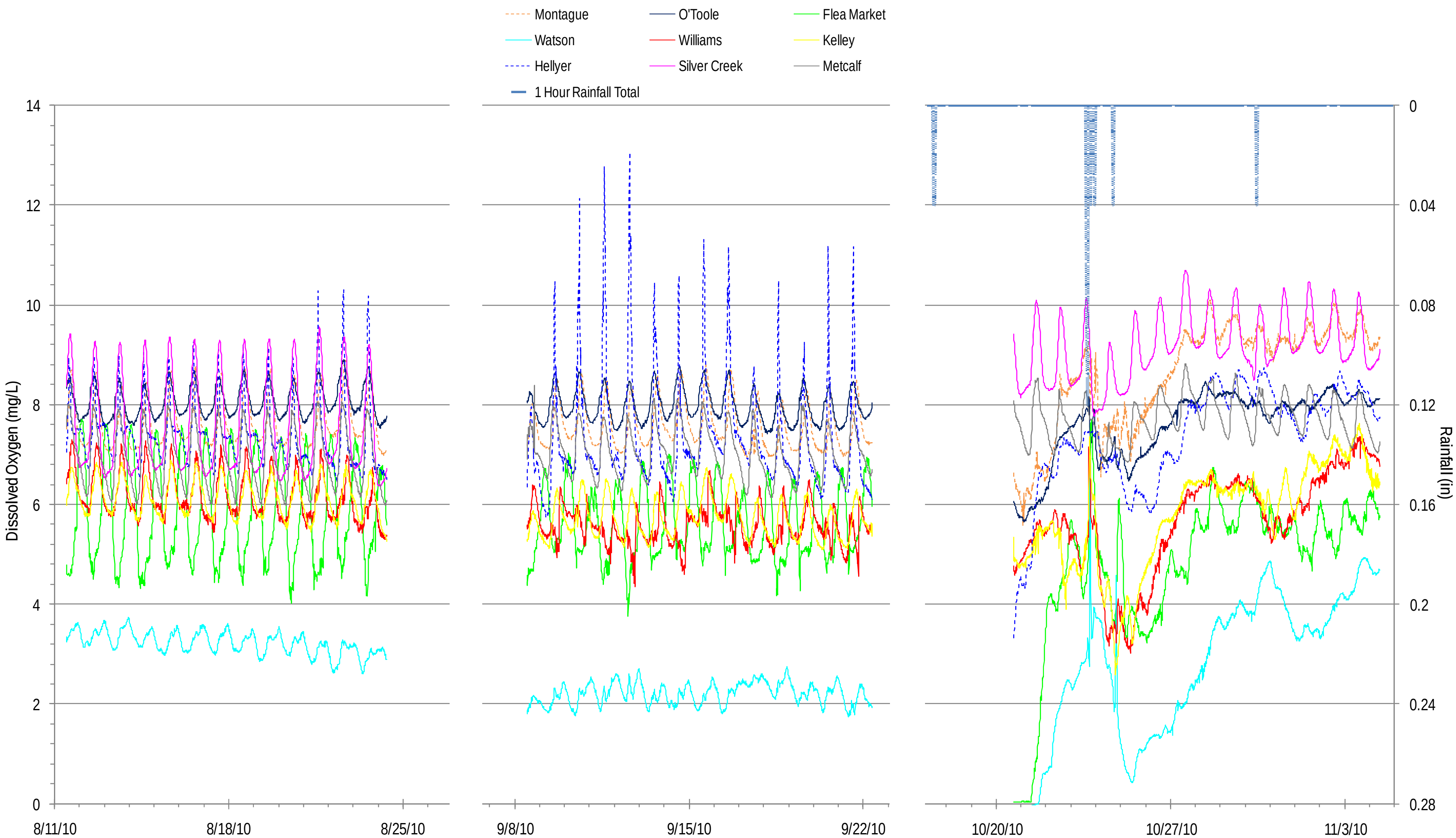

Figure 10. Dissolved oxygen concentrations measured at nine locations in Coyote Creek during three sampling events. The 1-hour rainfall totals in the general geographical area are also shown.

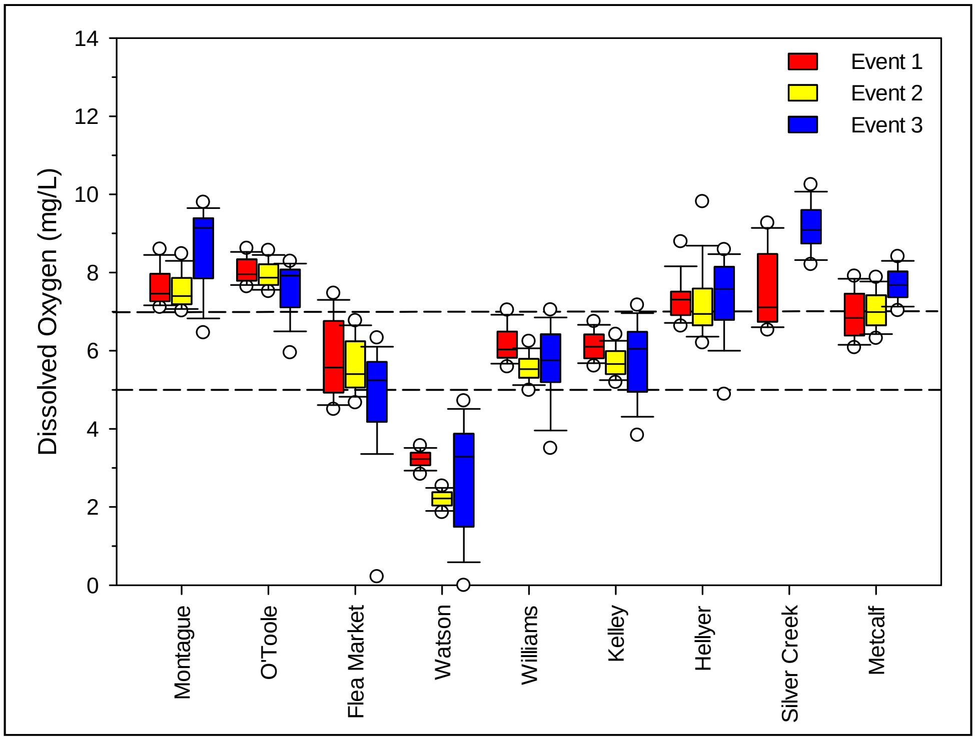

Figure 11. Box plots of dissolved oxygen concentrations at nine sites during all three sampling events. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

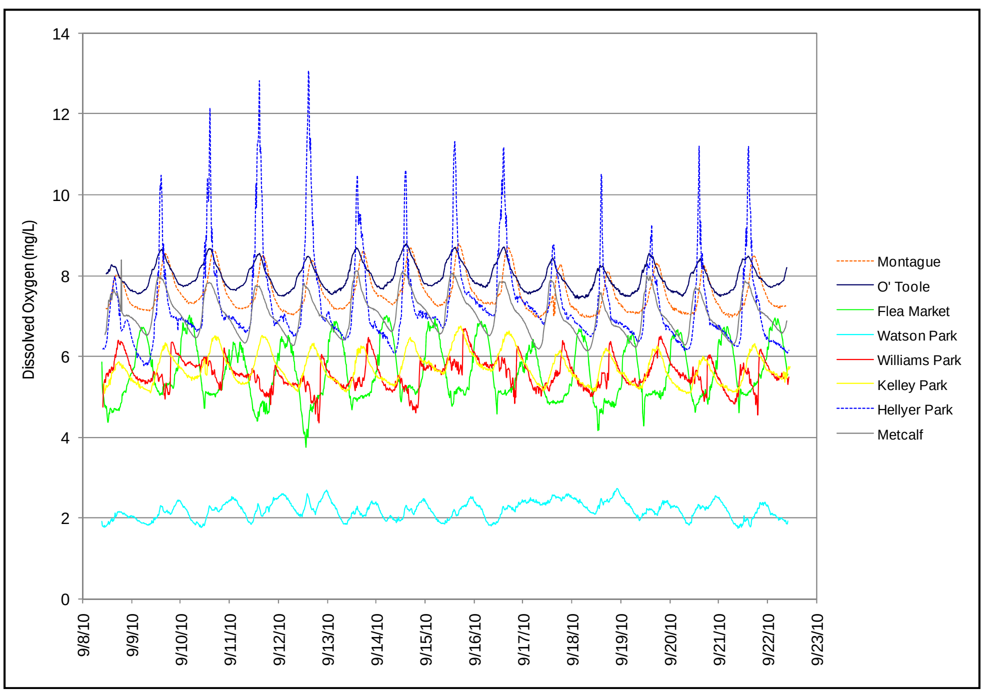

Figure 12. Diurnal patterns of dissolved oxygen concentrations recorded at nine sites during Event 2.

In Figure 13, mean water temperature is plotted with mean DO concentrations (percent saturation) at the nine sampling locations for the combined two dry season events. In the absence of other factors, DO is expected to be inversely proportional to temperature; however, total oxygen saturation and water temperature appear to follow the same trend across sites, indicating that factors other than temperature are affecting DO levels.

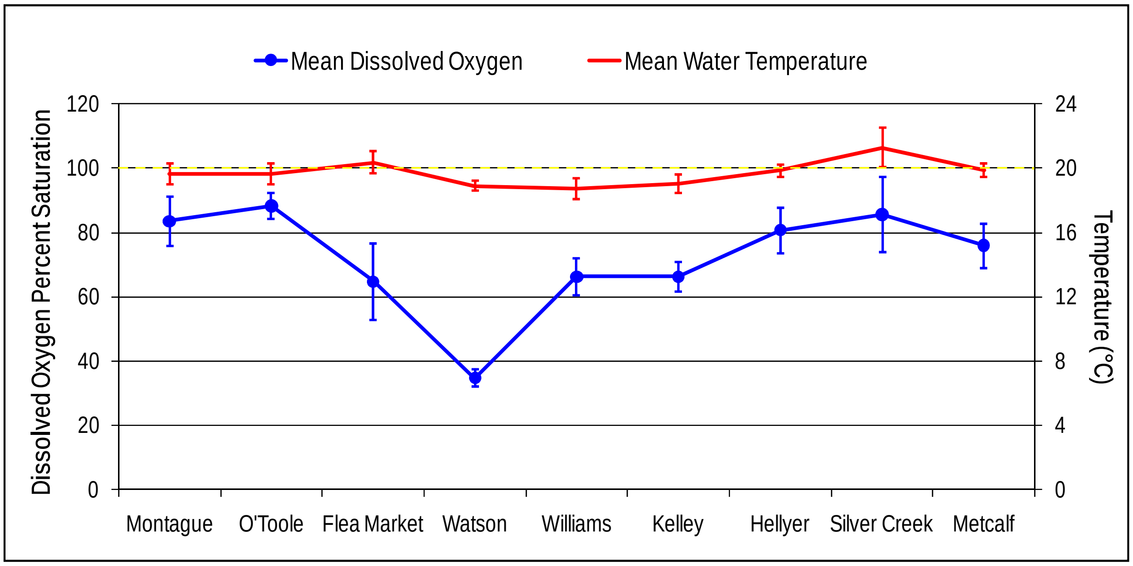

Figure 13. Mean dissolved oxygen percent saturation and mean water temperatures at each site during the first sampling event. The dotted line represents 100% saturation.

Solar irradiation may be an important factor influencing DO concentrations at the study sites. Sites with dense canopy cover may limit the amount of solar radiation to the creek, resulting in lower rates of photosynthesis during the day. In addition, higher levels of turbidity at the urban sites will further prevent light penetration. Lower levels of photosynthesis may be one explanation for low DO levels observed at the middle four sites during the summer season (Figure 3-7). In contrast, the Silver Creek site, which has limited canopy cover, has the highest DO concentrations compared to all other sites.

Low DO concentrations at these urban sites may also be explained by changes in the channel morphology and physical habitat in the reach between I-280 and Berryessa Road (downstream of the Flea Market site). Historical channel surveys of Coyote Creek have shown channel gradients in this reach are much lower than the reach directly below Berryessa Road (Figure 14). Highly incised channel with low gradients can result in habitats characterized as deep and slow, with potential for deposition of fine substrate which may increase biological oxygen demand. An increase in channel gradient is observed directly downstream of Upper Penitencia Creek confluence, which contributes cleaner water and sediment.

Biological and chemical oxygen demand may further explain DO concentrations observed at the three urban sites with relatively low DO. The Coyote Creek drainage area affecting the urban sites (Kelley to Flea Market) consists of predominantly urban land uses, and runoff from this area may be contributing to both chemical and biochemical demand to the system, resulting in lower DO concentrations. The longitudinal dissolved oxygen profile in Figure 13 resembles an oxygen sag curve common downstream of a wastewater or other discharge point. The increase of DO concentrations downstream of Watson site are likely due to contribution of cooler more oxygenated water that is originating from the confluences of Lower Silver and Upper Penitencia Creeks.

Lower DO concentrations directly following storm events may also be associated with higher concentrations of organic matter and nutrients creating higher oxygen demands at urban sites. This condition may be exacerbated with small storms that flush material that has accumulated in conveyance systems over the summer period. Antecedent conditions of high water temperatures may reduce the DO levels even further following a storm. These conditions were observed during study conducted in Guadalupe River during 2009 (EOA 2010).

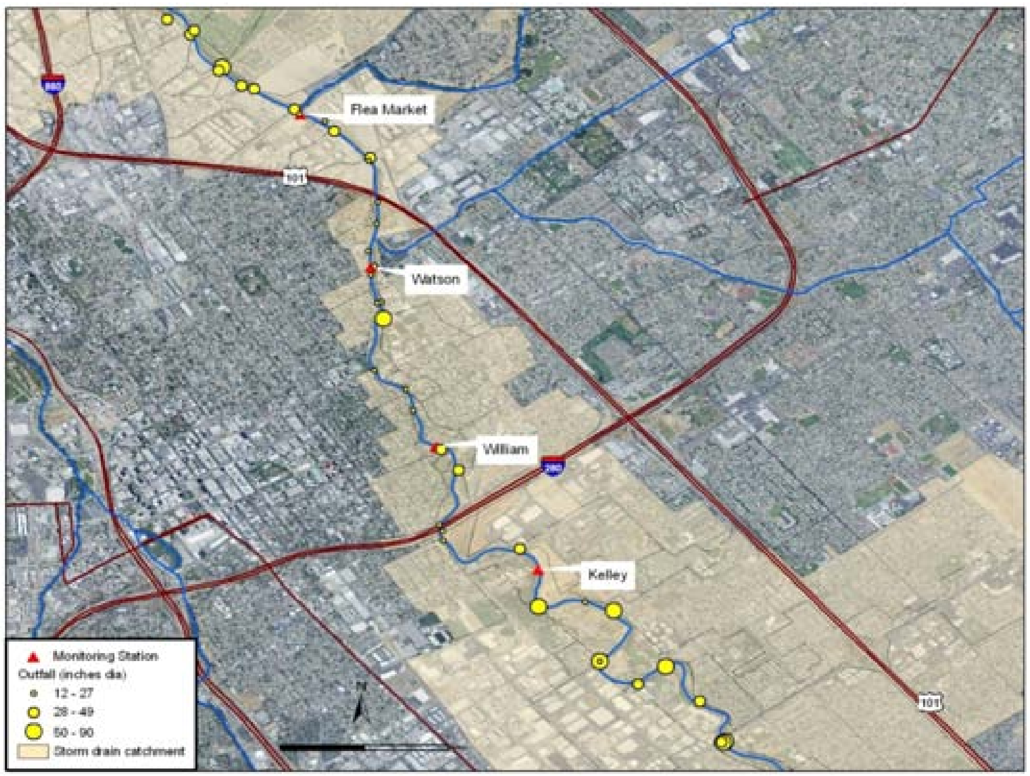

Figure 14. Drainage and outfall map for the area surrounding the four middle urban monitoring sites where lower dissolved oxygen concentrations were observed.

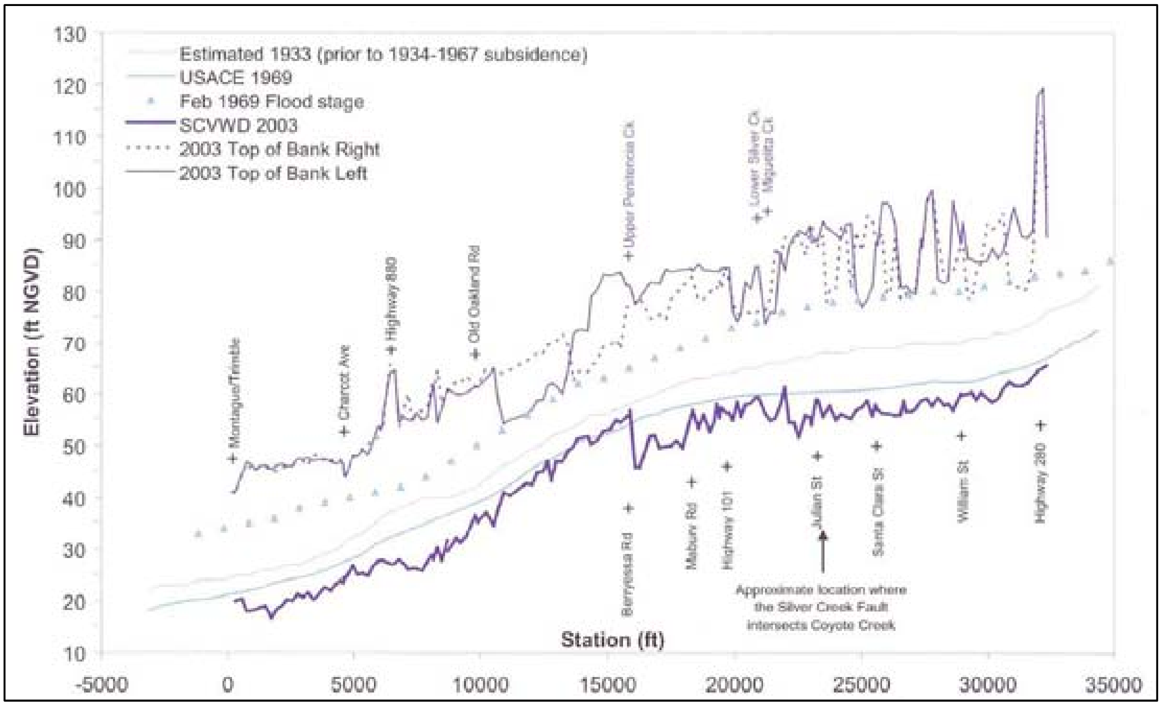

Figure 15. Current and historical longitudinal elevation profile of Coyote Creek with spatial markers (SFEI 2006).

3.3 pH

The pH measurements for the nine Coyote Creek sites monitored during the three sampling events are shown in Figure 16. No sites exceeded the water quality objective (6.5 and 8.5) listed in the San Francisco Bay Water Quality Control Plan (SWRCB 1995), with the exception of the Flea Market site during the October 23 rainfall event where pH exceeded 8.5 during a very brief period of time.

During the summer sampling events, pH was lower at four of the sites (Watson, Williams[4], Kelley and Metcalf) compared to the remaining sites (Figure 16). With the exception of the Metcalf site, diurnal variations in pH at these four sites were also much less, compared to the other five sites. The diurnal pattern for pH was similar to dissolved oxygen during the summer events, with peaks occurring during the middle of the day and valleys occurring around midnight. The observed diurnal pattern of pH and DO is likely explained by photosynthetic activity during the day and respiration during the night. Photosynthesis requires dissolved CO_2, resulting in lower pH values, while CO_2 is released during respiration, resulting in an increase pH. The Flea Market site, however, exhibited opposite diurnal pattern for both pH and DO, with peaks occurring at midnight and valleys during the day. It is currently unclear what may be causing this pattern at the Flea Market site.

[4] The pH dramatically increased (~1.0 units) at the Williams site midway through the second summer event, and remained at the higher level for the rest of the sampling period. The pH sensor met data quality objectives following the event, so it is not clear if the increase was due to change in water quality or equipment malfunction.

Figure 16. pH measured at nine locations in Coyote Creek during three sampling events. The 1-hour rainfall totals are also shown.

The pH was more variable during the wet season sampling event for a majority of the sites. The pH increased during the October 23 rain event, decreased directly following the rain event, and gradually increased back to pre-rain levels over the course of several days (Figure 16). A decrease in pH was also observed following the October 30 rain event. There appeared to be larger decreases in pH at the urban sites compared to rural sites following both storm events. In addition, the magnitude of diurnal patterns was greatly reduced in urban sites compared to rural sites.

3.4 Specific Conductivity

The specific conductivity measured at the nine stations in Coyote Creek during the three sampling events is shown in Figure 17. Conductivity varied substantially between the urban and rural sites (i.e., Hellyer, Silver Creek and Metcalf) during all three events. Specific conductivity was highest during the second summer sampling event. During the wet season event, conductivity decreased following both rainfall events with a gradual increase to pre-rain levels occurring over a period of days following the rainfall event. Similar to pH, the effect of rainfall on conductivity was much greater at the urban compared to rural sites.

The distribution of specific conductivities is shown as box plots in Figure 3-12. The median conductivity for all urban sites during both summer events was approximately 2.5X higher compare to urban sites (1282 versus 520 uS/cm). The rural sites had much lower diurnal variability compared to the urban sites (Figure 18). The highest specific conductivities are observed at the Flea Market site, and steadily decrease moving upstream to the rural sites. The highest range of conductivities occurred during the wet season at the urban sites. There was minimal variability in conductivities observed across all sampling events at the three rural sites.

Figure 17. Specific conductivity measured at nine locations in Coyote Creek during three sampling events. The 1-hour rainfall totals are also shown.

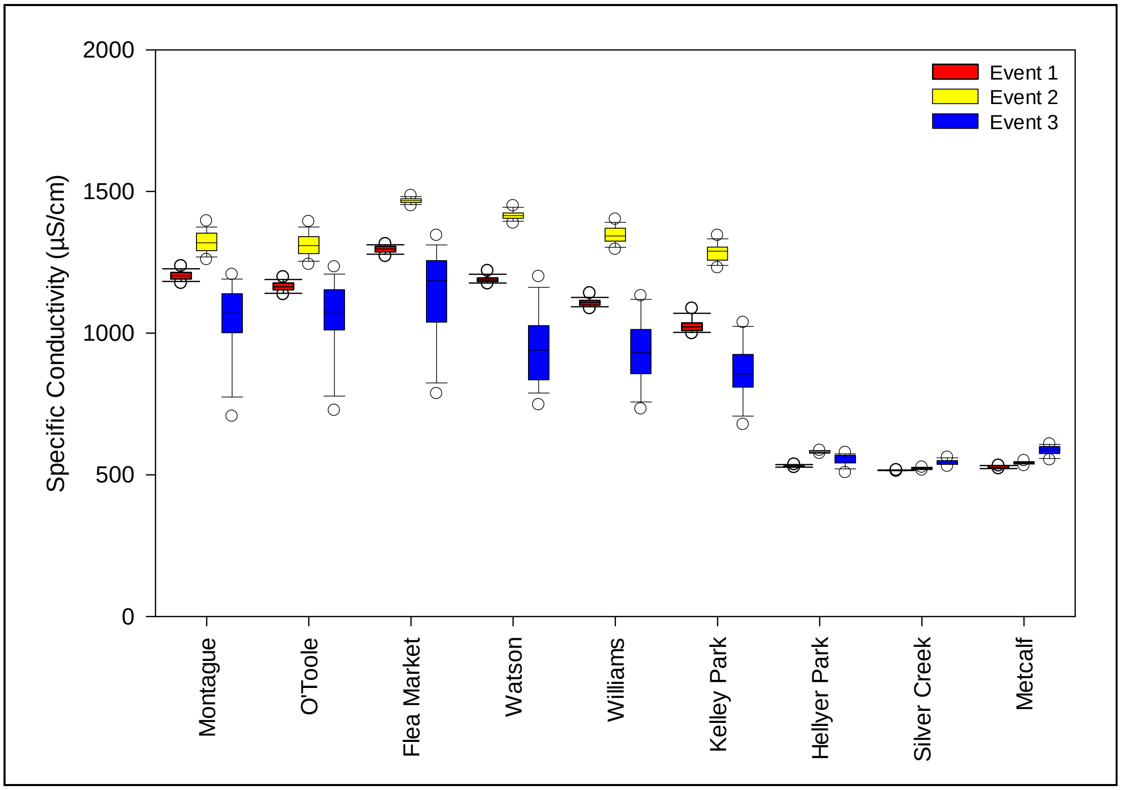

Figure 18. Box plots of specific conductivity at nine sites during all three sampling events. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

3.5 Turbidity

The turbidity measurements collected at nine sites in Coyote Creek over the three sampling events are shown in Figure 19, along with the hourly rainfall totals. Extremely high turbidity concentrations occurred at several locations at different times during all three events. These "spikes" in turbidity, at times exceeding 500 NTUs, were often a single data point over long time intervals. Spikes frequently occurred at Metcalf, Silver Creek, Williams, and Montague and O'Toole sites. Spiking at shorter time intervals were observed at Kelley site during both Events 2 and 3. Consistently elevated levels of turbidity concentrations (100-200 NTUs) were observed at the Flea Market site during Event 1.

Median turbidity concentrations generally increased in a downstream direction (Figure 20). Flea Market site at the highest median concentrations (140 NTUs), nearly 10X the amount recorded at all other sites. Median concentrations did not exceed 20 NTUs with the exception of Flea Market (Event 1) and Montague (Event 3). There was no pattern in turbidity concentrations over the three sampling events. Rainfall did not appear to affect turbidity concentrations during Event 3. The largest spikes in turbidity occurred at Kelley and Williams several days after the October 23 rain event (Figure 19). A small increase in turbidity was observed following the October 23 rain event at the three middle sites, Kelley, Williams and Watson. However, this increase did not occur in the rural sites and is only slightly larger than the diurnal peaks.

Upon closer inspection, a diurnal pattern can be observed at selected sites. Figure 21 shows the daily variability in turbidity at the three middle sites during the first event. Turbidity peaks in the mid-morning and then drops around midnight. The diurnal turbidity patterns are most likely associated with algal productivity since dissolved oxygen concentrations also peak in the morning and drop in the evening.

Turbidity spikes of greater than 30 NTUs consisted of about 7% of all measurements made at eight sites during the summer sampling events. These higher turbidity readings are likely the result of localized disturbances (e.g., bioturbation) occurring over short periods of time. High deposition of fine substrate at many of the sites, coupled with placement of water quality equipment on the streambed (Sensors were approximately six inches off the bottom), will result in higher turbidity readings that may not be representative of the conditions at the site higher in the water column.

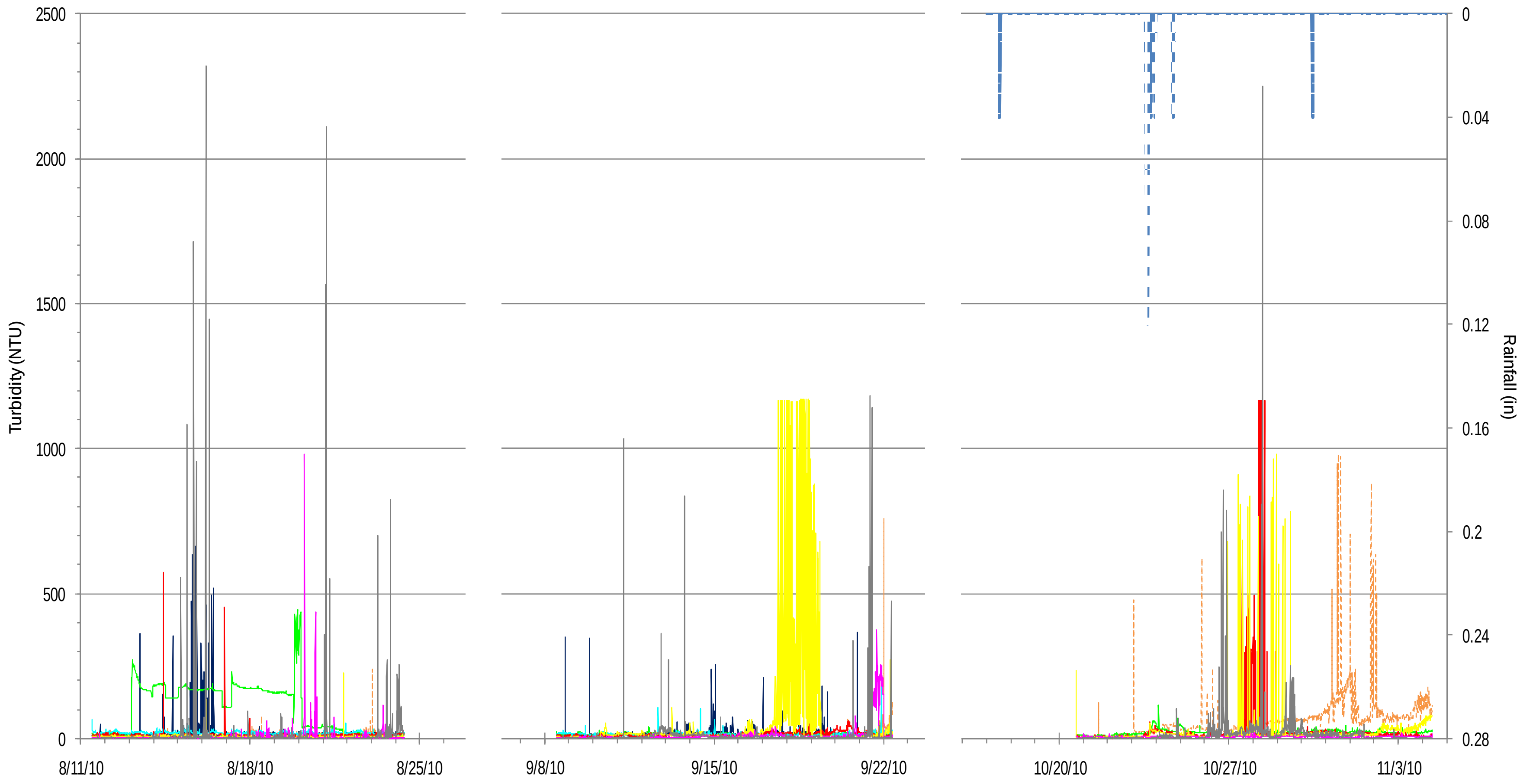

Figure 19. Turbidty (NTU) measured at nine locations in Coyote Creek during three sampling events. The 1-hour rainfall totals are also shown.

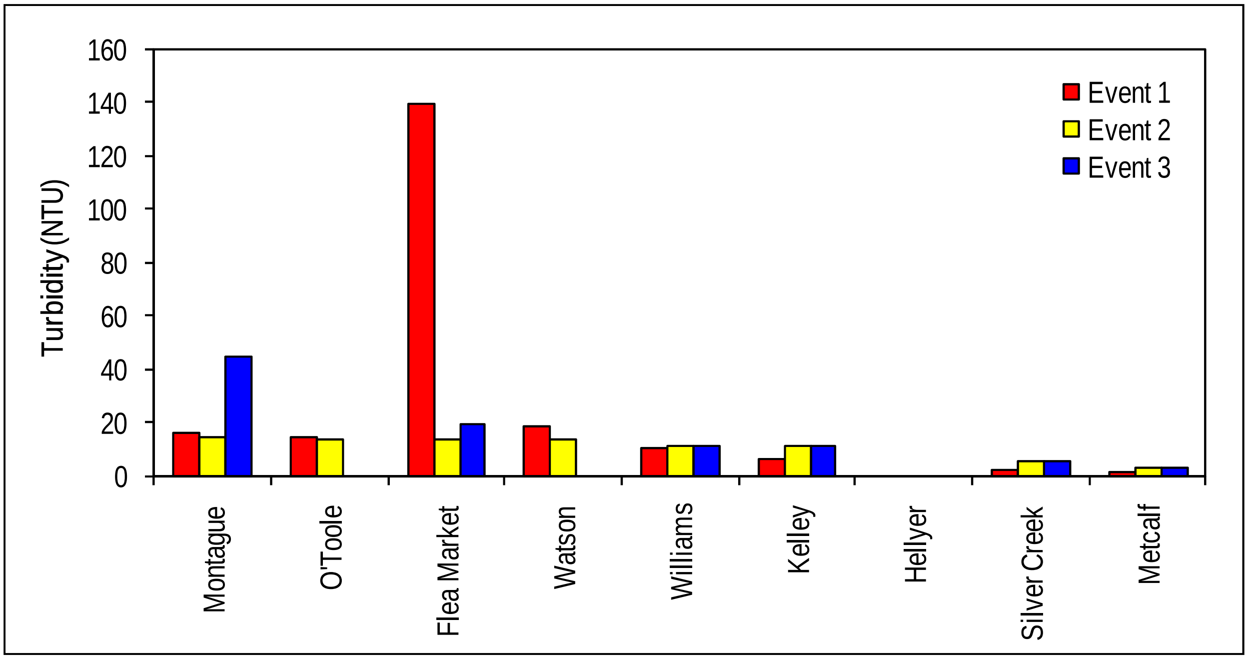

Figure 20. Median turbidity concentrations at eight sites in Coyote Creek during all sampling events.

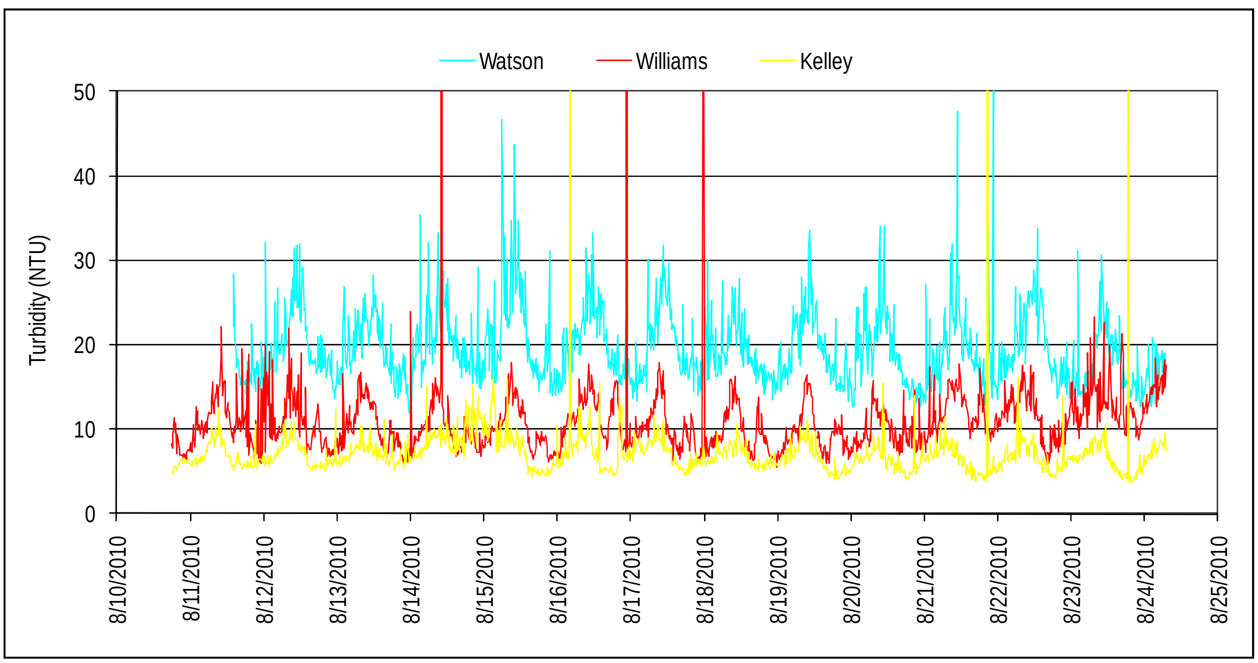

Figure 21. Diurnal pattern at the three middle sites during the first sampling event

4.0 CONCLUSIONS

The following preliminary conclusions were based on the water quality results from the three sampling events in Coyote Creek. Conclusions are organized by the four study objectives presented at the beginning of this report.

4.1 Spatial Variability

A clear spatial pattern between general water quality at urban and non-urban sites was observed during summer (dry) sampling events. The lowest DO concentrations occurred at four urban sites (Flea Market, Watson, Williams and Kelley) during all sample events. More specifically, the Watson site consistently had the lowest DO concentrations measured during dry season events. Of the urban sites, concentrations were highest at the two urban sites located further downstream of the Watson site, below the confluence with Upper Penitencia Creek. Water temperatures followed a similar spatial pattern as DO during the summer sampling events. pH measurements were lowest at three urban sites (Watson, Williams, Kelley) and one rural site (Metcalf) during the summer sampling events. Specific conductivity measured at urban sites during the summer sampling events was approximately 2.5X higher compare to rural sites (1282 versus 520 uS/cm). The highest specific conductivities occur at the Flea Market site, with levels decreasing at sites in an upstream direction.

The spatial variability in DO, pH and conductivity was generally much greater during the wet season event than the dry season events. Water quality parameters responded to changes in hydrology as the result of the initial rainfall events of the season. The response in these parameters following a rain event was much greater at the urban sites compared to the rural sites.

4.2 Diurnal Variability

The diurnal patterns for DO, temperature and pH were generally consistent across sites during the dry season sampling events with peaks occurring in the middle of the day (2:00 – 4:00 pm) and valleys occurring in the early morning hours (4:00 – 8:00 am). The exception to this pattern occurred at the Flea Market site, which had peaks in the early morning and valleys in the afternoon. This shift in the diurnal cycle at Flea Market site was observed during all three monitoring events.

The magnitude of diurnal change (i.e., size of the peaks) in parameter measurements was variable across sites. The Watson site had the lowest daily variability for all parameters, with the exception of turbidity, during the dry season events. There was minimal diurnal variability observed at Williams and Kelley sites during the dry season for pH and conductivity and practically no diurnal variability in conductivity for the three rural sites.

Excluding the periodic sharp spikes, turbidity exhbited diurnal pattern with peaks in the mid-morning and then drops around midnight. The diurnal patterns observed in the data are likely correlated with cycling between photosynthetic activity of algae and macrophytes during the day (when solar irradiation is present) and respiration activity of micro-organisms during the evening.

4.3 Water Quality Impacts Associated with Rain Events

Dissolved oxygen levels were reduced at most sites following the three rain events that occurred before and during the wet season sampling event. The largest decrease in DO concentration (0-2 mg/L) occurred at the Watson and Flea Market sites following the first (but smallest) of the three rainfall events that occurred prior to wet season sample event. An additional decrease in DO occurred following the October 23 rain event at Watson, Fleamarket, Williams and Kelley sites. The three upper, rural sites (Metcalf, Silver Creek and Hellyer) had smaller declines following rain events.

A small increase in pH occurred at a few sites during the October 23 rain event, followed by a sharp decline following the rain event. The pH levels gradually increased back to pre-rain levels over the course of several days. A small decrease in pH was also observed following the October 30 rain event. There appeared to be larger decreases in pH at the urban sites compared to rural sites following both storm events. Similar to pH, conductivity decreased during and directly after both rainfall events with a gradual increase to pre-rain levels occurring over a period of days. These changes were only observed at urban sites. Water temperature appeared to be mostly influenced by air temperature, with little or no influence from rainfall during the wet season sampling event. Changes in turbidity concentrations were not consistently observed during hydrologic events.

4.4 Stressor and/or Source Identification

Low DO concentrations measured at the Watson site appear to be a potential stressor to aquatic life uses during the late summer season. DO concentrations also appear to be depressed at the reach of Coyote Creek between the Flea Market and Williams sites. These conditions may explain the low biological diversity of native fish and biological integrity scores documented during previous studies at sites within this urban reach.

The source(s) or mechanisms responsible for low DO concentrations in this reach may include low stream velocities associated with lack of stream gradient, and a highly incised channel and deep pool habitats reducing turbulence and oxygenation of water. Fine sediment deposition in this reach may also increase the organic material and associated nutrients to settle within this reach, causing an increase in biological or chemical oxygen demand. Water with a high oxygen demand entering the site during initial storm events of the season may explain the changes in water quality parameters observed during the study. In particular, lower DO concentrations observed at the stream reach between Williams and the Flea Market directly following these storms may be associated with the deposition of organic material and nutrients hydraulically transported to the reach during storm events.

5.0 NEXT STEPS

This stressor/source identification study was conducted in compliance with provision C.8.d(i) of the MRP. As described in this provision, the monitoring conducted via this project complies specifically with provision C.8.d(i)-1, the first step in the stressor identification process. As an outcome of this monitoring project, the stream reach between the Williams and Flea Market site has been identified as a water quality reach of interest in Coyote Creek. To further define the spatial and temporal extent of water quality condition in this reach, and better determine the potential sources of stress, the Program (in coordination with the SCVWD and City of San Jose) plan to conduct the following monitoring in FY 2012-13 within the reach of interest:

- Conduct continuous water quality monitoring within the Coyote Creek reach of interest, including Flea Market, Watson Park and Williams Street. Establish monitoring locations and monitor upstream and downstream of the Watson Park site to further determine the spatial extent low dissolved oxygen. Physical habitat characteristics and potential source locations (e.g., larger storm drain outfalls) will be used to inform the site selection process. Monitoring equipment will be deployed during the late summer/early fall season of 2012, and remain in place through the first seasonal flush event. Monitoring will begin no later than September 15 and continue through December 2012. Field check of equipment and download of data should be conducted at 2 week intervals.

- Conduct visual survey at selected monitoring locations following first seasonal flush event, and subsequent events, during the project, for evidence of fish mortality and impacted water quality conditions.

Based on all information collected during this stressor/source identification monitoring project, SCVURPPP will continue implementation of the stressor/source identification process and attempt to identify and evaluate the effectiveness of options for controlling the cause of the impact.

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APPENDIX A

Calibration Worksheet

Calibration Measurements and Percent Drift

Calibrations

Sondes were calibrated prior to each event deployment (pre-deployment) and immediately after retrieval from the creek (post-retrieval). The percent drift, calculated as the percent change between the pre-deployment and post-retrieval readings indicated whether there were issues with the sondes and assure data quality.

Drift that exceeded acceptable error was flagged and evaluated for data quality. Similarly, calibrations were revisited for suspicious looking data. During the study, the following four flagged data sets were flagged:

- Dissolved oxygen at the Silver Creek site for Event 2
- Turbidity at the Flea Market site for Event 1
- Turbidity at the Kelley site for Event 2
- pH at the Williams site for Event 2

The dissolved oxygen sensor for the sonde deployed at the Silver Creek site during the second event failed to calibrate following retrieval, and subsequently the data was removed and the sensor was serviced. While the other three flagged data sets appeared suspicious, the calibrations for each were found to be within acceptable error. Specifically, the turbidity measurement at the Flea Market site during the first event jumped and remained elevated for several days before returning to low turbidities again. The turbidity at the Kelley site during the second event spiked to very high levels but was not maintained for long periods of time. In both cases, it appeared that an upper limit had been reached, though they were at different values. There were no problems with the turbidity sensors in subsequent sampling events. The pH measurement at the Williams site during the second deployment jumped 0.5 pH units in adjacent readings. However, both pH 7 and pH 10 drift were within acceptable error.

Calibration Measurements

		Montague		O'Toole		Flea Market		Watson		Williams		Kelley Park		Hellyer		Silver Creek		Metcalf	
		Pre[5]	*Post*[6]	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Event 1	**Conductivity**	1.409	1.394	1.409	1.422	1.409	1.379	1.409	1.415	1.409	1.392	1.409	1.413	1.408	1.351	1.409	1.411	1.409	1.428
	pH 7	7.02	7.22	7.09	7.02	7.02	7.16	7.02	7.03	7.02	7.12	7.02	7.08	7.02	7.22	7.02	7.08	7.02	7.08
	pH 10	10.06	9.96	10.07	10.02	10.06	10.04	10.06	10.05	10.06	10.08	10.06	10.06	10.06	9.94	10.06	10.05	10.06	10.05
	Turbidity #1	0.0	0.4	0.1	0.1	0.0	-0.2	0.0	0.7	0.0	-0.1	0.0	-0.1	*N/A*	*N/A*	0.0	1.6	0.0	-1.1
	Turbidity #2	126.0	124.4	123.2	125.3	126.0	124.5	100.0	100.8	126.0	125.0	126.0	122.2	*N/A*	*N/A*	126.0	124.7	126.0	127.0
	DO	100.0	102.5	99.3	101.0	100.0	103.7	100.1	100.0	99.8	100.0	100.0	100.0	99.9	99.8	100.0	101.0	100.0	101.3
Event 2	**Conductivity**	1.413	1.410	1.413	1.400	1.413	1.404	1.413	1.399	1.413	1.403	1.413	1.396	1.413	1.414	1.413	1.410	1.413	1.414
	pH 7	7.02	6.99	7.02	6.97	7.02	6.93	7.02	7.00	7.02	7.25	7.02	6.99	7.02	6.91	7.02	6.98	7.02	6.97
	pH 10	10.06	10.09	10.05	10.11	10.06	10.14	10.06	10.08	10.06	10.13	10.06	10.13	10.06	10.15	10.06	10.11	10.06	10.11
	Turbidity #1	0.0	-0.1	0.0	-0.2	0.0	0.3	0.0	0.8	0.0	-0.6	0.0	-0.5	*N/A*	*N/A*	0.0	0.1	0.0	-0.2
	Turbidity #2	126.0	125.1	126.0	126.3	126.0	125.7	100.0	100.5	126.0	125.8	126.0	126.1	*N/A*	*N/A*	126.0	121.9	126.0	127.3
	DO	99.8	102.6	100.0	100.5	100.0	103.3	99.6	101.5	99.7	99.1	99.7	99.2	99.7	103.4	99.7	-20.0	99.7	102.7
Event 3	**Conductivity**	1.413	1.399	1.413	1.414	1.413	1.421	1.414	1.377	1.413	1.428	1.413	1.405	1.413	1.454	1.413	1.429	1.413	1.451
	pH 7	7.02	7.06	7.02	7.03	7.02	7.12	7.02	6.96	7.02	7.01	7.02	6.97	7.02	7.38	7.02	7.11	7.02	7.05
	pH 10	10.05	10.05	10.05	10.05	10.05	10.06	10.06	10.13	10.06	10.05	10.05	10.08	10.06	10.02	10.06	10.15	10.06	9.97
	Turbidity #1	0.0	1.8	*N/A*	*N/A*	0.0	0.5	*N/A*	*N/A*	0.0	-0.7	0.0	-2.2	*N/A*	*N/A*	0.0	-0.4	0.0	-0.3
	Turbidity #2	126.0	125.6	*N/A*	*N/A*	126.0	125.6	*N/A*	*N/A*	100.0	103.3	126.0	125.6	*N/A*	*N/A*	126.0	126.3	126.0	126.8
	DO	100.2	127.3	100.3	101.3	100.4	110.3	100.3	100.6	100.2	99.9	100.3	103.7	99.8	102.4	100.2	100.9	99.8	101.7

[5] Pre-deployment reading
[6] Post-retrieval reading

Percent Drift between Pre-deployment and Post-retrieval Readings

		Limits	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Event 1	Conductivity	10%	-1.06%	0.92%	-2.13%	0.43%	-1.21%	0.28%	-4%	0.14%	1%
	pH 7	0.3	0.20	0.00	0.14	0.00	0.10	0.06	0.20	0.06	0.06
	pH 10	0.3	-0.10	-0.04	-0.02	-0.03	0.02	0.00	-0.12	-0.01	-0.01
	Turbidity #1	0.50	0.40	0.10	-0.20	0.00	-0.28	-0.10	0.00	1.60	-1.10
	Turbidity #2	10%	-1.27%	-0.56%	-1.19%	-1.67%	-0.79%	-3.02%	0%	-1.03%	1%
	DO	10%	2.50%	0.90%	3.70%	0.60%	0.00%	0.00%	0%	1.00%	1%
Event 2	Conductivity	10%	-0.21%	-0.92%	-0.64%	-0.99%	-0.71%	-1.20%	0.07%	-0.21%	0.07%
	pH 7	0.3	-0.03	-0.05	-0.09	-0.08	0.23	-0.03	-0.11	-0.04	-0.05
	pH 10	0.3	0.03	0.05	0.08	0.00	0.07	0.07	0.09	0.05	0.05
	Turbidity #1	0.50	-0.10	-0.20	0.30	0.00	-0.60	-0.50	0.00	0.10	-0.20
	Turbidity #2	10%	-0.71%	0.24%	-0.24%	0.91%	-0.16%	0.08%	0.00%	-3.25%	1.03%
	DO	10%	2.81%	0.80%	3.30%	0.10%	-0.60%	-0.50%	3.71%	**-120.06%**	3.01%
Event 3	Conductivity	10%	-0.99%	0.07%	0.57%	-2.62%	1.06%	-0.57%	2.90%	1.13%	1.06%
	pH 7	0.3	0.04	0.01	0.10	-0.06	-0.08	-0.05	0.36	0.09	-0.08
	pH 10	0.3	0.00	0.00	0.01	0.07	0.01	0.03	-0.04	0.09	0.01
	Turbidity #1	0.50	1.80	0.00	0.50	0.00	-0.70	-2.20		-0.40	-0.70
	Turbidity #2	10%	-0.32%	0.00%	-0.32%	0.00%	1.63%	-0.32%		0.24%	1.63%
	DO	10%	27.05%	1.00%	9.86%	0.30%	1.21%	3.39%	2.61%	0.70%	1.21%

APPENDIX B

Summary Statistics for Temperature, Dissolved Oxygen, pH,

Specific Conductivity, and Turbidity

Coyote Creek Temperature Statistics

Event 1	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	18.2	18.1	19.0	18.2	17.2	17.6	19.0	18.7	18.7
25th Percentile	19.1	19.1	19.9	18.7	18.2	18.6	19.5	20.2	19.5
Median	19.6	19.7	20.2	18.9	18.6	19.0	19.9	21.4	19.9
Mean	19.6	19.6	20.4	18.9	18.7	19.1	19.8	21.3	19.9
Standard Deviation	0.7	0.7	0.7	0.3	0.7	0.6	0.4	1.2	0.4
75th Percentile	20.2	20.2	20.9	19.2	19.2	19.6	20.2	22.4	20.2
Maximum	21.0	21.1	22.3	19.6	20.4	20.3	20.7	23.3	20.6

Event 2	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	17.6	17.5	18.3	16.9	16.2	16.6	17.2	16.7	17.6
25th Percentile	18.4	18.4	18.8	17.7	17.0	17.5	18.1	18.7	18.5
Median	19.0	19.0	19.4	18.0	17.5	18.1	18.6	19.7	18.9
Mean	18.9	18.9	19.4	17.9	17.6	18.1	18.5	19.6	18.9
Standard Deviation	0.6	0.7	0.6	0.4	0.7	0.7	0.6	1.2	0.5
75th Percentile	19.3	19.4	19.8	18.3	18.1	18.5	18.9	20.5	19.3
Maximum	20.1	20.1	20.7	18.9	19.4	19.5	19.6	22.0	20.0

Event 3	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	14.1	14.1	14.4	13.7	13.0	13.3	13.5	13.0	14.9
25th Percentile	15.2	15.2	15.2	14.4	14.4	14.4	14.2	14.7	15.8
Median	15.7	15.6	15.9	14.8	14.9	14.7	14.7	15.5	16.1
Mean	15.9	15.8	16.0	15.0	15.0	15.0	14.8	15.5	16.2
Standard Deviation	0.9	0.8	0.9	0.8	0.9	0.9	0.8	1.1	0.6
75th Percentile	16.6	16.5	16.6	15.5	15.7	15.7	15.7	16.2	16.7
Maximum	18.0	18.1	18.6	17.9	17.7	17.1	16.2	17.8	17.3

Coyote Creek Dissolved Oxygen Statistics

Event 1	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	7.0	7.5	4.0	2.6	5.3	5.3	6.5	6.4	6.0
25th Percentile	7.3	7.8	4.9	3.1	5.8	5.8	6.9	6.7	6.4
Median	7.5	8.0	5.6	3.2	6.0	6.1	7.3	7.1	6.8
Mean	7.6	8.1	5.8	3.2	6.2	6.1	7.4	7.6	6.9
Standard Deviation	0.5	0.3	1.0	0.2	0.5	0.4	0.6	1.0	0.6
75th Percentile	8.0	8.3	6.8	3.4	6.5	6.4	7.5	8.5	7.5
Maximum	8.9	8.9	7.7	3.7	7.3	6.9	10.3	9.6	8.1

Event 2	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	6.9	7.4	3.8	1.8	4.4	5.1	5.8	N/A	6.1
25th Percentile	7.2	7.7	5.1	2.0	5.3	5.4	6.7	N/A	6.7
Median	7.4	7.9	5.4	2.2	5.5	5.7	7.0	N/A	7.0
Mean	7.6	8.0	5.6	2.2	5.6	5.7	7.3	N/A	7.0
Standard Deviation	0.5	0.3	0.7	0.2	0.4	0.4	1.1	N/A	0.5
75th Percentile	7.9	8.2	6.2	2.4	5.8	6.0	7.6	N/A	7.4
Maximum	8.8	8.8	7.0	2.7	6.7	6.7	13.1	N/A	8.4

Event 3	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	5.6	5.7	0.0	0.0	3.0	2.6	3.3	7.8	6.9
25th Percentile	7.9	7.1	4.2	1.5	5.2	5.0	6.8	8.8	7.4
Median	9.1	7.9	5.3	3.3	5.8	6.1	7.6	9.1	7.7
Mean	8.6	7.6	4.8	2.8	5.7	5.8	7.4	9.1	7.7
Standard Deviation	1.1	0.7	1.5	1.5	1.0	1.0	1.0	0.6	0.4
75th Percentile	9.4	8.1	5.7	3.9	6.4	6.5	8.2	9.6	8.0
Maximum	10.1	8.5	7.7	6.9	7.4	7.6	8.7	10.7	8.8

Coyote Creek pH Statistics

Event 1	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	8.13	8.04	7.93	7.65	7.65	7.71	7.90	7.96	7.62
25th Percentile	8.19	8.06	8.03	7.68	7.66	7.76	7.97	8.02	7.67
Median	8.27	8.09	8.08	7.70	7.68	7.77	8.00	8.09	7.72
Mean	8.25	8.08	8.08	7.70	7.69	7.78	8.01	8.11	7.70
Standard Deviation	0.06	0.03	0.08	0.03	0.04	0.03	0.06	0.11	0.03
75th Percentile	8.31	8.10	8.15	7.73	7.70	7.79	8.03	8.21	7.73
Maximum	8.35	8.13	8.24	7.77	7.83	7.85	8.30	8.35	7.76

Event 2	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	8.10	8.06	7.84	7.66	7.73	7.80	7.70	7.94	7.53
25th Percentile	8.13	8.10	7.90	7.68	7.81	7.83	7.78	8.01	7.59
Median	8.15	8.13	7.93	7.69	8.23	7.85	7.81	8.08	7.63
Mean	8.15	8.12	7.95	7.70	8.08	7.85	7.84	8.10	7.62
Standard Deviation	0.03	0.03	0.06	0.02	0.24	0.02	0.09	0.11	0.04
75th Percentile	8.17	8.15	8.00	7.71	8.31	7.87	7.85	8.19	7.66
Maximum	8.21	8.18	8.09	7.77	8.35	7.91	8.30	8.33	7.70

Event 3	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	7.49	7.46	7.82	6.86	7.38	7.39	7.36	8.07	7.60
25th Percentile	7.79	7.71	7.96	7.30	7.60	7.61	7.64	8.16	7.65
Median	7.89	7.83	8.02	7.40	7.67	7.67	7.72	8.21	7.68
Mean	7.86	7.80	8.12	7.42	7.64	7.64	7.70	8.22	7.68
Standard Deviation	0.15	0.14	0.29	0.16	0.09	0.08	0.11	0.08	0.04
75th Percentile	7.98	7.91	8.10	7.58	7.70	7.69	7.78	8.27	7.70
Maximum	8.08	8.00	9.12	7.68	7.75	7.75	7.87	8.44	7.81

Coyote Creek Specific Conductivity Statistics

Event 1	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	1158	1113	1256	1137	1042	978	526	513	521
25th Percentile	1191	1153	1287	1183	1099	1009	528	515	524
Median	1203	1164	1297	1188	1108	1022	530	516	525
Mean	1204	1165	1296	1190	1109	1027	530	516	527
Standard Deviation	18	19	13	14	16	26	3	1	4
75th Percentile	1214	1177	1306	1195	1116	1036	531	516	532
Minimum	1255	1213	1325	1230	1155	1111	538	519	534

Event 2	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	1244	1236	1440	1383	1279	1217	571	514	281
25th Percentile	1292	1282	1461	1403	1326	1260	579	521	541
Median	1319	1309	1467	1415	1343	1289	584	523	543
Mean	1321	1313	1468	1417	1347	1285	582	523	542
Standard Deviation	40	44	11	18	31	33	4	3	14
75th Percentile	1356	1342	1474	1423	1369	1310	585	526	545
Minimum	1413	1418	1498	1457	1408	1353	587	529	554

Event 3	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	608	606	593	725	637	575	494	463	547
25th Percentile	1001	1012	1039	835	857	810	542	539	575
Median	1070	1075	1185	940	931	856	562	540	588
Mean	1028	1043	1129	948	940	864	554	544	587
Standard Deviation	155	156	179	135	126	106	22	12	18
75th Percentile	1139	1153	1256	1027	1013	925	569	550	600
Minimum	1241	1252	1388	1227	1150	1054	600	566	613

Coyote Creek Turbidity Statistics

Event 1	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	7.7	6.7	8.9	11.9	5.4	3.7	-	0.9	0.1
25th Percentile	12.3	11.1	15.4	16.4	8.5	5.7	-	1.6	0.5
Median	16.6	14.8	139.7	18.6	10.3	6.7	-	2.0	1.7
Mean	16.3	21.5	104.2	19.7	11.6	7.4	-	6.5	20.1
Standard Deviation	8.1	48.8	83.8	4.7	20.6	8.6	-	36.4	141.7
75th Percentile	18.6	17.3	169.8	22.0	12.6	8.1	-	3.1	3.7
Maximum	238.2	661.9	445.6	64.3	571.9	226.3	-	978.5	2319.8

Event 2	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	8.5	7.2	8.6	8.3	5.3	2.4	-	1.7	0.6
25th Percentile	12.3	11.4	11.8	12.0	9.3	6.5	-	4.0	2.2
Median	14.4	13.6	13.7	13.9	11.5	11.2	-	5.8	3.5
Mean	17.0	17.0	14.5	14.9	14.5	67.0	-	12.7	12.1
Standard Deviation	22.3	21.8	3.7	7.2	12.9	204.9	-	33.2	67.9
75th Percentile	17.1	16.6	16.6	16.4	17.0	19.1	-	8.4	6.2
Maximum	757.4	364.3	42.5	189.4	316.7	1171.2	-	372.6	1183.5

Event 3	Montague	O'Toole	Flea Market	Watson	Williams	Kelley	Hellyer	Silver Creek	Metcalf
Minimum	4.7	-	5.3	-	0.9	3.4	-	2.8	0.1
25th Percentile	25.5	-	14.4	-	7.8	7.9	-	4.7	1.3
Median	45.1	-	19.7	-	11.7	11.5	-	5.5	3.5
Mean	61.6	-	20.2	-	26.6	25.2	-	5.7	15.7
Standard Deviation	79.0	-	8.4	-	98.8	84.8	-	1.9	76.0
75th Percentile	73.3	-	23.8	-	16.7	17.3	-	6.4	15.7
Maximum	979.3	-	116.1	-	1166.8	979.1	-	34.3	2250.3

C2

Letter to Water Board Staff from SCVURPPP on Stressor/Source ID Project Next Steps and Time Schedule

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Campbell • Cupertino • Los Altos • Los Altos Hills • Los Gatos • Milpitas • Monte Sereno • Mountain View • Palo Alto
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March 15, 2013

Thomas Mumley, Ph.D., P.E.
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San Francisco Bay Regional Water Quality Control Board
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Oakland, CA 94612

Re: MRP Provision C.8.d(i) - Status and Next Steps on Coyote Creek and Guadalupe River Stressor/Source Identification Projects

Dr. Mumley: Tom

This letter provides an update on the status and planned next steps regarding two stressor/source identification projects being implemented by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). SCVURPPP is implementing the projects in compliance with provision C.8.d(i) of the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074) on behalf of all Santa Clara Valley Permittees. This MRP provision requires Permittees to conduct monitoring projects/studies to identify and isolate the potential sources and/or stressors associated with the water quality triggers.

We very much appreciated the meeting with you and other Water Board staff on November 29, 2012 and the letter from your staff on December 29, 2012 acknowledging that the two SCVURPPP projects in Coyote Creek and the Guadalupe River fulfill two of the ten stressor/source identification projects required by provision C.8.d(i). As discussed at the November 29, 2012 staff meeting, these projects are being conducted collaboratively with the City of San Jose and the Santa Clara Valley Water District (District), and in coordination with the Bay Area Stormwater Management Agencies Association's (BASMAA) Regional Monitoring Coalition (RMC). This letter serves as a follow up to our discussions and as a response to the Water Board staff December 29, 2012 letter from Ms. Naomi Feger.

Coyote Creek Project

The Coyote Creek Stressor/Source Identification Project was triggered by creek status/condition data previously collected by Program and Permittees, which suggests that an urban section of Coyote Creek has lower than expected dissolved oxygen concentrations and biological conditions scores (i.e., benthic macroinvertebrate biological integrity scores) that may be associated with poor water quality conditions within the stream reach. To further investigate the potential issue, continuous monitoring equipment was deployed at nine sites in Coyote Creek between August and November 2010. Results from the initial monitoring suggested that low dissolved oxygen was present at one of the nine sites (i.e., Watson Park), which corresponds with the location where low biological condition scores were observed. Detailed results and analysis for the monitoring activities performed in 2010 were presented during our meeting on November 29th and are provided in Appendix C1 of the *Water Year 2012 Urban Creeks Monitoring Report*, submitted by BASMAA on behalf of all Permittees.

Based on the information collected by the Program in 2010, the Program continued the stressor/source identification project in 2012[1]. Monitoring sites in 2012 were selected to further identify the reach of Coyote Creek where water quality impacts may be present. Water quality equipment was deployed at four of nine sites monitored in 2010 (i.e., O'Toole, Flea Market, Watson and Williams) and two new sites (i.e., Mabury and Julian). Sites monitored in 2012 are shown in Figure 1.

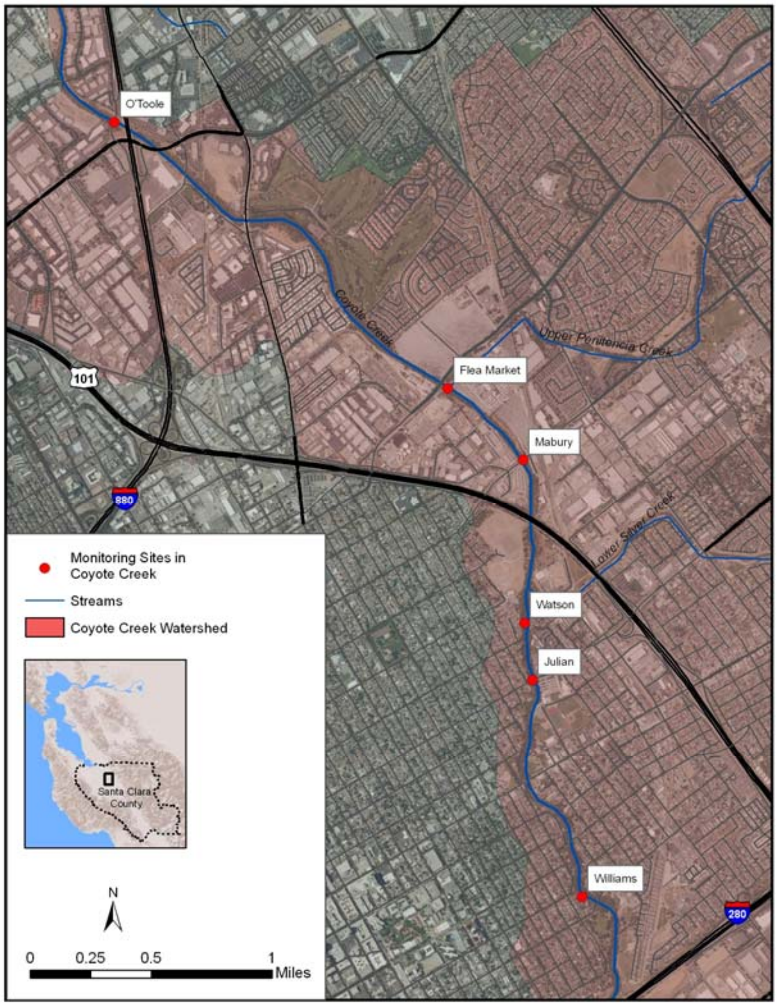

Figure 1. Sites monitored for water quality in Coyote Creek during 2012.

Of the six sites monitored in 2012, two had dissolved oxygen concentrations that were consistently below 5.0 mg/l, the threshold being used to identify potential water quality issues in Coyote Creek. These data allowed the Program to further delineate the reach of interest in Coyote Creek, which is now defined as the mainstem of Coyote Creek from Watson Park upstream to (and possibly directly upstream of) the Julian Street Bridge crossing. The distance of this reach of interest is approximately 0.5 mile.

[1] Please note that the main focus of monitoring efforts during 2011 was on the Guadalupe River.

Enhanced Control Measures Taken To-date

It is our understanding that the City of San José staff surveyed all outfalls in the area but found no indication of illicit or poor water quality discharges. However, management actions in the area for trash capture are expected to have the concurrent benefit of reducing the amount of organic matter flowing to the zone. Specifically, in 2012, three CDS units treating areas flowing directly to the zone were installed, as well as two immediately upstream. Together, these units treat over 600 acres, and should significantly reduce the amount of organic matter flowing directly to the zone through the MS4. City of San Jose staff has also noted that parking restriction signage to enhance the effectiveness of street sweeping has been proposed for various areas draining to this zone and is currently under review. In addition to these management actions, the City's "Clean Creeks Healthy Communities" project is occurring immediately upstream of the area and should significantly reduce the loading of pollutants from homeless encampments in that area. For more information on the projects, visit http://www.sanjoseca.gov/index.aspx?nid=1490 or http://www.epa.gov/region9/mediacenter/cleancreeks/.

Planned Next Steps and Time Schedule

Based on the information collected to-date, the Program, City of San Jose and Santa Clara Valley Water District plan to continue implementing the stressor/source identification project in Coyote Creek in 2013-14. Efforts will generally focus on attempting to identify the sources or mechanisms that are causing or contributing to low dissolved oxygen in the reach of interest. Additionally, management actions that may improve DO will also be evaluated. Planned next steps in 2013-14 are further described in Table 1.

Table 1. Planned next steps and time schedule for Coyote Creek Stressor/Source ID Project.

Task	Description	Planned Time Schedule
Develop Conceptual Model	Develop a conceptual model of potential sources and processes contributing low dissolved oxygen. The conceptual model will be used to develop hypotheses of all potential sources/processes relevant to the Coyote Creek reach of interest.	February - April 2013
Develop Monitoring Plan	Develop monitoring plan describing hypothesis of sources/processes, the parameters, methods, sampling locations and frequency of monitoring that will be conducted to identify sources/processes. Develop criteria that will be used to evaluate the importance of each source/process.	April – May 2013
Field Monitoring and Observations	Conduct additional source/process monitoring and field observations during the 2013 dry season and 2013-14 wet weather season. Monitoring will focus on testing high priority hypotheses identified in the conceptual model.	May – December 2013
Data analyses and reporting	Analyze and report results of hypotheses testing, including comparisons to thresholds/criteria selected to determine importance of potential stressors/sources. A refined conceptual model will also be developed and presented. Submit all data collected in Water Years 2013 to the RWQCB and the Regional Data Center by March 15, 2014, in concert with the Integrated Monitoring Report (IMR). A final report on monitoring conducted to-date and control measure evaluations (see below) will be included as part of the Integrated Monitoring Report and submitted to the RWQCB by March 15, 2014.	December - March 2014
Evaluation of Enhanced Control Measures	Based on the information available, evaluate practical and feasible control measures that may improve dissolved oxygen concentrations in the Coyote Creek reach of interest. Control Measures will be evaluated through a desktop analysis exercise. Recommended measures that should be considered by applicable Permittees will be included in the final evaluation report, which will also take into consideration information available on sources/processes. Further, it is also the intent to consider local historical ecology as well as anthropogenic modifications that may not be reversible. In addition, information on future flood control plans will be collected and, where practicable, incorporated into the analysis.	July 2013 – March 2014

Guadalupe River Project

The Guadalupe River Stressor/Source Identification Project was triggered by Program and Permittee observations suggesting that a section of the lower Guadalupe River may have poor water quality conditions causing impacts to beneficial uses. Specifically, dead fish in varying numbers were observed in 2008 and 2010 in Alviso Slough (downstream of the reach of interest) and in the Guadalupe River in 2009. These events occurred directly after the first runoff events of each wet weather season.

Based on limited monitoring conducted during the fish kill in 2009, low dissolved oxygen concentrations that were observed in the reach of interest by Permittees were considered low enough to possibly cause impacts to fish communities in the Guadalupe River during and directly after the first seasonal runoff event. Additionally, preliminary hypotheses also suggested that algal toxins could be a contributor to the fish kills during that time. To test initial hypotheses, SCVURPPP, the City of San Jose and the District conducted general water quality monitoring in the Guadalupe River and Alviso Slough in 2010 and 2011. Additionally, algal toxin and community composition monitoring were conducted in 2011. Detailed results and conclusions of the monitoring activities performed in 2010 and 2011 are provided in Appendix C3 of the *Water Year 2012 Urban Creeks Monitoring Report*, submitted by BASMAA on behalf of all Permittees.

Further investigations were conducted in late 2012 at a subset of sites previously sampled in 2010 and 2011 to assess if water quality impacts would occur during a first seasonal flush in a year where antecedent conditions were similar to 2009 (i.e., low precipitation, low stream flows, and warm air temperatures). The locations of sites monitored as part of the Guadalupe River project in 2010 through 2012 are shown in Figure 2.

Since 2011, fish kills have not been observed in the Guadalupe River Watershed including Alviso Slough. Dissolved oxygen concentrations were generally above 5.0 mg/L at all river sites monitored. Dissolved oxygen concentrations in Alviso Slough were below 5.0 mg/L in the fall of 2012, however these concentrations did not appear to be related to runoff during storm events.

Enhanced Control Measures Taken To-date

In addition to monitoring conducted in 2010, 2011 and 2012, it is our understanding that the City of San Jose and City of Santa Clara also began to evaluate and implement enhanced management actions at stormwater pump stations identified as potentially contributing to the fish kills in Guadalupe River. Following the 2008 fish kill event San Jose staff brought to bear considerable resources to address and identify possible sources of high concentrations of fecal indicator bacteria at the Gold Street pump station with no conclusive results. The City also conducted outreach in the surrounding Alviso area to help raise awareness and encourage reporting of illegal dumping to the City's hotline, and additional stormwater inspections were directed to the area. The City continues to explore additional options for reducing risk of illicit discharges (e.g., illegal dumping from recreational vehicles). Information regarding San Jose's actions in response to the 2008 event was included in the City's Fiscal Year 2008/09 Annual Report. A map that includes the location of the pump stations in comparison to monitoring sites is also included in the report.

It is our understanding that the City of San Jose is also taking additional steps to improve water quality in the catchments draining to the Gold Street and Rincon 2 pump stations. Capital projects are in initial planning stages to significantly reduce the amount of infiltration to the Gold Street pump station from the adjacent marsh. Conditional upon available funding, projects include lining the storm sewer mains and relocating the currently submerged outfall for the pump station. This should benefit the system by limiting the intrusion of corrosive, highly saline water into the pump station wet well, and excluding water high in bacteria from avian sources. To address possible human sources of bacteria, it is our understanding that outreach to residents has been completed to improve awareness of possible instances of illegal dumping. All storm drain inlets in Alviso have been re-marked with highly visible and durable thermoplastic markers, including the City's "No Dumping" hotline number. The City is also exploring the feasibility of installing a sanitary dump site at Alviso Marina County Park to provide an alternative to illegal sanitary dumping in the area. We also understand that the Rincon 2 pump station has been added to the yearly rotation of pump station cleaning by the City's Department of Transportation. Additional water quality improvements are anticipated.

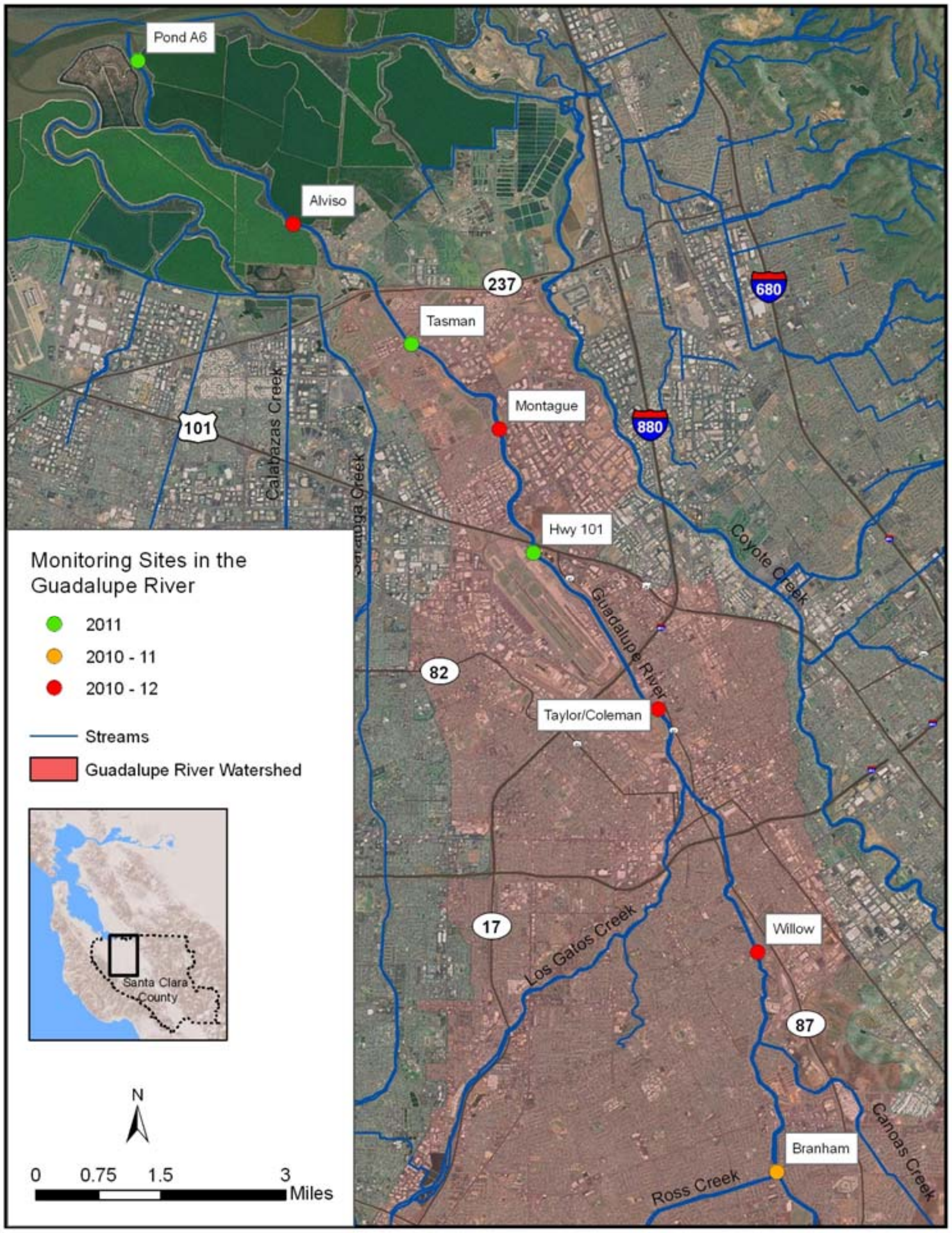

Figure 2. Sites monitored for water quality in Guadalupe River during fall season 2010 - 2012.

We understand that in late fall 2009, the City of Santa Clara conducted multiple stormwater inspections of businesses within the Victor Nelo pump station drainage area to evaluate potential sources of fecal indicator bacteria (FIB) (e.g., portable toilets, recreational vehicles). In addition, City of Santa Clara staff inspected the storm drain system draining to the pump station at selected manhole locations in an attempt to identify sources of dry season flows. The City also conducted an inspection and cleanout of the stormwater bypass draining a private property parcel to the Victor Nelo pump station. During maintenance of the pump station, at least 18 inches of organic matter that had deposited behind sand bags in the bypass was removed and disposed by the City. It is possible that this organic material may have contributed to the high concentrations of FIB enumerated at the Victor-Nelo pump station.

Planned Next Steps and Time Schedule

The Program, City of San Jose and the District will continue implementing the stressor/source identification project in the Guadalupe River during 2013. Efforts will generally focus on continuing to implement control measures described in this letter, observing whether fish kills occur during 2013, and responding to fish kills, should they occur. Planned next steps in 2013 are further described in Table 2.

Table2. Planned next steps and planned time schedule for Guadalupe River Stressor/Source ID Project.

Task	Description	Proposed Time Schedule
Develop Conceptual Model	Develop a conceptual model of potential sources and processes contributing to fish kills in Guadalupe River and Alviso Slough. The conceptual model will be used to develop hypotheses of all potential sources/processes relevant to fish kills observed in 2008, 2009 and 2010. Information collected to-date to answer hypotheses will be used to prove/disprove hypotheses to the extent possible.	February - April 2013
Develop Monitoring Plan	Develop a monitoring plan describing hypotheses of sources/processes, the parameters, methods, sampling locations and frequency of monitoring that will be conducted to better understand and help identify sources/processes. Develop criteria that will be used to evaluate the importance of each source/process.	April – May 2013
Field Monitoring and Observations	Conduct field observations following the first seasonal flush event of Water Year 2013 (i.e. fall 2013). Conduct follow-up source/process monitoring if needed.	September – December 2013
Data analyses and reporting	Analyze and report results of hypotheses testing, including comparisons to thresholds/criteria selected to determine importance of potential stressors/sources. A refined conceptual model will also be developed. Submit all data collected to the RWQCB and the Regional Data Center by March 15, 2014, in concert with the Integrated Monitoring Report (IMR). A final report on monitoring conducted to-date and control measure implementation will be included as part of the Integrated Monitoring Report and submitted to the RWQCB by March 15, 2014.	December - March 2014
Enhanced Control Measure Implementation and Further Evaluation	Control measure implementation that is currently underway will continue in 2013. Additionally, based on the results of the hypotheses testing conducted, additional control measures may be evaluated via a desktop analysis exercise and included (as necessary) as part of the Integrated Monitoring Report and submitted to the RWQCB by March 15, 2014. Further, it is also the intent to consider local historical ecology as well as anthropogenic modifications that may not be reversible. In addition, information on future flood control plans will be collected and, where practicable, incorporated into the analysis.	July 2013 – March 2014

Planned Coordination with Water Board Staff and Reporting Schedule

In addition to the planned next steps described in Tables 1 and 2, SCVURPPP program staff and staff from the City of San Jose and the District plan to continue coordinating with Water Board staff on the monitoring projects through written and verbal communications and meetings (as needed). SCVURPPP program staff plan to continue providing opportunities to Water Board staff for informal review and comment on draft documents, including conceptual models and monitoring plans. Interpretative reports and electronic data will be submitted by March 15th of each year and include data collected during the previous Water Year (i.e., previous September through October).[2] It is our understanding that the City of San Jose and District staff will report any observations of fish kills in Guadalupe River or Coyote Creek to the Water Board in the manner and timeframe requested in the Water Board staff's December 29th letter. If no fish kills are observed during 2013, the appropriate Water Board staff will be notified.

We look forward to continuing to work with you and your staff on successfully implementing the Coyote Creek and Guadalupe River stressor source identification projects. Should you have questions regarding the status update, planned next steps and time schedules presented, please feel free to contact Chris Sommers (csommers@eoainc.com), the SCVURPPP monitoring and assessment program coordinator.

Sincerely,

Adam W. Olivieri, Dr.PH, P.E.
SCVURPPP Program Manager

cc. SCVURPPP Management Committee
BASMAA Board of Directors
Jan O'hara, SF Bay Water Board
Naomi Feger, SF Bay Water Board

[2] Water Year 2012 Interpretative Reports for Coyote Creek and Guadalupe River are included as Appendix C1 and C3 of the *Water Year 2012 Urban Creeks Monitoring Report*, submitted by BASMAA on behalf of all Permittees.

C3

Interim Monitoring Project Report – Guadalupe River

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Interim Monitoring Project Report
Stressor/Source Identification Project (Guadalupe River)

Conducted in compliance with Provision C.8.d(i) of Order R2-2009-0074

September 15, 2012

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1.0 INTRODUCTION

This project was conducted in compliance with provision C.8.d(i) of the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074). This MRP provision requires Permittees to conduct monitoring projects to identify and isolate the sources and/or stressors associated with potential water quality impacts. Permittees are complying with this requirement via Program-led monitoring in coordination with the Bay Area Stormwater Management Agencies Association's (BASMAA) Regional Monitoring Coalition (RMC).[1] This interim report serves as a demonstration of progress made toward complying with Provision C.8.d (i). The project was included and is consistent with monitoring tasks described in the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) Fiscal Year 2011-12 Work Plan.

The Guadalupe River Stressor/Source Identification Project was triggered by previous Program and Permittees observations that suggested portions of Alvisio Slough and the lower Guadalupe River may have reduced water quality. Most specifically, dead fish in varying numbers were observed in 2008 and 2010 in Alviso Slough and in the Guadalupe River in 2009, following the first runoff events of the wet weather season.

The monitoring project was intended to answer the following questions related to water quality in these receiving waters, with a focus on water quality conditions in the Guadalupe River and Alviso Slough during the fall season, including the initial storm events of FY 2011-2012:

1) What is the spatial and temporal variability in water quality conditions during the late dry weather and early/mid wet weather seasons?
2) Are water quality impacts observed in Alviso Slough and Guadalupe River during and following the first rainfall event of the season?
3) To what extent do monitoring results provide information to identify and prioritize potential water quality stressors or sources that may cause or contribute to fish kills?
4) Are potentially toxic algal species observed in Alviso Slough?
5) Do algal toxins represent a potential stressor in Alviso Slough after the first rainfall event of the wet weather season?

The monitoring project was implemented by the Program, City of San José and Santa Clara Valley Water District (SCVWD) beginning late summer through fall of 2011-12.

2.0 BACKGROUND

2.1 PREVIOUS STUDIES

Through a review of existing readily available information, several pertinent water quality studies and observations have been conducted in the Alviso Slough or Guadalupe River. The studies most pertinent to this stressor/source identification project are summarized below.

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[1] All water quality monitoring activities required by Provision C.8 are coordinated regionally through the BASMAA Regional Monitoring Coalition (RMC). In a November 2, 2010 letter to Permittees, the Water Board's Assistant Executive Officer (Thomas Mumley) acknowledged that all Permittees have opted to conduct monitoring required by the MRP through the RMC.

2.1.1 Tidal Sloughs in the South Bay

Fish Kills in Alviso Slough

Fish kills were observed in Alviso Slough following first storm event of the season during 2008 and 2010. On October 8, 2008, approximately 4 days following the first storm of the season, dead striped bass were observed within an area that extended from one mile downstream of the Alviso Marina to about 1 mile upstream of the Gold Street Bridge in the town of Alviso (EOA 2010). In October 2010, another fish kill was observed in Alviso Slough and in Coyote Creek (upstream of the salt pond discharge points) following the first storm event of the season (Hobbs 2010). Although specific causes for the fish kill events described above have not been verified, it is presumed that low DO concentrations in the receiving waters following the first storm event may have been an important factor.

Dissolved Oxygen

Since 2004, there have been several studies conducted by the United States Fish and Wildlife Service (USFWS) and United States Geological Survey (USGS) in an area referred as the Alviso Salt Pond Complex (Shellenbarger et al., 2008), which includes the Guadalupe, Alviso and Artesian Sloughs and former salt evaporation ponds adjacent to these sloughs. The studies were conducted primarily to evaluate the water quality impacts of salt pond discharges to receiving waters. One component of these studies was to evaluate potential effects of pond discharge on dissolved oxygen (DO) concentrations in the tidal sloughs. Salt ponds can provide favorable conditions for algal growth and phytoplankton blooms, particularly in the summer, which can result in anoxic conditions in some of the ponds. The discharge of low-DO water from these ponds to the adjacent sloughs can affect slough water quality to the detriment of slough biota.

The USGS, on behalf of USFWS, has conducted water quality monitoring in several ponds within the Alviso Pond Complex during the months of June to October, on an annual basis from 2004 to the present. Monitoring efforts include continuous water quality measurements at various locations of the ponds, including the discharge points to the sloughs and Bay. In addition, water quality was measured on a monthly basis during the same time period at various locations in the sloughs, including seven sites in Alviso Slough. Management actions are required (i.e., reduction in pond discharge volumes) when DO concentrations fall below 3.3 mg/L in greater than 10% of discharge readings over a weekly interval. Water quality results are summarized in annual self-audit reports produced by USFWS (http://www.southbayrestoration.org/monitoring/#nsp).

The USGS also conducted a special study during summer season of 2007 to compare DO concentrations in sloughs with and without influence from salt pond discharges, and to determine the effect, if any, salt pond discharges have on Guadalupe Slough DO concentrations. The results indicated that DO concentrations in the three sloughs (Mowry, Newark and Guadalupe) varied semi-diurnally with the lowest DO concentrations occurring during low tides and the highest concentrations occurring during high tides (Shellenbarger et al., 2008). This result suggests that Bay water has higher DO concentrations compared to the sloughs. Lower DO concentrations in Guadalupe Slough compared to the other sloughs indicate distance from the Bay might be an important factor effecting slough DO.

The USGS study also found that in general, pond discharge effects DO concentrations in the slough at low tide, when pond discharge is greatest and dilution of slough water was smallest. However, at some ponds, during the late mornings during lower low water tide, DO in the discharge pond increases due to photosynthetic activity. At these ponds, the higher DO water moves into the slough during low tide resulting in higher DO concentrations in the receiving water. The USGS study results showed that DO concentration averaged over the entire study period was significantly lower in the pond than in the slough (p<00001, t-test).

In addition to the USGS and USFWS, the City of San José conducted continuous water quality monitoring at one location in Alviso Slough during wet weather conditions in 2009 and 2010. Monitoring equipment was not deployed in time to capture the first storm event of the season for either year; however, measurements made approximately 2 days after the initial event in 2010 showed DO concentrations were below 2 mg/L (San José 2011). Similar to patterns observed at monitoring sites farther upstream in Guadalupe River, the DO concentrations gradually increased with time following the storm (see Section 2.1.2).

2.1.2 Guadalupe River

Fish Kills in Guadalupe River

In 2009, dead fish were observed well upstream of Alviso Slough, into the Guadalupe River. Two days following the first storm of the season on September 14, 2009, a large fish kill (visual estimate of 200 fish comprised of Sacramento suckers, California roach, carp, largemouth bass and sunfish) was observed along an 8.5 mile reach of Guadalupe River between the Willow Glen Way Bridge and Tasman Boulevard during field reconnaissance conducted by SCVWD and San José staff (Brett Calhoun, SCVWD, personal communication, 2009). Although a specific cause for the fish kill event described above has not been verified, it is presumed that low DO concentrations in the receiving water following the first storm event may be an important factor.

Dissolved Oxygen

Continuous water quality monitoring was conducted in the Guadalupe River by the City of San José and City of Santa Clara in 2009 (EOA 2010), and the City of San José and the SCVWD in 2010 (San José 2011). The monitoring study in 2009 was conducted in response to requirements from the Water Board to investigate water quality from storm water pump station discharges during both dry and wet season. In addition to pump station monitoring, continuous water quality monitoring was conducted in Guadalupe River to provide greater context to the pump station water quality results. Results of the study indicated that dissolved oxygen concentrations in pump station discharges were well above 3 mg/L, and therefore not believed to pose a threat to receiving water quality. Continuous water quality measurements indicated that DO concentrations were reduced during and directly following storm events, with the lowest measured DO concentration (< 2 mg/L) just following the first monitored storm[2] of the wet season. The three continuous water quality monitoring sites were focused around stormwater pump stations, which are located downstream of Highway 101. As a result, condition of receiving water upstream of Highway 101 was not monitored during the study.

Building off of information collected in 2009, the City of San José conducted more detailed monitoring of storm water pump stations and receiving water in Guadalupe River during the 2010 dry season. In addition, the City of San José and SCVWD conducted continuous water quality monitoring at sites upstream and downstream of Highway 101 during first flush event of the wet season, at a total of five sites. Continuous water quality measurements indicated that DO concentrations at four Guadalupe

[2] The monitoring equipment was installed 2 days following the first flush event of 2009, so water quality was not recorded prior and during the actual event.

River sites were reduced during and directly following first measured storm event[3]; however the mean DO did not fall below 6 mg/L (San José 2011). Results of the study indicate pump station water quality did not appear to be a threat to receiving water quality and DO concentrations in Guadalupe River did not exceed water quality objectives during dry or wet season events. It is important to note however, that water quality measurements were not made for the entire duration of the initial storm event. As a result, the RWQCB requested additional monitoring from the City of San José in 2011. The City complied with this request, and the results of that additional monitoring are included in this report as requested by the RWQCB as Attachment B.

2.2 ALGAL TOXINS

Many different species of algae and cyanobacteria that commonly bloom in California waters produce toxins that are known to detrimentally affect fish species, causing decreased growth rates, metabolism, and mortality. Microcystins (MC) represent a large variety of heptotoxins produced by cyanobacteria such as *Microcystis*, *Anabaena*, *Oscillatoria*, and *Nostoc*. These toxins have been identified in fresh and brackish waters throughout CA (Statewide Blue-green Algae Workgroup, 2010), accumulate in the liver and muscle tissues of fish, and have caused mortality via feeding experiments in both common carp (C. carpio) within 8 hours, and rainbow trout (O. mykiss) within 96 hours (Malbrouk & Kestemount, 2006). *Prymnesium parvum* is a HAB species that has been identified in fresh and brackish waters throughout 18 states in the US, including CA. Over 34 million fish mortalities in Texas freshwaters have been attributed to *P. parvum* blooms, and their associated toxins called prymnesins (Brooks et al 2011). Paralytic Shellfish Toxins (PSTs) are large class of neurotoxins produced by several different dinoflagellate species, known to cause large-scale mortality events in marine finfish (White, 1981; Jester, et al. 2009). *Cochlodinium polykrikoides,* a dinoflagellate that has been blooming more frequently on the California coast (Curtiss et al, 2008), exhibits a toxic affect on spotted red snapper (Dorantes-Aranda et al 2009) and lethal effects on juvenile bivalves (Zhong-Tang and Gobler, 2009), although the mechanism for this toxicity is still unknown.

If not directly responsible for mortality events, microbial populations may exhibit a cumulative stress effect that can contribute to disease or mortality in fish populations (Vethaak,et al 2011). In March 2011, a massive fish kill, including millions of sardines, occurred in King Harbor, Redondo Beach, CA. While depleted oxygen was determined the ultimate cause of death, fish taken from the event tested strongly positive for domoic acid (DA) (SCOOS Program News, 2011) a phycotoxin known to adversely affect swimming behaviors in anchovies (Lefebvre et al, 2001). Jester et al.2009 found PST toxins associated with *Alexandrium catnella* presence in four species of finfish and two rock crabs harvested in Monterey Bay, CA. Lehman et al (2005) found *Microcystis aeruginosa* widely distributed throughout 180 km of waterways in the upper San Francisco Bay Estuary, and confirmed low levels of MC present both in water samples and the estuarine food web.

The phytoplankton assemblages of South San Francisco Bay are not well characterized, and no study has specifically examined Alviso Slough. One USGS pilot study preliminarily examined phytoplankton assemblages of the South Bay Salt Ponds and found known toxic species including PST producers *Alexandrium* and *Gonyaulax*, and DA producer *Pseudo-nitszchia*. (Personal contact, James Cloern, USGS). Microcystis blooms occurred in Lake Almaden, located within the Guadalupe watershed, throughout the

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[3] Similar to 2009, the monitoring equipment was not installed until a few days after the first storm of the season, so water quality was not recorded prior and during the actual event.

late summer-fall of 2010, and microcystin was detected in low levels during non-bloom events in 2011 (Unpublished data courtesy of Carol Boland, City of San José).

Solid Phase Adsorption Toxin Tracking (SPATT) is a resin-based passive sampling method which has recently been shown effective in tracking DA, saxitoxin and other PSTs, and microcystin toxin events, even at low levels (Lane, 2010; Kudela, 2011). The method has also been widely used to track various other types of lipophilic phycotoxins. Coupled with general taxonomic identifications, SPATT represents a low cost, broad-scale method to investigate the potential presence of phycotoxins in Alviso Slough.

2.3 STUDY AREA

The Guadalupe River watershed covers approximately 170 square miles, with its headwaters originating on the eastern Santa Cruz Mountains (elevation 3,790 feet) and then flowing north to the South San Francisco Bay (SCBWMI 2001). The Guadalupe River begins at the confluence of Alamitos Creek and Guadalupe Creek, and flows 19 miles through urbanized portions of San José and Santa Clara. There are three major subwatersheds that enter the Guadalupe River, including Ross Creek (10 sq mi), Canoas Creek (19 sq mi) and Los Gatos Creek (55 sq mi). The northern portion of the river includes a 5-mile tidally influenced reach through Alviso Slough until it enters the South San Francisco Bay.

Water flow in the Guadalupe River is heavily managed, including 4 reservoirs (Lexington, Guadalupe, Almaden and Calero) several percolation pond systems, and two large flood control projects, one in the downtown San José area, completed in December 2004, and one in the lower Guadalupe, completed in August 2005. Dry weather base flow is regulated by reservoir releases. Base flows at the highway 101 bridge in summer have ranged from approximately 15 cfs in 2009 to approximately 25 cfs in 2010 (Figure 1). During this period, first flush peak flows occurred on September 14, 2009 (59 cfs) and October 17, 2010 (61 cfs).

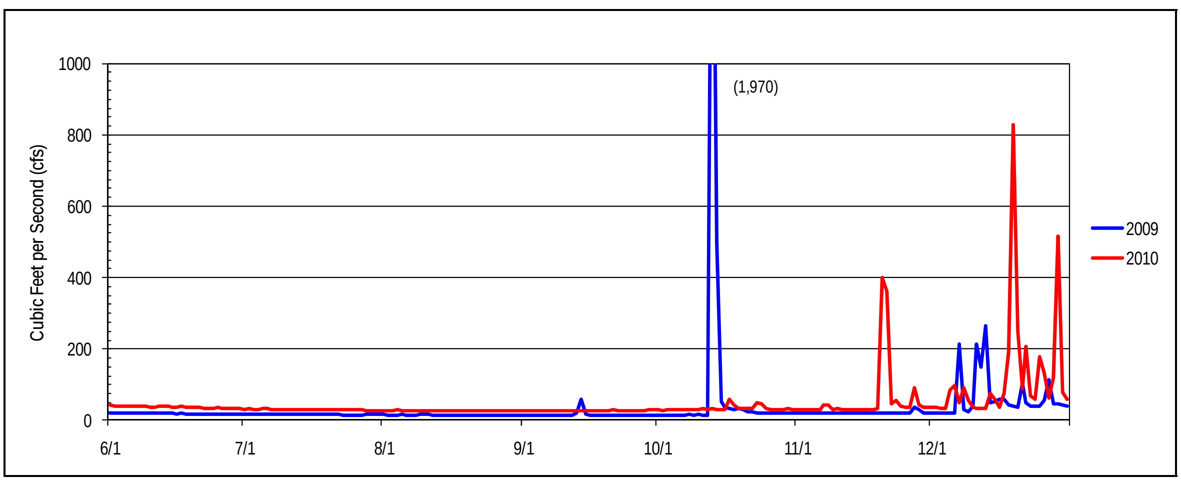

Figure 1. Guadalupe River discharge at USGS Highway 101 gage site from June through December, 2009 and 2010.

Alviso Slough is part of a complex system that includes freshwater flow from Guadalupe River, tidal inflow from San Francisco Bay and discharges from adjacent salt ponds. The salt ponds are part of the Alviso Salt Pond Complex (USGS 2007), which extend to Guadalupe Slough to the west and Coyote Creek to the east. Many of these ponds are currently being restored through a multi-agency effort to create tidal wetlands, bird habitat and recreation. Some of the salt ponds in Alviso Slough currently exchange water with the Bay or sloughs through control gates or levee breaches. As a result, biological and physical processes that occur in the ponds can strongly influence the water quality of the slough.

3.0 MONITORING AND SAMPLING METHODS

The monitoring project consisted of three components: 1) continuous monitoring of general water quality conditions in Alviso Slough and Guadalupe River; 2) monitoring in Alviso Slough for toxins produced by diatoms, dinoflagellates and cyanobacteria; and 3) characterizations of algal and cyanobacteria communities in Alviso Slough. In addition, visual observations for fish kills were conducted following the first season flush event and subsequent storms between October 3 and November 20, 2012. For continuous water quality monitoring, continuous monitoring equipment was calibrated, deployed and retrieved at a total of eight locations defined in Table 1 and illustrated in Figure 2. All water quality monitoring activities followed Standard Operating Procedures developed by the BASMAA Regional Monitoring Coalition (BASMAA 2011).

The City of San José collected, transported and stored algal taxonomy and algal toxin samples. Algal taxonomy and toxic samples were analyzed at Kudela Laboratory at UC Santa Cruz following methods described in Kudela (2011). The Program compiled all water quality data, conducted analyses, and provided preliminary results of compiled water quality data to the project team prior to the final report.

3.1 SAMPLE SITES

Sites that were monitored in Alviso Slough and the Guadalupe River are listed in Table 1, along with associated parameters and the entity leading the monitoring at each site. Monitoring locations are also shown in Figure 2.

Table 1. Continuous water quality monitoring sites in Alviso Slough and Guadalupe River and associated parameters.

#	Site Description	Latitude	Longitude	Continuous Water Quality	Algal Toxins	Algal Taxonomy	Lead Entity
1	Alviso Slough at south end of Pond A6	37.45816	122.02076	X	X	X	San José
2	Alviso Slough at boat ramp	37.43013	121.98613	X	X	X	San José
3	Guadalupe River at Tasman Blvd	37.40951	121.95993	X			SCVURPPP
4	Side Channel downstream Rincon 2 Pump Station	37.38486	121.93536	X			San José
5	Guadalupe River at Montague Exp	37.39490	121.94037	X			SCVURPPP
6	Guadalupe River at Highway 101/Airport	37.373439	121.93251	X			SCVURPPP
7	Guadalupe River at Taylor St.	37.34639	121.90475	X			SCVWD
8	Guadalupe River at Willow Glen.	37.30425	121.88225	X			SCVWD
9	Guadalupe River at Branham Ln.	37.26611	121.87728	X			SCVWD

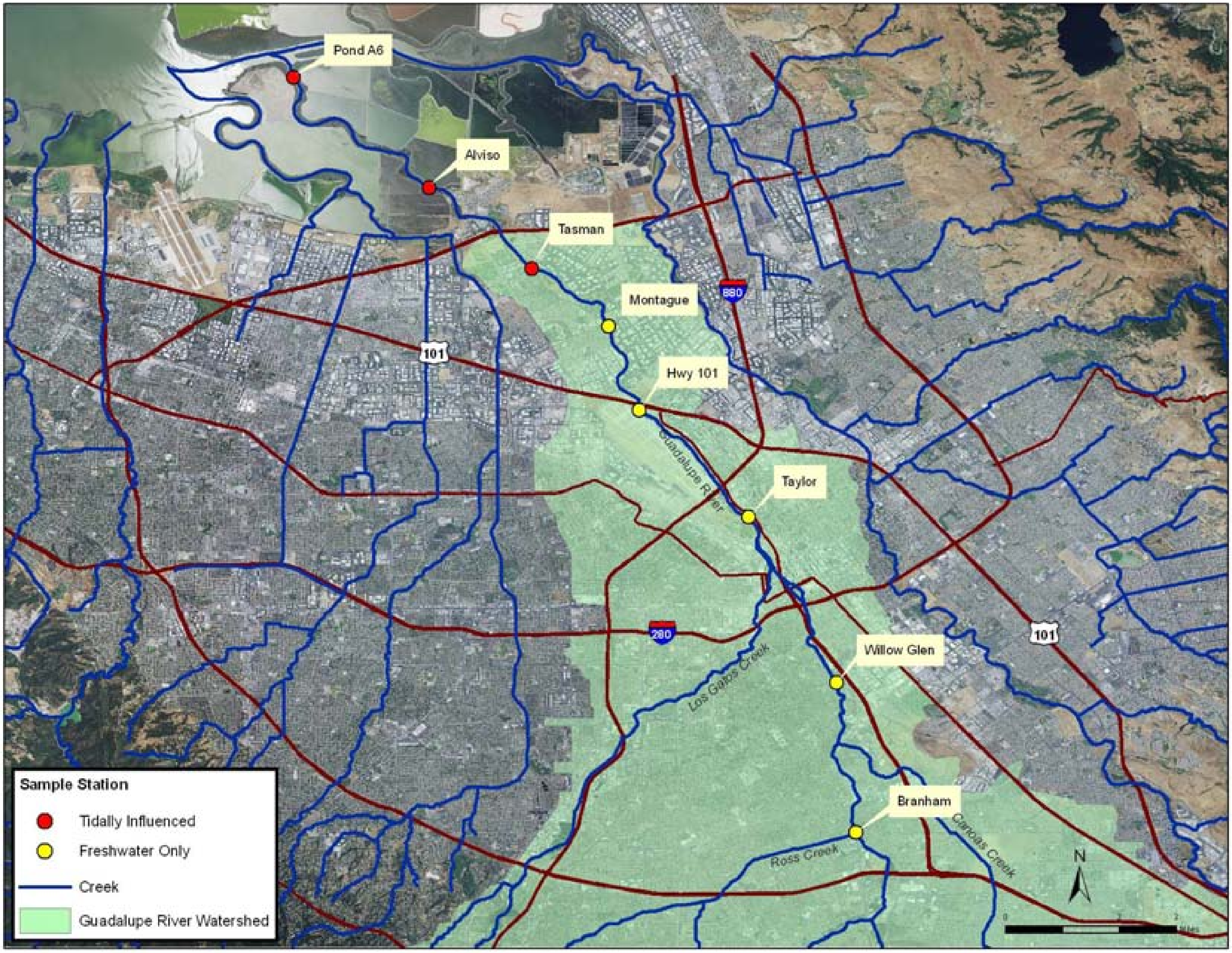

Figure 2. Continuous water quality monitoring locations in Alviso Slough and Guadalupe River.

3.2 MONITORING TIMING AND FREQUENCY

3.2.1 Continuous Water Quality

Continuous water quality monitoring equipment (data sondes) were deployed for approximately three months from September 8 through December 5, 2011 and were programmed to collect dissolved oxygen (DO), specific conductivity, pH, and temperature at 15-minute intervals. Field checks on continuous monitoring equipment were conducted approximately every two weeks to ensure equipment was working properly. During the field checks, data were downloaded from the sondes, and sensors were cleaned and re-calibrated. Probes and batteries were also replaced at this time when needed.

3.2.2 Algal/Cyanobacteria Toxins

Solid Phase Adsorption Toxin Tracking (SPATT) passive samplers (henceforth referred to as SPATT bags) were deployed at the Alviso and Pond A6 sites in conjunction with sonde deployments and calibration events that occurred approximately every two weeks between September 8 and November 3, 2011.

3.2.3 Algal/Cyanobacteria Taxonomy

Phytoplankton samples were collected at the Alviso and Pond A6 sites in conjunction with all sonde deployments and calibration events for taxonomic identification.

3.3 MONITORING METHODS AND EQUIPMENT

3.3.1 Continuous Water Quality

Calibration

The accuracy of sonde probe readings wwas checked against calibration standard solutions. Calibration of probes to these standards was performed at three different stages during the project: 1) initial deployment; 2) field checks; and 3) sonde retrieval. The post-run calibrations were used to check the data for accuracy and all data were flagged when measurement quality objectives were not met.

The pre- and post-deployment calibrations were conducted in the laboratory. Field calibrations occurred every 2-3 weeks for the duration of the project to ensure sensors were working properly and data were being recorded. An accuracy check for each sonde was conducted in the field before cleaning the probes to determine if potential fouling of sensors was affecting the accuracy of measurements. All sensors were then cleaned in the field and re-calibrated following instructions in Section 2.2 of SFBRWQCB (2011).

During field calibration checks, battery voltages were checked and batteries replaced if the voltage dropped below 10 volts. The batteries in the sonde located at the Alviso Slough boat ramp were drained on October 25, 2011 and were replaced during the following field check on November 3, 2011 when the problem was discovered.

Sonde Installation

At each monitoring site, the deployment location was established to limit access and visibility of equipment to reduce potential for vandalism or theft. Sites were selected to ensure that sondes were continually submerged during any anticipated change in flow stage.

Sondes were attached to metal cages – constructed with heavy gage 3/8 inch metal framing – with weights attached to the base (Figure 3). The sonde is attached to the metal cage using hose clamps. The metal cage can be placed in deepest part of the channel and anchored to a fixed location on the bank (e.g., tree) using stainless steel cables and key locks. The cage protects the equipment and keeps sensors about 6 inches off the stream bottom to reduce potential for fouling by fine sediment. Sondes in Alviso Slough were installed and positioned to avoid potential interference from boat traffic.

Figure 3. Metal cage used to secure sonde during deployment.

Prior to installation, the sondes were programmed and the transport/calibration cup was then replaced with the probe guard. Water quality measurements were taken with a hand-held multiparameter sonde prior to deployment and recorded on field sheets. Channel dimensions and other relevant sampling event information were recorded on the standard field sheet during installation.

3.3.2 Algal/Cyanobacteria Toxins

Solid Phase Adsorption Toxin Tracking (SPATT) bags were secured with a zip tie to the top of the metal cage holding the sonde. Once cage with sonde was deployed, the bags were situated approximately 10-12 inches off the bottom of the slough. SPATT bags were installed and retrieved during sonde deployment and field checks. Following retrieval, SPATT bags were archived in a freezer (0 °C) until ready for analyses. Toxin analyses were conducted by the Kudela Lab at UC Santa Cruz using methods described in Kudela (2011).

3.3.3 Algal/Cyanobacteria Taxonomy

Phytoplankton was collected using a combination of Vandorn water sampler and net tows at both the time of deployment and retrieval of SPATT passive samplers. Samples were collected from both the water surface and in close proximity to the bottom, composited and preserved with formalin. The samples were stored in a cooler and transported back to the laboratory for storage. All samples were later shipped in wet ice to the Kudela Lab at UC Santa Cruz for taxonomic identification.

3.3.4 Rainfall and Stream Flow

Fifteen minute rainfall data were obtained from two of SCVWD's ALERT (Automated Local Evaluation in Real Time) stations located in the lower Guadalupe River watershed at the City of San Jose's Office of Emergency Services (ALERT 1453). Stream flow was measured at United States Geological Survey (USGS) station located at Highway 101 (USGS 11169025) at the San Jose Airport downstream of the Highway 101/Airport sonde location.

3.4 DATA QUALITY ASSESSMENT METHODS

3.4.1 Continuous Water Quality

The continuous water quality data was exported to Microsoft Excel™ using the YSI EcoWatch software. These data were reviewed to flag potential outliers, such as data collected during brief exposure of probes to air. At the Tasman site, the sonde was exposed several times during low tide. Data from exposed time periods were removed and the sonde was re-deployed in the center on the thalweg during subsequent field checks.

The pre- and post-deployment calibration data was reviewed to determine if measurements met the Measurement Quality Objectives (MQOs) presented in Table 2. Any parameters that exceeded these MQOs were flagged as estimated or rejected depending on how severely they exceed the MQOs. At the Tasman site, the pH probe readings began to drift during the second and third field checks and the probe was subsequently replaced on October 20, 2011. As a result, the pH data prior to October 20, 2011 was flagged and removed.

Table 2. Measurement Quality Objectives for field measurements

Water Quality Parameter	Units	Resolution	Reporting Limits
Temperature	º C	0.01	-5.00 – 50.00
Dissolved Oxygen	mg/L	0.01	0.00 – 50.00
pH	pH units	0.01	0.00 – 14.00
Conductivity	uS/cm	1	0 – 100,000

4.0 RESULTS

4.1 STREAM FLOW AND RAINFALL

Four small storm events occurred during the monitoring project (Table 3). The first seasonal flush was the largest of the four storms (0.64 inches) and produced the largest increase in stream discharge (423 cfs) (Figure 4). Subsequent storms during November 3-5 and 18-20 resulted in a maximum discharge of 197 and 239 cfs, respectively. The seasonal base flow (excluding peak flows associated with four storm events) ranged on average between 32 and 36 cfs throughout the project (figure 4).

Table 3. Duration and magnitude of storm events during monitoring project.

Time Period	Precipitation (inches)[1]
October 3 - 6	0.64
October 10 - 11	0.12
November 3 - 5	0.32
November 18 - 20	0.24

[1] Precipitation data from SCVWD Alert Gage 1453 at City of San Jose Office of Emergency Services.

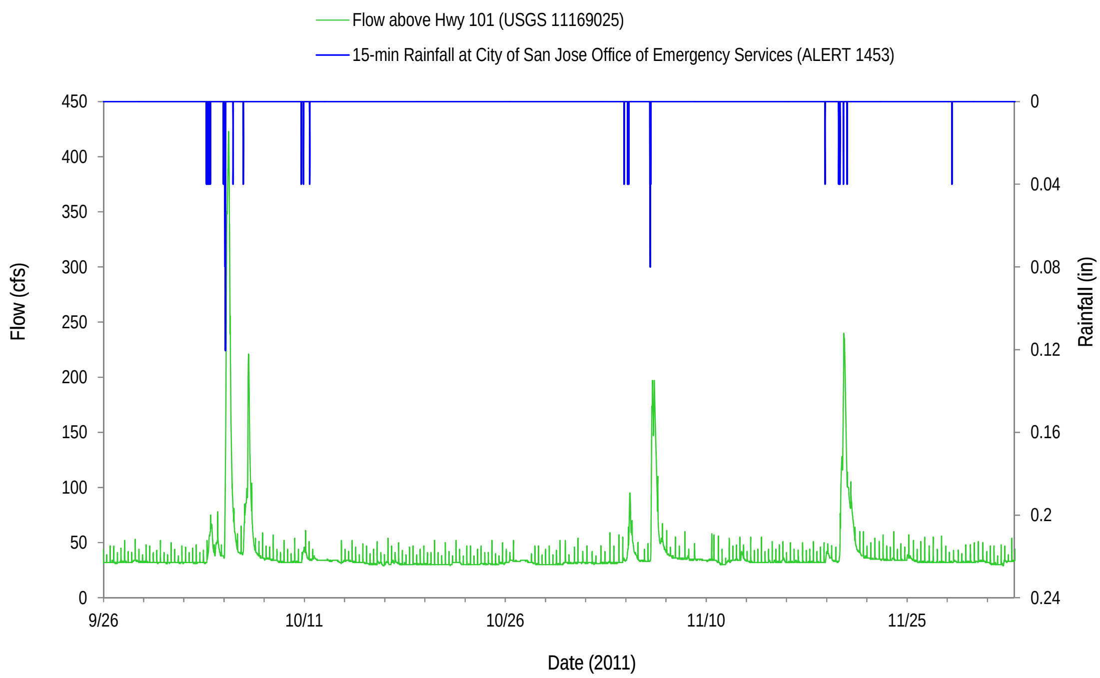

Figure 4. Rainfall (gage at City of San Jose City of Emergency Services) and stream flow (USGS gage at Highway 101) data collected during the 2011 study period.

4.2 TEMPERATURE

Water temperature measurements taken at the eight monitoring locations during the study period are shown in Figure 5. Minimum and maximum air temperature (taken at the San Jose Airport) and total rainfall (measured at Downtown San Jose) is also shown in the figure. Water temperature follows a pattern similar to minimum air temperature, gradually declining during the study. Water temperatures were typically reduced for short periods following each of the three storm events.

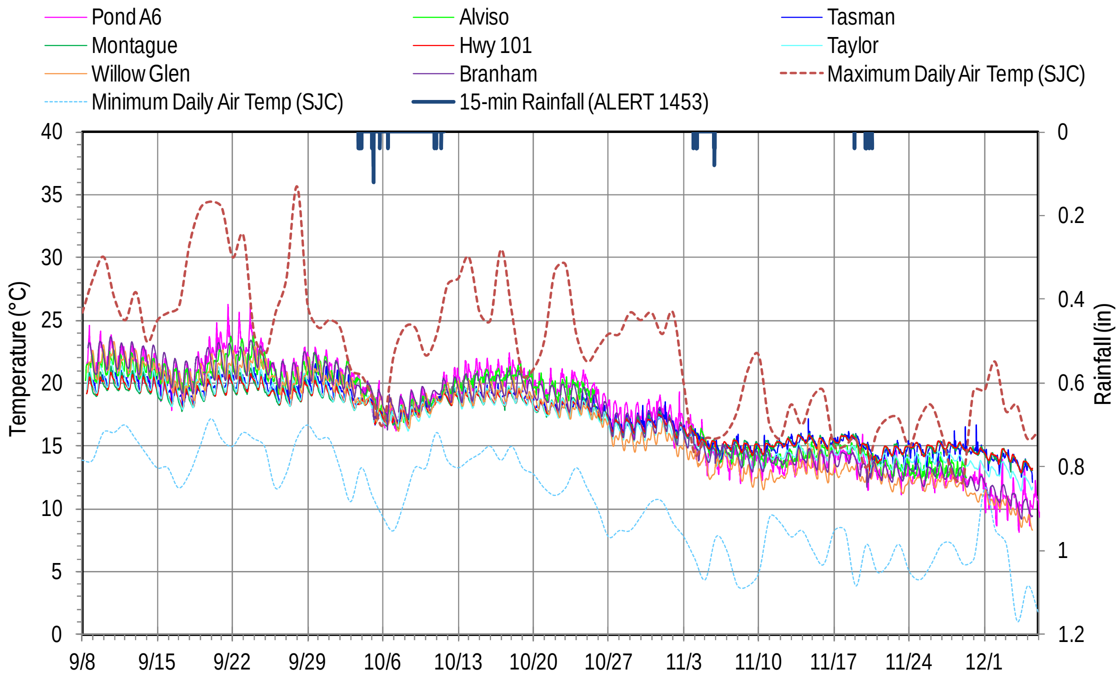

Figure 5. Water temperature at the eight monitoring sites, maximum and minimum air temperature at San Jose Airport, and 15-minute rainfall in downtown San Jose (ALERT 1453) during September-December 2011.

The distribution of water temperatures for each station is shown as box and whisker plots in Figure 6. There was minimal variability (< 2 degrees) in mean temperatures across all sites. The range of water temperature values was greatest at the two slough sites and at the two highest elevation creek sites.

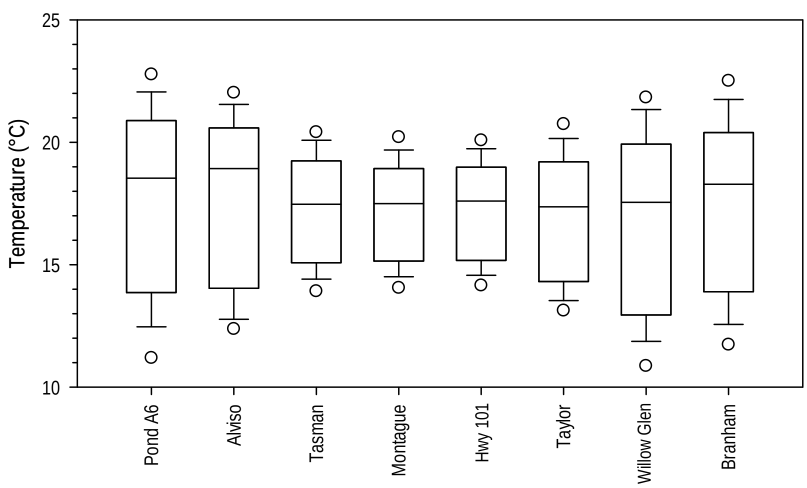

Figure 6. Box and whisker plots of water temperature recorded at eight stations during monitoring project. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

4.3 DISSOLVED OXYGEN

The distribution of dissolved oxygen concentrations for each site, presented as percent saturation[4], is shown in Figure 7. The temporal (both diurnal and weekly) variability of DO concentrations was greatest at the two slough sites compared to the creek sites. There was no apparent spatial trend in DO concentrations across creek sites. DO concentrations were reduced for a short period following each storm event at most sites, with the largest declines observed at the Alviso, Tasman, Montague and Willow Glen sites. DO levels typically returned to pre-storm concentrations after a few days.

The distribution of dissolved oxygen measurements for each station is shown as box and whisker plots in Figure 8. The mean DO concentrations at all the creek sites were above the Basin Plan Water Quality Objectives (WQO) for Cold Freshwater Habitat (COLD) Beneficial Use (7 mg/L). All DO measurements taken at the six creek sites were above the Basin Plan WQO for Warm Freshwater Habitat (WARM) (5 mg/L). The two lowest median DO concentrations occurred at the Alviso and Pond A6 sites, with the lowest recording of DO (< 2.0 mg/L) occurring at the Alviso site.

The DO concentrations at the slough sites appear to be affected by both daily and monthly (i.e., neap and spring) tidal cycles (Figure 9). The daily peak DO concentrations at Pond A6 site (which is at the north end of the slough, closest to the bay) appear correlated with high tide marks. The daily peak DO at the Alviso site is slightly offset with the tidal peaks, likely due to its southern position in the slough and time delay for tides to affect the water quality. In both cases, it appears that incoming water from the San Francisco Bay increase the DO levels in the slough.

[4] Percent Saturation (% Saturation) is the amount of dissolved oxygen in the water compared to the maximum amount that could be present at the same temperature.

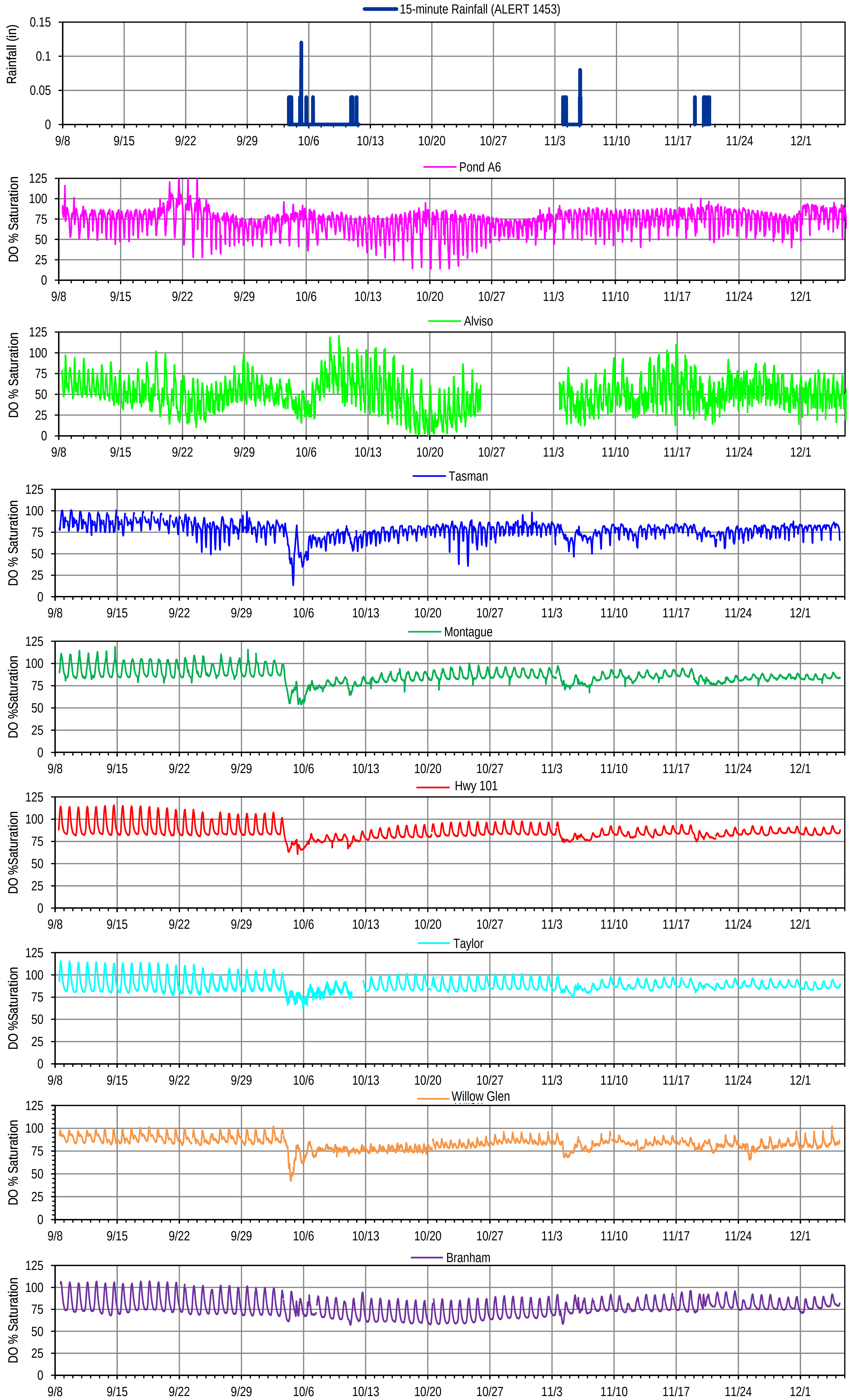

Figure 7. Dissolved oxygen percent saturation measurements made during September - December 2011 at eight monitoring stations in Alviso Slough[5] and Guadalupe River. Precipitation levels during the monitoring period are also shown.

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[5] DO measurements taken at Alviso during late October-early November were not recorded due to loss of battery power in the sonde.

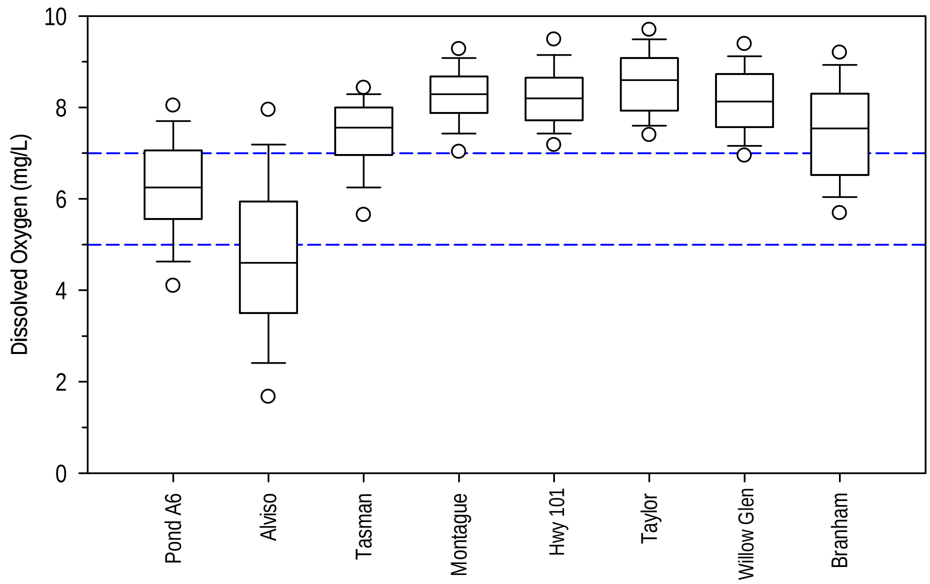

Figure 8. Box and whisker plots of dissolved oxygen recorded at eight stations during monitoring project. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

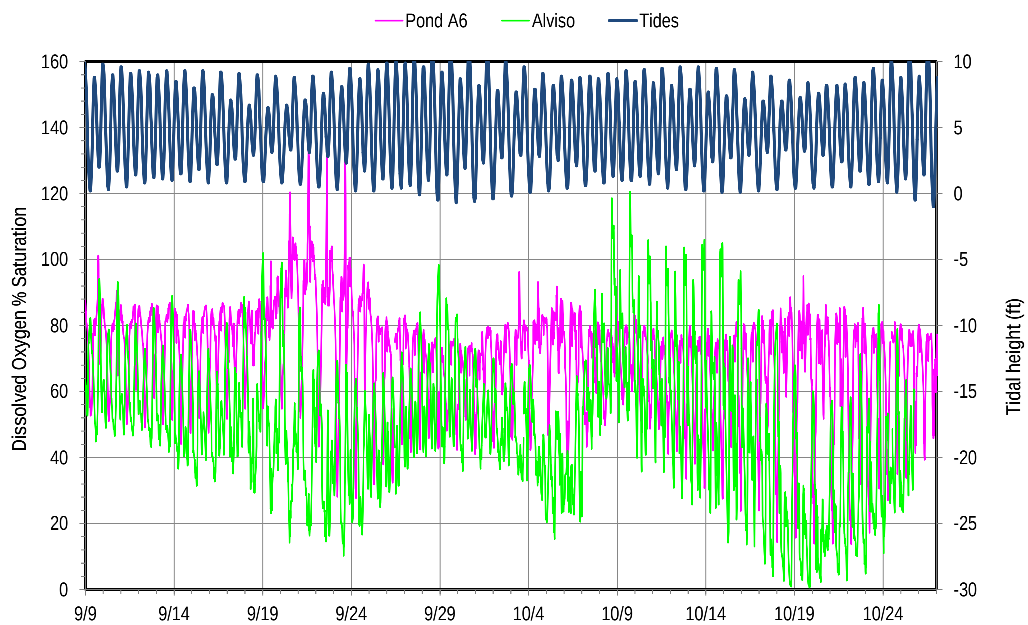

Figure 9. DO concentrations and tidal height[6] at two slough sites shown for first 45 days of monitoring, including period before and after the first seasonal flush.

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[6] Tidal data was provided by City of San Jose and was derived from a software program called *Nobeltec Tides & Currents* by Jeppeson Marine (version 3.5), which uses NOAA and Canadian Hydrographic Services (CHS) data to make tidal predictions.

Trend at the slough sites shows fluctuations in the overall range of DO concentrations every 1-2 weeks. These changes may be related to changes in tides associated with lunar cycle. There were highly saturated DO concentrations at the Alviso site following the first seasonal flush, subsequently followed by a drop in DO 1-2 weeks later. This may be explained by period of high photosynthetic activity associated with increased algal production (October 8-16), followed by a sharp reduction in DO associated with algal die off, reduced irradiance in water and subsequent increased levels of algal respiration (October 17-24).

DO concentrations at the creek sites were less variable, with a slight shift to lower DO concentrations between the months of September and October/November. All eight sites exhibited diurnal variation in DO concentrations.The time-average dissolved oxygen percent saturation at the Montague site is shown in Figure 10 with highest concentrations occurring during the early evening between 5:00 and 6:00 PM and the lowest levels between 6:00 and 9:00 in the morning.

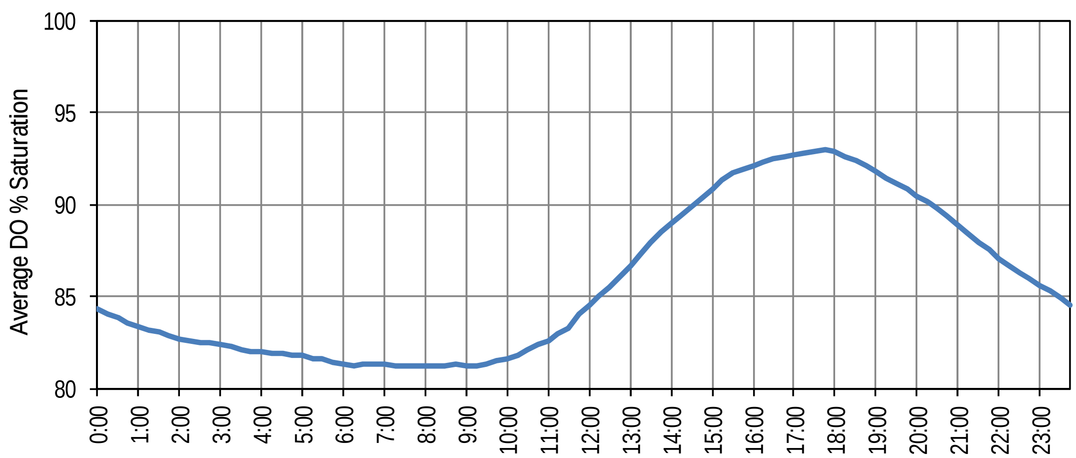

Figure 10. Time-average dissolved oxygen percent saturation at the Montague site.

4.4 PH

The distribution of pH measurements recorded at all eight monitoring stations is shown in Figure 11. The range of pH was between 6.5 and 8.5 during the study period at all eight sites. There was minimal spatial variability across creek sites, with the exception of Willow Glen, which consistently had higher pH compared to all creek sites. The pH drops at all sites, excluding Pond A6 site, following each storm event.

4.5 SPECIFIC CONDUCTIVITY

Conductivity generally increased at sites going from upstream to downstream direction (Figure 12). The conductivity at slough sites exhibited large fluctuations largely influenced by tides. There was minimal variation in conductivity at creek sites, except during storm events, which results in big decreased for short period following the storm (Figure 13).

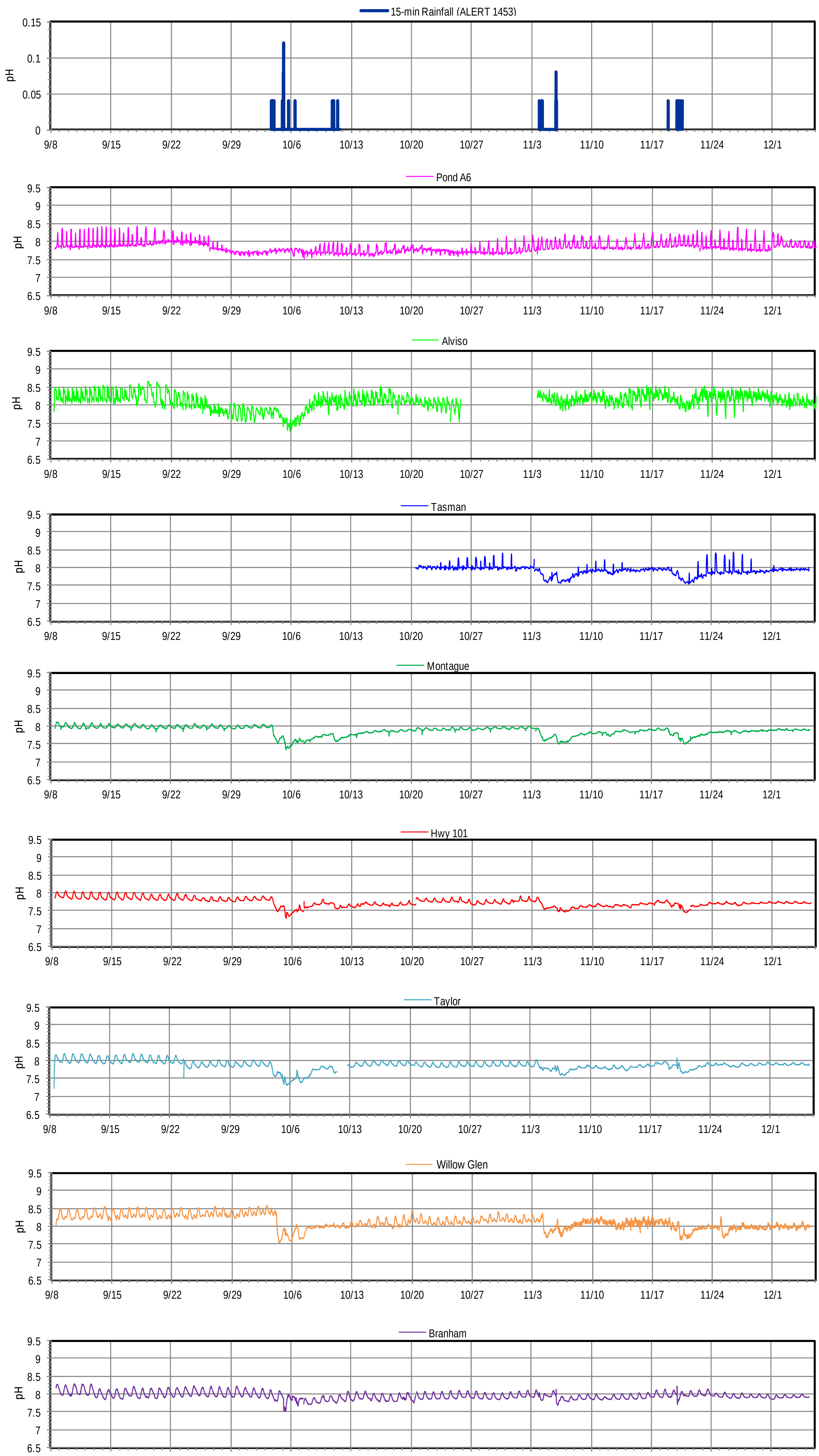

Figure 11. pH measurements made during September - December 2011 at eight monitoring stations in Alviso Slough[7] and Guadalupe River. Precipitation levels during monitoring period are also shown.

[7] pH measurements taken at Tasman during the first half of the study were removed due to sensor malfunction. pH measurements taken at Alviso during late October-early November were not recorded due to loss of battery power in the sonde.

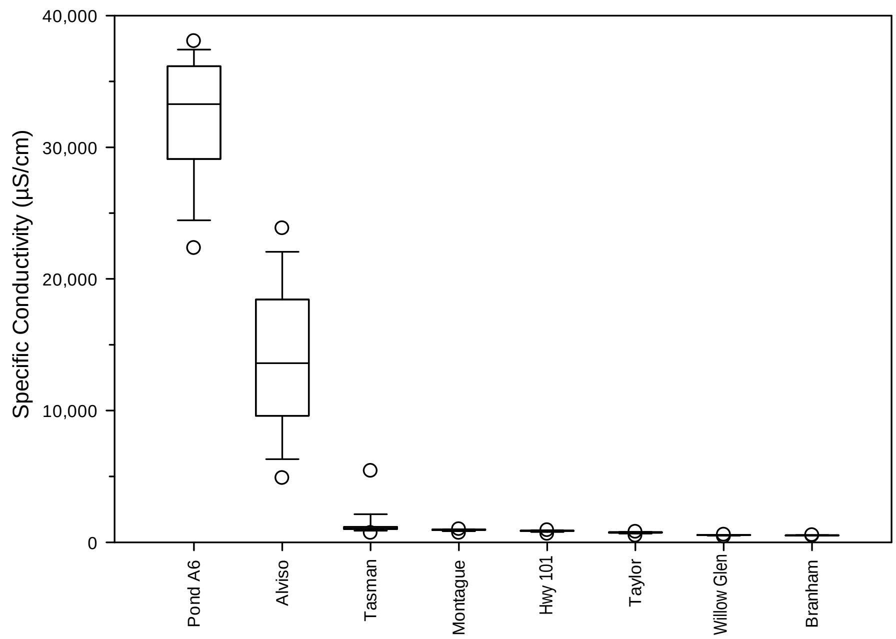

Figure 12. Box and whisker plots of specific conductivity recorded at eight stations during the monitoring project. The median is indicated by the midline of the box, the upper and lower edges of the boxes are the 75th and 25th percentiles, respectively, while the edges of the whiskers are the 10th and 90th percentile.

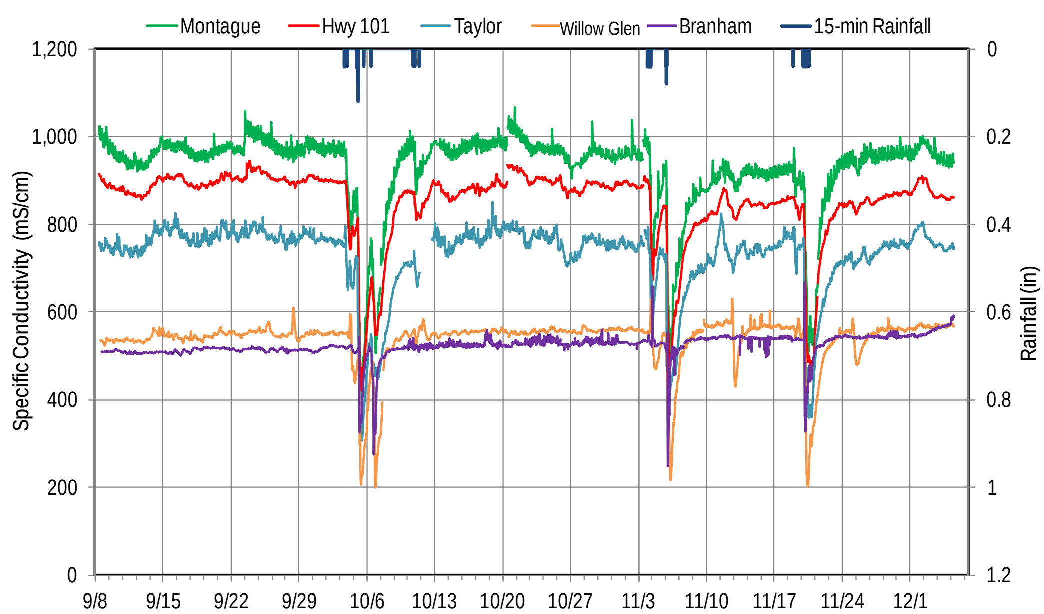

Figure 13. Specific conductivity observed at the five Guadalupe river sites (excluding Tasman) during the monitoring project.

4.6 Visual Observations

No fish kills were observed during field visits along Guadalupe River and Alviso slough following each storm events that occurred during the project.

4.7 Algal/Cyanobacteria Toxins

SPATT deployments demonstrated measureable levels of toxins for 7 of 10 SPATT samples (Table 4). Elevated concentrations (5.07-50.59 ng/g resin, excluding <MDL samples) were observed in September, with much reduced concentrations (4.81-13.42 ng/g resin, excluding <MDL samples) in subsequent months. The highest detected levels of toxin were MCY-LR (the most commonly measured variant), with lower levels MCY-RR and MCY-LA present for some deployments. MCY-YR was not detected.

Table 4. Toxin concentrations of SPATT samples collected at Alviso and Pond A6 sites for five sampling events.

Site	Date	MCY-LR	MCY-RR	MCY-YR	MCY-LA
Alviso	9/8/2011	50.59	<MDL	<MDL	<MDL
Pond A6		25.58	5.07	<MDL	15.9
Alviso	9/26/2011	32.26	<MDL	<MDL	6.97
Pond A6		6.56	<MDL	<MDL	<MDL
Alviso	10/07/2011	<MDL	<MDL	<MDL	<MDL
Pond A6		<MDL	<MDL	<MDL	<MDL
Alviso	10/24/2011	<MDL	<MDL	<MDL	6.97
Pond A6		<MDL	<MDL	<MDL	<MDL
Alviso	11/3/2011	<MDL	<MDL	<MDL	4.81
Pond A6		<MDL	<MDL	<MDL	13.42

Within the two sampling sites, Alviso site was qualitatively higher in total toxin levels than Pond A6 site but not significantly so (paired t-test, $p=0.36$). A larger data set would potentially improve the ability to discriminate between sites. Qualitatively, toxin concentrations also decreased after First Flush sample event, but there are insufficient data to determine whether this is significant. Refer to Attachment A for complete results of algal toxin report.

4.8 Algal/Cyanobacteria Taxonomy

Water samples for phytoplankton enumeration were inconclusive. Presumably due to the heavy sediment/detritus load, few to no intact cells were observed in the samples. For a subset of samples, additional microscopy was conducted using epifluorescence to determine if the “floc” material could be colonies of *Microcystis.* Based on the lack of fluorescence in either the chlorophyll or phycocyanin channels, it is unlikely the floc was cellular material.

5.0 DISCUSSION

5.1 WATER QUALITY IMPACT FOLLOWING THE FIRST RAINFALL EVENT OF THE SEASON

5.1.1 Guadalupe River

No water quality impacts were observed at the Guadalupe River sites during the 2011 stressor/source identification study. Although DO concentrations were reduced at all sites following each storm event that was monitored, the concentrations were consistently above WARM and COLD Water Quality Objectives and no fish kills were observed. These results are consistent with water quality monitoring results during late summer season/early winter season at four of the same Guadalupe River sites in 2010. The results from the previous two years of monitoring were *not* consistent, however, with monitoring results from 2009, when fish kills were observed within a long reach of lower Guadalupe River directly following first seasonal flush event. DO concentrations were below WQO (< 2.0 mg/L) at selected sites in the lower section of Guadalupe River during this timeframe.

Based on three years of monitoring data, antecedent conditions in the river appear to be critical in determining when a first seasonal flush event may significantly impact water quality resulting in fish kills. The fall of 2009 can be distinguished from the subsequent two years as having minimal rainfall (as recorded at City of San Jose Emergency Services Department) during the previous winter/spring season and a first season flush event that occurred one month earlier (i.e., September vs. October). Figure 14 also shows that antecedent conditions for fall 2012 may be similar to 2009 based on low precipitation amounts during winter/spring season of 2011-2012.

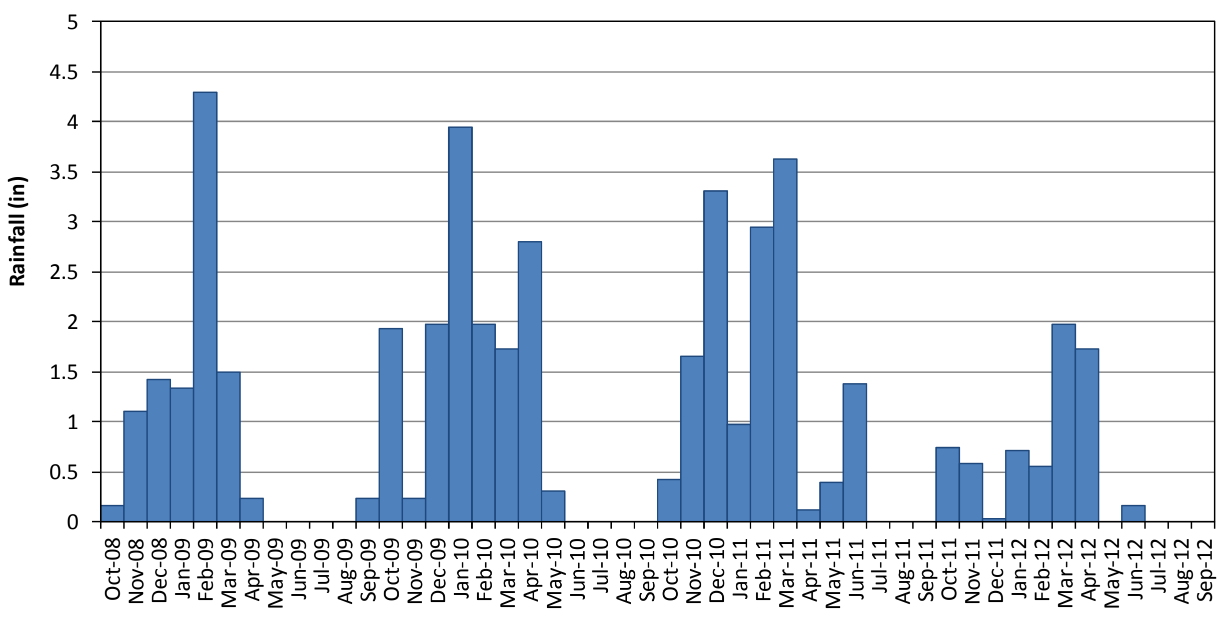

Figure 14. Monthly precipitation from October 2008 through September 2012 (City of San Jose Emergency Services Department).

Stream base flows, recorded at USGS Highway 101 stream gage during the months of September – December 2009, were lower compared to same period in 2010 and 2011 (figure 15). Several other characteristics related to the first seasonal flush event in 2009 are shown in Table 5. First seasonal flush event in 2009 was short and intense, creating a larger and flashier peak flow when compared to 2010 and 2011. This can be explained by the location of rainfall in 2009, where greater intensity of storm was in the lower, urban watershed area, compared to other years, when rainfall was more intense in the upper watershed area. In addition, air temperatures were slightly higher in 2009, compared to subsequent years.

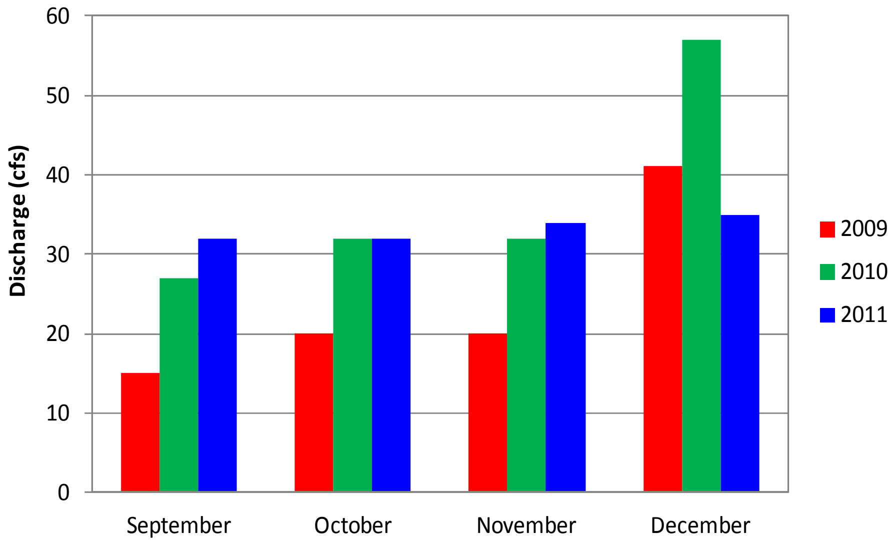

Figure 15. Median stream discharge recorded during months of September through December in 2009, 2010 and 2011.

Table 5. Stream, temperature and rainfall characteristics during first seasonal flush events in 2009 – 2011.

Characteristics	First Seasonal Flush Event		
	September 13, 2009	October 17, 2010	October 3, 2011
Min/Max Daily Temp During Storm (°C)	16/23	13/21	11/21
30 Day Ave Daily Temp Prior to Event (°C)	22	21	21
Rain Intensity During Storm (Lower Watershed[1])	0.24 inch 2.25 hrs	0.08 inch 1 hr	0.2 inch 7.25 hrs
Rain Intensity During Storm (Upper Watershed[2])	.04 inch 3 hrs	0.28 inch 2 hr	0.16 inch 16 hrs
Base Flow (cfs)	14-15	32-33	31-32
Peak Flow (cfs)	169	141	75
Response to Peak Flow (start of rain to peak flow)	5 hrs	7 hrs	7 hrs 30 minutes
30 Day Average Daily Solar Radiation (W/m^2)	214	190	223

[1] Alert Gage 1453, [2] Alert Gage 1526

5.1.1 Alviso Slough

The Alviso Slough is a complex system with multitude of factors that can potentially affect water quality. As shown previously in Figure 9, dissolved oxygen concentrations were highly variable during monitoring project in 2011. The first seasonal flush and subsequent storms reduced DO concentrations to less than 20% saturation at the Alviso site. However, DO concentrations were also reduced (<20% saturation) one week after the first flush event, indicating other factors such as tides and/or algal production, may also be causing reductions in DO.

5.2 POTENTIAL WATER QUALITY STRESSORS OR SOURCES

5.2.1 Guadalupe River

Low dissolved oxygen concentrations are a potential stressor to aquatic life uses during the late summer season. DO concentrations were consistently reduced following first seasonal flush and subsequent storm events during 2009-2011. Increased chemical and biological demand in the receiving waters following initial storm events of the season may explain the changes in water quality parameters observed during the study. In particular, lower DO concentrations directly following these storms may be associated with higher concentrations of organic matter and nutrients that create higher oxygen demands in the river.

In 2009, the reduced DO may have been a major factor for causing fish kills observed in lower Guadalupe River. Antecedent conditions in 2009 (i.e., low stream flows, warm air temperatures, short and intense first season flush event) may have exacerbated water quality impacts by causing a higher concentration of organic matter and chemical contaminants in the river resulting in a dramatic reduction in dissolved oxygen levels. Monitoring efforts in 2010 and 2011 further upstream Guadalupe River were intended to further investigate potential water quality sources and areas (e.g., deep, low velocity pool habitats) that may increase the potential for higher oxygen demand. Results from the previous two years, however, do not indicate specific sites or reaches with chronically low DO concentrations.

This study did not investigate the potential for algal/cyanobacteria producing toxins at freshwater sites in the Guadalupe River. There is a potential that the mycrorcystin toxins that were measured in Alviso slough during this study may have been produced further upstream. Further monitoring of phycotoxin producing species would provide better understanding if algal toxins are a potential source causing fish kills in Guadalupe River.

5.2.2 Alviso Slough

Similar to the freshwater creek sites, dissolved oxygen levels at the Alviso Slough site (less apparent in the Pond A6 site) are likely reduced from chemical and biological oxygen demand in the receiving waters following storm events. However, organic and chemical inputs can also originate from the San Francisco Bay during tidal activity. As a result, identifying specific sources of these stressors in slough environment is extremely challenging.

The results of the pilot investigation for presence of algal/cyanobacteria toxins in the slough indicate there is a reasonable probability of low-level exposure to microcystins at both Alviso and Pond A6 sites (Refer to Attachment A for interpretation of the results and comparison to other studies). These results should be considered preliminary however, since there are no current guidelines for aquatic life use and the low number of samples and high level of potential inter-annual variability in the timing of cyano-bacteria blooms creates significant uncertainty. Although these results suggest that cyanobacteria toxins may affect aquatic life uses in Alvisio Slough, additional study is needed to reduce the uncertainty on the importance of this potential stressor.

6.0 NEXT STEPS

This stressor/source identification study was conducted in compliance with provision C.8.d(i) of the MRP. As described in this provision, the monitoring conducted via this project complies specifically with provision C.8.d(i)-1, the first step in the stressor identification process. However, due to the lack of stress identified in the Guadalupe River in fall 2011, additional confirmatory monitoring is planned for FY 2012-13 to ensure water quality impacts are not observed. The planned confirmatory monitoring described below is based on continuous water quality data collected by SCVURPPP, SCVWD and City of San Jose over the three year time period (2009-2011):

- Continuous water quality monitoring at a subset of monitoring sites in the Guadalupe River in fall/winter 2012 to assess water quality during a season that has similar climatic conditions as 2009 and 2010 (i.e., low precipitation during late winter/spring season and low baseflows in the Guadalupe River). Recommended monitoring sites include Alviso, Montague and Willow Glen. Monitoring should begin no later than September 1 and continue for a two month period, or until at least one week following the first seasonal flush event.

- Conduct visual surveys at selected locations of Guadalupe River following first seasonal flush event for evidence of fish mortality and impacted water quality conditions.

Should planned confirmatory monitoring conducted in FY 12-13 indicate that water quality impacts are not present in the Guadalupe River, SCVURPPP will discontinue the stressor/source identification project consistent with the MRP. Should water quality impacts be observed during FY 12-13 monitoring, SCVURPPP will continue implementation of the stessor/source identification process and attempt to identify and evaluate the effectiveness of options for controlling the cause of the impact.

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ATTACHMENT A

Solid Phase Adsorption Toxin Tracking (SPATT) and
Phytoplankton Enumeration Report (Raphael Kudela (2012)

Solid Phase Adsorption Toxin Tracking (SPATT) and Phytoplankton Enumeration Report

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Summary and Guidance

City of San Jose deployed SPATT samplers at Alviso and A6 sites for monthly deployments. Water samples for phytoplankton enumertion were collected at the beginning and end of each SPATT deployment. Samples were analyzed for HAB organisms and for microcystin toxins.

Water samples for phytoplankton enumeration were inconclusive. Presumably due to the heavy sediment/detritus load, few to no intact cells were observed in the samples. For a subset of samples, additional microscopy was conducted using epifluorescence to determine if the “floc” material could be colonies of *Microcystis.* Based on the lack of fluorescence in either the chlorophyll or phycocyanin channels, it is unlikely the floc was cellular material (see methods in the Enumeration section for details) Of the 10 net tow samples, 5 were enumerated using fluorescence. We conclude that phytoplankton enumeration is not a useful method for tracking potential HAB organisms or water quality at these sites.

SPATT deployments demonstrated measureable levels of toxins for 7 of 10 SPATT samples. Elevated concentrations (5.07-50.59 ng/g resin, excluding <MDL samples) were observed in September, with much reduced concentrations (4.81-13.42 ng/g resin, excluding <MDL samples) in subsequent months. The highest detected levels of toxin were MCY-LR (the most commonly measured variant), with lower levels MCY-RR and MCY-LA present for some deployments. MCY-YR was not detected. Biological weighting functions (see http://www.who.int/water_sanitation_health/resourcesquality/toxcyanchap3.pdf) Can be applied to these congeners. Based on WHO guidelines, MCY-LR and MCY-LA are equally toxic, while MCY-YR is about 71% as toxic, and MCY-RR is about 8% as toxic as MCY-LR and MCY-LA at the same concentration (i.e. it takes 12 ppb of MCY-RR to equal the biological effects of 1 ppb MCY-LR or MCY-LA). Note that rapid test kits are designed to detect (primarily) MCY-LR, and may not accurately represent other congeners.

Based on the biologically-weighted toxin loads observed, there is a reasonable probability of low-level exposure to microcystins at these sites. The World Health Organization guidelines are 1 and 10 ppb (μg/L) for polished drinking water and recreational contact. There are currently no guidelines for aquatic life use. As described by Burch (2008): “Although guidelines for cyanotoxins and cyanobacterial cell numbers for recreational waters are in place in a number of countries, it is considered that there is currently insufficient information to derive sound guidelines for the use of water contaminated by cyanobacteria or toxins for agricultural production, fisheries and ecosystem protection.” However, there have been exposure studies for fish. A review by Malbrouck and Kestemont (2006) implicated microcystin toxicity through both oral uptake and by exposure across the epithelium to dissolved toxins, and indicated that fish are exhibit similar toxic effects as mammals. The impact on fish is particularly acute for juveniles because the toxins interfere with critical phases of development. Chellappa et al. (2008) reported a fish kill in Brazil at MCY concentrations of 0.07-8.73 ppb, while lesions consistent with exposure to microcystins were reported for juvenile striped bass in the Sacramento and San Joaquin Rivers with average reported toxin concentration of 0.06 ppb in San Joaquin and Old Rivers (Lehman et al. 2010).

SPATT does not measure the toxin in a manner that allows direct comparison with grab or tissue samples, which are typically reported as ppb. Units are instead expressed as [ng toxin/gram resin/time]. Based on field deployments in Pinto Lake, CA (see Kudela 2011) an approximation is that SPATT values can be divided by a factor of 10 to provide mean concentrations from the deployment period. This approximation was derived by comparing grab samples with weekly-deployed SPATT from the same site, and fitting a linear regression to the dataset. A comparison was also made at Pinto Lake between weekly and monthly deployments of SPATT (n=6 monthly samples). Monthly sample SPATT concentrations were proportional ($p>0.05$, paired t-test) to averaged weekly sample concentrations over a range of toxin levels (1.75-635.46 ng/g; see Table 1).

Using the empirical data from Pinto Lake SPATT deployments, Both Alviso and A6 are approaching average values of ~0.5 ppb for monthly deployments (September Alviso sample of 50.59 ng/g MCY-LR, divided by 10, and September A6 sample of 46.55 ng/g total toxin, divided by 10). Given the time-weighted average that SPATT represents (see Kudela et al. 2011), the possibility exists for higher discrete values. These toxin concentrations are in the range of values reported by others (see above) for impacts to fish.

Within the two sampling sites, Alviso Slough was qualitatively higher in total toxin levels than A6 but not significantly so (paired t-test, $p=0.36$). A larger data set would potentially improve the ability to discriminate between sites. Qualitatively, toxin concentrations also decreased after First Flush (compare the 8-September-2011, pre-Flush, and 26-September-2011 First Flush deployment) but there are insufficient data to determine whether this is significant.

Based on these results, there is at least a potential for microcystin exposure to wildlife at these sites. Given the inconclusive nature of the phytoplankton enumeration, a monitoring program would likely be most effective using a combination of grab and SPATT toxin sampling. It is also important to remember that there can be significant inter-annual variability. 2011 was generally cooler with later cyanobacterial blooms throughout California, while 2010 was dominated (again, throughout CA) by *Aphanizomenon* rather than *Microcystis.* Figure 1 shows substantial interannual variability in timing, duration, and intensity of blooms in Pinto Lake, for example.

SPATT is currently being tested or deployed as part of several ongoing monitoring programs in the State of California, including Pinto Lake (Kudela 2011) and surrounding water sheds, Clear Lake and the Sacramento-San Joaquin Delta (as part of a Central Valley Regional Water Quality Control Board study; final report is pending), a pilot study conducted with the Central Coast Regional Water Quality Control Board, a pilot study conducted with the Southern California Coastal Water Research Project, and a pilot study conducted with the US Geological Survey San Francisco Bay Monitoring Program. Much of these data are still restricted for distribution. However, an overview map showing locations where microcystins have been detected (using SPATT and grab samples) is provided (Figure 2) together with a bar chart showing SPATT concentrations for a subset of these sites (Figure 3).

Report Documents:

1) Final Microcystin Data Report
2) Interim Microcystin Data Reports (2)
3) Phytoplankton Enumeration summary

References Cited:

Burch, MD. 2008. Effective doses, guidelines, and regulations. In: *Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs*, Hudnell, KH (Ed.), Springer New York, pp. 831-853.

Chellappa, NT, Chellappa, SL, Chellappa, S. 2008. Harmful phytoplankton blooms and fish mortality in a eutrophicated reservoir of northeast Brazil. *Braz. arch. biol. technol.* [online], 51(4): 633-641.

Kudela, RM. 2011. Characterization and Deployment of Solid Phase Adsorption Toxin Tracking (SPATT) resin for monitoring of microcystins in fresh and salt water. *Harmful Algae*, doi: 10.1016/j.hal.2011.08.006.

Lehman, PW, Teh, SJ, Boyer, GL, Nobriga, ML, Bass, E, Hogle, C. 2010. Initial impacts of *Microcystis aeruginosa* blooms on the aquatic food web in the San Francisco Estuary. *Hydrobiologia* 637(1): 229-248.

Malbrouk, C, Kestemont, P. 2006. Effects of microcystins on fish. *Environmental Toxicology and Chemistry*, 25(1): 72-86.

Table 1. Comparison of weekly SPATT versus ~monthly SPATT deployed in Pinto Lake, CA. Mean weekly (column 2) and monthly (column 3) values are not significantly different (p=0.25, t-test).

Weekly SPATT (ng/g)	Weekly Average	Monthly SPATT (ng/g)
2.78 1.76 2.92 1.92	2.34	2.10
23.02 34.50 74.43 25.08	39.26	65.97
5.63 14.61 15.84 30.92	16.75	16.26
5.63 14.61 15.84 30.92	371.43	505.84
5.33 5.03 13.27 6.32	7.49	13.67
5.07 4.09 4.23 8.61	5.5	6.98

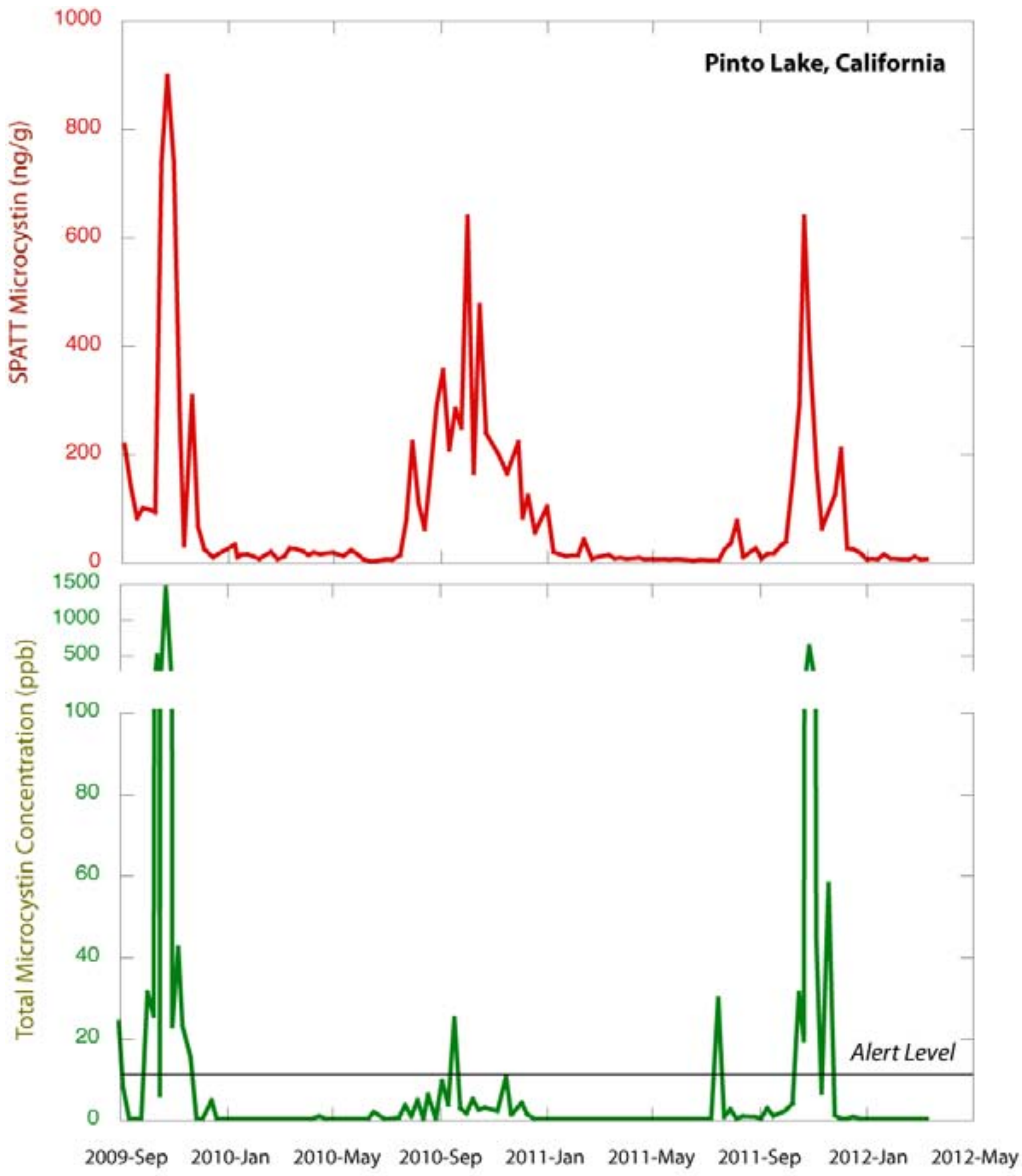

Figure 1. Interannual variability in SPATT (top) and grab samples (bottom) for Pinto Lake, CA. The low levels for grab samples in 2010 are attributed to patchy sampling; significantly higher levels were observed in surface scum (not shown).

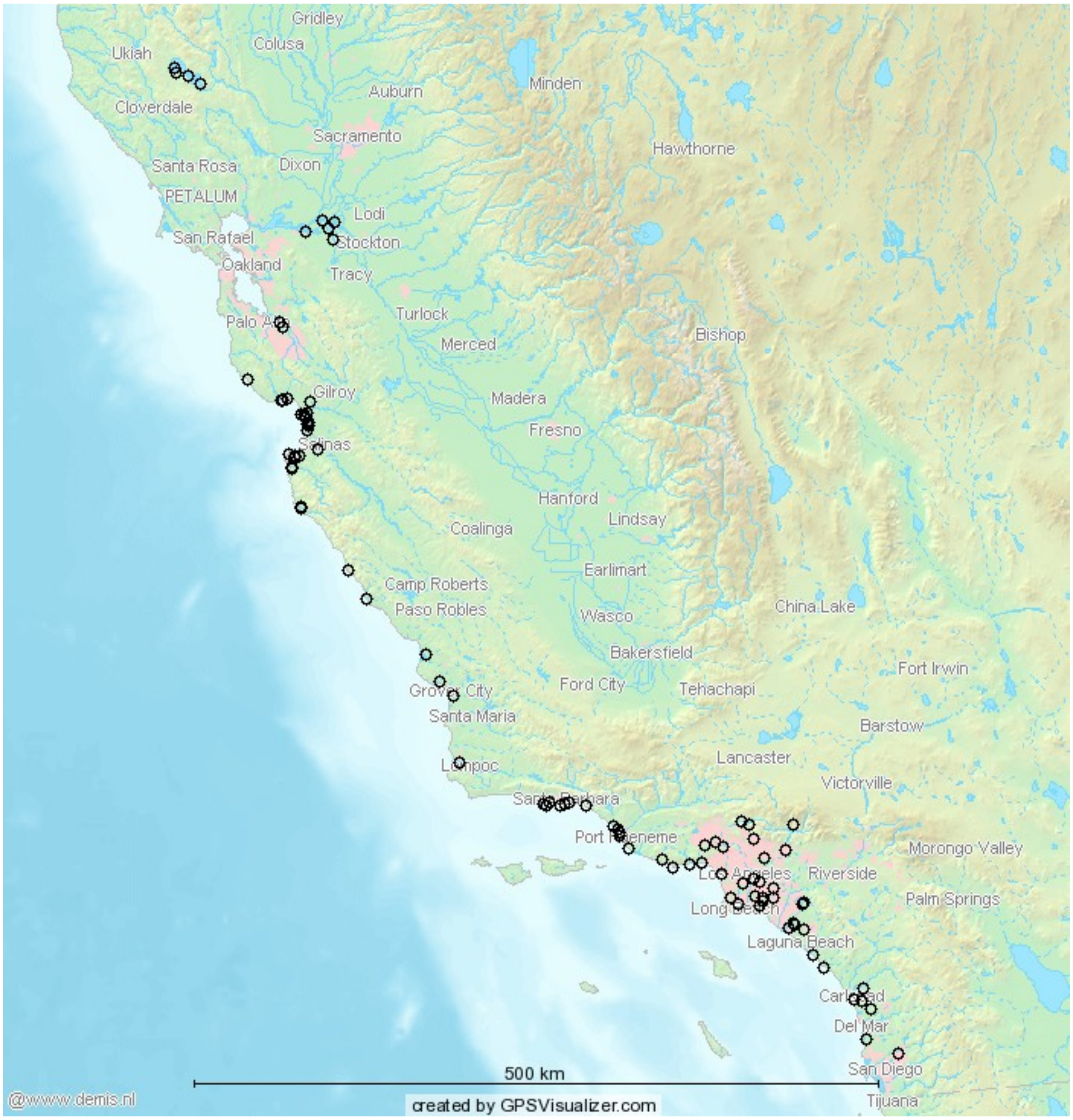

Figure 2. Sites in California where microcystins have been detected using SPATT and grab samples between 2007-2011.

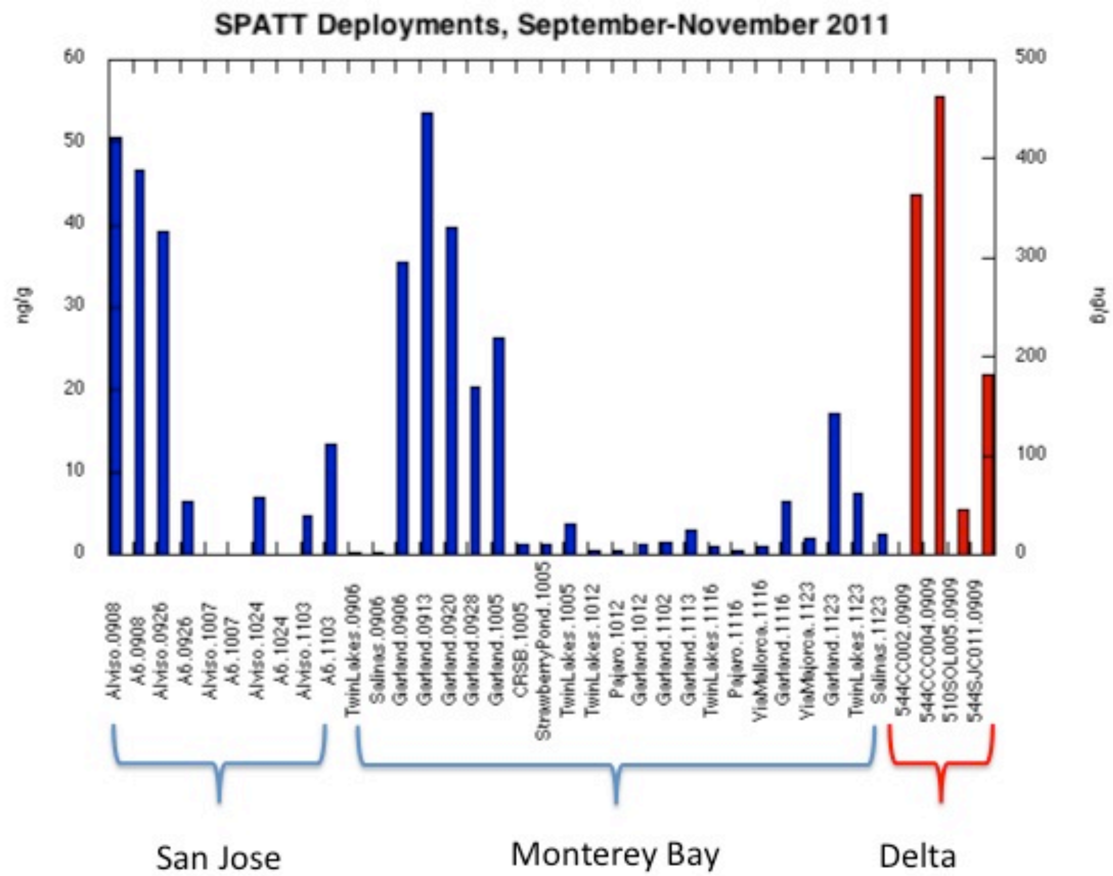

Figure 3. SPATT toxin results for the greater Bay area. San Jose samples (from this report), Monterey Bay samples (Kudela Lab), and Delta samples (Kudela/Mioni; in red). Note that the Delta samples are on a different scale. SPATT were deployed for between 7-30 days during September-November 2011. Labels indicate the site name and initial deployment date. Toxin values are the sum of MCY-LR, MCY-RR, MCY-YR, and MCY-LA.

FINAL MICROCYSTIN DATA REPORT

REQUESTOR EOA, Inc., 1410 Jackson Street, Oakland, CA 94612
RUN BY: R Kudela
ANALYSIS: MCY-LR, RR, YR, LA SPATT samples

METHOD
LC/MS, AGILENT 6130
GRADIENT ELUTION, PHENOMENEX KINETIX 100X2.10 C18
MC-995, MCLR

DATA

SAMPLE*	MCY-LR	MCY-RR	MCY-YR	MCY-LA
SJ.HP20.090811.ALVISO	50.59	<MDL	<MDL	<MDL
SJ.HP20.090811.A6	25.58	5.07	<MDL	15.90
SJ.HP20.092611.ALVISO	32.26	<MDL	<MDL	6.97
SJ.HP20.092611.A6	6.56	<MDL	<MDL	<MDL
SJ.HP20.100711.ALVISO	<MDL	<MDL	<MDL	<MDL
SJ.HP20.100711.A6	<MDL	<MDL	<MDL	<MDL
SJ.HP20.102411.ALVISO	<MDL	<MDL	<MDL	6.97
SJ.HP20.102411.A6	<MDL	<MDL	<MDL	<MDL
SJ.HP20.110311.ALVISO	<MDL	<MDL	<MDL	4.81
SJ.HP20.110311.A6	<MDL	<MDL	<MDL	13.42

* Sample name indicates deployment date.

QA/QC

Blank	< MDL	<MDL	<MDL	<MDL
Matrix Spike (% Recovery)	98	88	101	99

MDL = 0.25 ng/g resin
RL= 1.25 ng/g resin (5x MDL)
Percent Recovery based on standard addition to sample matrix
See interim reports for slopes and R^2 values

NOTE: toxin congeners are reported in order of analysis.

METHOD

Sample processed according to methods described in Mekebri et al. 2009, Kudela 2011. The SPATT samples were stored frozen until processing, extracted with (10, 20, 20 mL) 50% MeOH, syringe-filtered, and analyzed by LC/MS using an Agilent 6130 instrument equipped with a Phenomex Kinetix C18 column. MDL based on 7x replicate analysis of 1 ug/L standards (on column). Blanks included for every 10 samples. Matrix Spike recovery was completed with each sample run; reported percentages are averages of the sample runs.

Mekebri, A, GJ Biondina, DB Crane. 2009. Method validation for microcystins in water and tissue by enhanced liquid chromatography tandem mass spectrometry. Journal of Chromatography A, 1216: 3147-3155.

Kudela, RM. 2011. Characterization and Deployment of Solid Phase Adsorption Toxin Tracking (SPATT) resin for monitoring of microcystins in fresh and salt water. Harmful Algae, doi: 10.1016/j.hal.2011.08.006.

Phytoplankton Observations – City of San Jose

Data are provided in the following format. Date/Location (from the sample label), followed by sample type (WW=Whole Water, NT=Net Tow). There were insufficient algal cells to apply a Relative Abundance Index, so qualitative descriptions of the samples are provided. The "Chl" notes for the NT samples indicate where the sample was also enumerated using a Zeiss Axioscop A1 microscope equipped with epifluorescence illumination using a chlorophyll excitiation/emission filter cube, and a Zeiss Axioplan epifluorescence microscope using green excitation/emission for phycoerythin/phycocyanin. The same methods were tested on preserved 2.5% (v/v) glutaraldehyde and 4% (v/v) formalin samples from Pinto Lake to verify lack of interference from preservation.

General observations: all of the samples were heavily dominated by detritus (combination of sediment/sand particles and organic detritus) making it difficult to enumerate cells. The Epifluorescent data suggest that there is a low abundance of intact cells in the samples. The only HAB organisms that were identified was a chain of *Anabaena* in the 10/7/2011 Alviso sample, but the heavy detritus load could be masking *Microcystis* cells if the colonies were broken up.

Since the samples were dominated by detritus, data are not reported according to the Relative Abundance Index (RAI) method, since there were too few observations of intact cells to make such a report meaningful.

9/8/11 – Alviso

Whole Water (WW) – Mostly detritus/debris, few cells. Couple of diatoms.

9/8/11 – A6

WW – Mostly detritus/debris (flocculant/flakey), no cells.

9/26/11 – Alviso

Net Tow (NT) – Mostly detritus/debris, difficult to see any cells. Couple of diatoms.

Chl – A few diatoms.

WW – Similar to net tow.

9/26/11 – A6

NT – Mostly detritus/debris, few cells. Couple of diatoms.

Chl – A few diatoms.

WW – Similar to net tow, no cells.

10/4/11 – Boat Ramp

NT – Mostly detritus/debris (distinct fecal pellets), few cells. A few diatoms.

Chl – A few diatoms.

WW – Similar to net tow (no fecal pellets).

10/7/11 – Alviso

NT – A lot of detritus/debris (~40% of the field of view; less than other samples), few cells. 1 chain of Anabaena.

Chl – More diatoms than previous samples, still not very many.

WW – Similar to net tow, no cells.

10/7/11 – A6

NT – Cloudy sample. Mostly detritus/debris, no cells.

Chl – More diatoms than previous samples, still not very many.

WW – Similar to net tow, distinct fecal pellets.

10/24/11 – Alviso

NT – A lot of (fluffy/flocculent) detritus/debris (50-70% of the field of view), few pennate diatoms.

10/24/11 – A6

NT – Tons of sediment debris (>90% of the field of view), cloudy water. A couple pennate diatoms.

11/3/11 – Alviso

NT – A lot (50-70% of the field of view) of fluffy/flocculent debris. Oscillatoria-like strand.

11/3/11 – A6

NT – A lot of sediment debris (~50% of the field of view), lots of copepods. Several diatoms – single cell pennate and centrics and a 5 cell chain of Lithodesmium.

11/27/11 – Alviso

NT – Some fluffy/flocculent debris and Cylindrotheca. Bloom?

11/27/11 – A6

NT – Tons of sediment debris (>90% of the field of view), cloudy water, few pennate diatoms.

12/5/11 – Alviso

NT – Tons of debris (70-100% of the field of view), sediment and flocculent. A few pennate and centric diatoms.

12/5/11 – A6

NT – Tons of sediment debris (70-100% of the field of view), cloudy water. A few centric and pennate diatoms.

*Sediment debris = sediment and fecal pellets, colored and separate particles.

*Fluffy/flocculent debris = colorless debris, particles stuck together.

ATTACHMENT B

Rincon 2 Pump Station Monitoring
Early Storm Season 2011

Monitoring Stormwater Pump Station Discharges in San José:

Rincon 2 - Early Storm Season 2011

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY
Environmental Services

Watershed Protection Division

200 East Santa Clara Street

San José, CA 95113

September 15, 2012

Acknowledgements

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1.0 INTRODUCTION

In 2009 and 2010, in response to San Francisco Bay Regional Water Quality Control Board (Water Board) requests for information on pump station discharges, the City of San José (City) collected samples and monitored water quality discharged from a selection of its pump stations and in receiving waters (the Guadalupe River). Results of these monitoring efforts did not indicate impacts from pump station discharges likely to cause or contribute to the fish kills seen after the first rain storms of 2008 through 2010. To continue the investigation of water quality issues in the Guadalupe River, the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) developed a project to fulfill stormwater permit monitoring requirements to identify potential stressors/sources. On September 7, 2011 the Program transmitted a monitoring plan describing the planned monitoring to Water Board staff as a courtesy. On September 29, 2011 the Water Board issued the City of San José a letter pursuant to California water code section 13267 requiring San José to perform additional monitoring beyond what the Program had described in the September 7 monitoring plan, specifically to collect time-dependent discrete samples of discharges during the first rain storm event of Fiscal Year (FY) 2011-2012 at Rincon 2, Oakmead, and Gold Street pump stations. Due to timing, staffing, safety, and physical sampling location constraints, City staff could not fulfill this request as stated. In response, the City deployed continuous monitors to record wet well depth, discharge timing, and discharge channel water quality of the Rincon 2 pump station. This monitoring coincided with and complemented monitoring described in the Program's Stressor/Source Identification work plan. The following report focuses primarily on data collected by the City of San José with select references to data collected concurrently with the Program's Stressor/Source Identification Study.

The original request and response set a timeline for reporting by June 30, 2012, however late rains pushed the Program's monitoring efforts much later into the year, subsequently delaying the monitoring report, including the Stressor/Source Identification Report. Moreover, the Stressor/Source Identification Study report to which the response report was to be attached was not due per NPDES Stormwater Permit requirements until September 15, 2012. Another unforeseen complication was the need for the entire report to be approved by the Program's Management Committee such that it would need to be reviewed along with the full Program monitoring report. City and Water Board staff discussed the matter in late June and agreed that the report would submitted as an attachment to the Program's Stressor/Source Identification Report on September 15, 2012. The Program's Annual Report Appendix 8-3 contains the full report for that study.

2.0 METHODS

2. 1 RINCON 2 PUMP STATION DISCHARGE MONITORING

Rincon 2 pump station employs five large-capacity main pumps (estimated working capacity 37,800 GPM) and two smaller jockey pumps (estimated working capacity 2800 GPM). City of San José Department of Transportation (DOT) staff maintains records of each pump's total hourly run time at the start of each business day. Records were multiplied by pump capacities to estimate total pump station discharge volumes.

City staff deployed a Solinst Levellogger into the wet well of the Rincon 2 pump station from September 9-December 2, 2012 measuring depth changes at 3 minute intervals. The device was pulled within 48 hours following each storm event for data download and maintenance inspection, then immediately redeployed to the same location within the wet well.

2.2 SIDE CHANNEL WATER QUALITY MONITORING

City staff deployed a YSI 6600-V2 continuous monitoring device identical to those used in previous monitoring efforts (CSJ, 2010; 2011) into the Rincon 2 pump station discharge channel from September 30-October 14, 2011; and again from November 2 – December 2, 2011. The device measured temperature, dissolved oxygen, pH, and conductivity at 15 minute intervals. Figure 1 shows the timing of these deployments in relation to rainfall and river discharge.

2.3 FIRST FLUSH OBSERVATIONS

City staff conducted visual surveys and took photographs along the Guadalupe River, Alviso Slough, and the Rincon 2 pump station discharge channel, within 24 hours of the first flush rain event. Staff inspected channel conditions for signs of fish kill, degradation/aggradation, and other visually apparent water quality impacts.

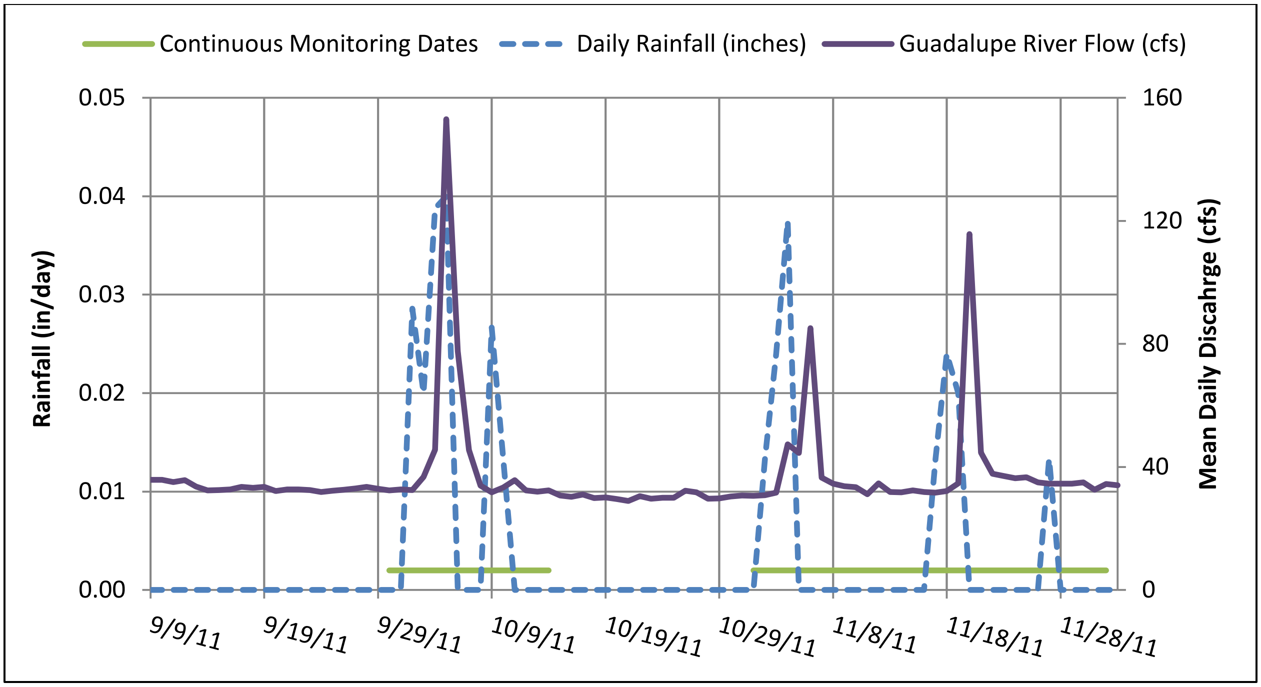

FIGURE 1. MEAN DAILY RAINFALL (CITY OF SAN JOSÉ ALERT GAUGE), GUADALUPE RIVER FLOW (DISCHARGE FROM USGS HIGHWAY 101 GAUGE), AND SIDE CHANNEL CONTINUOUS WATER QUALITY SAMPLING EVENTS BETWEEN SEPTEMBER 9 AND DECEMBER 2, 2011.

3.0 RESULTS

3.1 RINCON 2 PUMP STATION DISCHARGE MONITORING

Wet well depth was successfully monitored for the entire deployment period. Figure 2 shows wet well depth with respect to rainfall and calculated pump discharge volumes. Abrupt declines in wet well depth occur during pumping events to produce discharges and incur pump run times used to calculate discharge volume. Regular individual discharges occur during non-storm events 3-4 times a week, depending on the type of pumps operating and non-storm flows to the pump station. Storm events produce rapidly successive discharges depending on the intensity and duration of the storm and the type of pumps operating. The intermediate volume/frequency discharges from 9/15/11 to 9/29/11 represent discharges of the jockey pumps as per DOT dry season standard operating procedures for the Rincon 2 pump station. Pumping to the discharge channel was curtailed on 9/30/11 at the request of the Santa Clara Valley Water District (Water District) in preparation for planned sediment removal activities. The wet well was pumped as low as possible to reduce potential discharges that might interfere with Water District operations, and discharges were routed to the main channel using two small (90 GPM) Begeman Series (BS) portable pumps. The start and lag set points on the jockey pumps were also adjusted to reduce potential volumes of water pumped, which produced the more frequent and smaller volume discharges observed from 10/3/11 to 10/12/11. The BS pumps were removed from the wet well in preparation for the first flush storm of 10/3/11, and water was rerouted to the side channel, but jockey pumps remained activated through the first flush storm. (Personal communication; Moses Arroyo, Senior Maintenance Worker, City of San José Department of Transportation; July-August, 2011) After 10/14/11 the main pumps were activated for the remainder of the study period, as seen by the larger volume, less frequent discharges.

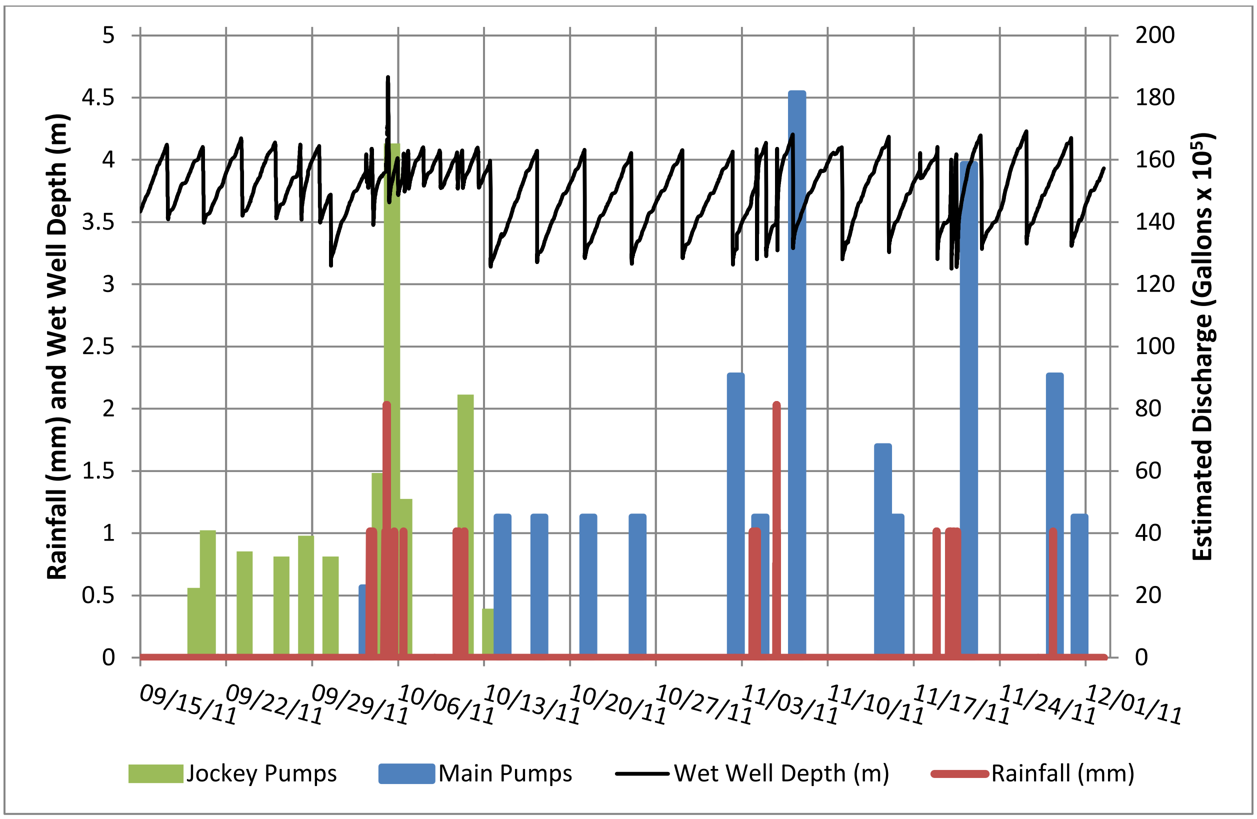

FIGURE 2. WET WELL DEPTH, EVENT RAINFALL (CITY OF SAN JOSÉ ALERT GAUGE), AND CALCULATED VOLUME OF WATER DISCHARGED FROM RINCON 2 FROM SEPTEMBER 15-DECEMBER 2, 2011. GREEN BARS REPRESENT DISCHARGES BY LOWER VOLUME JOCKEY PUMPS. BLUE BARS REPRESENT HIGHER VOLUME MAIN PUMPS. NOTE THAT PUMP VOLUME IS ESTIMATED EACH BUSINESS DAY. HIGH VOLUME RELEASES (I.E. OBSERVED ON 11/7 AND 11/21) MAY REPRESENT CUMULATIVE WEEKEND DISCHARGES.

3.2 Side channel water quality monitoring

Dissolved oxygen data is not available for the first flush deployment (September 30-October 14, 2011) due to malfunction of the ROX DO probe. City staff found the sonde buried under a significant amount of newly mobilized sediment upon retrieval (see Attachment A); which fouled the ROX DO probe. The ROX DO probe was replaced and the sonde was redeployed on November 2, 2011; it successfully collected all water quality parameters through three separate storms until the final retrieval date on December 2, 2011.

Water quality readings generally met water quality objectives for measured parameters during the first flush deployment from 9/30-10/14/11. Daily temperature increases did not exceed 2.4°C, and daily mean pH levels were between 7.09 and 7.48. From 11/2-12/2/11 daily mean dissolved oxygen levels generally met water quality objectives for WARM. Lowest dissolved oxygen levels were observed from 11/3-11/6/11, corresponding to lower levels of solar radiation (Figure 5) following a rainfall event. This is consistent with past findings (San José, 2011). There were, however, no apparent effects on receiving water quality (in the Guadalupe River) at the closest downstream Program monitoring site at Montague (Figure 6).

3.3 First Flush Observations

On 10/4/11, City staff surveyed Alviso Slough by boat from the Gold St. Bridge to the mouth of the Guadalupe River near Pond A6. Water was turbid throughout the stretch. Water surrounding the marina was bright red at the surface (See Attachment B). Two small dead fish were found on the boat ramp (one yellowfin goby and one three-spined stickleback). Both fish were sent to the DFG Fish Pathology Lab in Rancho Cordova (see Attachment C). No remarkable pathogens were observed in or on the specimens, and cause of death remained undetermined. No other dead fish were observed.

City staff surveyed Guadalupe River levee roads on 10/5/11 from Willow Glen Way to Montague. Water was turbid, but no dead fish were observed or other noticeable adverse effects to wildlife. Large piles of sediment were visible within and immediately adjacent to the river at Coleman Ave. and at the monitoring site in the Rincon 2 pump station side-channel.

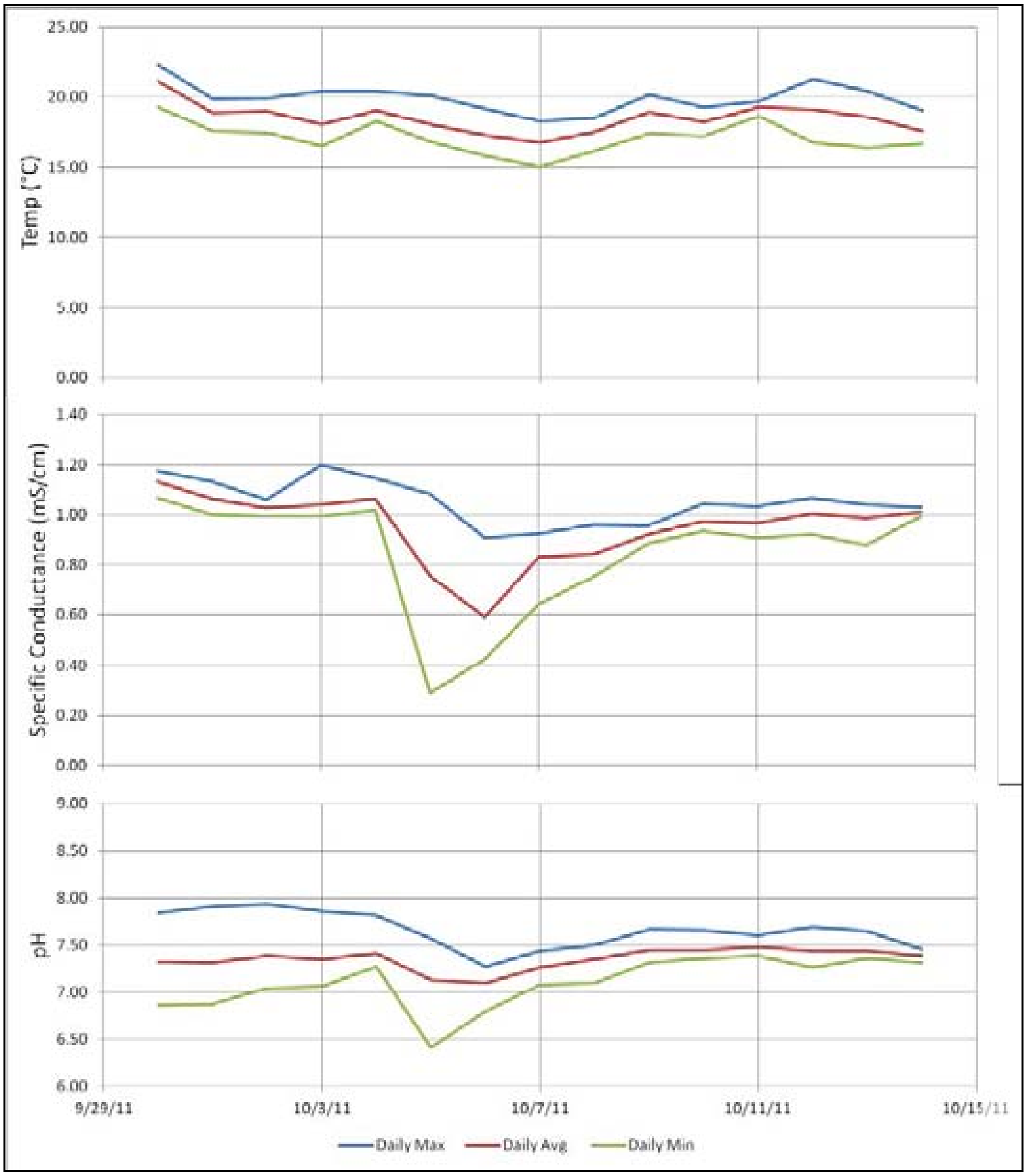

FIGURE 3. DAILY MEAN WATER QUALITY RESULTS FOR THE FIRST DEPLOYMENT FROM SEPTEMBER 30-OCTOBER 14, 2011, WHICH INCLUDED THE FIRST FLUSH EVENT ON OCTOBER 3, 2011. DISSOLVED OXYGEN DATA WAS NOT AVAILABLE DUE TO MALFUNCTION OF THE ROX DO PROBE.

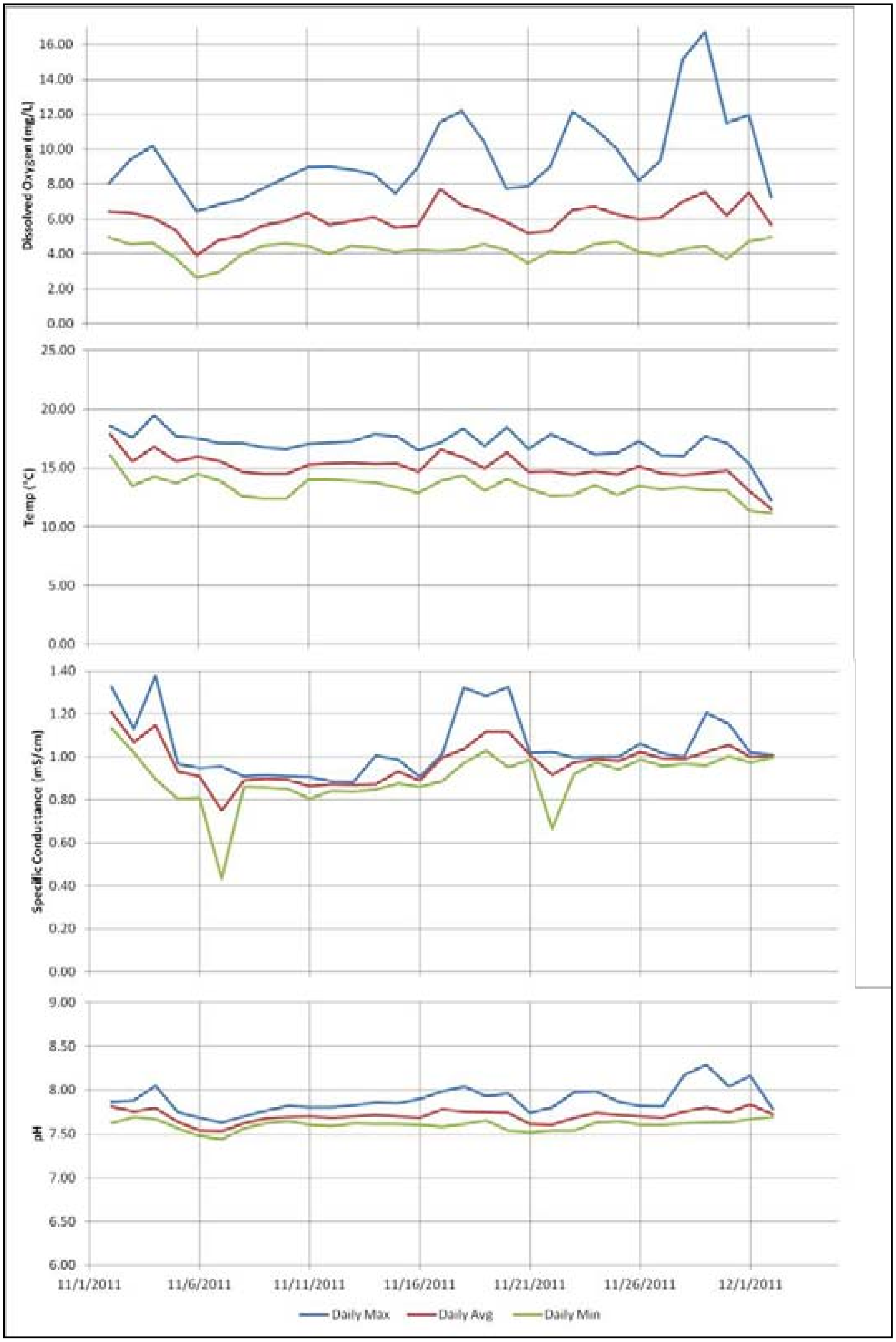

FIGURE 4. DAILY MEAN WATER QUALITY RESULTS FOR THE SECOND AND THIRD DEPLOYMENTS FROM NOVEMBER 2 – DECEMBER 2, 2011.

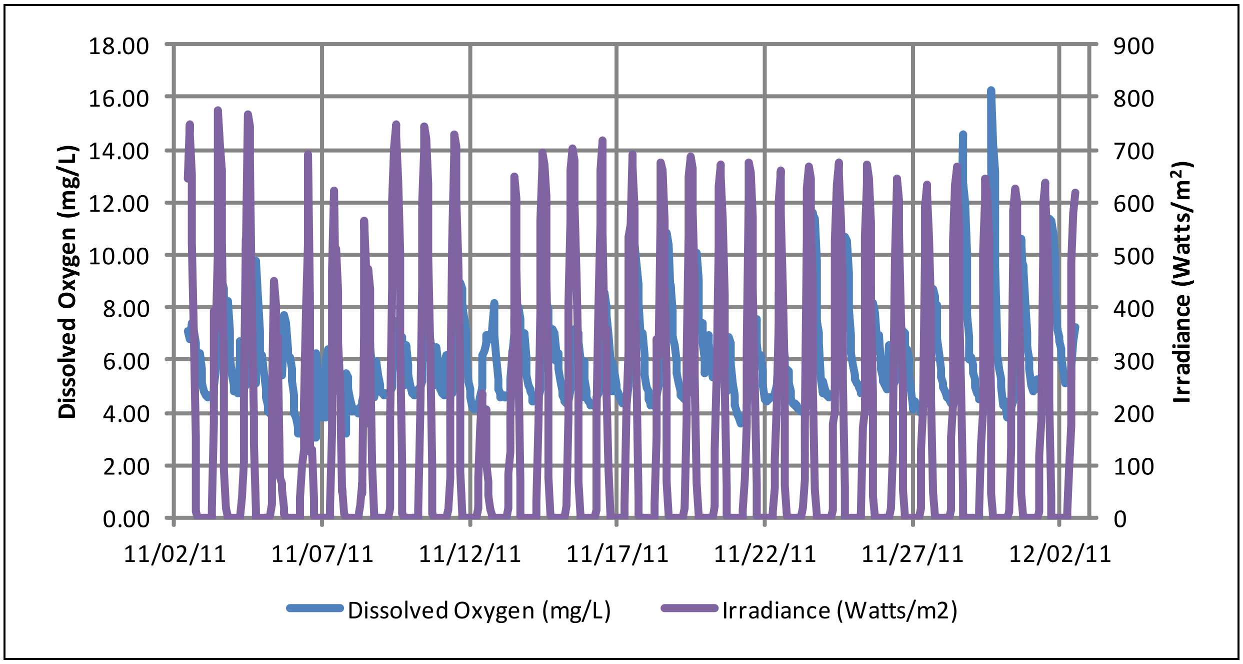

FIGURE 5. EFFECT OF IRRADIANCE ON THE SIDE CHANNEL FROM NOVEMBER 2 – DECEMBER 2, 2011.

4.0 DISCUSSION

Discharges from the Rincon 2 pump station are somewhat unique in that they do not discharge directly to the receiving water (Guadalupe River). Instead, discharges immediately flow to a shallow, normally vegetated earthen ditch (the side channel) and join the main channel (Guadalupe River) about 1 mile downstream of the pump station. The side channel is largely isolated from the main channel in both flow regime and water quality. The side channel flows during pump station discharges, but has little to no flow most of the time. Past monitoring efforts (San José 2010; San José 2011) have noted considerable differences in dissolved oxygen patterns between the Rincon 2 side channel and downstream receiving water quality; with the side channel showing greater daily variability, more sensitivity to changes in flow and irradiance, and longer recovery times following storm events. Downstream effects from these differences have not been observed in the main channel. The results of the 2011 monitoring effort are consistent with previous findings, with dissolved oxygen levels showing wet season response to irradiance (Figure 5), and more variation than main channel sites, but no discernible effect on downstream water quality (Figure 6).

The two main sources of dissolved oxygen in the water column are infusion from gas exchange and supply from primary production (i.e. photosynthesis). Since the side channel usually has little to no flow, its primary dissolved oxygen source is photosynthesis. Dissolved oxygen levels from 11/3-11/6/11 showed a longer recovery time than observed in previous winters (2-3 days as opposed to 1-2 days). The Santa Clara Valley Water District's sediment removal operations also removed submerged macrophytes, periphyton, and levee vegetation (Attachment A). Vegetation was not noted as showing signs of reestablishment until the sonde was retrieved on 12/2/11. Algal growth was noted in the side channel during subsequent deployments on 11/17/11 and 12/2/11. In general, vegetation removal and sediment mobilization would have changed the regular photosynthetic productivity of the side channel. Lowered and/or erratic dissolved oxygen readings following such an event are not remarkable. However, impacts on dissolved oxygen were not apparent in the main channel, as evidenced by the close relationship of upstream (Hwy 101) and downstream (Montague) sites (Figure 6). Sediment removal operations may have created localized impacts to the side channel's primary productivity, but no effects from either pump station discharges or sediment removal were observed in main channel dissolved oxygen levels.

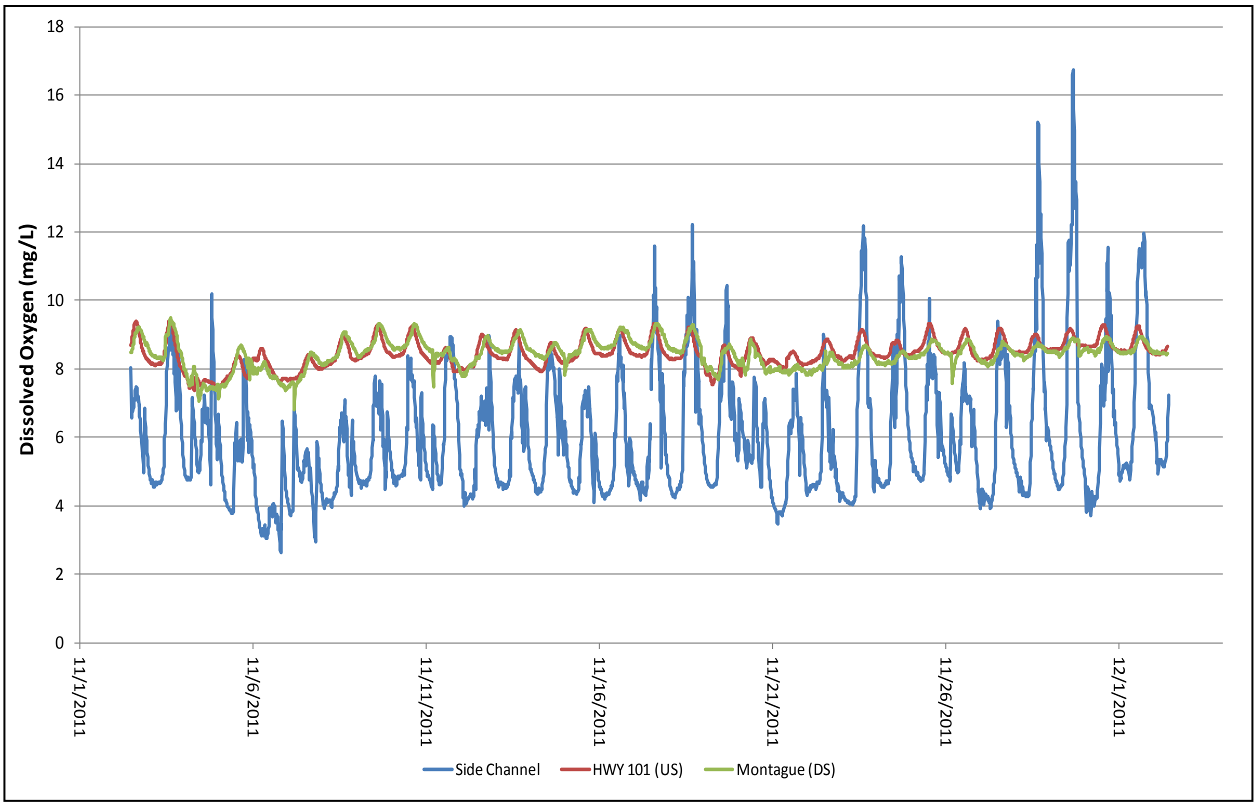

FIGURE 6. DISSOLVED OXYGEN LEVELS OF THE SIDE CHANNEL, UPSTREAM AT HWY 101 (AIRPORT), AND DOWNSTREAM AT MONTAGUE.

5.0 CONCLUSIONS

No fish kill was observed in the Guadalupe River for the first flush of 2011-2012. The Guadalupe River system has a number of inputs and environmental factors that may affect water quality during first flush events. Past studies have identified environmental variables such as storm intensity, duration, and location, and other factors such as base flow, channel morphology, and in-stream temperatures (San José, 2011) as possible important factors influencing fish kills. Results of this monitoring effort are consistent with previous monitoring results (San José 2010; San José 2011), and do not show significant impacts to water quality from pump station discharge.

6.0 REFERENCES

CITIES OF SANTA CLARA AND SAN JOSÉ, JUNE 30, 2010. EVALUATION OF STORMWATER PUMP STATION DISCHARGES IN SANTA CLARA AND SAN JOSÉ.

CITY OF SAN JOSÉ, AUGUST 8, 2011. FOLLOW UP EVALUATION OF STORMWATER PUMP STATION DISCHARGES IN SAN JOSÉ.

ATTACHMENT A:

Rincon 2 side channel qualitative condition assessment related to 2011 First Flush storm (10/3/11)
Impact of sediment accumulation on WQ data from data sonde deployed in the side channel during the 2011 first flush event in response to the WB 13267 letter issued on 9/29/11.

Notes on condition of site, levee, and sonde unit (from 10/14/11 sonde maintenance):

(1) Site and levee condition: From the Rincon 2 pump station downstream to the monitoring site, there were three stretches of creek bank ranging in length from approximately 50-80 feet on the San Jose side where the vegetation had been removed and the bank was dominated by exposed excavated clay and soil (Figure 4 and 5). This was not the condition of these banks during sonde deployment on 9/30/11. The creek bed in these locations showed evidence of being excavated with heavy equipment (Figure 4 and 5) to remove sediment placed in the channel prior to the first flush event (Figure 3). The banks that were lacking vegetation also looked like there were attempts to compact and shape them using heavy equipment (Figure 4 and 5), but there was no vegetation or other physical supplement (rock, rip-rap, etc) to stabilize the exposed banks. It is known that Water District sediment removal operations were taking place in the side channel during the week prior to the first flush storm.

(2) Sonde unit condition: Deployment cage was out of position when initially retrieved, oriented vertically with the weights on the side rather than horizontally with the weights on the bottom (standard operating procedure for sonde deployment). It is unlikely this would be a resting position from high flows (i.e. the cage "tumbled" during high storm flows and rested perfectly vertically when flows subsided). It is more likely that someone moved the sonde and replaced it in that position, which increased the ROX DO probe's vulnerability to sediment.

(3) Sonde unit condition: There was substantial amount of mud packed into the bottom of the probe guard when initially retrieved. This could be the result of the cage/sonde positioning (probes facing down towards the creek bed) or could be the result of the high sediment/mud loads mobilized during the storm.

(4) Dissolved oxygen probe condition: The accumulated mud covered the end of the optical DO probe (ROX probe) on the sonde unit. The wiper was still functioning but was caked with wet mud. The optical sensor on the end of the probe had some sediment remaining on it, which certainly would have interfered with optical readings. While the wiper was still functioning, the amount of mud in the probe guard (or that the end of the probe was submerged into because of the cage position) would have caused erroneous DO readings from the probe.

(5) Initial in-field QA/QC: After retrieving the sonde and downloading the data from the previous 2 weeks of deployment, City staff discovered that the sonde was not returning DO readings. Both DO concentration and % saturation were returning 0.00 mg/L and 0.0% saturation readings respectively. The wiper on the DO probe was still functioning and responsive, but the probe was not returning any readings. All other probes (pH, conductivity) on the sonde passed accuracy check QA procedures and temperature also appeared to be accurate.

Actions and notes following retrieval of 6600 sonde unit after discovering DO probe malfunction:

(1) Immediate field actions: City staff did not re-deploy the sonde since it was not collecting dissolved oxygen data meeting Q/A standards (i.e. returning reading of 0.00 mg/L and 0.0% saturation). City staff left the bank anchor and cable at the site but retrieved the cage. The anchor and cable were left in place in order to re-deploy another functioning sonde in the same location to capture subsequent storm events.

(2) Data QA/QC: Upon download and review of the WQ data collected over the first flush, it was clear that the DO data was not useable. The sonde went in the water at 13:30 on 9/30/11 and took 2 DO readings (at 13:30 and 13:45) that appear reasonable. Following those readings, DO measurements were extremely erratic, ranging from negative DO concentrations and % saturations to super-saturated (500%) until 10/11/11 at 12:15 when DO readings from that point forward were all 0.00 mg/L and 0.0% saturation.

Summary:

The exact cause for the DO probe failure remains unknown, but it is likely due to malfunctions associated with the extremely high sediment exposure to the end of the ROX DO probe. Similar effects were not observed downstream at the Program's Montague monitoring site. It is likely any water quality impacts associated with sediment removal operations represent localized impacts to the side channel.

Side Channel Condition in previous years' studies:

City staff monitored water quality parameters of the Rincon 2 side channel in FY 2009-2010 and 2010-2011. In these years, the side channel functioned as a riparian habitat, with regularly spaced pools and riffles, variegated banks, point bars, and mixed native and nonnative vegetation. The stream bottom was characterized by fine sediment and rip rap. Figures 1 and 2 below were taken in the FY 2010-2011 and represent typical conditions during previous monitoring studies.

Figure 1: Photo date 01/28/2011: Rincon 2 Side channel monitoring site from downstream looking upstream towards Rincon 2 pump station in the previous winter. Note the banks were vegetated and variegated.

Figure 2: Photo Date 01/28/2011: Rincon 2 Side-channel monitoring site from upstream looking downstream in the previous winter 2011. The monitoring site is to the bottom left of the photo. Note regularly spaced pools, riffles, and bars.

Side Channel Condition following the first flush on 10/4/11:

City staff found large sediment piles along the banks of the side channel and smaller sediment piles in stream (Figure 3). The sonde cage was undisturbed from its original deplyment position and no operations were apparently taking place around the monitoring site.

Figure 3: Photo Date 10/4/11: An example of sediment piles in stream. This photo is upstream of the side channel monitoring site. At this point the banks were still vegetated and stream morphology largely unaltered.

Side Channel Condition upon sonde retrieval 10/14/11:

Side channel was notably altered in morphology and levee-facing banks were lacking vegetation (Figure 4 and 5) See bullet (1) above for detailed description of levee and monitoring site conditions.

Figure 4: Photo Date: 10/14/11: Picture of levee bank adjacent to the Rincon 2 side channel continuous monitoring site showing the levee bank now characterized by exposed, unstabilized mud. Note also the remaining evidence of sediment piles in the creek that appear to have been scraped clean by equipment. This picture is taken from a position on the opposite side of the stream bank, in line with the monitoring location but looking Northeast (angled downstream).

Figure 5: Photo Date 10/14/11: Picture of the Rincon 2 side-channel looking upstream of the monitoring site. Note the freshly eroding banks and large amount of fresh sediment in stream. The sediment is the same type found in the probe guard.

ATTACHMENT B:

Visual Surveys of selected locations along Guadalupe River and Alviso Slough

following the 2011 first flush storm (10/3/11)

Tuesday (10/4/11) and Wednesday (10/5/11) Biologist Carol Boland and Supervising Environmental Service Specialist (S.E.S.S.) James Downing surveyed Alviso Slough and the Guadalupe River for water quality impacts and potential fish kills following the first flush rain event on 10/3/11. The following is a summary of their observations.

10/4/2011:

At approximately 11:00 Biologist Boland and S.E.S.S. Downing launched a skiff from the Alviso boat launch ramp and motored slowly up the slough to the Gold Street Bridge. Water was turbid, but they observed no dead fish or other indication of adverse effects from the first flush. They next traveled slowly down the slough looking for signs of effects. They stopped near the location of the two deployed sondes and took surface and bottom water quality readings with the handheld unit. Water was gently flowing out of the slough.

They returned to the boat launch ramp, at which time they noticed a mild “rotting vegetation” odor. While preparing to put the skiff back on the trailer, S.E.S.S. Downing noticed a dead yellowfin goby on the launch ramp. He collected the goby and placed it in a ziplock bag and began looking more carefully at the entire area around the boat launch. He also found and collected one Three-spined Stickleback, also on the launch ramp. Both fish were placed on ice in a small cooler.

After this discovery, the pair re-launched the boat and again traveled slowly upstream, this time more closely approaching the bank in areas where vegetation permitted, and where mudflat was more exposed. They found no additional dead fish and returned to the boat launch ramp.

Water in the slough at this point appeared somewhat reddish, and Boland used a plankton net vertically towed off the dock to collect a phytoplankton sample which was immediately preserved. She also took a whole water sample using a Niskin type sampler. Downing took photos of the reddish-colored water which could be seen in contrast with the lighter-colored water exiting the small slough channel that terminates at the Gold Street Pump Station outfall in the marsh.

They returned to the WPCP laboratory at approximately 14:00, cleaned and stowed equipment, and packaged the two fish for shipment to the DFG laboratory in Rancho Cordova.

Boland took the package to Fed Ex while Downing continued on to the Rincon 2 pump station to survey the Rincon 2 side channel. District sediment removal operations could be heard, but could not be seen from the eastern side of the river. Large piles and rows of sediment were exposed on the bank and in the side channel. Downing took photos and left at approximately 16:10.

Figure 1: Photo Date 10/4/11: An example of the red colored water observed in Alviso Slough.

Figure 2: Photo Date 10/4/11: Biologist Boland taking a water sample at the Alviso Marina shortly after finishing field observations. The dead fish were found on the boat ramp at the center of the photo.

10/5/2011:

Significant rain occurred overnight.

Boland and Downing arrived at the Willow Glen Way Bridge at approximately 09:30 and surveyed upstream and downstream. Water was flowing quickly and the turbulence was creating some slight foaming. Water was very turbid and brown. They observed no dead fish.

Boland and Downing arrived at the Woz Way bridge at approximately 09:45 and surveyed upstream and downstream approximately 30 yards in each direction. They found no dead fish, and observed ducks in and around the water. Water was very turbid and brown.

Boland and Downing arrived at the Coleman Avenue area at approximately 10:00 and surveyed approximately 200 yards south of the bridge. Large piles and rows of sediment were exposed and actively being eroded in the channel, apparently left from sediment removal activities. Water was turbid and brown, but they observed no dead fish.

At approximately 10:30 they drove the western levee from Trimble to Montague. They observed turbid water, but no dead fish.

They then moved to the Eastern side of the river and attempted to drive along the road to the Oakmead pump station, but the road under Montague was inundated, so they drove surface streets, arriving at approximately 11:15. They surveyed upstream and downstream approximately 50 yards in either direction. Water was turbid and brown, but there were no odors or dead fish.

Figure 3: Photo Date 10/5/11: Willow Glen Way looking upstream from the bridge.

Figure 4: Photo Date 10/5/11: Coleman Ave. looking downstream from the west bank.

Figure 5: Photo Date 10/5/11: Montague Ave. looking downstream from the east levee road. Note the inundated levee road to the far right of the photo. The Program's continuous monitoring location is approximately adjacent to the tree on the left.

Figure 6: Photo Date 10/5/11: Guadalupe River adjacent to the Oakmead pump station outfall.

ATTACHMENT C:

Department of Fish and Game Fish Pathology Report

State of California -The Natural Resources Agency
DEPARTMENT OF FISH AND GAME
Fish Health Laboratory
2111 Nimbus Road
Rancho Cordova, CA 95670
Phone: (916) 358-1489
Fax: (916) 358-2825

EDMUND G. BROWN, Jr, Governor
JOHN McCAMMAN, Director

FISH PATHOLOGIST REPORT

Location
Alviso Marina Boat Ramp
Latitude: 37°25'45.51
Longitude: 14°58'54.51

Date
October 6, 2011

Species
Yellowfin Goby (*Acanthogobius flavimanus*)
Three-spine stickleback (*Gasterosteus aculeatus*)

Parasites and Disease Condition:
The Fish Health Laboratory was contacted by Carol Boland (Biologist, City of San Jose - Environmental Services) and asked to examine several species of fish from a possible fish kill at Alviso Marina. On 4 October 2011, yellowfin goby (n = 1) and three-spine stickleback (n = 1) were examined whereupon high levels of motile/non-motile mixed *Aeromonad /Pseudomonad* –type bacteria were found in wet mounts of skin scrapes. The yellowfin goby had moderate levels of mesenteric and peritoneal adhesions in conjunction with low to moderate levels of nematodes.

Comments:
During prior fish kills multiple species were affected and losses were acute in nature. Due to the fact that a reddish tint was present at time of this collection, it is strongly suggested that further studies are performed to rule out any toxins that may contribute to acute fish loss. At the time of this examination, no significant pathogens were observed externally by light microscopy, and the nematodes that were found are common and typically occur as asymptomatic infections of wild fish. Although high levels of bacteria were present, the proliferation of mixed bacteria after death is expected and these findings are considered unremarkable.

Water Temp: 19.26°
DO (mg/L): 3.98
DO (% Sat): 44.2
pH: 7.86

Submitted By

Garry O. Kelley, Ph.D., Associate Fish Pathologist, CDFG

Conserving California's Wildlife Since 1870

Appendix D

Pollutants of Concern Monitoring (Provision C.8.e)

D1 - Small Tributaries Loading Strategy (STLS) Multi-Year Monitoring Plan (Version 2013)

D2 - Pollutants of concern (POC) loads monitoring data progress report (Water Year 2012)

D1

Small Tributaries Loading Strategy (STLS) Multi-Year Monitoring Plan (Version 2013)

Small Tributaries Loading Strategy Multi-Year Plan - Version 2013

Prepared for

Bay Area Stormwater Management Agencies Association (BASMAA)

And

Regional Monitoring Program for Water Quality in the San Francisco Estuary
Sources Pathways and Loadings Workgroup (SPLWG)
Small Tributaries Loading Strategy (STLS)

Prepared by
Alameda Countywide Clean Water Program
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San Francisco Estuary Institute
4911 Central Avenue
Richmond, CA 94804

Final: March 7, 2013

Small Tributaries Loading Strategy Multi-Year Plan

Contents

Acknowledgments

This document was developed collaboratively by the Small Tributaries Loading Strategy Local Team of the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP):

- Lester McKee, Alicia Gilbreath, Ben Greenfield, Jennifer Hunt, Michelle Lent, Aroon Melwani (SFEI)
- Arleen Feng (ACCWP) and Chris Sommers (EOA/SCVURPPP) for BASMAA
- Richard Looker, Tom Mumley and Jan O'Hara (SFRWQCB)

BASMAA and ACCWP provided funding for preparation of the draft text and Appendix A incorporating information from many working products by RMP and BASMAA. [SFEI staff are responsible for preparation of Appendices B, C, D, E and G – if not credited in those respective appendices];

Additional technical advice to the STLS Work Group was provided in early meetings by Mike Stenstrom (UCLA) and Eric Stein (SCCWRP), who also participated in reviews by the RMP Sources Pathways and Loadings Workgroup and more recently since October 2011, by Roger Bannerman, retired and formerly of DNR Wisconsin.

Members of the BASMAA Monitoring and Pollutants of Concern Committee and stormwater program staff also participated in development and review of the Multi-Year Plan, especially Jamison Crosby and Khalil Abu-Saba (Contra Costa Clean Water Program) and Jon Konnan and Lucy Buchan (San Mateo Countywide Water Pollution Prevention Program).

Introduction

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) was established to provide the scientific information needed to support water quality management. In the 21st century, the RMP's activities are shifting to provide more direct support for answering specific Management Questions through multi-year Strategies consisting of coordinated activities centered on particular pollutants or processes. The Small Tributaries Loading Strategy (STLS, SFEI 2009) presented an initial outline of potential activities to address four key Management Questions regarding local watershed contributions of Pollutants of Concern to San Francisco Bay. The objective of this Multi-Year Plan (MYP) is to provide a more comprehensive description of the suite of activities to be included in the STLS over the next 5-10 years. It provides a detailed rationale for the methods and locations of proposed activities, including watershed monitoring of local tributaries.

Some of these activities will be conducted by stormwater programs to fulfill the requirements of the Municipal Regional Stormwater Permit (MRP, SFRWQCB 2009) for Pollutants of Concern (POC) loads monitoring[1]; this MYP documents an improved alternative monitoring approach for addressing these MRP needs that is integrated with the RMP-funded activities.

The MYP includes continuing development of the Regional Watershed Spreadsheet Model as a tool for estimating regional loads. It also clarifies the linkage between the STLS and the RMP's developing Modeling Strategy for pollutant fate and transport in the Bay as a whole and also in the Bay margins which are a vital link between the local watersheds and the Bay.

The first version of the MYP (Version 2011) was prepared in September 2011. Updated Versions 2012A and 2012B incorporated additional information and STLS activities through July 2012, including:

- Development of the Regional Watershed Spreadsheet Model including preliminary explorations and recommendations for developing Event Mean Concentrations to parameterize the model for priority POCs and planning submodel construction for individual POCs .
- Initiation of watershed monitoring at four initial sites, supported by preparation of a draft Quality Assurance Project Plan (QAPP) and Field Manual, and coordination among field crews.
- Coordination and standardization of laboratory contracting and management and Quality Assurance/Quality Control (QA/QC) of watershed monitoring data

Version 2013 incorporates additional information and STLS activities through January 2013, including:

[1] Described in MRP Provisions C.8.e and its sub-provisions i, iii, iv and v. Sub-provisions vi and vii are also related to the same objectives, see Appendix A.

- Development of a user interface for the RWSM, and spatial datasets for modeling of copper, mercury and PCBs.
- Review of lessons learned from the first year of watershed monitoring
- Startup of two additional watershed monitoring sites in addition to the four previously selected.

Previous MYP versions included Appendices with supporting information and details of individual MYP elements[2]. Updated or new versions of some Appendices will be provided in the future.

Background

Based on data collected by the RMP and others, the San Francisco Regional Water Quality Control Board (Water Board) has determined that San Francisco Bay is impaired or potentially impaired by a number of POCs. For some of these, the Water Board has adopted water quality attainment strategies including Total Maximum Daily Loads (TMDLs) for mercury and PCBs (SFRWRCB 2006, 2008) due to their persistence in the environment and accumulation in aquatic food webs that pose threats to wildlife and human consumers of fish from the Bay.

Each TMDL identifies sources and pathways contributing to the impairment or detrimental effects associated with the subject pollutant, as illustrated for PCBs (Figure 1). The sizes of the arrows on the figure illustrate, conceptually, the importance of each source, pathway or process. For PCBs, urban runoff, deposition of associated sediment, and transfer from sediment up through the food chain are the important pathways and processes. For each source, the TMDL estimates current annual loads and identifies reductions in those loads that would be required to eventually eliminate the impairment. Each TMDL is adopted along with an implementation plan consisting of management actions to be taken by various discharger groups in order to achieve these load reductions.

Urban runoff from local watersheds is a significant pathway for many pollutants of concern into the Bay, and the MRP contains several provisions requiring management actions and studies to address mercury and PCB its (see Appendix A for details). The MRP's monitoring provisions also include other pollutants for which storm water data are needed. The MRP also encourages coordination of storm water program activities with the RMP are other regional collaborative groups.

[2] On behalf of MRP Permittees, the Bay Area Stormwater Management Agencies Association (BASMAA) provided MYP Version 2011 and available Appendices A, C, D, E and F to the San Francisco Regional Water Quality Control Board as attachments to a Monitoring Status Report (Part B of a composite document that also included a Regional Pollutants of Concern Report for required annual reporting) in September 2011. In September 2012, MYP version 2012B was attached to another semiannual Monitoring Status Report along with Appendix B, ; Internet links for the above Appendices are listed at the end of this document. This version of the MYP is included in the BASMAA Regional Monitoring Coalition Urban Creeks Monitoring Report (UCMR) of March 2013, as UCMR Appendix D-1.

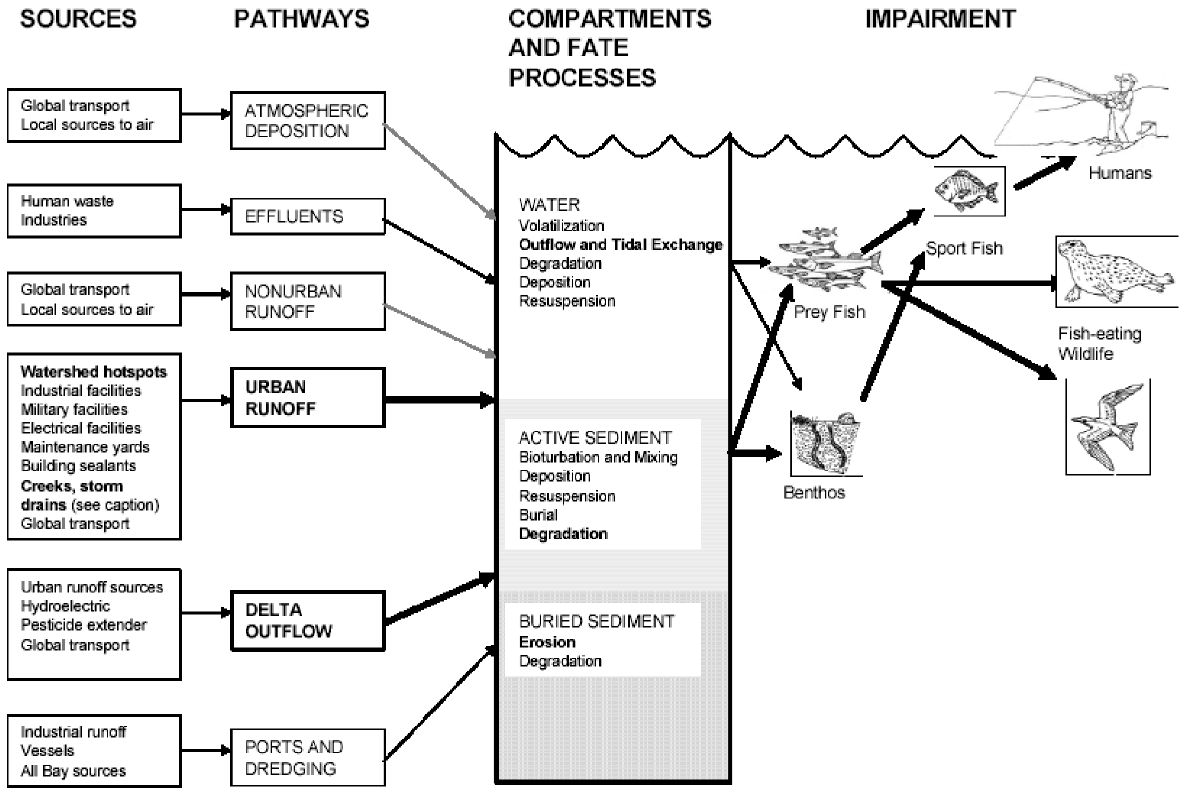

Figure 1. Conceptual Model of PCBs in San Francisco Bay (from Davis et. al 2006)

The STLS MYP is a major component of the RMP Multi-Year Plan, which integrates the efforts of many workgroups and strategy teams to develop five-year plans addressing the highest priority management information needs identified by the RMP stakeholders. The intent of the Multi-Year Plan is to anticipate regulatory or management decisions and policies that are on the horizon, so that the specific scientific knowledge needed to inform the decisions will be available at the required times.

The RMP's Multi-Year Planning Process, initiated as the "Master Planning Process" in 2010[3], articulates several "strategies" which coordinate studies across the pre-existing process-oriented work groups (see Appendix A). The STLS is a major strategy with linkages to other strategies for mercury, PCBs and forecasting/ modeling. The Water Board has given a high priority to refining and tracking load estimates of PCBs and mercury to assess progress towards the reductions in the TMDLs. Initial estimates of stormwater contributions to annual loads of mercury and PCBs to the Bay were based on limited data and one of the RMP's goals has been to improve both data collection and the conceptual framework for developing load estimates. Understanding trends from individual watersheds will also be important, whether in response to general demographic

[3] RMP activities are planned on a calendar year basis, while BASMAA and most of its member agencies operate on a Fiscal Year (FY) that begins on July 1.

and climatic changes or targeted management actions to reduce local discharges of PCBs and mercury.

Depending on the state of existing knowledge and potential impairment status, loading information needs may be a somewhat lower priority for other POCs such as copper (for which the highest priority information gaps are about effects and not loading) or legacy organochlorine pesticides (for which the monitoring objective may be tracking a long-term “recovery” curve of diminishing concentrations in the Bay). A third group of POCs are present in the Bay at concentrations that cause concern; since existing data are insufficient to assess the amount of contribution from stormwater conveyance, initial STLS work will contribute to a general characterization of spatial occurrence and ranges of concentrations. This differential prioritization is reflected in the MRP’s partitioning of required stormwater monitoring parameters into two groups with different levels of minimum sampling frequency:

- Category 1 (minimum 4 events per year): Total and Dissolved Copper; Total Mercury; Total Methyl Mercury; Total PCBs; Suspended Sediments (SSC); Total Organic Carbon; Water Column Toxicity; Nitrate as N; Hardness.
- Category 2 (minimum 2 events in alternate years): Total and Dissolved Selenium; Total PBDEs (Polybrominated Diphenyl Ethers); Total PAHs (Poly-Aromatic Hydrocarbons); Chlordane; DDTs (Dichloro-Diphenyl-Trichloroethane); Dieldrin; Nitrate as N[4]; Pyrethroids - bifenthrin, cyfluthrin, beta-cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, and tralomethrin; Carbaryl and fipronil; Total and Dissolved Phosphorus.

The RMP Sources Pathways and Loadings Work Group (SPLWG) was initiated in 1999 to address pollutant loading to the Bay. It has overseen monitoring studies of high-priority POCs in small tributaries at the Guadalupe River (McKee et al., 2004; 2005; 2006) and at Zone 4 Line A (a small flood control channel in Hayward) (McKee et al., 2009; Gilbreath et al., in review) as well as at Mallard Island (Leatherbarrow et al., 2005; McKee et al., 2006; David et al., 2009, David et al., in review) where the Sacramento River enters the region.

Development of the draft MRP led to an RMP initiative in 2007 to develop the STLS as a framework for coordinating stormwater requirements and RMP activities. In recognition of those discussions already initiated prior to its adoption, the MRP allows Permittees to pursue an alternative approach to answer the same information needs underlying the STLS. The STLS Work Group, a subgroup of SPLWG, includes representatives from BASMAA and Water Board staff to ensure close coordination, as well as SFEI staff and technical advisors recruited through the RMP. A series of meetings during 2008 and 2009 and associated meeting support materials led to the finalization of the draft Strategy (SFEI, 2009). In 2009 and 2010 SFEI provided further planning support through the completion of several data synthesis reports (Greenfield et al., 2010; Melwani et al., 2010). An initial draft MYP presented the STLS Work Group’s recommended approach

[4] Erroneous duplication in MRP language.

for implementing the STLS, was reviewed by the SPLWG at its May 2011 meeting, followed by brief review of the completed Version 2011 at its meeting on October 25, 2011; at this meeting the SPLWG agreed to a communications strategy for informing the SPLWG of further MYP updates produced by the STLS Work Group.

MYP updates in 2012 reviewed the status of planning and implementation for coordinated watershed monitoring beginning October 1, 2011[5]. This 2013 version updates the plan as of the second season of watershed monitoring begun in October 2013[6]. Further details and documentation of watershed monitoring and other work plan activities for later years will be added in future MYP versions as needed (see Adaptive Updates below).

Management Questions and Strategy Elements

The stakeholder process established the following Management Questions for the STLS:

1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs;
2. What are the annual loads or concentrations of POCs from tributaries to the Bay;
3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay; and,
4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact.

STLS technical activities are grouped into three Elements, listed with their sub-elements in Table 1. Figure 2 shows the main linkages between Management Questions and individual Elements; some Elements also support each other, as suggested by the dotted lines and described in the following MYP sections. Other activities outside the scope of the STLS also have bearing on these Management Questions; see Appendix A for background and context of regional projects to evaluate the potential effectiveness of management actions to reduce PCB and mercury loads to the Bay.

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[5] The Water Year (WY) designation used by USGS begins on October 1 of the previous year, which is the nominal start of the wet weather monitoring season in the Bay Area. Stormwater monitoring beginning in October is customarily budgeted by the RMP with funds for the following calendar year and by BASMAA with funds for the Fiscal Year beginning the previous July.

[6] Monitoring results for Water Year 2012 are reported separately in the main body and Appendix D-2 of the UCMR.

Table 1. Small Tributaries Loading Strategy Elements and projected implementation roles.

Element	RMP	Stormwater Programs
1. Watershed and associated Bay Modeling		
A. Regional Watershed Spreadsheet Model	X	
B. Coordination with Bay Margins Modeling	X	
C. HSPF dynamic modeling (potential)	(X)	
2. Source Area Runoff Monitoring and EMC Development	X	
3. Small Tributaries Monitoring		
A. Monitor Representative Small Tributaries	X	X
B. Monitor Downstream of Management Actions		X

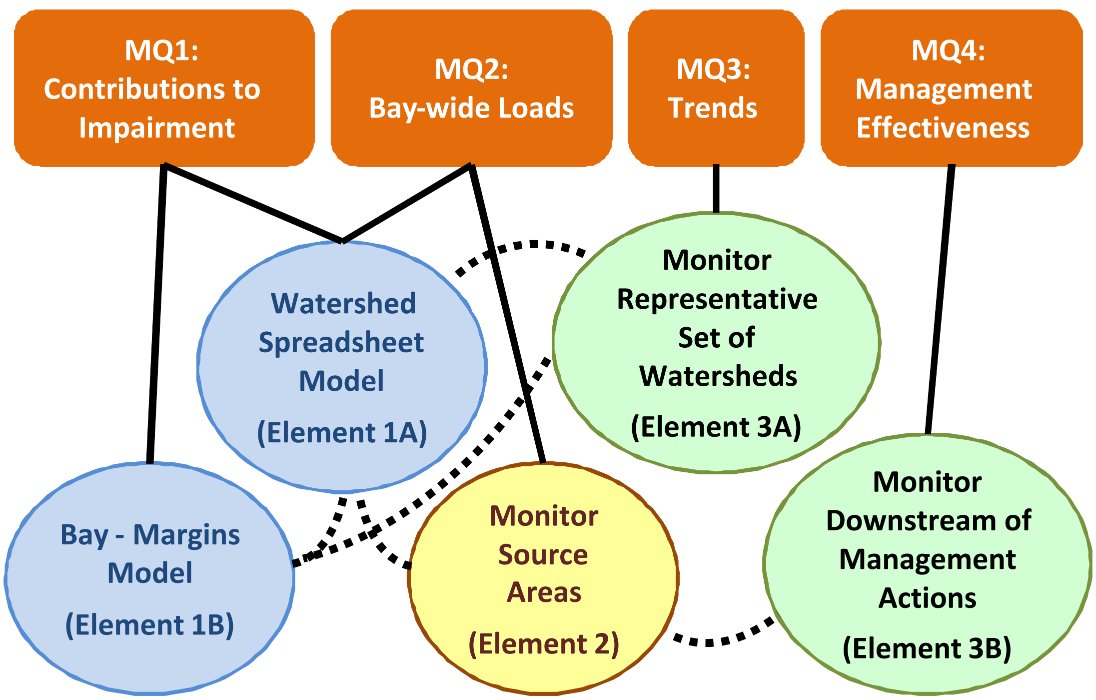

Figure 2: Primary relationships between Small Tributaries Loading Strategy management questions and Elements.

The first element, Modeling, includes a watershed spreadsheet model specifically designed to estimate Bay-wide loads of POCs (Management Question 2) which will also clarify the relative contribution of small tributary loads to the overall Bay impairment for each pollutant (Management Question 1). The spreadsheet model will provide first order estimates of relative load contributions from individual watersheds around the Bay and will help to identify high-leverage watersheds or more likely clusters[7] of watersheds that may be having a greater local impact to sensitive reaches of the Bay margin[8]. However, the model is of limited use for this question without comparable understanding of the spatial variation within the Bay and local contributions from non-runoff sources; these will be provided through a Bay margins model being developed by the RMP as part of a separate Forecasting or Modeling Strategy. In the future, dynamic modeling of one or more individual watersheds may be useful to deepen the understanding of underlying mechanistic behavior not captured by the spreadsheet model. The finer temporal scale of dynamic models may also be helpful in linking the tributary loads to the time scales of biological processes represented in the Bay margins model.

The second element, Monitor Source Areas, is intended to provide Event Mean Concentrations (EMCs) of targeted POCs to parameterize the watershed loadings spreadsheet model. Such monitoring would require catchments that are relatively homogenous in terms of land use or other source area characteristics, which would differ from the watersheds selected for Element 3. The STLS is exploring a number of desktop approaches to estimate EMCs for initial work on the Regional Watershed Spreadsheet Model. Understanding that is gained through this element about the range of EMCs and the factors that affect them can also inform the approach to monitoring downstream of management actions.

Element 3, Watershed Monitoring, has two sub elements to address Management Questions 3 and 4. Initial monitoring efforts focus on six watersheds which represent a range of size and land uses among urban watersheds. Two stations added in WY 2013 are located in pump stations that drain catchments where management actions for reducing PCB loads will be implemented by stormwater programs.

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[7] Given the lumped one-dimensional nature of the RWSM rainfall run-off model that is based on annual average rainfall, land use, and land use specific coefficients, it is considered unlikely that the model outputs will be reliable at the scale of the individual watersheds despite sub-regional and regional calibrations of potentially as good as +/-75% with less than +/-5% bias.

[8] Another group of spreadsheet models is being used by the stormwater programs to address Management Question 4 by providing quantitative scenarios of PCB and mercury load reductions from implementation of source control measures in local watersheds. Monitoring data from pilot projects begun in 2010 to refine and test these “desktop evaluation” models are also likely to provide useful input for running scenarios on the RWSM. See Appendix A.

Strategy Elements

Load Estimation and Modeling

The Regional Watershed Spreadsheet Model (RWSM) is the primary STLS tool for estimation of overall loads to the Bay. Spreadsheet runoff models are based on the simplifying assumption that unit area runoff for each homogenous subcatchment can be represented by a constant concentration (called an event mean concentration) for each POC. Given the large number of small tributaries, initial STLS Work Group discussions indicated this is more suitable as a framework for regional load estimation than simulation models such as HSPF and SWMM that require large and detailed calibration datasets. The RWSM is structured similarly to the model presented by Ha and Stenstrom (2008), using GIS-derived data for land use, imperviousness, average soil type/slope and annual precipitation. It uses recent local data on land use based concentrations collected in the Bay Area and augmented using data and information extracted from recent stormwater literature. The input coefficients such as EMCs for each target pollutant in the model can be updated periodically as new data become available through the monitoring elements of the STLS or related compatible efforts.

RWSM Development

This section summarizes the details and development of the RWSM which are described in reports submitted to the SPLWG and cited or provided in Appendix B in the 2012B version of the MYP. The model's spatial extent covers the entire region overseen by the Region 2 Water Board boundary (corresponding closely to the Calwater outline in Figure 3). Within this region, the spatial resolution of individual watershed areas is provided by several data sources:

- Watershed boundaries for Central and South Bay. The urban portions of this dataset are based on compilations by the Oakland Museum of California (OMC) Creek and Watershed Mapping Project (a long term collaboration between William Lettis and Associates, OMC, and SFEI funded by cities and counties http://www.sfei.org/content/gis-data). Begun in 1993, and largely completed in 2008 through a state bond-funded Proposition 13 grant awarded to SFEI, this dataset incorporates further corrections by stormwater managers and is provides a fairly accurate depiction of urbanized catchments, although many of the smaller catchments have been arbitrarily aggregated and the dataset is not fully conformant to data standards of the National Hydrography Dataset.
- Contra Costa Flood Control District's watershed boundaries to fill in the eastern portion of Contra Costa County (CCCDD, 2003)
- Provisionally, Calwater Hydrologic Areas are used to fill in remaining portions of the North Bay, Contra Costa, SF & coastal peninsula. Later versions of the RWSM could use increased spatial resolution provided by NHD or other sources if needed.

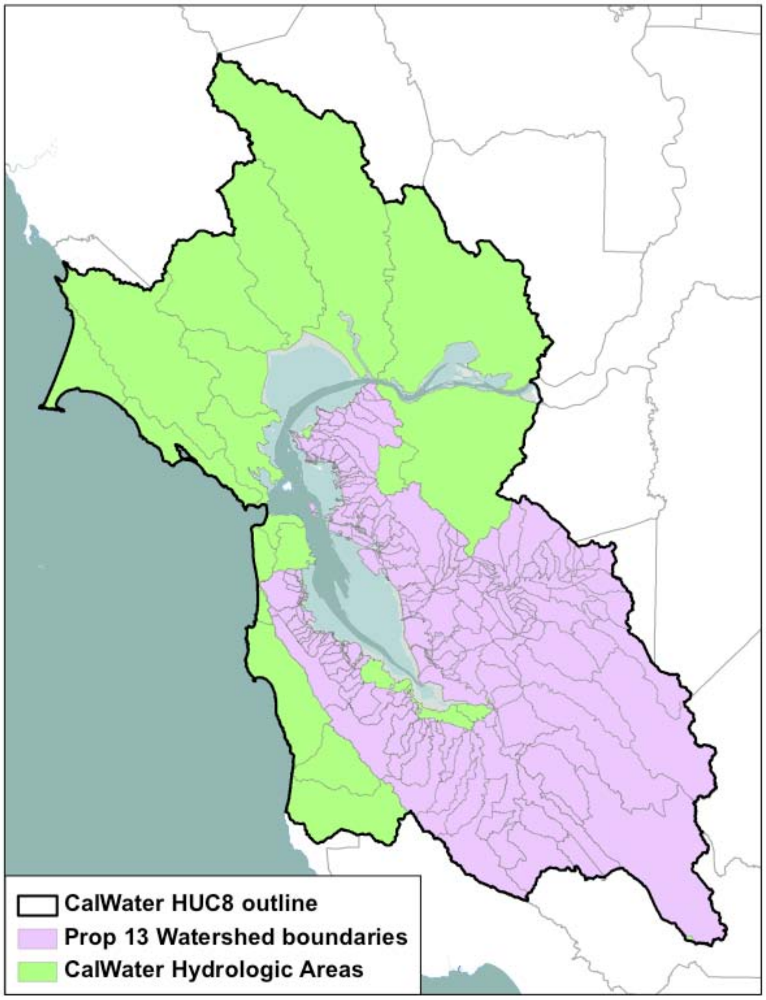

Figure 3: Spatial extent of RWSM and detailed watershed boundaries[9]

The outcomes of the first year included the development of two parallel hydrological models, one using land use based runoff coefficients and the other using imperviousness based runoff coefficients. The model outcomes were compared to empirical observations in 18 calibration watersheds. Preliminary loads of suspended sediment were also generated but the loads generated were quite different from the empirical observations (of which there are many).

The RWSM's land use dataset for the Bay Area (ABAG, 2005) is based on a combination of remote sensing and local assessor's parcel information. The first construction of the RWSM used the land use categories of Ha and Stenstrom (2008), with Event Mean Concentrations (EMCs) in initial runs taken from literature. Other categories could be substituted following further analyses from Element 2 studies to develop a framework for

[9] Watershed boundaries based on the Oakland Museum of California Guide to San Francisco Bay Area Creeks (http://museumca.org/creeks/GIS/index.html) and compiled and improved through a Proposition 13 grant awarded to SFEI (http://www.sfei.org/content/gis-data).

specific loads based on land use or other source area characteristics such as age or condition of development.

Work for the RWSM in 2011 included preparation of the Year 1 report (Lent and McKee 2011a) and follow-up on several of its recommendations to refine the hydrology model by:

- Adding several calibration watersheds to ensure watershed characteristics that span a wider range of imperviousness. Since the original calibration data set used in the RWSM year 1 model lacked representation at the high end of the imperviousness range, three high imperviousness catchments were added to the calibration data set. All three of these catchments drain to pump stations and required conversion of pump logs to estimated flow; these records were only available for short periods.
- Removing gage records for some watersheds and time periods with pre-development land use / impervious characteristics differing significantly from present conditions
- Refining land use categories with the updated ABAG 2005 dataset used as base. This improved the consistency of the spatial dataset among counties, particularly in the treatment of transportation land uses which are highly impervious.

The Year 2 progress report (Lent et al 2012) describes these model refinements and is incorporated as part of Appendix B, along with a workplan for further model development. The year 2 tasks served to correct or reduce errors and biases in the hydrological model that were noted in the year 1 report. The hydrologic model will need to be re-visited, in the context of further model development such as calibrating the sediment model or the pollutant models, which are the focus of RWSM work in year 3 (See Appendix B).

Each pollutant has a unique set of properties that determines its uses, the resulting products and environmental attributes such as in-use spatial distribution, potential for reuse, and mechanisms of inadvertent environmental pollution. A series of “pollutant profile” fact sheets will summarize these properties and frame conceptual models of source areas and other information needed to build each POC specific model using the RWSM. The initial version of the RWSM focuses on load estimates for sediment, mercury and PCBs. The year 1 report presents the available information and proposed modeling approaches for the highest priority POCs, along with discussion of data gaps:

- There is little direct EMC information about PCBs, so the sediment surrogate will initially be used to understand the potential range of loadings. Refining the spatial characterization of the particular types of land uses and source areas for PCBs is a high priority as described below.
- The sediment model does not have the same structure as other POCs and will be represented as a hybrid of available USGS datasets for larger mixed-use watersheds and a more land use oriented source area model for highly urbanized watersheds which are generally smaller.

- Mercury will likely follow a similar conceptual model to the sediment model.

Copper was also included in the first round of RWSM development because extensive data are available both from the Bay Area and in the world literature, and also because as a primarily dissolved constituent it serves to define the limitations of the hydrologic model alone and helps to set up realistic definitions for success for the other more difficult pollutants.

Parameter estimation (also known as inverse optimization) is an approach for back-calculating multiple source concentrations from downstream storm runoff concentrations that has been successfully used for more conventional analytes (Silverman et al., 1988; Ha and Stenstrom, 2008). Using methodology based in part on Ha and Stenstrom (2008), an optimization procedure was run repeatedly within a Monte Carlo loop that fed the optimization a set of randomly chosen observed concentration data points, one from each calibration watershed. The optimization then searched the parameter space of land use specific concentrations, and computed "simulated" downstream concentrations from these parameters, using a simple model that incorporated categorized land use and runoff coefficients with an underlying hydrological model.

Initial parameter estimation results for mercury and PCBs were presented to the SPLWG in October 2012, indicating promise for using this method to estimate loads. Mercury seemed to exhibit fairly consistent land use associations while PCBs showed less consistent land use associations, likely due to the tendency for its sources to be highly localized. While this would make it difficult to get good fit at the scale of individual catchments, reasonable results are still likely at more aggregated scales as long as the calibration data set is representative of the area modeled. To fully assess the potential of this approach, recommendations for follow-up work included further development of input data sets, both spatial data sets (GIS layers) and calibration/validation data sets for hydrology. SFEI and BASMAA began working collaboratively on development of more specific GIS layers for source areas, primarily of land uses and source areas associated with PCBs and secondarily those associated with mercury.

In March 2012 the STLS Work Group reviewed a draft multi-year planning matrix for RWSM-related activities, which is included in the Year 3 and RWSM multi-year work plan in Appendix B. The planning matrix includes all tasks and POCs that are of interest to the STLS, BASMAA and other RMP strategies, which are potential funding sources for specific tasks. The draft matrix projects construction of a version 2 model for each of the above POCs in 2012; due to a slow down on the GIS layer development, this is now slated for 2013. Pollutant profiles will also be drafted for the next tier of POCs to be examined, which were selected based on MRP priorities with the concurrence of Water Board staff as described in the next section. Work plan details will be updated as findings of further model testing and calibration are incorporated in future versions of Appendix B. These updates will also describe recommendations for further testing and verification, for example selection of monitoring locations that would be supportive for improving model weaknesses; EMC-related data needs and proposed future activities will be detailed in Appendix G for future versions of the MYP.

RWSM Uses

In 2011 and 2012 the RWSM framework contributed to the watershed monitoring design and influenced the selection of the fifth and sixth watershed monitoring sites. When coupled with monitoring data in the near future, it will provide improved estimates of current loading. Other near-term functions will be as a tool to help stormwater programs address two related MRP requirements:

- Provision C.8.e(vi) requires developing a design for a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages. RWSM model coefficients will also be developed for sediment, which will provide improvements to the methodologies and regional load estimates previously developed by Lewicki and McKee (2009).
- Provision C.14.a(v) requires developing information required to compute loads to San Francisco Bay of PBDEs, legacy pesticides, and selenium from urban runoff conveyance systems throughout the Bay. The RWSM workplan includes developing input information and a framework for initial load characterization with available data from RMP and STLS monitoring. Further recommendations may be made for additional studies as needed to improve these initial estimates.

Water Board staff have indicated that the RWSM is an appropriate tool for addressing these provisions, and BASMAA has approved regional project budgets to support work on sediment, PBDEs and the legacy pesticides chlordane, dieldrin and DDTs[10]. These budgets are incorporated in the workplan Table 11 and will be integrated with the RWSM multi-year planning matrix that is presented in Appendix B. In particular the sediment modeling work in 2012 and 2013 will address both the MRP requirements and also may improve the calibration of the hydrological model to support development of the PCB and mercury models.

A related model that was discussed in the STLS but is not part of the STLS workplan is a desktop model for evaluating the effectiveness of management options to reduce loads of POCs from local watersheds (see description of Proposition 13 products in Appendix A). As storm water programs collect monitoring data from sites of pilot management projects, these can be used in conjunction with existing EMC information to run scenarios for wider application of various management strategies and predict regional load reductions using the RWSM. Other medium and long term uses will be determined by the STLS Work Group, which will provide ongoing stakeholder discussion forums to update priorities as described in Adaptive Updates below.

[10] A status update on the RWSM sediment modeling is included in the March 2013 UCMR as Appendix E. Lent and McKee (2011a) also includes a contaminant profile for selenium.

Coordination with Bay Modeling and Other Modeling Efforts

The RMP has also prepared a Bay Margins Conceptual Model as part of a separate Bay Modeling Strategy overseen by the Contaminant Fate Work Group (CFWG). The draft report (Jones et al., 2012) reviews ecosystem characteristics and physical, chemical and biological processes affecting contaminant fate, and identifies desirable characteristics for more refined modeling of the Bay. Challenges of linking physical models to biological endpoints are noted and Recommendations for a general framework for a modeling strategy are presented; development of a full-Bay 3-D model is suggested as an example of mechanistic physical modeling that could be used to address management questions, such as the STLS priority to identify high-leverage watersheds whose POC loadings contribute disproportionately to Bay impacts. Until the RMP Modeling Strategy is developed to a point that offers practical guidance on characterizing the relationship of specific tributaries or groups of tributary POC sources to contaminant fate in local portions of the Bay margin, working versions of the RWSM will not apply special weighting or other spatial considerations when estimating individual tributary inputs.

Dynamic Watershed Modeling (Potential)

The SPLWG supported development of a dynamic watershed model for the Guadalupe River Watershed as a pilot effort with funds from 2008 and 2009. This watershed is the subject of a separate TMDL for legacy mercury from the historic New Almaden Mining district. An abundance of local water, sediment, and pollutant data made this watershed a logical place for an initial exercise in mechanistic modeling using Hydrologic Simulation Model-Fortran (HSPF). The basic proof-of-concept Guadalupe watershed model for hydrology was completed (Lent et al., 2009) and the final report was presented (Lent and McKee, 2011b).

Further dynamic modeling work for the Guadalupe River watershed, or initiation of modeling for other watersheds, may be recommended in the future depending on specific information needs of the STLS or Bay Modeling Strategy. STLS need for detailed watershed modeling would be identified through the Adaptive Update process.

Watershed Monitoring

This MYP element outlines a cost-effective and flexible approach to watershed monitoring that can be implemented in the context of both the RMP Multi-Year Plan and MRP permit requirements. As part of STLS development, the RMP conducted several related projects in 2010 through 2011 to evaluate potential design considerations:

- Desktop methods optimization study
- Preliminary watershed classification
- Watershed characterization sampling study

Results of these studies were evaluated along with several other considerations, including analytical sensitivity and cost, to develop several alternative scenarios for implementation of the MYP watershed monitoring element.

Table 2 shows the six STLS watershed monitoring stations and their phasing for start-up during the first two years of sampling, beginning in (WY 2012. The assignment of responsibilities for operation of the stations were based on funding sources and availability of staffing by SFEI and BASMAA consultants. The rest of this section summarizes various aspects of the watershed monitoring and the discussions that informed the decisions made by the STLS Work Group.

In 2011, frequent STLS meetings and communications focused on decisions regarding site selection and procedures for setup and operation of the first four (Phase 1) watershed monitoring stations. In the WY 2012 wet season SFEI operated two stations for the RMP and one station (Guadalupe River) under contract to the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), while the fourth site is operated by contractors for the Contra Costa Clean Water Program (CCCWP). In WY 2013 SFEI operated two stations for the RMP; one continuing from WY 2012 (Sunnyvale East Channel) and one new for WY 2013 (North Richmond Pump Station). Contracting for the continuing operation of the San Leandro Creek station was assumed by the Alameda Countywide Clean Water Program and contracting for the Guadalupe River station was assumed by SCVURPPP, while contractors for the San Mateo Countwide Clean Water Pollution Prevention Program (SMCWPPP) operated the other new WY 2013 site at Pulgas Creek Pump Station. The STLS work group continued to coordinate details of setup and monitoring throughout the second half of 2012.

BASMAA has supported preparation of a draft Quality Assurance Project Plan (QAPP) and BASMAA and RMP funds were used to draft a Field Manual to document standard procedures for field sampling and Quality Assurance. These documents address the MRP requirement for protocols and data quality comparable to the Surface Water Ambient Monitoring Program. The QAPP and Field Manual will be finalized and incorporated in the MYP later in 2013, to include the lessons of the first field season and additional protocol variations associated with the Phase 2 locations in pump stations.

Table 2. Watershed Monitoring Stations for the STLS

Station Name (County)	Funding source WY 2012	Funding source WY 2013
Phase 1		
Lower Marsh Creek (Contra Costa County)	CCCWP in-kind	CCCWP in-kind
San Leandro Creek (Alameda County)	ACCWP in-kind (setup) RMP (operation & maintenance)	ACCWP in kind
Guadalupe River - (Santa Clara County)	SCVURPPP in-kind (SFEI contract)	SCVURPPP in-kind
Sunnyvale East Channel (Santa Clara County)	RMP	RMP

Additional Phase 2		
North Richmond Pump Station (Contra Costa County)	N/A	RMP
Pulgas Creek Pump Station (San Mateo County)	N/A	SMCWPPP in-kind

Monitoring Methods

A standard approach for stormwater monitoring is composite sampling in which multiple discrete samples from one storm event are combined into one sample for analysis. This concept is the basis for basic requirements in 40CFR121.21(7)(g)(ii), referenced in the MRP as the default procedure to be used. A common practice for collecting stormwater samples is to use automated samplers with onset of the storm event sampling triggered by increase in flow (as indicated by a change in stage height of the monitored channel or conveyance) with subsequent discrete aliquots sampled at pre-programmed intervals that may represent equal increments of elapsed time or of discharge volume.

The SPLWG oversaw RMP load studies on the Guadalupe River in Water Years (WYs) 2003-06, 2010, and at Zone 4 Line A (Z4LA) in WYs 2007-10, collecting multiple discrete depth integrated point samples (loosely referred to as grab samples for STLS purposes) during many storm and base flow events. These studies were based on the use of continuous turbidity monitoring as a more sensitive way to identify the onset of storm discharge, as well as for characterizing the within-storm variations in transport of sediments and POCs associated with fine sediments. The turbidity record was used as a surrogate for continuous estimation of finer fractions of SSC and the associated POCs to generate highly accurate and precise load estimates at 5-15 minute intervals which could then be summed to any other desired time interval (e.g. event, day, month or season).

Using the Guadalupe and Z4LA datasets, an optimization study was conducted to recommend sampling methods and style of sampling that would be useful for assessing loads and determining trends. Using methods similar to those outlined in Leecaster et al (2002) and Ackerman et al. (2011), a series of analyses were performed to assess the optimal number of samples and style of sampling for SSC, PCBs and mercury within storms as well as approaches for choosing which storm events to sample. Detailed methods and results are presented in Appendix C. Results differed somewhat for Guadalupe vs. Z4LA and for PCBs vs. mercury, but preliminary review of tested scenarios suggested the following:

- Turbidity triggering was slightly better than flow for defining the start of the storm, but no particular trigger strategy for within-storm sampling was identified that was consistently more accurate for characterizing the POC loads of a particular event.
- To use regression on the turbidity surrogate records for estimating annual loads, at least 10 but ideally 16 samples per year should be collected at each site; however

focusing this number of samples on just a few randomly selected storms would likely cause spurious loads estimates of poor accuracy and precision.

- Strategies for selecting a more representative set of storms to sample (e.g. first flush + a larger storm + several random, first flush + several random, vs. all random) were evaluated. From the analysis it appears that scenarios that include first flush and one of the largest storms of the year provide more robust loads estimates than random sampling alone.
- Power for detecting trends appeared to be possible with just 10 samples collected per year, based on a preliminary scenario in which the samples were randomly selected and did not confirm to any of the tested sampling designs

While the optimization assessment focused on PCBs and mercury, the findings should be generally applicable to other sediment-associated pollutants and probably more than adequate for dissolved constituents since dissolved concentrations generally vary much less with flow. They may not be as relevant for methylmercury since the intent of the permit is to investigate a representative set of drainages and obtain seasonal information and to assess the magnitude and spatial/temporal patterns of methylmercury concentrations. It may also not be particularly good for water toxicity since toxicity response is a function of both concentration and cumulative duration of exposure.

Taking into consideration recent automated sampling experiences at other Bay Area sites, the final sampling design for WY 2012 was modified to include manual grabs for mercury and methylmercury, and both discrete and composite samples using autosamplers as shown in Table 10. Discrete samples collected with a D94 or DH84 FISP sampler were depth-integrated. Samples collected using ISCOs are considered mid depth relative to flow, and samples collected using hand dipping methods (Marsh Creek only) will be reported as collected 25 cm below water surface. This hybrid approach was estimated to be roughly equivalent or slightly lower in cost compared to using autosamplers for all samples; other advantages include reducing the likelihood of false starts and more flexibility in sampler configuration.

The STLS Work Group decided that all sites would use a new high-range model of turbidity probe based on turbidities observed during the WY 2011 characterization study. However delays in delivery of the probes caused a delay in completing the site set-up. At Guadalupe River, logistical problems prevented completion of composite sampler installation prior to the WY 2012 sampling season so monitoring during WY 2012 is being conducted using manual grabs (a D95 FISP) water quality sampler and 4-wheel boom-truck assembly.

Categories of watersheds

From its early days, the SPLWG has recommended stratifying the numerous watersheds of Bay Area small tributaries into general categories to provide a rationale for systematic sampling of a subset of watersheds in selected categories (Davis et al., 2000). These categories are needed to answer two key questions for the design of the STLS MYP watershed monitoring:

1. How many types of watersheds occur in the region and,
2. How many watersheds should be studied to answer key management questions, and how should they be distributed among the identified types?

To address the first question, SFEI conducted a preliminary characterization study using ordination and cluster analysis, exploratory statistical techniques designed to visualize patterns on complex multivariate data sets (see background in Appendix C preliminary discussion "Categorization of watersheds for potential stormwater monitoring in San Francisco Bay"). The study aimed for an initial classification of Bay Area small tributary watersheds into a small number (<10) of classes, relevant for loads monitoring and Bay margin impacts. Statistics were generated for 18 attributes on each of the watersheds to form the basis for analyses. Table 3 summarizes a scheme consisting of eight clusters or classes which appeared robust and meaningful for the STLS purposes.

The descriptions in Table 3 include those attributes that seemed most influential in discriminating among the clusters (all attributes were assigned equal weight in the analyses). Clusters 1, 2, and 3 are similar to each other in all having relatively high residential, commercial, and industrial land cover and consequently, high surface imperviousness. Combined, these clusters include 119 watersheds, and could therefore be described as typical watersheds for the study area. These clusters generally include densely populated, low-lying areas that drain into South Bay and Central Bay
In the remaining groupings, Cluster 6 watersheds are distinguished by their large size while the rest seem to fall into smaller, more specialized clusters.

Table 3. Description of eight preliminary watershed clusters generated using Bray-Curtis distance with Ward's linkage method.

Cluster No.	Number of watersheds	Description
1	41	High commercial and residential land cover and imperviousness. High historic industry and railroads. No PG&E facilities. Moderate area.
2	43	High commercial and residential land cover and imperviousness. High historic industry and railroads. One to four PG&E facilities. Large area.
3	35	High commercial and residential land cover and imperviousness. Low historic industry or railroads. Smaller area.
4	11	Small, sparsely populated, predominantly industrial, highest historic industrial and imperviousness. Located around San Francisco Airport and Brisbane.
5	11	Sparsely populated, low development, high open land cover, no railroads, "green space." Located adjacent to Bay or in undeveloped uplands.
6	22	Largest watersheds, with moderate population density, high open

		land cover, and low imperviousness.
7	17	High agricultural land cover, lower rainfall, draining to Carquinez Strait and Suisun Bay.
8	5	Small, sparsely populated, predominantly open, containing historic railroad, and draining to Carquinez Strait.

Design of characterization study

After reviewing the preliminary watershed classification the STLS agreed that further information was needed to select watersheds for future STLS monitoring. RMP resources for WY 2011 monitoring were redirected to a characterization study consisting of storm water grab samples from 16 of the candidate watersheds for which there were little or no existing PCB or mercury concentration data[11].

Table 4 shows the watersheds selected for the characterization study, along with a summary of some of their key attributes. Criteria for the composition of the sampling list included the following:

- Multiple representatives of the most common small to medium sized watershed classes 1-3, distributed throughout the four counties (Contra Costa, Alameda, Santa Clara, and San Mateo) where loads monitoring is required by the MRP.
- A few representatives of the medium to large watershed classes.
- Smaller catchments, generally heavily urban with industrial land uses, where stormwater programs are planning enhanced management actions to reduce PCB and mercury discharges.
- Other watersheds with distinctive histories of mercury or PCB occurrence, or related management concerns.

Figure 3 shows the general locations of the study watersheds and the drainage areas above the initially selected monitoring locations. Some of the monitoring station locations were adjusted after field reconnaissance. Table 5 lists watersheds considered but not selected for the study, and also watersheds excluded from the study because of the availability of significant amounts of previously collected PCB and mercury data. Appendix E provides details of the study design, methods and preliminary results, which will be updated with a more complete analysis later in 2013.

In June 2011 the STLS Work Group reviewed the results of the WY 2012 sampling. Analytes measured at each sampling site varied depending on budget and Water Board management questions (Table 6). Between 4-7 PCB, total mercury, SSC and organic carbon samples were collected at each site. PBDE and PAHs were collected at a subset of sites chosen based on logistics (essentially randomly from a water quality perspective). Selenium data were only measured at Contra Costa sampling locations.

[11] This redirection was allowed by MRP Provision C.8.a, which indicates that initiation of the required POC loads monitoring can be deferred to October 2011 if the stormwater Permittees are participating in a regional collaborative process to plan and conduct the monitoring.

Table 4. Watersheds sampled during reconnaissance characterization study of Water Year 2011.

Watershed/ station	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	Reconnaissance Feasibility/ Safety	PCB-Hg attributes
Ettie Street Pump Station	4.0	1*	73.4**	28.60**	Good/Good	PCB P13 Cluster, CW4CB pilot watershed
Pulgas Creek	7.1	2	28.2		Good/Good	CW4CB pilot watershed
Sunnyvale East Channel	18.0	2	59.7	3.47	Good/Good	PCB P13 Cluster
Santa Fe Channel	2.64	2	70.3	3.6	Poor-Medium/ Good	Confirm proposed station vs. locations of CW4CB pilot watersheds
Lower San Leandro Creek	8.9	2	37.5	2.96	Good/Good	PCB spill into creek in 1995
Stevens Creek	73.7	6	15.8	0.24	Good/Good	Within airshed of Lehigh-Hanson Cement Manufacturer
Zone 5 Line M	8.1	*	33.5	3.15	Good/Good	Hg P13 Cluster
Lower Marsh Creek	97.5	?	14.7		Good/Good	Drains historic Hg mine
San Lorenzo Creek	124.8	6	13.2	0.50	Medium/Good	
Walnut Creek	318.7	7	16.6	0.72	Good/Good	
Lower Penitencia Creek	12.0	*	67.1	7.14	Good/Good	
Belmont Creek	7.2	2	27.4	0.00	Medium/Good	
Borel Creek	3.2	2	31.4	1.57	Medium/Good	
Calabazas Creek	52.9	1	45.6	0.44	Good/Good	
Glen Echo Creek	5.4	3	39.3	0.80	Good/Good	Hg P13 Cluster
San Tomas Creek	114.1	1	34.4	0.35	Good/Good	

***** Catchment does not correspond to a polygon used in cluster analyses
****** Estimated for larger polygon used in cluster analyses

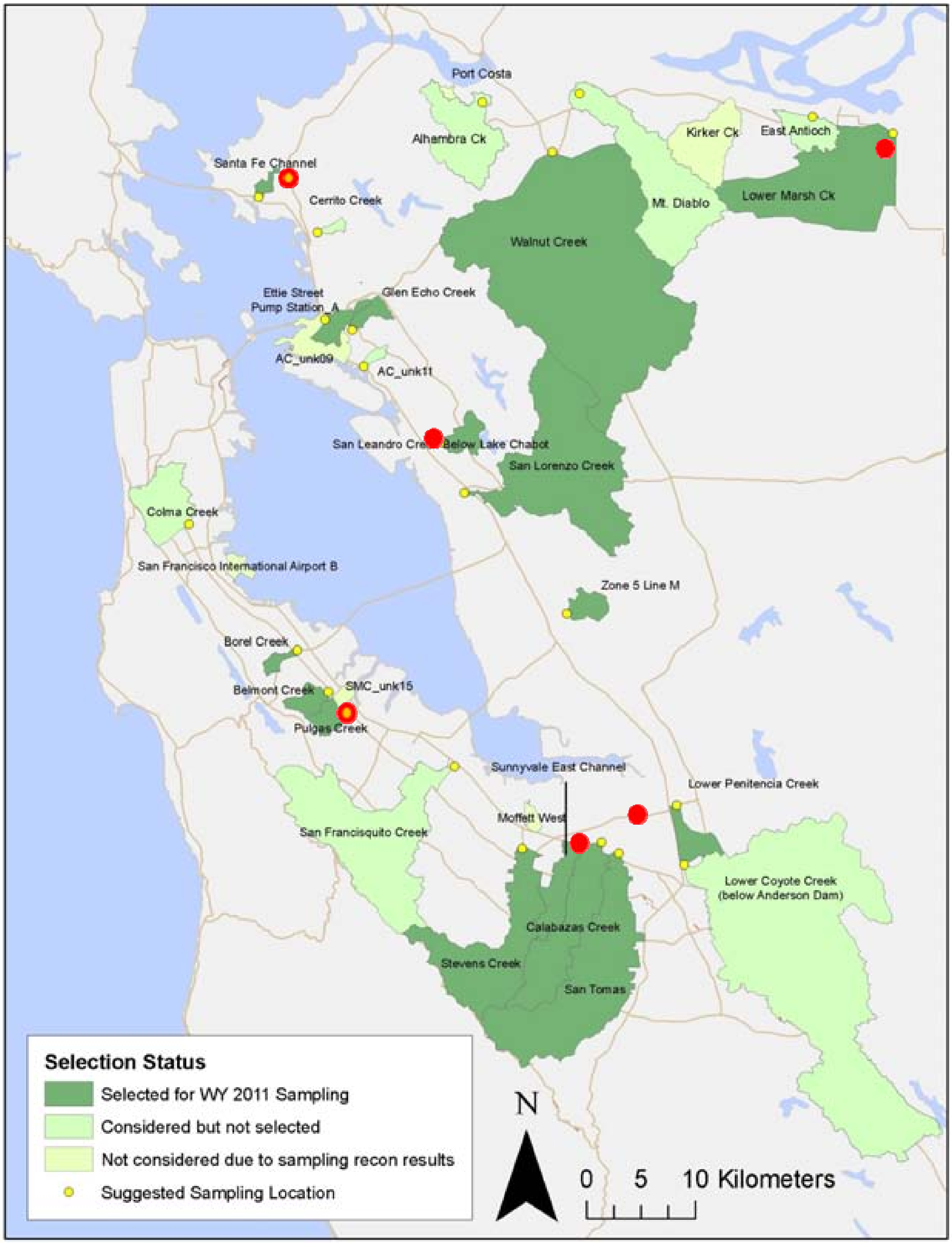

Figure 4. Watersheds sampled in Water Year 2011 reconnaissance characterization study. Red circles indicate approximate locations of six watershed monitoring stations for WY 2013.

Table 5. Potential candidate watersheds, not selected for reconnaissance characterization sampling during WY 2011.

County	Watershed	Area (km^2)	Prelim, Cluster No.	Percent Impervious	Percent Old Industrial	PCB-Hg attributes
San Mateo	Colma Creek	28.0	2	37.5	2.18	PCB P13 Cluster, CW4CB pilot watershed
Contra Costa	Alhambra Creek	41.0	6	6.0	0.01	
Alameda & Contra Costa	Cerrito Creek	1.9	2	35.8		
Contra Costa	East Antioch	14.4	7	41.4	1.31	
Contra Costa	Mt Diablo Creek	80.2	6	10.5		
Alameda	Oakland, East of Lake Merritt	2.1	2	67.3	6.18	PCB P13 Cluster
Alameda	Zone 4 Line A	8.78*	1	67.6	10.1	
Santa Clara	Lower Coyote Creek (below Anderson Dam)	318.6	6	21.1	0.38	PCB P13 Cluster
Santa Clara	Guadalupe River	226	6	32.5	2.7	Hg TMDL
San Mateo & Santa Clara	San Francisquito	111.8	6	7.3	0.27	

Table 6. Summary of analytes collected during the water year 2011 reconnaissance characterization study.

Analyte	MRP Category	Number of Samples
PCB	Category 1	91
Total Mercury	Category 1	91
SSC	Category 1	91
Total Organic Carbon	Category 1	91
PBDE	Category 2	22
PAH	Category 2	22
Total Selenium	Category 2	30
Dissolved Selenium	Category 2	30

Table 7 shows that while maximum concentrations of total mercury varied from 19-1740 ng/L (about 100x) between sites in relation to suspended sediment concentration and watershed characteristics, maximum PCB concentrations varied from 1,851 - 467,696 pg/L a variation of about 250x. Methylmercury did not relate directly to maximum total mercury observed at each site. Normalizing mercury and PCB data to SSC and turbidity respectively (see Appendix E for discussion) resulted in a different pattern and rankings of the sampled watersheds, as shown in Table 8.

Table 7. Maximum concentrations of mercury and PCBs for the Water Year 2011 reconnaissance characterization study.

Watershed	Max HgT (ng/L)	Max. PCBs (pg/L)
Belmont Creek	59	4,909
Borel Creek	74	8,671
Calabazas Creek	89	24,765
Ettie Street Pump Station	73	68,996
Glen Echo Creek	179	85,815
Lower Marsh Creek	200	4,136
Lower Penetencia Creek	19	1,851
Pulgas Creek Pump Station - North	27	84,490
Pulgas Creek Pump Station - South	28	53,894
San Leandro Creek	477	31,336
San Lorenzo Creek	77	20,421
San Tomas Creek	129	4,372
Santa Fe Channel	217	467,696
Stevens Creek	121	22,554
Sunnyvale East Channel	151	67,462
Walnut Creek	181	24,396
Zone 5 Line M	1740	25,091

Table 8. Summary of PCB and Hg results in relation to suspended sediment or turbidity and organized by PCB/SSC ratio.

Watershed	PCB/SSC Avg Ratio (pg/mg)	THg/SSC Avg Ratio (ng/mg)	PCB Rank	Hg Rank	Rank Sum	Comment
Santa Fe Channel	1401	0.68	1	4	5	Tidal
Pulgas Creek Pump Station - North	1048	0.47	2	5	7	Extremely flashy
Pulgas Creek Pump Station - South	905	0.83	3	1	4	Extremely flashy
Ettie Street Pump Station	741	0.78	4	3	7	Access time restricted
San Lorenzo Creek	114	0.21	5	12	17	
Glen Echo Creek	86	0.42	6	6	12	Underground downstream
San Leandro Creek	86	0.80	7	2	9	
Sunnyvale Channel	59	0.35	8	8	16	
Zone 5 Line M	48	0.40	9	7	16	SSC >1800 mg/L
Calabassas Creek	41	0.16	10	16	26	
Stevens Creek	35	0.26	11	10	21	
San Tomas Creek	23	0.27	12	9	21	
Walnut Creek	19	0.09	13	17	30	SSC > 1800 mg/L, 12-24 hour hydrograph - sample preservation
Lower Penitencia Creek	17	0.16	14	15	29	
Belmont Creek	14	0.25	15	11	26	
Borel Creek	13	0.17	16	14	30	
Lower Marsh Creek	3	0.20	17	13	30	SSC > 1800 mg/L, Remote, access by Hwy 4, sample preservation

For the most part, sampling logistics at these sites were taken into account as part of the decisions made prior to the reconnaissance study. However, there were some additional lessons learned during the reconnaissance study about feasibility and potential sampling constraints that are worth noting in Table 8. The tidal nature of the Santa Fe channel, although it was sampled during low tide, will challenge the measurement of discharge if loads at this site are desired in the future; acoustic Doppler technology at a greater cost would be needed. Three locations (Zone 5 Line M, Walnut and Lower Marsh) had observed turbidities that exceed the use of the DTS12 turbidity sensors employed previously at Guadalupe and Zone 4 Line A; sensor technology that ranges to 4000 NTU is available but with some loss of sensitivity at the lower end of the range (<50 NTU).

The narrow sampling platform at Sunnyvale East Channel adds challenges for manual sampling equipment and safety due to lack of space. Sampling locations at the base of large watersheds such as Walnut Creek and Guadalupe River, with storm hydrographs that can span a day or more, may add sample preservation challenges if ice melts before samples can be retrieved following storm events. Lower Marsh Creek is a challenging location due to travel time to the site and the same kinds of preservation challenges.

Criteria for selection of watersheds for monitoring

In June 2011 the STLS WG reviewed characteristics of the candidate watersheds that it considered as priorities for the watershed monitoring:

- **Representative** for purposes of long-term trends monitoring. Watersheds selected have a station near the bottom of the watershed, and include a range of sizes and land uses, ranging from already urban to those expected to undergo significant additional urbanization over the next 20 -30 years.
- Containing **Management** opportunities for TMDL load reductions, especially of PCBs and mercury, that are likely to be explored through pilot projects or other targeted stormwater program activities during the next 5-10 years (see Appendix A). Since the first round of pilot management activities will be limited to a few local catchments, the STLS Work Group decided to focus the watershed selection for Phase 1 (WY 2012) on representative sites and defer potential selection of this category of watersheds until later planning for Phase 2.
- Named as a monitoring location for specific NPDES **Permit** requirements affecting Bay Area stormwater programs. This includes Lower Marsh Creek which is named in a parallel C.8.e provision in the municipal stormwater permit for eastern Contra Costa County. The Guadalupe River site previously monitored by the RMP is one of the 8 stations identified as default locations for POC Loads Monitoring in the MRP, and continued monitoring at this site is also required by a permit supporting the implementation of the mercury TMDL for that watershed.[12]
- **Feasibility** of monitoring for the desired Management Question. For example, many catchments with planned or potential management activities are heavily culverted and located in low-lying Bayside areas, so that monitoring stations downstream of the management areas are often subject to tidal inflow or inaccessible due to private property boundaries.

The four stations selected for Phase 1 start-up (See Table 2 for funding sources) were:

- Lower Marsh Creek (Contra Costa County)
- Lower San Leandro Creek (Alameda County)
- Sunnyvale East Channel (Santa Clara County)
- Guadalupe River (Santa Clara County)

[12] Both of these permits specify additional monitoring requirements which are not included in the scope of this STLS MYP, i.e. additional parameters for Lower Marsh Creek and additional sites and periodic intensified monitoring in the Guadalupe River watershed.

In March 2012 the STLS Work Group discussed criteria for selecting two additional stations to be initiated in 2012 for Phase 2. Priority attributes identified for these additional watersheds included:

- High percentage of impervious area to help fill gaps in available hydrological data for calibrating the RWSM
- Significant proportion of older industrial land uses which are more likely to have higher PCB concentrations. Such catchments are also more likely to be priorities for future management actions to reduce PCBs in runoff.

Most watersheds meeting the above criteria present logistical challenges for runoff monitoring, since most older industrial areas are located close to the Bay within the zone of tidal influence and often have completely culverted storm drain systems, For these reasons both Phase 2 sites were selected at existing pump stations.

Analytes and Data Quality Objectives

Where applicable, the MRP specifies that default standards for monitoring data quality be consistent with the latest version of the Quality Assurance Program Plan (QAPrP; SWAMP 2008) adopted by the Surface Water Ambient Monitoring Program (SWAMP). The QAPrP adopts a performance-based approach with target Reporting Limits (RL) for a large list of analytes in water and sediment.

The RMP has not specified target Reporting Limits for most analytes; for the SPLWG monitoring studies SFEI has utilized laboratory services that provide much lower method detection limits (MDL) for some analytes than those that would be associated with the SWAMP Target RLs.

Table 9 summarizes the results of a review of detection frequency at Zone 4 Line A, indicating that the RMP's laboratories have obtained much higher frequencies of detection with much lower detection levels for the organic compounds (see Appendix F).

MDLs are variable depending on the concentrations of the target analyte and similar compounds as well as potential interference from other constituents in the sampling matrix. While quality assurance considerations should be used in interpreting data near the MDL, accurate quantitative results at low range are important for developing load estimates.

For WYs 2012 and 2013, analyses were performed by the laboratories listed in Table 10[13]. Laboratory contracting and Quality Assurance procedures for laboratory data are being performed by SFEI for all STLS stations, through funding provided by both the RMP and BASMAA.

[13] The STLS MYP does not include other analytes for which occasional sampling at some or all of the STLS watershed monitoring stations may occur, such as monitoring required by the municipal stormwater permit for eastern Contra Costa County issued by the Central Valley Regional Water Quality Control Board, or sampling for special studies initiated through other RMP strategy workgroups (e.g. nutrients and dioxins) that take advantage of the existing infrastructure for STLS monitoring stations while covering all incremental costs for sampling those analytes.

Table 9. Comparison of detection rates for selected analytes using SWAMP Reporting Limits vs. RMP-contracted lab results for storm water samples at Zone 4 Line A; see Appendix F for additional notes.

Analyte	SWAMP Target RL	Z4LA data, fraction > SWAMP RL	Actual RL	Z4LA % detection	Sample Volume, Liters
Category 1					
Copper (Total)	0.01 µg/L	45/45	0.03-0.1 µg/L	100%	0.12
Copper (Dissolved)	0.01 µg/L	11/11	0.1 µg/L	100%	
Mercury (Total)	0.0002 µg/L	112/112	0.0002 µg/L	100%	0.25
Methylmercury	0.00005 µg/L	55/56	0.00002 µg/L	99%	0.25
PCB congeners	0.02 µg/L	20/77	NA	(98%)	2.5
SSC	0.5 mg/L	392/392	0.6 mg/L	99%	0.25
TOC	0.6 mg/L	40/40	0.3-2.4 mg/L	100%	.25
Nitrate as N	0.01 mg/L	10/12	NA	(NA)	(0.15)
Hardness (as CaCO3)	1 mg/L	NA	NA	NA	NA
Category 2					
Selenium (Total) [e]	0.30 µg/L	15/30	0.045-1 µg/L	36%	0.5
Selenium (Dissolved)	0.30 µg/L	0/5	0.045-0.053 µg/L	66%	
PBDEs	NL - assume 0.02 µg/L	18/36	NA	(75%)	2.5
PAHs [g]	10 µg/L	3/21	NA	(99%)	2.5
DDTs	0.002 µg/L[h]	14/20	NA	(100%)	
Chlordane[i]	0.002 µg/L	13/20	NA	(100%)	
Dieldrin[i]	0.002 µg/L	3/20	NA	(100%)	
Pyrethroids [j]	NL	NA	NA	NA?	4
• Bifenthrin		--	NA		
• Delta/Trihalomethrin		--	NA		
• Permethrin, total		--	NA		
Carbaryl	NL	NA	NA	NA	NA
Fipronil	NL	NA	NA	NA	NA
Phosphorus (Total)	NL	NA	NA	NA	(with N)
Phosphorus (Diss.)	NL	NA	NA	NA	(0.17)

Table 10. Final list of STLS watershed monitoing analytes and associated analytical laboratories, methods and sample holding times.

Analyte	Hold Time	Laboratory WY2012	Laboratory WY2013	Method
Copper (Total) Selenium (Total)	180 days	BRL	Caltest	EPA 1638
Copper (Dissolved) Selenium (Dissolved)	48 hours	BRL	Caltest	EPA 1638
Mercury (Total)	90 days	MLML	Caltest	EPA 1631
Methylmercury	90 days		Caltest	EPA 1630
PCB congeners	One year	AXYS	AXYS	AXYS MLA-010 Rev 1
SSC	7 days	EBMUD	Caltest	ASTM D3977-97B
TOC	28 days	Delta	Caltest	SM20 5310B
Nitrate as N	28 days	EBMUD	Caltest	EPA 353.2
Hardness (as CaCO3)	180 days	BRL	Caltest	EPA 1638
PBDEs	One year	AXYS	AXYS	AXYS MLA-033 Rev 0
PAHs [g]	7 days	AXYS	AXYS	AXYS MLA-021 Rev 1
Pyrethroids [j]	3 days	AXYS	Caltest	EPA 8270 mod
Carbaryl	7 days	DFG - WPCL	DFG - WPCL	EPA 632 Mod / CDFA Mod
Fipronil	7 days	DFG - WPCL	DFG - WPCL	EPA 632 Mod / CDFA Mod
Phosphorus (Total)	28 days	EBMUD	Caltest	SM20 4500---P E
Dissolved Orthophosphate	48 hours	EBMUD	Caltest	SM20 4500---P E

Laboratory name abbreviations: AXYS - AXYS Analytical Services; MLML - Moss Landing Marine Laboratory; BRL – Brooks Rand Labs; Caltest – Caltest Analytical Laboratory; EBMUD – East Bay Municipal Utility District; Delta – Delta Environmental Laboratories; PER – Pacific EcoRisk; DFG – WPCL – California Department of Fish and Game Water Pollution Control Laboratory.

Watershed Monitoring Approach

The MRP requires POC loads monitoring effort that is equivalent to conventional flow weighted composite sampling at eight sites, with an annual average of four events sampled for Category 1 analytes and one event for Category 2. The MRP allows phased implementation: Phase 1 monitoring of at least four stations, or roughly half of the effort, must be initiated by October 2011 and Phase 2 monitoring of the remaining stations must start by October 2012.

After discussion of assumptions for the MRP default plan compared with alternative scenarios incorporating the recommendations for sampling frequency and laboratory data quality described above, the STLS work group agreed to pursue a watershed monitoring plan that approximates the MRP cost benchmark and includes:

- A total of six watershed monitoring stations, with four to be deployed in Phase 1 (WY 2012) and an additional two stations in Phase 2 (WY 2013).
- Continuous turbidity monitoring (not included in the MRP) at all stations to enable turbidity surrogate regression estimation of seasonal loads of particulate associated POCs and allow for the future inclusion of other analytes and the back calculation of loads using turbidity records.
- For best load estimation of mercury, PCBs and sediment at least 16 samples should be collected in a season; for planning purposes, this would be a minimum of 4 events with an average of 4 samples per event. Sampled events should target a first flush event and at least one of the larger storms of the year.
- Samples would not be analyzed for organochlorine pesticides.
- Sample analyses for all stations would be performed by specific laboratories recommended on the basis of previous performance and reliability in achieving low MDLs for each parameter.

In March 2011 Water Board staff indicated that this STLS program with annual cost similar to the MRP benchmark of $800,000-$1,000,000[14] would meet the MRP requirement for an alternative monitoring approach that addresses the priority Management Questions, with the assumption that at least 2/3 of this cost would be supported by the storm water programs (see work plan below). At the SPLWG meeting on October 25, 2011, Water Board staff confirmed that the mobilization then in progress for Phase 1 watershed monitoring stations was in compliance with the MRP.

In July 2011 the STLS Work Group determined that all monitoring stations should use the same sampling methods for each parameter, and began developing a plan using automated sampling equipment (Model 6712 full size by Teledyne ISCO, hereafter “ISCO”) for all parameters except methyl mercury. After further evaluation this was changed to a hybrid of several sampling methods as described above. Modifications were also made to the sampling plan to permit efficient use of ISCOs for composite sampling and to reflect evolving regulatory priorities for data on particular analytes. The revised STLS Work Group consensus plan for sampler configuration is shown in Table 11. Annual number of samples per site is equal to or greater than the average annual frequency specified in the MRP for all analytes except organochlorine pesticides, for which recent data have suggested a reduced regulatory priority. Due a very dry WY 2012 rainy season, fewer than the planned number of storm events were sampled at 3 of the first 4 stations. With concurrence of Water Board staff, The STLS Work Group agreed that additional samples would be added to sampling plans in the next two Water Years so that over a 3- year period, a total of 12 representative storm events will be sampled at each site.

[14] Benchmark cost for default MRP monitoring (including ongoing project administration but excluding data management and reporting and contingency for false starts) was established as a range to express variation in labor costs among the participating agencies. Benchmark calculations distributed one-time start-up costs over 3 years of operation, although this assumption has limited value for actual project planning. No site-specific cost variations were assumed other than stage-discharge monitoring and calibration for sites not served by an existing USGS gauging station.

In June 2012 the STLS Work Group also discussed potential improvements to monitoring procedures for WY 2013 including:

- Collecting composite samples on a time-interval rather than flow-weighted basis.
- Re-evaluating guidelines for number of composite aliquots per storm event to balance needs for storm representation against variability in pumping capabilities of the auto samplers.
- Changing contract laboratories for some analytes (pyrethroids, SSC, TOC) to improve turnaround times, quality control and costs. These changes are noted in Table 10.

Further adaptations are required for monitoring in the pump stations, which typically have little to no dry weather flow. Updated methods will be finalized in 2013 and incorporated in the Quality Assurance Project Plan and Field Manual as described below.

Table 11. Sample type and target frequency of STLS sampling by analyte.

MRP Category	Parameter	No. of Storms / year	No. of Samples/ storm	Frequency change from MRP	Sample Type
1	PCBs (40 congener)	4	4	400%	Discrete
1	Total Mercury	4	4	400%	Grab
1	Total methyl mercury	2[15]	4	400%	Grab
1	Dissolved Cu	4	1	0%	Composite
1	Total Cu	4	1	0%	Composite
1	Hardness	4	1	0%	Composite
1	SSC (GMA)	4	8	800%	Discrete
1	Nitrate as N and Total Phosphorous	4	4	400%	Discrete
2	Dissolved phosphorus	4	4	400%	Discrete
1	Total Organic Carbon	4	2.5	250%	Discrete
1	Toxicity – water column (3 species + *Hyalella azteca*)	4	1	0%	Composite
2	Pyrethroids	4	4	1600%	Composite
2	Carbaryl	4	4	1600%	Composite
2	Fipronil	4	4	1600%	Discrete
2	Chlordane, DDTs, Dieldrin	0	0	-100%	N/A
2	Dissolved Se (collect with Dissolved Cu)	4	1	400%	Composite
2	Total Se (collect with Total Cu)	4	1	400%	Composite
2	PBDE	2	1	200%	Discrete
2	PAH	2	1	200%	Discrete

Watershed Monitoring Plan

This section contains recommendations in two categories. The core plan is the minimum recommendation to meet the requirements for an alternative equivalent approach to the POC Loads Monitoring in the MRP. Additional plan options may be considered subject to the availability of additional resources, either for the current participants or by leveraging resources of additional programs or partners in the future.

[15] Two additional dry weather methyl mercury grab sampling events, required by the MRP, will generally soccur during station set-up in September and shutdown in April or May.

The core plan comprises six sites as shown in Table 2, using the sampling frequencies and methods in Table 11.
In January 2012, STLS Work Group members noted that initiating field sampling for EMC development seemed premature during the discovery phase of final model structures for the initial group of POCs, and evaluating GIS data quality in relation to pollutant specific land use/ source areas and the usefulness of existing data sets for back-calculation of EMCs. After further discussion, the STLS Work Group agreed on the RWSM workplan assuming initial model runs would use EMCs derived from available data. Should model runs indicate weaknesses, field data many be collected during subsequent wet seasons to provide improved input data for later model versions.

The Quality Assurance Project Plan and Field Manual with Standard Operation Procedures will document details of equipment and methods, to be summarized in a future revision of Appendix F. The updates will include modifications made during the first two years of monitoring along with guidelines for additional quality assurance/quality control procedures.

Should additional resources become available, plan options could include:

- Accelerating Core Plan activities on an earlier schedule.
- Adding other analytes where compatible with the STLS autosampler configuration and grab sampling logistics described in the Field Manual and summarized in Table 10. MYP updates would not necessarily include short-term examples such as the RMP nutrient and dioxins strategies' separately funded studies involving supplemental nutrient and dioxins sampling and analysis at the two STLS sites operated by the RMP.

The STLS Work Group will not produce a detailed written interpretive report of WY 2012 results, but will provide a limited summary of the monitoring activities for purposes of the RMP and MRP. SFEI presented a preliminary review of the first year's data for discussion at STLS and SPLWG meetings in the second half of 2012. An integrative two-year report will be prepared in late 2013 updating loads estimates for WY 2012 with improved information and interpretation and providing loads estimates for WY 2013. This information will be incorporated in BASMAA's Integrated Monitoring Report to fulfill MRP reporting requirements.

Source Area Runoff Monitoring

The RWSM literature review identified several gaps in available information about EMCs. As an alternative to starting reconnaissance for source area monitoring sites, SFEI began exploratory work with an approach suggested at the May 2011 SPLWG meeting that uses available data from sediment samples collected in storm drain conveyances to back-calculate EMCs for the input side of the RWSM. After initial explorations several refinements pursued as described above for the RWSM and in Appendix B. Further results and potential implications for source area runoff monitoring will be provided in future updates of the MYP and its Appendix G.

Adaptive Updates

This MYP is a working document and will require revisions as new information and data are reviewed for POCs on the existing priority list, or new pollutants are identified as regional priorities. Updated working versions of the MYP will be incorporated in BASMAA Urban Creeks Monitoring Reports related to MRP requirements. Future versions may incorporate added or updated materials listed below:

- Updated Appendix F with details of watershed monitoring sampling procedures, & QA, with reference to QAPP, field Manual, and field training materials; also documentation of procedures for coordinating management, QA/QC of watershed monitoring data,
- Review priorities for watershed monitoring data vs. EMC studies, document potential scenarios for future allocations of STLS effort,
- Draft planning timeline for future data reviews (e.g. trends analyses, integration with spreadsheet modeling),
- Updates on potential coordination with RMP Modeling Strategy, as applicable
- Updates on Regional Watershed Spreadsheet Model development and load estimates for additional POCs,
- Updates to work plan and descriptions of future planned studies,
- Recommendations for EMC development studies,
- Coordination with other RMP strategies, as applicable, and
- Timeframe for future MYP version(s) and adaptive updates.

As the primary stakeholder forum, the STLS Work Group will track these various needs and set priorities for further MYP updates. The SPLWG will review these updates, at least annually but ideally several times per year, to track progress according to the RMP Multi-Year Plan, or at milestones such as the following:

- Trends power analysis, after accumulation of appropriate minimum number of samples. Revisions of the MYP in 2012 will develop a provisions timeframe for trends analyses over the next 3-5 years, and
- Bay Modeling milestones as they become established through Modeling Strategy.

Workplan and Detailed RMP Task Descriptions

This section outlines the 5-year STLS workplan for both the RMP and stormwater programs acting collaboratively through the Bay Area Stormwater Management Agencies Association (BASMAA) (see Table 12), and presents capsule summaries of RMP workplan tasks for the same time period as guided by the RMP Multi-Year Plan which has committed approximately $400,000 annually during 2012-2014[16]. The budgets and scopes shown below are updated as of RMP adoption of its 2013 budget for Pilot Studies/Special Studies. Detailed task scopes for future years will be prepared as part of the annual planning process with STLS and SPLWG oversight.

1A) Regional Watershed Spreadsheet Model Development and Support.

Objective: Develop and use GIS-based spreadsheet model for regional load estimation.

Deliverables: Load estimates for priority pollutants of concern and sediment; see 2012 study proposal in Appendix B for more details on near-term activities.

Milestones and Linkages to other Projects: see workplan in Appendix B.

Project Participants: RMP

Due Date: ongoing; see schedule in Appendix B

RMP Contributions and Years: 2011 approved $20,000; 2012 approved $20,000; 2013 approved $25,000; 2014 planned $25,000; -2015 TBD .

BASMAA funding for sediment load estimation (Phase I, estimated) 2012: $33,000; 2013: $12,000; 2014 TBD. PBDE, chlordane, dieldrin, DDT (Phase II) 2012 $35,000; 2013 $14,000; 2014 TBD.

Total Cost: TBD,

[16] RMP Master Planning Workshop, February 7. 2011

Table 12. 2013 update of five-year STLS workplan. Numbers indicate budget allocations or planning projections in $1000s. Stormwater programs budgets interpolated from BASMAA Fiscal Year budgets (regional reporting budgets not shown). Budget numbers shown in parentheses for later years are projected, subject to annual authorization processes of the RMP and BASMAA.

Task ID	Funding Agency	Task Description	2011	2012	2013	2014	2015
0	RMP	**Coordination and Management**			20		
1		**Watershed and Associated Bay Modeling**					
1A		Regional Watershed Spreadsheet Model					
1A.1	RMP	Phase I – Water, Sediment, PCBs and Mercury	20	20	25	25	
1A.1	BASMAA	Phase I – Sediment		33	12	TBD	
1A. 2	RMP	Phase II – Other Pollutants of Concern				TBD	
1A.2	BASMAA	Phase II– PBDE, DDT, chlordane, dieldrin		35	14	TBD	
1A.3	RMP	Phase III – Periodic Updates				TBD	TBD
1B	RMP	Coordination with Bay Margins Modeling				TBD	
1C	TBD	HSPF dynamic modeling					TBD
2	RMP	**Source Area Monitoring / EMC Development**	20	80	80	TBD	TBD
3		**Small Tributaries Monitoring**					
3.1	BASMAA	Multi-Year Plan Development	15				
3.2	BASMAA	Standard Operating and Quality Assurance Procedures	55		5		
3A	RMP	Monitor Two Representative Small Tributaries[a]	300	328	343	300	TBD
3AB.1	BASMAA	Monitor Two to Four Representative Small Tributaries or Sites Downstream of Management Actions	255	468	440	(500)	TBD
3AB.2	BASMAA	Lab analyses, Quality Assurance, Data Management	183	377	375	(375)	TBD
4	RMP	**Reporting, Stakeholder Administration and Adaptive Updates**	41		50	TBD	
	BASMAA	**Data Analysis, Communications, Administration**	45	94	115	(100 est)	TBD
RMP Total		[a]includes lab analyses, QA, Data Management	**381**	**428**	**518**	**TBD**	**TBD**
BASMAA Total		**Task 1**		**68**	**26**	**TBD**	
		Tasks 2-4	**553**	**939**	**935**	**TBD**	**TBD**
Total			**934**	**1,435**	**1,479**	**TBD**	**TBD**

1B) Coordinate STLS with Bay Margins Modeling.

Objective: Identification of high-leverage watersheds contributing to POC impairment in S.F. Bay.

Deliverables: Timely coordination and exchange of information between STLS and Bay Margins modeling Work Groups.

Milestones and Linkages to other Projects: Depends on Modeling Strategy

Project Participants: RMP

Due Date: Depends on Modeling Strategy

RMP Contributions and Years: 2014-2015 TBD?

Total Cost: TBD

2) Land Use/Source Area Specific EMC Development and Monitoring.

Objective: Calibrate RWSM loading estimates to Bay Area specific conditions and POCs.

Deliverables: Refined EMCs or other modeling coefficients for RWSM; see 2012 study proposal for more details on near-term activities.

Milestones and Linkages to other Projects: Coordinate with 1A, RWSM Development.

Project Participants: RMP

Due Date: TBD

RMP Contributions and Years: 2011 approved $20,000; 2012 approved $80,000; 2013 approved $80,000; 2014-2015 TBD.

Total Cost: TBD

3.1) Development of STLS Multi-Year Plan

Objective: Develop alternative monitoring approach to POC Loads Monitoring that meets objectives of STLS and MRP; facilitate consistent implementation

Deliverables: Consensus STLS MYP document for timely implementation of required stormwater monitoring.

Milestones and Linkages to other Projects: To be coordinated with RMP 3A and MRP reporting requirements (initial Phase 1 results in late.2012)

Project Participants: BASMAA

Due Date: Selection of monitoring methods and Phase 1 sites by July 2011; sites for Phase 2 monitoring by January 2012

RMP Contributions and Years: (review using 2010 available funds).
BASMAA funding 2011: $15,000

Total Cost: BASMAA $15,000 one-time

3.2) Stormwater Programs - Monitoring, Standard Operating and Quality Assurance Procedures.

Objectives: Ensure that alternative monitoring methods in STLS meet MRP requirements for SWAMP comparability and reporting formats; provide documentation and facilitate consistent implementation

Deliverables: Quality Assurance Project Plan, Standard Operating Procedures

Milestones and Linkages to other Projects: To be coordinated with RMP 3A and MRP reporting requirements (initial Phase 1 results in late.2012)

Project Participants: BASMAA

Due Date: July 2012

RMP Contributions and Years: RMP N/A;
BASMAA funding 2011: $55,000; 2013 $5,000

Total Cost: BASMAA $60,000 one-time

3A) Monitor Representative Small Tributaries.

Objective: Collect POC stormwater data to be used for tracking long-term trends in loading to S.F. Bay

Deliverables: small tributaries monitoring data

Milestones and Linkages to other Projects:

Project Participants: RMP, BASMAA[17]

Due Date: Exploratory watershed characterization results by June 2011; Phase 1 monitoring begins October 2011; Phase 2 monitoring begins October 2012

RMP Contributions and Years: 2011 approved $300,000; 2012 approved $328,000; 2013 approved $343,000; 2014 planned $300,000.
BASMAA funding $2011: 255,000, see 3A/B.1 below for 2012-2015

Total Cost: RMP: [$300,000/year projected in RMP Multi-Year Plan?]

3A/B.1) Monitor Sites Downstream of Management Actions.

Objectives: Collect POC stormwater data to be used for tracking potential load reductions downstream of Management Actions.

Deliverables: Monitoring data.

Milestones and Linkages to other Projects:

Project Participants: BASMAA

Due Date: Phase 2 monitoring begins October 2012

RMP Contributions and Years: N/A.
BASMAA funding $468,000 for monitoring field operations including 3A and setup in 2012; budgeted $440,000 in 2013[18]; budgeted $500 in 2014; -2015 TBD.

[17] RMP budgets include all field operations, project management, laboratory analyses and data management and Quality Assurance, while BASMAA scopes and regional budgets for laboratory analyses, data management/QA and a portion of management and coordination costs are shown under Task 3A/B.2 and a portion of Task 4.2. Additional cozts to individual BASMAA stormwater programs of managing and coordinating watershed monitoring stations not included.
[18] After subtracting estimated cost-sharing contribution from another SMCWPPP project to WY2013 monitoring at the Pulgas Creek Pump station

Total Cost: TBD.

3A/B.2) Stormwater Programs ongoing Quality Assurance and Data Management.

Objective: implement and document QA procedures and reporting for SWAMP comparability.

Deliverables: QA review and data management on laboratory results, consistent with those for RMP-operated stations.

Milestones and Linkages to other Projects: To be coordinated with Task 3A/B.1 and MRP reporting requirements.

Project Participants: BASMAA

Due Date: Ongoing Quality Assurance and Data Management; BASMAA funding

RMP Contributions and Years: N/A;
BASMAA funding 2011: $183,000, 2012: $377,000, 2013: $375,000 budgeted; 2014: 375,000 estimated; 2015 TBD

Total Cost: TBD.

4) Reporting, Stakeholder Administration and Adaptive Updates.

Objectives: Report results at agreed-upon intervals; support future STLS decision-making through facilitation of stakeholder processes and timely updates to STLS MYP.

Deliverables

Milestones and Linkages to other Projects

Project Participants: BASMAA (initial MYP draft); RMP (ongoing)

Due Date: WY 2012 Watershed Monitoring Plan complete by July 2011; other due dates TBD.

RMP Contributions and Years: 2011 special allocation approved: $41,000; 2012: $0; 2013 approved $50,000. ; 2014-2015 TBD.
BASMAA funding 2011: $45,000; 2012: $94,000; 2013 $115,000 budgeted; 2014-2015 TBD.

Total Cost: TBD.

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Appendix A – References and Resources for PCBs and Mercury-related Activities by the Regional Monitoring Program and BASMAA.
(provided with Version 2011, BASMAA Monitoring Status Report Appendix B2a http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/2011_AR/BASMAA/B2a_2010-11_MRP_AR.pdf).

Appendix B – Regional Watershed Spreadsheet Model Construction and Calibration
(provided with Version 2012B, BASMAA Monitoring Status Report Appendix B4b
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/2012_AR/BASMAA/BASMAA_2011-12_MRP_AR_POC_APPENDIX_B4b.pdf)

Appendix C - Optimizing Sampling Methods for Pollutant Loads and Trends in San Francisco Bay Urban Stormwater Monitoring.
(provided with Version 2011, BASMAA Monitoring Status Report Appendix B2c http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/2011_AR/BASMAA/B2c_2010-11_MRP_AR.pdf)

Appendix D - Exploratory Categorization of Watersheds for Potential Stormwater Monitoring in San Francisco Bay.
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Appendix F – Sampling and Analysis: Quality Assurance.
(provided with Version 2011, BASMAA Monitoring Status Report Appendix B2f http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/2011_AR/BASMAA/B2f_2010-11_MRP_AR.pdf)

Appendix G – EMC Development and Source Area monitoring
(to be included in future version as applicable)

D2

Pollutants of concern (POC) loads monitoring data progress report (Water Year 2012)

Pollutants of concern (POC) loads monitoring data progress report, water year (WY) 2012

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On

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For

Bay Area Stormwater Management Agencies Association (BASMAA)

And

Regional Monitoring Program for Water Quality in San Francisco Bay (RMP)
Sources Pathways and Loadings Workgroup (SPLWG)
Small Tributaries Loading Strategy (STLS)

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1. Introduction

The San Francisco Regional Water Quality Control Board (Water Board) has determined that San Francisco Bay is impaired by mercury and PCBs due to threats to wildlife and human consumers of fish from the Bay. These contaminants persist in the environment and accumulate in aquatic food webs (SFRWRCB 2006; SFRWRCB, 2008). The Water Board has identified urban runoff from local watersheds as a pathway for pollutants of concern into the Bay, including mercury and PCBs. The Municipal Regional Stormwater Permit (MRP; SFRWRCB, 2009) contains several provisions requiring studies to measure local watershed loads of mercury and PCBs (provisions C.8.e), as well as other pollutants covered under C.13. (copper) and provision C.14. (e.g., legacy pesticides, PBDEs, and selenium).

Bay Area Stormwater Programs, represented by the Bay Area Stormwater Management Agencies Association (BASMAA), are collaborating with The San Francisco Bay Regional Monitoring Program (RMP) to develop an alternative strategy allowed by Provision C.8.e of the MRP, known as the Small Tributaries Loading Strategy (STLS) (SFEI, 2009). An early version of the STLS provided an initial outline of the general strategy and activities to address four key management questions (MQs) that are found in MRP provision C.8.e:

> MQ1. Which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs;
>
> MQ2. What are the annual loads or concentrations of POCs from tributaries to the Bay;
>
> MQ3. What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay; and,
>
> MQ4. What are the projected impacts of management actions (including control measures) on tributaries and where should these management actions be implemented to have the greatest beneficial impact.

Since then, a Multi-Year-Plan (MYP) (BASMAA, 2011) has been written and updated (BASMAA, 2012). The MYP provides a comprehensive description of activities that will be implemented over the next 5-10 years to provide information and comply with the MRP. The MYP provides rationale for the methods and locations of proposed activities to answer the four MQs listed above. Activities include modeling using the regional watershed spreadsheet model (RWSM) to estimate regional scale loads (Lent and McKee, 2011; Lent et al., 2012; Gilbreath et al., in preparation), and pollutant characterization and loads monitoring of local tributaries beginning Water Year (WY) 2011 (McKee et al., in review) and continuing (this report).

The purpose of this report is to describe data collected during WY 2012 in compliance with MRP provision C.8.e., following the standard report content described in provision C.8.g.vi. The study design (selected watersheds and sampling locations, analytes, sampling methodologies and frequencies) as outlined in the MYP was developed to assess concentrations and loads in watersheds that are considered to likely be important watersheds where PCB and mercury load reductions from urban runoff will be sought (MQ1):

- Lower Marsh Creek (Hg);
- San Leandro Creek (Hg);
- Guadalupe River (Hg and PCBs); and
- Sunnyvale East Channel (PCBs).

The loads monitoring will provide calibration data for the RWSM (MQ2), and is intended to provide baseline data to assess long term loading trends (MQ3) in relation to management actions (MQ4). This report is structured in a manner that allows annual updates after each subsequent winter season of data collection (likely WY 2013; 2014).

2. Watershed physiography, sampling locations, and methods

The San Francisco Bay estuary is surrounded by nine highly urbanized counties with a total population greater than seven million people (US Census Bureau, 2010). Although urban runoff from approximately 500 small tributaries flowing from the adjacent landscape represents only about 6% of the total freshwater input to the San Francisco Bay, this input has broadly been identified as a significant source of pollutants of concern (POCs) to the estuary (Davis et al., 2007; Oram et al., 2008; Davis et al., 2012; Gilbreath et al., 2012). Four watersheds were sampled in WY 2012 (Figure 1; Table 1) and two more sites will come online in WY 2013. The sites were distributed throughout the counties where loads monitoring are required by the MRP. The selected watersheds include urban and industrial land uses, watersheds where stormwater programs are planning enhanced management actions to reduce PCB and mercury discharges, and watersheds with historic mercury or PCB occurrences or related management concerns.

Composite and discrete samples were collected for multiple analytes from the water column over the rising, peak, and falling stages of the hydrograph. Composite samples represent average concentrations of storm runoff over the entire storm event and were collected using the ISCO autosampler at all of the sites except Guadalupe River, where the FISP D-95 depth integrating water quality sampler was used. Discrete samples were collected using the ISCO as a pump at all the sites besides Guadalupe; discrete mercury and methylmercury samples were collected with the D-95 at all sites, except at Lower Marsh Creek where samples were manually taken by dipping an opened bottle from the side of the channel (Table 1). Tubing for the ISCOs was installed using the clean hands technique, as was the 1 L Teflon bottle when used in the D-95. Samples for dissolved nutrients were filtered in the field within 15 minutes of sample collection while dissolved selenium/dissolved copper samples were filtered off site within 48 hours of collection.

Blind field duplicates were collected using the same methods and filled sequentially. Thus, field duplicates reflect environmental variability over a short period of time (minutes) as well as other issues of sample integrity such as inconsistencies in preservation, shipping, storage, and handling prior to

Figure 1. Water year 2012 sampling watersheds.

Table 1. Sampling locations in relation to County programs and sampling methods at each site.

County program	Watershed name	Watershed area (km^2)[1]	Sampling location			Operator	Discharge monitoring method		Turbidity	Water sampling for pollutant analysis		
			City	Latitude (WGS1984)	Longitude (WGS1984)		USGS	STLS creek stage/ velocity/ discharge rating		FISP US D95[6]	ISCO auto pump sampler[7]	Manual grab
Contra Costa	Marsh Creek	99	Brentwood	37.990723	-122.16265	ADH	Gauge Number: 11337600[2]	X	OBS-500[4]		X	X
Alameda	San Leandro Creek	8.9	San Leandro	37.726073	-122.16265	SFEI		X	OBS-500	X	X	
Santa Clara	Guadalupe River	236	San Jose	37.373543	-121.69612	SFEI	Gauge Number: 11169025[3]	X	DTS-12[5]	X		
Santa Clara	Sunnyvale East Channel	14.8	Sunnyvale	37.394487	-122.01047	SFEI		X	DTS-12*	X	X	

[1]Area downstream from reservoirs.
[2]USGS 11337600 MARSH C A BRENTWOOD CA
[3]USGS 11169025 GUADALUPE R ABV HWY 101 A SAN JOSE CA
[4]Campbell Scientific OBS-500 Turbidity Probe
[5]Forest Technology Systems DTS-12 Turbidity Sensor
[6]FISP US D-95 Depth integrating suspended hand line sampler
[7]Teledyne ISCO 6712 Full Size Portable Sampler
*OBS-500 malfunctioned during WY 2012 due to low flow water depth. A DTS-12 was installed during WY 2013.

analysis. Lab duplicates were collected for PCBs, PBDEs, and PAHs to test the precision of the analyses; the samples were collected side-by-side (simultaneously). Field blanks were collected using the same methodology as field sample collection. Field Blanks were collected with ISCO autosamplers by rinsing and purging the suction with high purity water (HPW) provided by a laboratory, then directly filling the appropriate analyte bottle with HPW using the autosampler.

3. Laboratory analysis and quality assurance

3.1. Sample preservation and laboratory analysis methods

All samples were labeled, placed on ice, transferred back to the respective site operator's headquarters, and refrigerated at 4 °C until transport to the laboratory for analysis. Laboratory methods were chosen to ensure the highest practical ratio between method detection limits, accuracy and precision, and costs (BASMAA, 2011; 2012) (Table 2). For details on sample I.D., date and time of collection, and media, please see Appendix 1.

3.2. Quality Assurance Methods

3.2.1. Sensitivity

The sensitivity review evaluated the percentage of field samples that were non-detects as a way to evaluate if the analytical methods employed were sensitive enough to detect expected environmental concentrations of the targeted parameters. In general, if more than 50 % of the samples were ND then the method may not be sensitive enough to detect ambient concentrations. However, review of historical data from the same project/matrix/region (or a similar one) helped to put this evaluation into perspective; in most cases the lab was already using a method that is as sensitive as is possible.

3.2.2. Blank Contamination

Blank contamination review was performed to quantify the amount of targeted analyte in a sample from external contamination in the lab or field. This metric was performed on a lab-batch basis. Lab blanks within a batch were averaged. When the average blank concentration was greater than the method detection limit (MDL), the field samples, within this batch, were qualified as blank contaminated. If the field sample result was less than 3 times the average blank concentration (including those reported as ND) those results were "censored" and not reported or used for any data analyses.

3.2.3. Precision

Rather than evaluation by lab batch, precision review was performed on a project or dataset level (e.g., a year or season's data) so that the review took into account variation across batches. Only results that were greater than 3 times the MDL were evaluated, as results near MDL were expected to be highly variable. The overarching goal was to review precision using sample results that were most similar in characteristics and concentrations to field sample results. Therefore the priority of sample types used in this review was as follows: lab-replicates from field samples, or field replicates (but only if the field replicates are fairly homogeneous - unlikely for wet-season runoff event samples unless collected simultaneously from a location). Replicates from CRMs, matrix spikes, or spiked blank samples were

Table 2. Laboratory analysis methods.

Analyte	Method	Field Filtration	Field Acidification	Laboratory
Carbaryl	EPA 632M	no	no	DFG WPCL
Fipronil	EPA 619M	no	no	DFG WPCL
Suspended Sediment Concentration	ASTM D3977	no	no	EBMUD
Total Phosphorus	EBMUD 488 Phosphorus	no	no	EBMUD
Nitrate	EPA 300.1	yes	no	EBMUD
Dissolved OrthoPhosphate	EPA 300.1	yes	no	EBMUD
PAHs	AXYS MLA-021 Rev 10	no	no	AXYS Analytical Services Ltd.
PBDEs	AXYS MLA-033 Rev 06	no	no	AXYS Analytical Services Ltd.
PCBs	AXYS MLA-010 Rev 11	no	no	AXYS Analytical Services Ltd.
Pyrethroids	AXYS MLA-046 Rev 04	no	no	AXYS Analytical Services Ltd.
Total Methylmercury	EPA 1630M	no	yes	Moss Landing Marine Laboratories
Total Mercury	EPA 1631EM	no	yes	Moss Landing Marine Laboratories
Copper	EPA 1638M	no	no	Brooks Rand Labs LLC
Selenium	EPA 1638M	no	no	Brooks Rand Labs LLC
Total Hardness[1]	EPA 1638M	no	no	Brooks Rand Labs LLC
Total Organic Carbon	SM 5310 C	no	yes (bottle pre-preserved)	Delta Environmental Lab LLC
Toxicity	See 2 below	no	yes	Pacific Eco-Risk Labs

[1] Hardness is a calculated property of water based on magnesium and calcium concentrations. The formula is: Hardness (mg/L) = (2.497 [Ca, mg/L] + 4.118 [Mg, mg/L])

[2] Toxicity testing includes: chronic algal growth test with *Selenastrum capricornutum* (EPA 821/R-02-013)chronic survival & reproduction test with *Ceriodaphnia dubia* (EPA 821/R-02-013), chronic survival and growth test with fathead minnows (EPA 821/R-02-013), and10-day survival test with *Hyalella Azteca* (EPA 600/R-99-064M)

reviewed next with preference to select the samples that most resembled the targeted ambient samples in matrix characteristics and concentrations. Results outside of the project management quality objective (MQO) but less than 2 times the MQO (e.g., ≤50% if the MQO RPD is ≤25%) were qualified, those outside of 2 times the MQO were censored.

3.2.4. Accuracy

Accuracy review was also performed on a project or dataset level (rather than a batch basis) so that the review takes into account variation across batches. Only results that were greater than 3 times the MDL were evaluated. Again, the preference was for samples most similar in characteristics and concentrations to field samples. Thus the priority of sample types used in this review was as follows:

Certified Reference Materials (CRMs), then Matrix Spikes (MS), then Blank Spikes. If CRMs and MS were both reported in the same concentration range, CRMs were preferred because of external validation/certification of expected concentrations, as well as better integration into the sample matrix (MS samples were often spiked just before extraction). If both MS and blank spike samples were reported for an analyte, the MS was preferred due to its more similar and complex matrix. Blank spikes were used only when preferred recovery sample types were not available (e.g., no CRMs, and insufficient or unsplittable material for creating an MS). Results outside the MQO were flagged, and those outside 2 times the MQO (e.g., >50% deviation from the target concentration, when the MQO is ≤25% deviation) were censored for poor recovery.

3.2.5. Comparison of dissolved and total phases

This review was only conducted on water samples that reported dissolved and particulate fractions. In most cases the dissolved fraction was less than the particulate or total fraction. Some allowance is granted for variation in individual measurements, e.g. with an MQO of RPD<25%, a dissolved sample result might easily be higher than a total result by that amount.

3.2.6. Average and range of field sample versus previous years

Comparing the average range of the field sample results to comparable data from previous years (either from the same program or other projects) provided confidence that the reported data do not contain egregious errors in calculation or reporting (errors in correction factors and/or reporting units). Comparing the average, standard deviation, minimum and maximum concentrations from the past several years of data aided in exploring data, for example if a higher average was driven largely by a single higher maximum concentration.

3.2.7. Fingerprinting summary

The fingerprinting review evaluated the ratios or relative concentrations of analytes within an analysis. For this review, we looked at the reported compounds to find out if there are unusual ratios for individual samples compared to expected patterns from historic datasets or within the given dataset.

4. Results

The following sections present results from the four monitored tributaries. In this section, a summary of data quality is initially presented. This is then followed by sub-sections specific for each monitoring location where we report on flow, SSC and turbidity, POC concentrations, and toxicity.

4.1. Project Quality Assurance Summary

Overall the data were acceptable with few data quality issues. The exceptions were PAH and pyrethroids. Below is a summary of quality assurance and data validation for the data set. QA tables can be found in Appendix 2.

The PCB data were acceptable. MDLs were sufficient for all of the PCBs, including lab-replicates. NDs were reported for only PCB 170 (2% NDs). There was some laboratory blank contamination but no field samples were censored. Precision and accuracy metrics were within MQOs.

Total mercury and total methylmercury results were generally acceptable. MDLs were sufficient and there was only one ND for methylmercury. Methylmercury was found in blanks for most batches, with most results qualified but not censored. Two of the 44 methylmercury results (4%) were censored. Precision and accuracy metrics were within MQOs.

The nutrient data were generally acceptable. Concentrations of most analytes were above their MDLs, with no NDs. There was no contamination in field or laboratory blank samples. Precision and accuracy metrics were within MQOs.

The carbaryl and fipronil data were acceptable. MDLs were mostly sufficient except for carbaryl where 26% of samples were non-detects. No blank contamination was found. Precision and accuracy metrics were within MQOs.

The PAH data set was acceptable with some minor QA issues. MDLs were sufficient, with >50% NDs only for Benz(a)anthracene. One half of the target analytes were found in laboratory blanks, but only 17 results had field sample concentrations less than 3x those in blanks and required censoring, Biphenyl and Fluorenes, C1 were around 40% censored. Precision was good with <35% RSD on lab or blank spike replicates for all analytes. Recovery was good, average <35% from target for all except *Tetramethylnaphthalene, 1,4,6,7-,* which was ~40% above target and represents the C4 Naphthalenes, which was flagged for marginal recovery.

The PBDE data were generally acceptable. MDLs were sufficient for most PBDEs, with >50% NDs for some minor congeners. Some of the congeners (BDE 28, 37, 47, 49, 85, 99, 100, 153, 183, 209) were found in blanks, but only BDE 37 had half the samples with <3x the blank level and were censored. Precision and accuracy metrics were within MQOs.

The pyrethroid data were acceptable with various QA issues summarized below. The majority of the pyrethroid samples, 77% (10 of 13), had extensive NDs (>50% NDs for some analytes). Bifenthrin, Delta/Tralomethrin, and total Permethrin were the only pyrethroids where the MDLs were sufficient (<50% NDs). Five lab blanks were reported with 73% (11 out of 15) of the pyrethroids having some blank contamination. Allethrin, total Cyfluthrin, total lambda Cyhalothrin, Delta/Tralomethrin, total Esfenvalerate/Fenvalerate, Fenpropathri, Phenothrin, Resmethrin, and Tetramethrin had 13.3% of results censored. Blank spike samples were used to evaluate accuracy, as no CRMS or matrix spikes were provided, with the average % Error generally below the target MQO of 35%. Only two pyrethroids required flagging, Phenothrin and Resmethrin, which were above 35%, but below 70% % error, and were flagged with a non-censoring qualifier. The field replicates on field samples, and replicates on blank spikes, were generally good with Bifenthrin, total Cypermethrin, Delta/Tralomethrin, total Permethrin, total lambda Cyhalothrin, Fenpropathrin, total Esfenvalerate/Fenvalerate, and total Cyfluthrin having average RSDs below the target MQO of 35%. Allethrin , Phenothrin, Prallethrin, Resmethrin, and Tetramethrin had blank spike average RSDs above 35%, but below 70%, and were, therefore, flagged with a non-censoring qualifier.

Overall the other trace elements dataset was acceptable. All of the calcium, copper, magnesium, selenium and computed hardness results were above the detection limits with no NDs reported. No blank contamination was observed. Precision and accuracy metrics were within MQOs. The average dissolved/total ratio for hardness (0.74), calcium (0.83), copper (0.43), magnesium (0.79), and selenium (0.74) was less than 1. Three individual dissolved/total ratios (1 copper and 2 selenium) were >1, but the percent difference for each was <35%.

4.2. Marsh Creek

4.2.1. Marsh Creek flow

The US geological survey has maintained a flow record on Marsh Creek (gauge number 11337600) since October 1, 2000 (13 WYs). Peak annual flows for the previous 12 years have ranged between 168 cfs (1/22/2009) and 1770 cfs (1/2/2006). Annual runoff from Marsh Creek based on the previous 12 years of United States Geological Survey (USGS) records has ranged between 3.03 Mm^3 (WY 2009) and 26.8 Mm^3 (WY 2006). WY 2006 may be considered representative of very rare wet conditions (upper 10th percentile) and WY 2009 is perhaps representative of moderately rare dry conditions (lower 20th percentile) based on long-term records that began in WY 1953 at a nearby East Bay USGS gauging location (USGS gauge number 11182500, San Ramon Creek near San Ramon). A number of relatively minor storms occurred during WY 2012 (Figure 2). Flow peaked at 174 cfs on 1/21/2012 at 1:30 am and then again 51 ½ hours later at 143 cfs on 1/23/2012 at 5:00 am. Total runoff during WY 2012 based on preliminary USGS data was 1.83 Mm^3; discharge of this magnitude is likely exceeded most years in this watershed. Rainfall data corroborates this assertion; rainfall during WY 2012 was 69% of mean annual precipitation (MAP) based on a long-term record at Concord Wastewater treatment plant (NOAA gauge number 041967) for the period Climate Year (CY) 1992-2012.

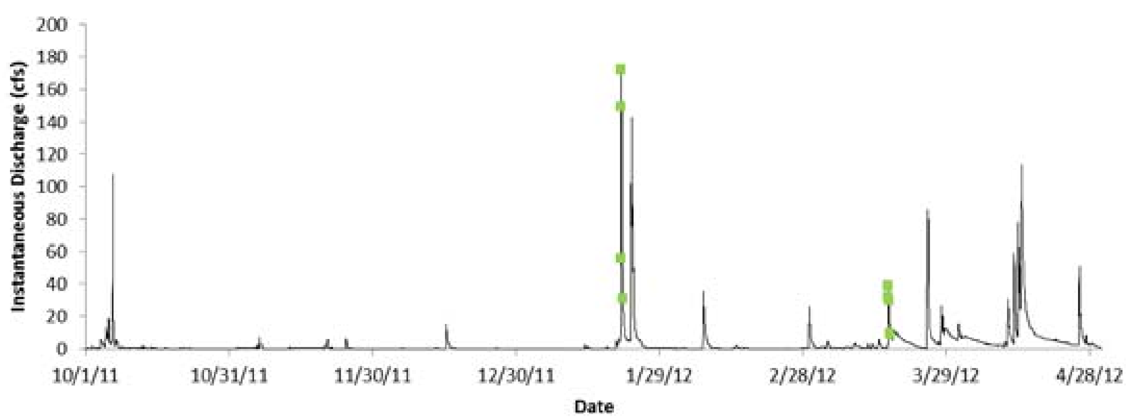


Figure 2. Flow characteristics in Marsh Creek during Water Year 2012 based on preliminary 15 minute data provided by the United States Geological Survey, gauge number 11337600) with sampling events plotted in green. Note, USGS normally publishes finalized data for the permanent record in the spring following the end of each Water Year.

4.2.2. Marsh Creek turbidity and suspended sediment concentration

Turbidity is a measure of the "cloudiness" in water caused by suspension of particles, most of which are less than 62.5 µm in size and, for most creeks in the Bay Area, virtually always less than 250 µm (USGS data). In natural flowing rivers and urban creeks or storm drains, turbidity usually correlates with the concentrations of suspended sediments and hydrophobic pollutants. Turbidity generally responded to rainfall events in a similar manner to runoff. Turbidity peaked at 532 NTU during a late season storm on 4/13/12 at 7 pm. Relative to flow magnitude, turbidity remained elevated during all storms and was the greatest during the last storm despite lower flow. These observations, and observations made previously during the RMP reconnaissance study (maximum 3211 NTU; McKee et al., in review), provide evidence that during larger storms and wetter years, the Marsh Creek watershed is capable of much greater sediment erosion and transport than occurred during WY 2012, resulting in greater turbidity and concentrations of suspended sediment. The OBS-500 instrument utilized at this sampling location with a range of 0-4000 NTU will likely be exceeded during medium or larger storms.

Suspended sediment concentration, since it was computed from the continuous turbidity data, follows the same patterns as turbidity in relation to discharge. SSC peaked at 1312 mg/L during the 4/13/12 late season storm at the same time as the turbidity peak. Relative to flow magnitude, SSC remained elevated during all storms and was the greatest during the last storm despite lower flow. The maximum SSC observed during the RMP reconnaissance study (McKee et al., in review) was 4139 mg/L, indicating that in wetter years, greater SSC can be expected.

4.2.3. Marsh Creek POC concentrations summary (summary statistics)

Summary statistics (Table 3) help compare Marsh Creek water quality to other Bay Area nonurban streams. The maximum PCB concentrations (4.32 ng/L) was similar to background concentrations normally found in relatively nonurban areas and maximum mercury concentrations (252 ng/L) were similar to concentrations found in mixed land use watersheds (Lent and McKee, 2011). Maximum and mean MeHg concentrations (0.407 ng/L; 0.219 ng/L (n=5)) were greater than the proposed implementation goal of 0.06 ng/l for methylmercury in ambient water for watershed tributary to the Central Delta (Wood et al., 2010: Table 4.1, page 40). Nutrient concentrations appear to be reasonably typical of other Bay Area watersheds (McKee and Krottje, 2005). As is typical in the Bay Area, phosphorus concentrations appear greater than elsewhere in the world under similar land use scenarios, an observation perhaps attributable to geological sources (McKee and Krottje, 2005). For pollutants sampled at a sufficient frequency for loads analysis (suspended sediments, PCBs, mercury, organic carbon, and nutrients), concentrations exhibited the typical pattern of median < mean with the exception of organic carbon. Thus, the comparison of summary statistics to knowledge from other watersheds and our conceptual model of the statistical distribution of water quality data provided a first order check on quality assurance.

A similar style of first order quality assurance is also possible for analytes measured at a lower frequency. Pollutants sampled at a lesser frequency and appropriate for characterization only (copper, selenium, PAHs, carbaryl, fipronil, and PBDEs) were quite low and similar to concentrations found in watersheds with limited or no urban influences. Carbaryl and fipronil (not measured previously by RMP studies) were on the lower side of the range of peak concentrations reported in studies across the US

Table 3. Summary of laboratory measured pollutant concentrations in Marsh Creek during WY 2012.

Analyte Name	Unit	Samples taken (n)	Proportion detected (%)	Min	Max	Median	Mean	Standard Deviation	FWMC[1]	Mean Particle Ratio (mass/mass)[2]	Standard Deviation of Particle Ratios
SSC	mg/L	27	96	43	930	215	308	275	154	NA	NA
∑PCB	ng/L	7	100	0.354	4.32	1.27	1.95	1.61	1.15	6.87	2.05
Total Hg	ng/L	8	100	8.31	252	34.6	74.3	85.2	38.9	193	58.6
Total MeHg	ng/L	5	100	0.090	0.407	0.185	0.219	0.118	0.763[3]	1.19	0.248
TOC	mg/L	8	100	4.60	12.4	8.55	8.34	2.37	8.02	52.4	41.7
NO3	mg/L	8	100	0.47	1.10	0.64	0.68	0.20	0.741	NA	NA
Total P	mg/L	8	100	0.295	1.10	0.545	0.576	0.285	0.469	2.64	1.52
PO4	mg/L	8	100	0.022	0.120	0.056	0.065	0.030	0.439	NA	NA
Hardness	mg/L	2	100	200	203	202	202	2	NA	NA	NA
Total Cu	µg/L	2	100	0.650	0.784	0.717	0.717	0.095	NA	NA	NA
Dissolved Cu	µg/L	2	100	0.483	0.802	0.643	0.643	0.226	NA	NA	NA
Total Se	µg/L	2	100	13.8	27.5	20.7	20.7	9.69	NA	NA	NA
Dissolved Se	µg/L	2	100	4.99	5.62	5.31	5.31	0.45	NA	NA	NA
Carbaryl	ng/L	2	50	-	-	-	16	-	NA	NA	NA
Fipronil	ng/L	2	100	7	18	13	13	8	NA	NA	NA
∑PAH	ng/L	1	100	-	-	-	494	-	NA	NA	NA
∑PBDE	ng/L	1	100		-	-	20.0	-	NA	NA	NA
Delta/ Tralo-methrin	ng/L	2	100	0.954	6.00	3.48	3.48	3.57	NA	NA	NA
Fenpropathrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Esfenvalerate/ Fenvalerate	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Cypermethrin	ng/L	2	50	-	-	-	68.0	-	NA	NA	NA
Cyfluthrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Cyhalothrin lambda	ng/L	2	50	-	-	-	3.00	-	NA	NA	NA
Permethrin	ng/L	2	100	3.81	17.0	10.4	10.4	9.33	NA	NA	NA
Bifenthrin	ng/L	2	100	25.3	257	141	141	164	NA	NA	NA
Allethrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Prallethrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Phenothrin	ng/L	2	0		-	-	-	-	NA	NA	NA
Resmethrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA

[1] FWMC = flow weighted mean concentration. Calculation is total annual mass load divided by total annual discharge volume.
[2] ∑PCB, Total Hg, and Total MeHg unit is µg/kg, and TOC and Total P unit is g/kg. Note: mean particle ratios were computed based on the individual paired samples and not by regression as is shown in Table 7. PCB ratios were not blank corrected.
[3] The interpolation method may have over predicted concentrations during unsampled periods. Subsequent years sampling will provide improved interpretation of mean concentrations as well as resulting loads.

and California (fipronil: 70 – 1300 ng/L, Moran, 2007) (Carbaryl: DL - 700 ng/L, Ensiminger et al., 2012). Pyrethroid concentrations of Delta/ Tralo-methrin and Cyhalothrin lambda were similar to those observed in Zone 4 Line A, a small 100% urban tributary in Hayward, whereas concentrations of

Permethrin were about 5x lower and concentrations of Bifenthrin were about 10x higher; cypermethrin was not detected in Z4LA (Gilbreath et al., 2012). In summary, the statistics indicate pollutant concentrations typical of a Bay Area non-urban stream; we have no reason to suspect data quality issues.

4.2.4. Marsh Creek toxicity

Composite water samples were collected at the Marsh Creek station during two storm events in Water Year 2012. No significant reductions in the survival, reproduction and growth of three of four test species were observed during these storms. Significant reductions in the survival of the amphipod *Hyalella azteca* was observed during both storm events. Although limited use of this species has occurred for the evaluation of toxicity in water, it has consistently been used by scientists to assess the toxicity of sediments in receiving waters.

Results from sampling in Marsh Creek are similar to those from recent wet weather monitoring conducted in Southern California (Riverside County 2007, Weston Solutions 2006), the Imperial Valley (Phillips et al. 2007), the Central Valley (Weston and Lydy 2010a, b), and the Sacramento-San Joaquin Delta (Werner et al., 2010), where follow up toxicity identification evaluations indicated that pyrethroid pesticides were almost certainly the cause of the toxicity observed. Via studies of toxicity in California receiving waters (Amweg et al. 2005, Weston and Holmes 2005, Anderson et al. 2010), pyrethroid pesticides have also been identified as the likely current causes of sediment toxicity in urban creeks. The toxicity testing results from Water Year 2012 monitoring in Marsh Creek are not unexpected given that *H. azteca* is considerably more sensitive to pyrethroids than other species tested as part of the POC monitoring studies.

4.3. San Leandro Creek

4.3.1. San Leandro Creek flow

There is no historic flow record on San Leandro Creek. A preliminary rating curve was developed by the SFEI team based on discharge sampling during WY 2012 and augmented by the Manning's formula. This rating will be improved in future sampling years. Based on this preliminary rating curve, total runoff during WY 2012 for the period 11/7/11 to 4/30/12 was 4.13 Mm^3, although we suspect the rating is low.

A series of relatively minor storms occurred during WY 2012 (Figure 3). Flow peaked at 121 cfs on 1/20/12 22:45. San Lorenzo Creek to the south has been gauged by the USGS in the town of San Lorenzo (gauge number 11181040) from WY 1968-78 and again from WY 1988-present. Based on these records, annual peak flow has ranged between 300 cfs (1971) and 10300 cfs (1998). During WY 2012, flow peaked on San Lorenzo Creek at San Lorenzo at 1600 cfs on 1/20/2012 at 23:00; a flow that has been exceeded 65% of the years on record. Based on this evidence alone, we suggest flow in San Leandro Creek was much lower than average.

In addition to the flow response from rainfall, East Bay Municipal Utility District (EBMUD) made releases from Chabot Reservoir in the first half of the season indicated by the square and sustained nature of the hydrograph at the sampling location, and the corresponding reservoir release data obtained from EBMUD (presented on the secondary y-axis of Figure 3). Despite this augmentation, it seems likely that

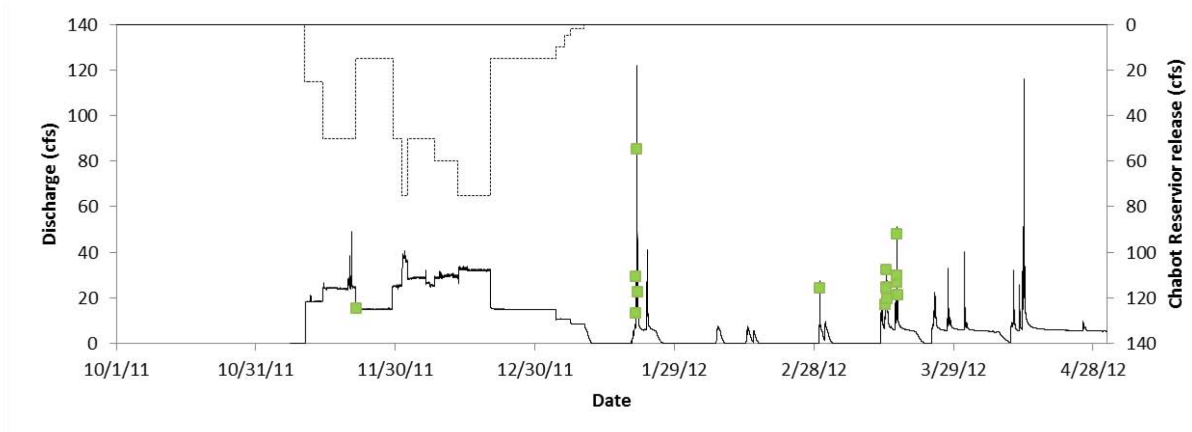


Figure 3. Preliminary flow characteristics (primary y axis) in San Leandro Creek at San Leandro Boulevard during Water Year 2012 with sampling events plotted in green. Note, flow information will be updated in the future with more velocity sampling and an improved rating curve.

annual flow in San Leandro Creek during WY 2012 was below average and would be exceeded in 60-70% of years. Rainfall data corroborates this assertion; rainfall during WY 2012 was 19.14 inches, or 75% of mean annual precipitation (MAP = 25.67 in) based on a long-term record at Upper San Leandro Filter (gauge number 049185) for the period 1971-2010 (Climate Year (CY)). CY 2012 ranked 18th driest in the available 57-year record (1949-present [Note 7-year data-gap during CY 1952-58]).

Flow data is based on preliminary 5 minute data generated by a rating relationship between stage and periodic discharge measurements made by the SFEI field team and augmented with computations using Manning's formula[1]. For comparison, the release from Chabot Reservoir is provided on the secondary y-axis. It is seen that the flow from Chabot reservoir exceeded the estimated flow from the rating relationship but at this time we have chosen not to manipulate the rating. The rating relationship for this location will be improved in subsequent years with additional field data and will result in updated flow and loads estimate for Water Year 2012 that will likely be greater.

4.3.2. San Leandro Creek turbidity and suspended sediment concentration

Turbidity generally responded to rainfall events in a similar manner to runoff. During the reservoir release period in the early part of the season, turbidity remained relatively low indicating very little sediment is within San Leandro Creek and available for transport at this magnitude and consistency of stream power. With each of the storms that occurred beginning 1/20/2012, maximum storm turbidity increased in magnitude. Turbidity peaked at 929 NTU during a late season storm on 4/13/12 at 5:15 am. These observations provide evidence that during larger storms and wetter years, the San Leandro Creek watershed is likely capable of much greater sediment erosion and transport resulting in greater turbidity and concentrations of suspended sediment. At this time, we have no evidence to suggest that the OBS-

[1] Manning's formula defines an empirical relationship between channel geometry, roughness, and hydraulic slope. (Chow, 1959).

500 instrument utilized at this sampling location (with a range of 0-4000 NTU) will not be sufficient to handle most future storms.

Suspended sediment concentration, since it was computed from the continuous turbidity data, follows the same patterns as turbidity in relation to discharge. Suspended sediment concentration peaked at 1324 mg/L during the late season storm on 4/13/12 at 5:15 am. The maximum concentration observed during the RMP reconnaissance study (McKee et al., in review) was 965 mg/L but at this time we have not evaluated the relative storm magnitude between WY 2011 and WY 2012 to determine if the relative concentrations are logical.

4.3.3. San Leandro Creek POC concentrations summary (summary statistics)

Summary statistics of pollutant concentrations measured in San Leandro Creek in WY 2012 are presented in Table 4 to provide a basic understanding of general water quality and also to provide a first order judgment of quality assurance. For pollutants sampled at a sufficient frequency for loads analysis (suspended sediments, PCBs, mercury, organic carbon, and nutrients), concentrations followed the typical pattern of median < mean with the exception of organic carbon. The range of PCB concentrations were typical of mixed urban land use watersheds (Lent and McKee, 2011). Maximum mercury concentrations (577 ng/L) were greater than observed in Zone 4 Line A in Hayward (Gilbreath et al., 2012) and of a similar magnitude to those observed in the San Pedro stormdrain draining an older urban residential area of San Jose (SFEI, unpublished). Nutrient concentrations were in the same range as measured in in Z4LA (Gilbreath et al., 2012), and as is typical in the Bay Area, phosphorus concentrations appear to be greater than reported elsewhere in the world under similar land use scenarios, an observation perhaps attributable to geological sources (McKee and Krottje, 2005). We find no reason to suspect data quality issues since the concentration ranges appear reasonable in relation to our conceptual models of water quality for these analytes.

Pollutants sampled at a lesser frequency and appropriate for water quality characterization only (copper, selenium, PAHs, carbaryl, fipronil, and PBDEs) were similar to concentrations observed in Z4LA (Gilbreath et al., 2012). Carbaryl and fipronil (not measured previously by RMP studies) were on the lower side of the range of peak concentrations reported in studies across the US and California (Fipronil: 70 – 1300 ng/L, Moran, 2007) (Carbaryl: DL - 700 ng/L, Ensiminger et al., 2012). Pyrethroid concentrations of Delta/ Tralo-methrin, Cyhalothrin lambda, and Bifenthrin were similar to those observed in Z4LA whereas concentrations of Permethrin were about 10x lower (Gilbreath et al., 2012). In summary, mercury concentrations in San Leandro are on the high end of typical Bay Area urban watersheds, whereas concentrations of other POCs are either within the range of or below those measured in other typical Bay Area urban watersheds. The does not appear to be any data quality issues.

4.3.4. San Leandro Creek toxicity

Composite water samples were collected at the San Leandro Creek station during four storm events in Water Year 2012. The survival of the freshwater fish species Pimephales promelas was significantly reduced during one of the four events. Similar to the results for other POC monitoring stations, significant reductions in the survival of the amphipod Hyalella azteca were observed, in this case in three

Table 4. Summary of laboratory measured pollutant concentrations in San Leandro Creek during WY 2012.

Analyte Name	Unit	Samples taken (n)	Proportion detected (%)	Min	Max	Median	Mean	Standard Deviation	FWM[1]	Mean Particle Ratio (mass/ mass)[2]	Standard Deviation of Particle Ratios
SSC	mg/L	53	98	21.0	590	105	165	144	242	NA	NA
∑PCB	ng/L	16	100	2.91	29.4	10.5	12.3	8.74	3.76	96.1	51.3
Total Hg	ng/L	16	100	11.9	577	89.4	184	203	31.9	965	520
Total MeHg	ng/L	9	100	0.164	1.48	0.220	0.499	0.456	0.432	4.17	2.40
TOC	mg/L	16	100	4.50	12.7	8.05	7.98	2.27	8.20	112	108
NO3	mg/L	16	100	0.140	0.830	0.340	0.356	0.194	0.334	NA	NA
Total P	mg/L	16	100	0.200	0.760	0.355	0.393	0.176	0.250	3.26	2.43
PO4	mg/L	16	100	0.0570	0.160	0.0725	0.0866	0.0282	0.070	NA	NA
Hardness	mg/L	4	100	33.8	72.5	56.5	54.8	18.5	NA	NA	NA
Total Cu	µg/L	4	100	12.3	39.5	20.1	23.0	11.8	NA	NA	NA
Dissolved Cu	µg/L	4	100	6.04	10.00	8.34	8.18	1.99	NA	NA	NA
Total Se	µg/L	4	100	0.112	0.292	0.216	0.209	0.085	NA	NA	NA
Dissolved Se	µg/L	4	100	0.0680	0.195	0.131	0.131	0.057	NA	NA	NA
Carbaryl	ng/L	4	50	10	14	12	12	2.83	NA	NA	NA
Fipronil	ng/L	4	100	6	10	8	8	1.63	NA	NA	NA
∑PAH	ng/L	2	100	3230	5352	4291	4291	1501	NA	NA	NA
∑PBDE	ng/L	2	100	64.9	82.0	73.5	73.5	12.1	NA	NA	NA
Delta/ Tralo-methrin	ng/L	4	75	0.326	1.74	1.41	1.16	0.740	NA	NA	NA
Fenpropathrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Esfenvalerate/ Fenvalerate	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Cypermethrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Cyfluthrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Cyhalothrin lambda	ng/L	4	25	-	-	-	3.86	-	NA	NA	NA
Permethrin	ng/L	4	100	3.35	13.1	5.77	7.00	4.45	NA	NA	NA
Bifenthrin	ng/L	4	75	10.2	32.4	14.0	18.9	11.9	NA	NA	NA
Allethrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Prallethrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Phenothrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA
Resmethrin	ng/L	4	0	-	-	-	-	-	NA	NA	NA

[1] FWMC = flow weighted mean concentration. Calculation is total annual mass load divided by total annual discharge volume.
[2] ∑PCB, Total Hg, and Total MeHg unit is µg/kg, and TOC and Total P unit is g/kg. Note: mean particle ratios were computed based on the individual paired samples and not by regression as is shown in Table 7. PCB ratios were not blank corrected.

of the four storm events sampled. Although limited use of this species has occurred for the evaluation of toxicity in water, it has consistently been used by scientists to assess the toxicity of sediments in receiving waters. No significant reductions in the survival, reproduction and growth of the crustacean Ceriodaphnia dubia or the algae Selenastrum capricornutum were observed during these storms.

Results from sampling in San Leandro Creek are similar to those from recent wet weather monitoring conducted in Southern California (Riverside County 2007, Weston Solutions 2006), the Imperial Valley (Phillips et al. 2007), the Central Valley (Weston and Lydy 2010a, b), and the Sacramento- San Joaquin Delta (Werner et al., 2010), where follow up toxicity identification evaluations indicated that pyrethroid pesticides were almost certainly the cause of the toxicity to H. azteca. Via studies of toxicity in California receiving waters (Amweg et al. 2005, Weston and Holmes 2005, Anderson et al. 2010), pyrethroid pesticides have also been identified as the likely current causes of sediment toxicity in urban creeks. The toxicity testing results from Water Year 2012 monitoring in San Leandro Creek are not unexpected given that H. azteca is considerably more sensitive to pyrethroids than other species tested as part of the POC monitoring studies.

4.4. Guadalupe River

4.4.1. Guadalupe River flow

The US Geological Survey has maintained a flow record on lower Guadalupe River (gauge number 11169000; 11169025) since October 1, 1930 (82 WYs; note 1931 is missing). Peak annual flows for the period have ranged between 125 cfs (WY 1960) and 11000 cfs (WY 1995). Annual runoff from Guadalupe River has ranged between 0.422 (WY 1933) and 241 Mm^3 (WY 1983).

During WY 2012, a series of relatively minor storms[2] occurred (Figure 4). A storm that caused flow to escape the low flow channel and inundate the in-channel bars did not occur until January 21st 2012, very late in the season compared to what has generally occurred over the past years of sampling and analysis for this system (McKee et al., 2004; McKee et al., 2005; McKee et al., 2006; McKee et al., 2010; Owens et al., 2011). The flow during this January storm was 1220 cfs; flows of this magnitude are common in most years. Flow peaked at 1290 cfs on 4/13/2012 at 7:15 am. Total runoff during WY 2012 based on preliminary USGS data was 25.8 Mm^3; discharge of this magnitude is about 62% mean annual runoff (MAR) based on 81 years of record and 46% MAR if we consider the period WY1971-2010 (perhaps more representative of current climatic conditions given climate change). Rainfall data corroborates this assertion; rainfall during WY 2012 was 7.05 inches, or 47% of mean annual precipitation (MAP = 14.89 in) based on a long-term record at San Jose (NOAA gauge number 047821) for the period 1971-2010 (CY). CY 2012 was the driest year in the past 42 years and the 7th driest for the record beginning CY 1875 (138 years). Flow data and resulting loads calculations for this site will be updated once USGS publishes the official record. The USGS normally publishes finalized data for the permanent record in the spring following the end of each Water Year.

[2] A storm is defined as resulting in flow that exceeds bankfull, which, at this location, is 200 cfs, and is separated by non-storm flow for a minimum of two days.

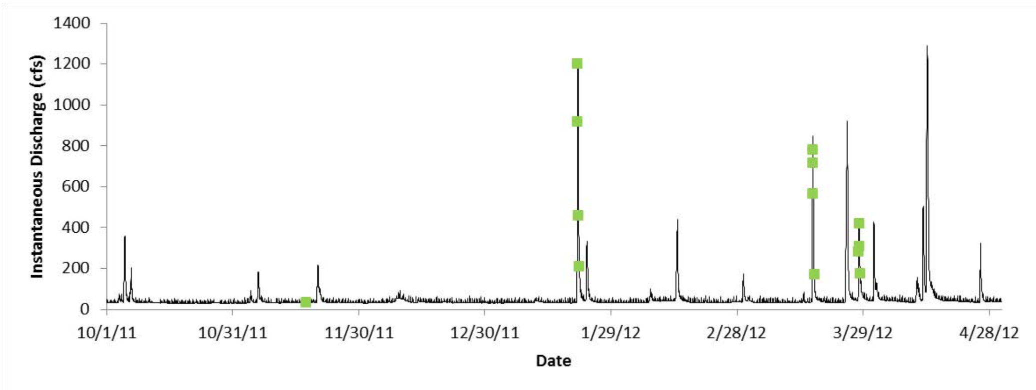


Figure 4. Preliminary flow characteristics in Guadalupe River during Water Year 2012 based on preliminary 15 minute data provided by the USGS (gauge number 11169025), with sampling events plotted in green. The fuzzy nature of the low flow data is caused by baseflow discharge fluctuations likely caused by pump station discharges near[3] the gauge.

4.4.2. *Guadalupe River turbidity and suspended sediment concentration*

Turbidity generally responded to rainfall events in a similar manner to runoff. Guadalupe River exhibited a pronounced first flush during a very minor early season storm when, relative to flow, turbidity was elevated and reached 260 FNU. In contrast, the storm that produced the greatest flow for the season that occurred on 4/13/2012 had lower peak turbidity (185 FNU). Peak turbidity for the season was 388 FNU during a storm on 1/21/12 at 3:15 am. Based on past years of record, turbidity can exceed 1000 FNU at the sampling location and the FTS DTS-12 turbidity probe is quite capable of sampling most if not all future sediment transport conditions for the site.

The USGS data record on SSC is not yet available. Therefore, preliminary estimates were computed by SFEI using the POC monitoring SSC data, the preliminary USGS turbidity record, and a linear regression model between instantaneous turbidity and SSC. Based on USGS sampling in Guadalupe River in past years, >90% of particles in this system are <62.5 µm in size (e.g. McKee et al., 2004). Because of these consistently fine particle sizes, turbidity correlates well with the concentrations of suspended sediments and hydrophobic pollutants (e.g. McKee et al., 2004). Suspended sediment concentration, since it was computed from the continuous turbidity data, follows the same patterns as turbidity in relation to discharge. It is estimated that SSC peaked at 844 mg/L during the January 21st storm event at 3:15 am. The maximum SSC observed during previous monitoring years was 1180 mg/L in 2002. Rainfall intensity was much greater during WY 2003 than any other year since leading to the hypothesis that concentrations of this magnitude will likely occur in the future during wetter years with greater and more intense rainfall (McKee et al., 2006).

[3] Pump station discharges actually occur downstream of the gauge; however, the gradient in this area is low enough that it affects upstream water levels on the hydrograph (pers comm., K. Abusaba, February 2013).

4.4.3. Guadalupe River POC concentrations summary (summary statistics)

A summary of concentrations is useful for providing comparisons to other systems and also for doing a first order quality assurance check. Concentrations measured in Guadalupe River during WY 2012 are summarized in Table 5. The range of PCB concentrations are typical of mixed urban land use watersheds (Lent and McKee, 2011) and maximum concentrations in this watershed were the 2nd highest measured of the four locations (Sunnyvale Channel >Guadalupe River >San Leandro Creek >Lower Marsh Creek). Maximum mercury concentrations (1000 ng/L) are greater than observed in Z4LA (Gilbreath et al., 2012) and the San Pedro stormdrain, which drains an older urban residential area of San Jose. This maximum concentration was higher than the average mercury concentration (690 ng/L) over the period of record at this location (2002-2010). Nutrient concentrations were in the same range as measured in in Z4LA (Gilbreath et al., 2012), and typical for the Bay Area, phosphorus concentrations appear greater than elsewhere in the world under similar land use scenarios, perhaps attributable to geological sources (McKee and Krottje, 2005). We have no reason to suspect any data quality issues.

In a similar manner, summary statistics and comparisons were developed for the lower sample frequency analytes. Copper, which was sampled at a lesser frequency for characterization only, was similar to concentrations previously observed ((McKee et al., 2004; McKee et al., 2005; McKee et al., 2006) and similar to those observed in Z4LA (Gilbreath et al., 2012). Selenium concentrations were generally 2-5 fold greater than the other three locations; elevated groundwater concentrations have been observed in Santa Clara County previously (Anderson, 1998). Carbaryl and fipronil were on the lower side of the range of peak concentrations reported in studies across the US and California (Fipronil: 70 – 1300 ng/L, Moran, 2007) (Carbaryl: DL - 700 ng/L, Ensiminger et al., 2012). Pyrethroid concentrations of Delta/ Tralo-methrin and Cyhalothrin lambda were similar to those observed in Z4LA whereas concentrations of Permethrin and Bifenthrin were lower (Gilbreath et al., 2012). No quality issues appear from the comparisons.

4.4.4. Guadalupe River toxicity

Composite water samples were collected at the Guadalupe River station during three storm events in WY 2012. Similar to the results for other POC monitoring stations, no significant reductions in the survival, reproduction and growth of three of four test species were observed during storms. Significant reductions in the survival of the amphipod Hyalella azteca was observed during two of the three storm events sampled. Although limited use of this species has occurred for the evaluation of toxicity in water, it has consistently been used by scientists to assess the toxicity of receiving water sediments.

Results from sampling in Guadalupe River are similar to those from recent wet weather monitoring conducted in Southern California (Riverside County 2007, Weston Solutions 2006), the Imperial Valley (Phillips et al. 2007), the Central Valley (Weston and Lydy 2010a, b), and the Sacramento- San Joaquin Delta (Werner et al., 2010), where follow up toxicity identification evaluations indicated that pyrethroid pesticides were likely the cause of toxicity. Via studies of toxicity in California receiving waters (Amweg et al. 2005, Weston and Holmes 2005, Anderson et al. 2010), pyrethroid pesticides have also been identified as the likely current causes of sediment toxicity in urban creeks. The toxicity testing results for WY 2012 in the Guadalupe River are not unexpected given that H. azteca is considerably more sensitive to pyrethroids than other species tested as part of the POC monitoring studies.

Table 5. Summary of laboratory measured pollutant concentrations in Guadalupe River.

Analyte Name	Unit	Samples taken (n)	Proportion detected (%)	Min	Max	Median	Mean	Standard Deviation	FWM[1]	Mean Particle Ratio (mass/mass)[2]	Standard Deviation of Particle Ratios
SSC	mg/L	40	100	9	730	106	203	205	59	NA	NA
∑PCB	ng/L	11	100	2.702	59.08	7.17	17.66	21.46	6.79	97.3	77.4
Total Hg	ng/L	13	100	0.14	1000	91.7	247.1	318.7	71.6	1111	428
Total MeHg	ng/L	9	100	0.086	1.150	0.386	0.478	0.356	0.522	6.20	3.74
TOC	mg/L	12	100	4.90	18.0	7.45	8.73	4.03	5.06	81.0	59.2
NO3	mg/L	12	100	0.56	1.90	0.82	0.92	0.38	1.020	NA	NA
Total P	mg/L	12	100	0.190	0.81	0.315	0.453	0.247	0.307	3.56	2.07
PO4	mg/L	12	100	0.060	0.160	0.101	0.101	0.032	0.075	NA	NA
Hardness	mg/L	3	100	133	157	140	143	12	NA	NA	NA
Total Cu	µg/L	3	100	10.7	26.3	24.7	20.6	8.582	NA	NA	NA
Dissolved Cu	µg/L	3	100	5.07	7.91	5.51	6.16	1.529	NA	NA	NA
Total Se	µg/L	3	100	1.2	1.6	1.2	1.3	0.26	NA	NA	NA
Dissolved Se	µg/L	3	100	0.77	1.32	1.04	1.04	0.27	NA	NA	NA
Carbaryl	ng/L	3	100	13	67	57	46	28.73	NA	NA	NA
Fipronil	ng/L	3	100	7	20	11	13	7	NA	NA	NA
∑PAH	ng/L	1	100	-	-	-	2186	-	NA	NA	NA
∑PBDE	ng/L	1	100	-	-	-	34.5	-	NA	NA	NA
Delta/ Tralo-methrin	ng/L	3	100	0.704	1.90	1.82	1.47	0.67	NA	NA	NA
Fenpropathrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Esfenvalerate/ Fenvalerate	ng/L	3	33	-	-	-	3.30	-	NA	NA	NA
Cypermethrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Cyfluthrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Cyhalothrin lambda	ng/L	3	33	-	-	-	1.20	-	NA	NA	NA
Permethrin	ng/L	3	100	16.80	20.5	19.5	18.9	1.91	NA	NA	NA
Bifenthrin	ng/L	3	67	6.2	13	10	10	5	NA	NA	NA
Allethrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Prallethrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Phenothrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA
Resmethrin	ng/L	3	0	-	-	-	-	-	NA	NA	NA

[1] FWMC = flow weighted mean concentration. Calculation is total annual mass load divided by total annual discharge volume.
[2] ∑PCB, Total Hg, and Total MeHg unit is µg/kg, and TOC and Total P unit is g/kg. Note: mean particle ratios were computed based on the individual paired samples and not by regression as is shown in Table 7. PCB ratios were not blank corrected.

4.5. Sunnyvale East Channel

4.5.1. *Sunnyvale East Channel flow*

Santa Clara Valley Water District (SCVWD) has maintained a flow gauge on Sunnyvale East Channel from WY 1983 to present. Unfortunately, the record is known to be poor quality (pers. comm., Ken Stumpf, SCVWD), which was apparent when the record was regressed against rainfall (R^2 = 0.58) (Lent et al., 2012). The gauge is presently scheduled for improvement by SCVWD. In the absence of a reliable agency record at this time, a preliminary rating curve was developed by the SFEI team based on discharge sampling during WY 2012 and Manning's formula. This rating will be improved in future sampling years with additional field data and will likely result in updated flow estimate for WY 2012.

A series of relatively minor storms occurred during WY 2012 (Figure 5). Flow peaked at 227 cfs overnight on 4/12/12- 4/13/12 at midnight. Total runoff during WY 2012 for the period 11/30/11 to 4/30/12 was 2.05 Mm^3 based on our preliminary rating curve. Given that SCVWD maintains the channel to support a peak discharge of 800 cfs, it seems likely that flows observed in Sunnyvale East Channel during WY 2012 were likely below average. Rainfall data corroborates this assertion; rainfall during WY 2012 was 8.82 inches, 58% of mean annual precipitation (MAP = 15.25 in) based on a long-term record at Palo Alto (NOAA gauge number 046646) for the period 1971-2010 (CY). CY 2012 ranked 6th driest in the available 59-year record (1954-present).

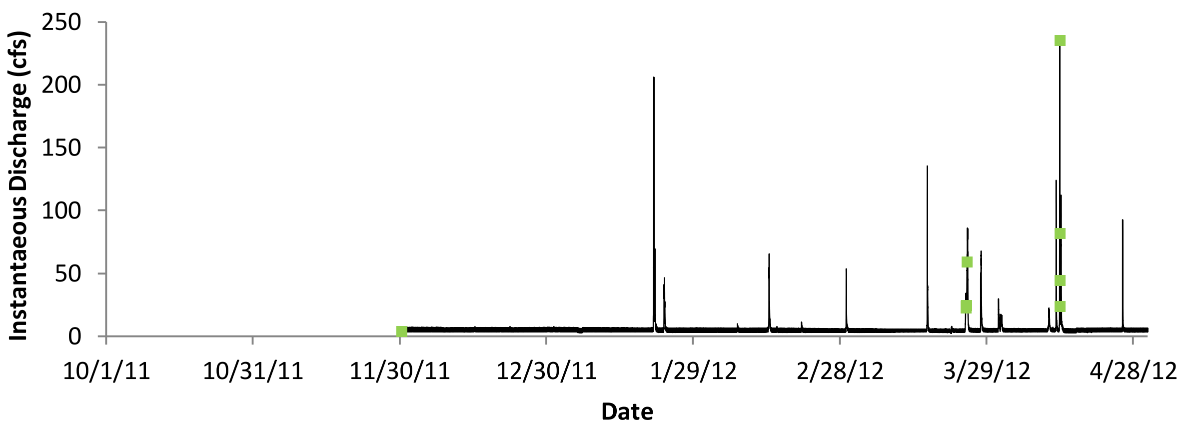


Figure 5. Preliminary flow characteristics in Sunnyvale East Channel at East Ahwanee Avenue during WY 2012 with sampling events marked in green. The flow record is based on preliminary 5 minute data generated by a rating relationship between stage and periodic discharge measurements augmented with Manning's formula computations. The rating relationship will be improved in subsequent years.

4.5.2. *Sunnyvale East Channel turbidity and suspended sediment concentration*

Turbidity for WY 2012 was rejected due to problems with the installation design and the OBS-500 instrument seeing the bottom of the channel. In WY 2013 it was replaced with an FTS DTS-12 turbidity probe (0-1,600 NTU range) which, based on WY 2012 SSC lab results, should be in range for all storms. Suspended sediment concentration could not be computed from the continuous turbidity data, and was alternatively computed during WY 2012 as a function of flow.

4.5.3. Sunnyvale East Channel POC concentrations summary (summary statistics)

A wide range of pollutants were measured in Sunnyvale East Channel during WY 2012 (Table 6). Concentrations for pollutants sampled at a sufficient frequency for loads analysis (suspended sediments, PCBs, mercury, organic carbon, and nutrients) exhibited the typical pattern of median < mean. The range of PCB concentrations were typical of mixed urban land use watersheds (Lent and McKee, 2011). Maximum mercury concentrations (64.1 ng/L) were less than observed in Z4LA (Gilbreath et al., 2012). Nutrient concentrations were also in the same range as measured in in Z4LA (Gilbreath et al., 2012) and like the other watersheds here reported, phosphorus concentrations are greater than elsewhere in the world under similar land use scenarios. Pollutants sampled at a lesser frequency appropriate for characterization only (copper, selenium, PAHs, carbaryl, fipronil, and PBDEs) were similar to concentrations observed in Z4LA (Gilbreath et al., 2012). Carbaryl and Fipronil (not measured previously by RMP studies) were on the lower side of the range of peak concentrations reported in studies across the US and California (Fipronil: 70 – 1300 ng/L, Moran, 2007) (Carbaryl: DL - 700 ng/L, Ensiminger et al., 2012). Pyrethroid concentrations of Bifenthrin were about 5x lower than observed in Z4LA and concentrations of Permethrin were about 10x lower (Gilbreath et al., 2012). No other pyrethroids were detected. Based on these first order comparisons, we see no quality issues with the data.

4.5.4. Sunnyvale East Channel toxicity

Composite water samples were collected in the Sunnyvale East Channel during two storm events in WY 2012. No significant reductions in the survival, reproduction and growth of three of four test species were observed during storms. Significant reductions in the survival of the amphipod Hyalella azteca was observed during both storm events[4]. Although limited use of this species has occurred for the evaluation of toxicity in water, it has consistently been used for assessments of receiving water sediment toxicity.

Results from sampling in the Sunnyvale East Channel are similar to those from recent wet weather monitoring conducted in Southern California (Riverside County 2007, Weston Solutions 2006), the Imperial Valley (Phillips et al. 2007), the Central Valley (Weston and Lydy 2010a, b), and the Sacramento-San Joaquin Delta (Werner et al., 2010), where follow up toxicity identification evaluations indicated that pyrethroid pesticides were almost certainly the cause of the toxicity observed. Via studies of toxicity in California receiving waters (Amweg et al. 2005, Weston and Holmes 2005, Anderson et al. 2010), pyrethroid pesticides have also been identified as the likely current causes of sediment toxicity in urban creeks. The toxicity testing results from WY 2012 monitoring in the Sunnyvale East Channel are not unexpected given that H. azteca is considerably more sensitive to pyrethroids than other species tested as part of the POC monitoring studies.

[4] In one of the two samples where significant toxicity was observed, a holding time violation occurred and therefore the results should be considered in the context of this exceedance of measurement quality objectives.

Table 6. Summary of laboratory measured pollutant concentrations in Sunnyvale East Channel.

Analyte Name	Unit	Samples taken (n)	Proportion detected (%)	Min	Max	Median	Mean	Standard Deviation	FWMC[1]	Mean Particle Ratio (mass/ mass)[2]	Standard Deviation of Particle Ratios
SSC	mg/L	28	96	6.30	370	50.0	84.6	101	22.3	NA	NA
∑PCB	ng/L	8	100	3.05	119	33.6	41.3	41.5	16.8	476	265
Total Hg	ng/L	9	89	6.30	64.1	21.7	27.7	21.7	12.1	427	118
Total MeHg	ng/L	5	100	0.045	0.558	0.267	0.300	0.205	0.143	3.66	2.03
TOC	mg/L	8	100	4.91	8.60	5.94	6.41	1.40	6.40	255	277
NO3	mg/L	8	100	0.200	0.560	0.280	0.309	0.119	0.307	NA	NA
Total P	mg/L	8	100	0.190	0.500	0.250	0.278	0.0975	0.214	7.96	7.10
PO4	mg/L	8	100	0.0670	0.110	0.0790	0.0849	0.0191	0.0847	NA	NA
Hardness	mg/L	2	100	51.4	61.2	56.3	56.3	6.93	NA	NA	NA
Total Cu	µg/L	2	100	10.8	19.0	14.9	14.9	5.80	NA	NA	NA
Dissolved Cu	µg/L	2	100	4.36	14.80	9.58	9.58	7.38	NA	NA	NA
Total Se	µg/L	2	100	0.327	0.494	0.411	0.411	0.118	NA	NA	NA
Dissolved Se	µg/L	2	100	0.308	0.325	0.317	0.317	0.0120	NA	NA	NA
Carbaryl	ng/L	2	100	11	21	16	16	7.07	NA	NA	NA
Fipronil	ng/L	2	100	6	12	9	9	4.24	NA	NA	NA
∑PAH	ng/L	1	100	-	-	-	1289	-	NA	NA	NA
∑PBDE	ng/L	1	100	-	-	-	4.77	-	NA	NA	NA
Delta/ Tralo-methrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Fenpropathrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Esfenvalerate/ Fenvalerate	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Cypermethrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Cyfluthrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Cyhalothrin lambda	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Permethrin	ng/L	2	100	5.70	20.9	13.3	13.3	10.8	NA	NA	NA
Bifenthrin	ng/L	2	50	-	-	-	8	-	NA	NA	NA
Allethrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Prallethrin	ng/L	2	0	-	-	-	-	-	NA	NA	NA
Phenothrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA
Resmethrin	ng/L	1	0	-	-	-	-	-	NA	NA	NA

[1] FWMC = flow weighted mean concentration. Calculation is total annual mass load divided by total annual discharge volume.

[2] ∑PCB, Total Hg, and Total MeHg unit is µg/kg, and TOC and Total P unit is g/kg. Note: mean particle ratios were computed based on the individual paired samples and not by regression as is shown in Table 7. PCB ratios were not blank corrected.

5. Estimated Loads

Within the context of limited sampling during a very dry year water year, less storms were sampled than had been planned (2 of 4 storms in Marsh Creek and Sunnyvale East Channel, and 3 of 4 storms in Guadalupe River) in addition to limitations with the original sampling design (limited samples collected that represent base flow conditions), loads estimates are presented which will likely be updated when additional data are collected in subsequent years. The STLS plans to sample additional storms in subsequent monitoring years so that overall, on average 4 storms are sampled each year. Loads presented in this report will be updated in future years when improved flow data becomes available at each site and when a better understanding of discharge-turbidity-pollutant relationships is learned as more data is collected.

5.1. Marsh Creek preliminary loading estimates

The following loads computation methods were applied. During sampled stormflow conditions, linear interpolation using particle ratios was used to estimate total mercury, methylmercury, PCBs, and total phosphorus concentrations between sample concentrations that were measured by our laboratories, and linear interpolation using water concentrations was used to estimate nitrate and phosphate concentrations between sample concentrations that were measured by our laboratories. During unsampled storm flow, total mercury, methylmercury, TP, TOC, and PCB concentrations were computed using regression equations with SSC (Table 7). During base flow, total mercury and PCB concentrations were computed using regression equations with SSC, whereas the dry weather total methylmercury concentration from the lab's analysis was applied to the base flow conditions and the TOC concentration measured during the lowest flow was applied to all base flow conditions. No wet season loads estimates were reported for nitrate and phosphate because there was insufficient data at this time to speculate on defensible loads computation methods during non-sampled storm flow and base flow.

Table 7. Regression equations used for loads computations for Marsh Creek during water year 2012. Note that regression equations will be reformulated with each future wet season of storm sampling.

Analyte	Slope	Intercept	Correlation coefficient (r^2)	Notes
Total PCBs (ng/mg)[1]	0.0047	0.27	0.98	Great correlation despite small number of samples.
Total Mercury (ng/mg)	0.25	0.00	0.93	Forced through zero.
Total Methylmercury (ng/mg)	0.00074	0.055	0.96	Dry weather methylmercury sample not included.
Total Organic Carbon (mg/mg)	0.0049	6.8	0.45	
Total Phosphorus (mg/mg)	0.00089	0.29	0.91	

[1]PCB regressions were based on data that were not blank corrected.

Preliminary monthly loading estimates correlate fairly well with monthly discharge (Table 8). There are no data available for October and November because monitoring equipment was not installed until the end of November. Monthly discharge was greatest in April as were the highest monthly loads for each of

Table 8. Preliminary monthly loads (if data were sufficient) for Marsh Creek.

Month	Rainfall (mm)	Discharge (Mm^3)	SS (t)	TOC (kg)	PCBs (g)	HgT (g)	MeHgT (g)	NO3 (kg)	PO4 (kg)	Total P (kg)
Oct-11	33	0.105	-	-	-	-	-	-	-	-
Nov-11	26	0.038	-	-	-	-	-	-	-	-
Dec-11	6	0.025	0.435	173	0.110	0.00359	0.0129	-	-	8.45
Jan-12	51	0.318	64.2	3409	16.1	0.315	0.458	-	-	220
Feb-12	22	0.078	2.63	541	0.665	0.0170	0.0456	-	-	28.7
Mar-12	60	0.360	14.9	2536	3.60	0.0802	0.238	-	-	145
Apr-12	59	0.646	138	4788	35.0	0.674	0.884	-	-	267
Wet season total	198	1.43	220	11447	55.5	1.09	1.64 [1]	-	-	669

Rainfall in the lower watershed (Ironhouse Sanitary District, Oakley ISD39).
All loads were reported with a minimum of 3 significant figures to allow other to post manipulate the data. Loads are only accurate to 1-2 significant figures.
[1] The interpolation method may have over predicted concentrations during unsampled periods. Subsequent years sampling will provide improved interpretation of mean concentrations as well as resulting loads. Methyl mercury loads will most likely decrease with improved information.

the contaminants. The suspended sediment load in March appears to be low relative to rainfall and discharge; this may be due to the small magnitude of the storms during that month. At this time, all loads estimate should be considered preliminary. In addition (and, in this case, more importantly), data collected during WY 2013 will be used to improve our understanding of rainfall-runoff-pollutant transport processes and used to recalculate and finalize loads for WY 2012. Regardless of these improvements however, given the very dry flow conditions of WY 2012 (see discussion on flow above), preliminary loads presented here may be considered representative of very dry conditions.

5.2. San Leandro Creek preliminary loading estimates

The following methods were applied for calculating preliminary loading estimates. During sampled stormflow conditions, linear interpolation using particle ratios was used to estimate total mercury, methylmercury, PCBs, and total phosphorus concentrations between sample concentrations that were measured by our laboratories. Since TOC did not correlate with SSC or discharge, loads were not reported this year but data from subsequent sampling years may help to decide better how to interpolate data sufficiently to estimate monthly loads. During sampled stormflow conditions, linear interpolation using water concentrations was used to estimate nitrate and phosphate between sample concentrations that were measured by our laboratories. During nonsampled storm flows, concentrations were computed using regression equations between PCBs, total mercury and methylmercury, and SSC (Table 9). Of interest, there is evidence, that, relative to SSC, total mercury concentrations are lesser in flow derived from the urban areas and PCBs concentrations are greater; a pattern seen before for Guadalupe River (McKee et al., 2004; McKee et al., 2005). During base flows,

Table 9. Regression equations used for loads computations for San Leandro Creek during water year 2012. Note that regression equations will be reformulated with future wet season storm sampling.

Analyte	Origin of runoff	Slope	Intercept	Correlation coefficient (r^2)	Notes
Total PCBs (ng/mg)[1, 2]	Mainly urban	0.21	0.76	0.86	A combination of rainfall records and professional judgment was used to separate the samples. These interpretations will be revisited when WY 2013 data become available. Non-urban PCB regression forced through zero.
Total PCBs (ng/mg)[2]	Mainly non-urban	0.048	0	0.88	
Total Mercury (ng/mg)[2]	Mainly urban	0.50	5.0	0.97	
Total Mercury (ng/mg)[2]	Mainly non-urban	1.45	1.58	0.84	
Total Methylmercury (ng/mg)	-	0.0024	0.083	0.98	
Total Organic Carbon (mg/mg)	-	-	-	-	Scattershot – additional data might illuminate pattern.
Total Phosphorus (mg/mg)	-	0.0011	0.22		

[1]PCB regressions were based on data that were not blank corrected.
[2]Note the opposite patters of the regressions for PCBs and total mercury relative to SSC based on the origin of water.

PCB concentrations were assumed to be 2.91 ng/L (the lowest measured during the study year). The choice of base flow PCB concentration had a large impact on the total wet season load due to reservoir release; this weakness may not be as important during a wetter year but if reservoir releases are normal, sampling design may need to be modified in future years. The dry weather total methylmercury concentration from the lab's analysis was applied to the early season base flow conditions.

Preliminary monthly loading estimates correlate fairly well with monthly discharge except when reservoir releases were occurring (November and December) (Table 10). During November and December, flow conditions were elevated but suspended turbidity and sediment concentrations were low. Monthly discharge was greatest in April as were the highest monthly loads for suspended sediment and most pollutants. At this time, all loads estimates should be considered preliminary. Flow data will be improved as the rating curve is improved. In addition (and, in this case, as importantly), pollutant data collected during WY 2013 will be used to improve our understanding of rainfall-runoff-pollutant transport processes and used to recalculate and finalize loads for WY 2012. Further discussion is needed on the choice of pollutant concentrations to apply during reservoir release periods. Regardless, given the very dry conditions, loads during WY 2012 may be considered representative of very dry conditions.

5.3. Guadalupe River preliminary loading estimates

Within the context of limited sampling during the very dry year (three out of the four planned storms) in addition to limitations with the sampling design (limited samples collected that represent base flow conditions), the following methods were applied. Suspended sediment concentration was estimated from the turbidity record using a power relation ($SSC = 0.80*turbidity^{1.17}$). Once the official USGS flow and SSC record is published, the loads will be recalculated for suspended sediments and other dependent analytes. During sampled stormflow conditions, linear interpolation using particle ratios was used to estimate total mercury, methylmercury, PCBs, and total phosphorus concentrations between

Table 10. Preliminary monthly loads for *San Leandro Creek*.

Month	Rainfall (mm)	Discharge (Mm^3)	SS (t)	TOC (kg)	PCBs (g)	HgT (g)	MeHgT (g)	NO3 (kg)	PO4 (kg)	Total P (kg)
Oct-11	64	-	-	-	-	-	-	-	-	-
Nov-11	37	0.986	3.21	-	2.87	6.22	0.416	326	67.7	225
Dec-11	0	1.87	12.8	-	5.44	21.4	0.788	617	129	434
Jan-12	73	0.384	12.6	-	2.13	15.5	0.167	139	27.8	98.9
Feb-12	22	0.0545	1.56	-	0.164	2.29	0.0226	18.4	3.84	14.0
Mar-12	151	0.350	24.1	-	1.61	31.4	0.135	117	25.5	105
Apr-12	85	0.481	41.3	-	3.33	54.8	0.253	164	35.8	154
Wet season total	369	4.13	95.6	-	15.5	132	1.78	1380	289	1031

Rainfall data for the lower watershed is from the Estudillo-Huff Fire Stn, gauge 02G0007, except in October, in which the data is from the WRCC San Leandro Fltr station, gauge number 049185

All loads were reported with a minimum of 3 significant figures (s.f.) to allow other to post manipulate data. Loads are only accurate to 1-2 s.f.

sample concentrations that were measured by our laboratories. During sampled stormflow conditions, linear interpolation using water concentrations was used to estimate nitrate and phosphate between sample concentrations that were measured by our laboratories. During other storm flows and during base flow, concentrations were estimated using regression equations between total mercury and methylmercury, PCBs, and total phosphorus and SSC (Table 11). As found during other dry years (McKee et al., 2006), a separation of the data for PCBs and total mercury to form to regression relations based on origin of flow was not possible with WY 2012 data. During base flow, NO3 and PO4 concentrations were estimated using regression equations with flow. The dry weather total methylmercury concentration from the lab's analysis was applied to the early season base flow.

Table 11. Regression equations used for loads computations for Guadalupe River during water year 2012. Note that regression equations will be reformulated upon future wet season storm sampling.

Analyte	Slope	Intercept	Correlation coefficient (r2)	Notes
Total PCBs (ng/mg)[1]	0.070	2.81	0.65	This is lower slope than previously reported.
Total Mercury (ng/mg)	1.24	0	0.90	Forced through zero.
Total Methylmercury (ng/mg)	0.0047	0.26	0.42	
Total Organic Carbon (mg/cfs)	0.0109	3.16	0.82	Better correlation with discharge than with SSC.
Total Phosphorus (mg/mg)	0.0090	0.25	0.72	

[1]PCB regressions were based on data that were not blank corrected.

Preliminary monthly loading estimates correlate fairly well with monthly discharge except for January when the first flush caused elevated SSC relative to flow (Table 12). Monthly discharge was greatest in April as were loads of most pollutants (exceptions being suspended sediment and total mercury).

Table 12. Preliminary monthly loads for Guadalupe River.

Month	Rainfall (mm)	Discharge (Mm^3)	SS (t)	TOC (kg)	PCBs (g)	HgT (g)	MeHgT (g)	NO3 (kg)	PO4 (kg)	Total P (kg)
Oct-11	19	2.91	140	11232	18.0	173	1.41	3053	191	857
Nov-11	15	2.88	70.3	10761	13.0	87.0	1.08	3038	187	789
Dec-11	1	2.73	19.4	9751	9.05	24.0	0.801	2893	174	705
Jan-12	18	3.85	458	23817	37.2	575	3.15	4015	326	1408
Feb-12	14	3.15	170	12697	20.7	210	1.62	3295	211	945
Mar-12	50	5.06	330	28509	39.8	378	2.54	4919	403	1609
Apr-12	44	5.23	325	33784	37.5	402	2.89	5123	444	1609
Wet season total	161	25.8	1511	130551	175	1849	13.5	26336	1937	7923

Rainfall for the lower watershed (City of San Jose, SCVWD gauge number RF-131).
All loads were reported with a minimum of 3 significant figures to allow other to post manipulate the data. Loads are only accurate to 1-2 significant figures.

Compared to previous sampling years (McKee et al., 2004; McKee et al., 2005; McKee et al., 2006; McKee et al., 2010; Owens et al., 2011), loads of total mercury and PCBs were 3-4x lower. At this time, all loads estimates should be considered preliminary. Once available, USGS official records for flow, turbidity, and SSC can be substituted for the preliminary data presented here. In addition (and, in this case, as importantly for nutrients), pollutant data collected during WY 2013 will be used to improve our understanding of rainfall-runoff-pollutant transport processes and used to recalculate and finalize loads for WY 2012. Regardless of these improvements, overall, given the very dry flow conditions, loads during WY 2012 may be considered representative of very dry conditions.

5.4. Sunnyvale East Channel preliminary loading estimates

Within the context of limited sampling during the very dry year (two out of the four planned storms) in addition to limitations with the sampling design (limited samples collected that represent base flow conditions), the following methods were applied. Given that the turbidity record appears spurious and unreliable due to optical interference from bottom substrate (note problem now rectified), suspended sediment concentration was estimated from the discharge record using a linear relation (SSC (mg/L) = 1.496*discharge (cfs). During sampled stormflow conditions, linear interpolation using particle ratios was used to estimate total mercury, methylmercury, PCBs, and total phosphorus concentrations between sample concentrations that were measured by our laboratories. During sampled stormflow conditions, linear interpolation using water concentrations was used to estimate nitrate and phosphate between sample concentrations that were measured by our laboratories. During unsampled storm flow and base flow, concentrations were estimated using regression equations between total mercury and methylmercury, PCBs, and total phosphorus and SSC (Table 13). During base flow, POC, NO3 and PO4 concentrations were assumed to be the concentrations measured during the lowest flow conditions we observed during storms. The dry weather total methylmercury concentration from the lab's analysis was applied to the early season base flow.

Table 13. Regression equations used for loads computations for Sunnyvale East Channel during water year 2012. Note that regression equations will be reformulated upon future wet season storm sampling.

Analyte	Slope	Intercept	Correlation coefficient (r2)	Notes
Total PCBs (ng/mg)[1]	0.34	9.3	0.72	Great correlation despite small number of samples.
Total Mercury (ng/mg)	0.21	7.4	0.8	
Total Methylmercury (ng/mg)	0.0017	0.10	0.92	
Total Organic Carbon		-	-	Scattershot – additional data might illuminate pattern.
Total Phosphorus (mg/mg)	0.00090	0.19	0.93	Great correlation despite small number of samples.

[1]PCB regressions were based on data that were not blank corrected.

Preliminary monthly loading estimates correlate fairly well with monthly discharge (Table 14). Monthly discharge was greatest in January and April as were loads of most water quality constituents. At this time, all loads estimate should be considered preliminary. Sampling during WY 2013 should provide data on velocity during storms. In addition, pollutant data collected during WY 2013 will be used to improve our understanding of rainfall-runoff-pollutant transport processes and be used to recalculate and finalize loads for WY 2012. Regardless of these improvements, overall, given the very dry flow conditions, loads during WY 2012 may be considered representative of very dry conditions.

Table 14. Preliminary monthly loads for Sunnyvale East Channel.

Month	Rainfall (mm)	Discharge (Mm^3)	SS (t)	TOC (kg)	PCBs (g)	HgT (g)	MeHgT (g)	NO3 (kg)	PO4 (kg)	Total P (kg)
Oct-11	21	-	-	-	-	-	-	-	-	-
Nov-11		-	-	-	-	-	-	-	-	-
Dec-11	2	0.377	2.94	-	4.49	3.42	0.0443	116	32.0	75.8
Jan-12	37	0.442	14.3	-	8.93	6.27	0.0704	136	37.5	98.7
Feb-12	22	0.353	3.76	-	4.55	3.41	0.0432	109	29.9	71.9
Mar-12	69	0.441	10.6	-	7.38	5.38	0.0641	137	37.7	94.9
Apr-12	39	0.436	14.3	-	9.19	6.43	0.0709	134	36.8	97.9
Wet season total	169	2.05	45.9	-	34.6	24.9	0.293	632	174	439

Rainfall data collected at Sunnyvale Hamilton WTP.
All loads were reported with a minimum of 3 significant figures to allow other to post manipulate the data. Loads are only accurate to 1-2 significant figures.

5.5. Comparison of regression slopes and normalized loads estimates between watersheds

The comparison of loading estimates between watersheds is confounded by variations in drainage area, climate, and the suitability of the sampling design and the number of available samples collected so far.

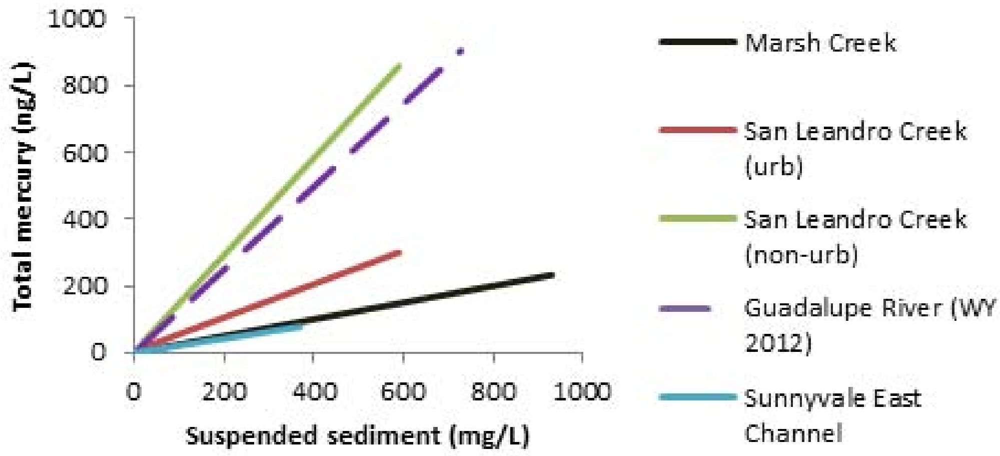
These caveats accepted, a preliminary comparison based on data collected during water year 2012 was provided here. We anticipate that these comparisons will change as additional data are collected in subsequent water years, and, should data be sufficient eventually, the best comparisons will be made with climatically averaged data.

One method of comparing watersheds is facilitated by comparing regression slopes based on the relationship between suspended sediment concentration and the target analyte (Figure 6). This method is valid for pollutants that are dominantly transported in a particulate form (total Mercury and the sum of PCBs are examples) and when there is relatively little variation in the particle ratios between water years. Based on particle ratios, runoff from San Leandro Creek that was derived mainly from the upper watershed and run-off from the Guadalupe River watershed exhibit the greatest particle ratios for total mercury (Figure 6). Given confidence intervals (not shown) and the relatively low numbers of samples collected during a relatively dry year, the relative nature of these two regression equations may change in the future as more samples are collected. Similarly, Marsh Creek and Sunnyvale East channel appear to have relatively low particle ratios for total mercury. In contrast, for the sum of PCBs, Sunnyvale East channel exhibits the highest particle ratios among these four watersheds, with urban sourced run-off from San Leandro Creek and Guadalupe River ranked second and third. Marsh Creek exhibits very low particle ratios for PCBs. Even with improved sample numbers, Marsh Creek will likely retain a low ranking for PCB pollution. At this time, given the very small number of samples, we have chosen not to report particle ratios for other analytes. These can be computed in the future once additional samples are available.

An alternative method for ranking watersheds in a relative sense is to compare area normalized loads (Table 15). This method is much more highly subject to climatic variation then the particle ratio method for ranking and is ideally done on climatically averaged loads. Despite quite large differences in unit run-off between the watersheds during water year 2012, in a general sense, the relative rankings for mercury and PCBs still follow the same trends using this method. However, we would anticipate changes of greater magnitude in the relative nature of the normalized loads with improved data in subsequent years. In particular, the relative rankings for suspended sediment loads normalized by unit area could change substantially with the addition of data from a water year that is closer to the climatic normal for each watershed. The same would be said for total phosphorus unit loads.

6. Conclusions and lessons learned

Overall, sampling during WY 2012 was reasonably successful. Given the dry conditions, only two of four storms planned for sampling were monitored on Lower Marsh Creek and Sunnyvale East Channel, and three of four were sampled on the Guadalupe River. Also given that Water Year 2012 was the first year of data collection under the STLS Multi-Year Plan (Plan), the results presented should be viewed as preliminary. Once implementation of the plan is completed, we intend to have a full set of representative data for both loads computations and characterization. The main objective this year was to complete a preliminary review of the data and develop the first versions of the loads computation techniques for each analyte and each watershed to support recommendations for improvement. A



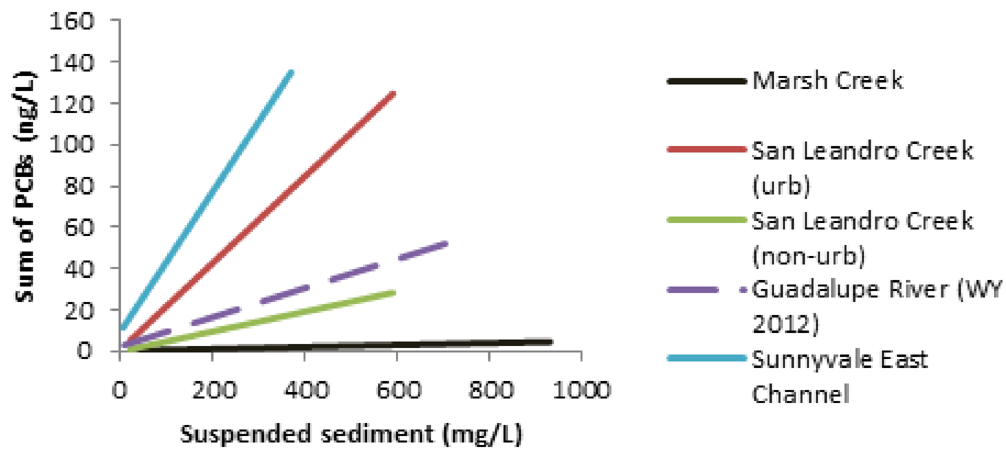


Figure 6. Comparison of regression slopes between watersheds based on data collected during water year 2012. Note these will likely change once additional data is collected in subsequent water years.

Table 15. Area normalized loads for water year 2012 based on free flowing areas downstream from reservoirs (see Table 1 for areas used in the computations). Note, direct comparison is confounded by the dry year and differing unit runoff. With additional years of sampling, climatically-averaged area-normalized loads may be generated.

	Unit runoff (m)	SS (t/km^2)	TOC (mg/m^2)	PCBs ($\mu g/m^2$)	HgT ($\mu g/m^2$)	MeHgT ($\mu g/m^2$)	NO3 (mg/m^2)	PO4 (mg/m^2)	Total P (mg/m^2)
Marsh Creek	0.014	2.2	116	0.56	0.011	0.017	-	-	6.8
San Leandro Creek	0.46	11	-	1.7	15	0.20	155	33	116
Guadalupe River	0.11	6.4	553	0.74	7.8	0.057	112	8.2	34
Sunnyvale East Channel	0.14	3.1	888	2.3	1.7	0.020	43	12	30

preliminary synthesis of the data using two techniques (regression slopes and normalized loads) also provided a further quality check on the preliminary results. We anticipate the general trends between watersheds won't change substantially with additional sampling in subsequent years, however, we do anticipate changes will occur to most of the regression equations and loads estimates. Based on this first year effort, recommended improvements in the sampling design to increase the quality of data collected via composite sampling include:

- A change from flow-based to time-based sampling in order to collect date more representative of *in-situ* organism exposure to pollutants (toxicity sample),
- A change from borosilicate glass containers for selenium/copper to polyethylene to align better with analytical protocols, and
- A reduced number of aliquots per storm from 24 to 16 in order to increase the accuracy of the autosamplers in relation to the measured aliquot volume.

Additionally, the turbidity instrument was changed at Sunnyvale Channel due to the poor data quality during WY2012. At this time, comparison of loads between sites is not too instructive given loads are not finalized but more importantly because WY 2012 was so dry. Variations between sites for such dry years might be overwhelmed by climatic conditions rather than variations in sources. Therefore, our further preliminary recommendations are:

- Once a second year of data is collected for each site, comparisons between concentrations and loads or more importantly exports (mass per unit area) should be recalculated,
- Generally for all sites, two additional grab samples collected during base flow early and late in the season and analyzed for, at a minimum, SSC, Hg, PCBs, would improve loads estimates. This would ideally be implemented in WY 2013 or as soon as budgets allow, and
- Specifically for San Leandro Creek, at least one sample taken during reservoir release and analyzed for, at a minimum, SSC, Hg, PCBs, would improve loads estimates. This would ideally be implemented WY 2013 or as soon as budgets allow.

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Appendix 1. Sample ID, sample date, station name, and analyte name

As called for in provision C.8.g.vi. of the MRP.

Sample ID	Sample Date	Station Name	Analyte Name
ST-SunCh-200	11/30/2011	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-200	11/30/2011	East Sunnyvale Channel	Mercury, Methyl
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Survival
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Total Cell Count
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Calcium
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Magnesium
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Carbaryl
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Copper
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Fipronil
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	PYRETHROIDS
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Selenium
ST-SunCh-210	3/24/2012	East Sunnyvale Channel	Total Hardness (calc)
ST-SunCh-211	3/24/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-211	3/24/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-211	3/24/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-211	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-211	3/24/2012	East Sunnyvale Channel	PCB
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	PAHs
ST-SunCh-212	3/24/2012	East Sunnyvale Channel	PCB
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	PBDPE
ST-SunCh-213	3/24/2012	East Sunnyvale Channel	PCB
ST-SunCh-214	3/25/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-214	3/25/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-214	3/25/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-214	3/25/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-214	3/25/2012	East Sunnyvale Channel	PCB
ST-SunCh-215	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-215	3/24/2012	East Sunnyvale Channel	Mercury
ST-SunCh-216	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration

Sample ID	Sample Date	Station Name	Analyte Name
ST-SunCh-216	3/24/2012	East Sunnyvale Channel	Mercury
ST-SunCh-217	3/24/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-217	3/24/2012	East Sunnyvale Channel	Mercury
ST-SunCh-218	3/25/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-218	3/25/2012	East Sunnyvale Channel	Mercury
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Survival
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Total Cell Count
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Calcium
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Carbaryl
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Copper
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Fipronil
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Magnesium
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	PYRETHROIDS
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Selenium
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-220	4/12/2012	East Sunnyvale Channel	Total Hardness (calc)
ST-SunCh-221	4/12/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-221	4/13/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-221	4/13/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-221	4/13/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-221	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-221	4/13/2012	East Sunnyvale Channel	PCB
ST-SunCh-222	4/13/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-222	4/13/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-222	4/13/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-222	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-222	4/13/2012	East Sunnyvale Channel	PCB
ST-SunCh-223	4/13/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-223	4/13/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-223	4/13/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-223	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-223	4/13/2012	East Sunnyvale Channel	PCB
ST-SunCh-224	4/13/2012	East Sunnyvale Channel	Nitrate as N
ST-SunCh-224	4/13/2012	East Sunnyvale Channel	OrthoPhosphate as P
ST-SunCh-224	4/13/2012	East Sunnyvale Channel	Phosphorus as P
ST-SunCh-224	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-224	4/13/2012	East Sunnyvale Channel	PCB
ST-SunCh-225	4/12/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-225	4/12/2012	East Sunnyvale Channel	Mercury
ST-SunCh-225	4/12/2012	East Sunnyvale Channel	Mercury, Methyl

Sample ID	Sample Date	Station Name	Analyte Name
ST-SunCh-226	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-226	4/13/2012	East Sunnyvale Channel	Mercury
ST-SunCh-226	4/13/2012	East Sunnyvale Channel	Mercury, Methyl
ST-SunCh-227	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-227	4/13/2012	East Sunnyvale Channel	Mercury
ST-SunCh-227	4/13/2012	East Sunnyvale Channel	Mercury, Methyl
ST-SunCh-228	4/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
ST-SunCh-228	4/13/2012	East Sunnyvale Channel	Mercury
ST-SunCh-228	4/13/2012	East Sunnyvale Channel	Mercury, Methyl
ST-SunCh-250	6/13/2012	East Sunnyvale Channel	Mercury, Methyl
ST-SunCh-250	6/13/2012	East Sunnyvale Channel	Suspended Sediment Concentration
GR-900	11/17/2011	Guadalupe River	Mercury, Methyl
GR-900	11/17/2011	Guadalupe River	Suspended Sediment Concentration
GR-910	1/21/2012	Guadalupe River	Survival
GR-910	1/21/2012	Guadalupe River	Total Cell Count
GR-910	1/21/2012	Guadalupe River	Calcium
GR-910	1/21/2012	Guadalupe River	Carbaryl
GR-910	1/21/2012	Guadalupe River	Copper
GR-910	1/21/2012	Guadalupe River	Fipronil
GR-910	1/21/2012	Guadalupe River	Magnesium
GR-910	1/21/2012	Guadalupe River	PYRETHROIDS
GR-910	1/21/2012	Guadalupe River	Selenium
GR-910	1/21/2012	Guadalupe River	Suspended Sediment Concentration
GR-910	1/21/2012	Guadalupe River	Total Hardness (calc)
GR-911	1/21/2012	Guadalupe River	Mercury
GR-911	1/21/2012	Guadalupe River	Nitrate as N
GR-911	1/21/2012	Guadalupe River	OrthoPhosphate as P
GR-911	1/21/2012	Guadalupe River	PCB
GR-911	1/21/2012	Guadalupe River	Phosphorus as P
GR-911	1/21/2012	Guadalupe River	Suspended Sediment Concentration
GR-912	1/21/2012	Guadalupe River	Mercury
GR-912	1/21/2012	Guadalupe River	Nitrate as N
GR-912	1/21/2012	Guadalupe River	OrthoPhosphate as P
GR-912	1/21/2012	Guadalupe River	PAHs
GR-912	1/21/2012	Guadalupe River	PCB
GR-912	1/21/2012	Guadalupe River	Phosphorus as P
GR-912	1/21/2012	Guadalupe River	Suspended Sediment Concentration
GR-913	1/21/2012	Guadalupe River	Mercury
GR-913	1/21/2012	Guadalupe River	Nitrate as N
GR-913	1/21/2012	Guadalupe River	OrthoPhosphate as P

Sample ID	Sample Date	Station Name	Analyte Name
GR-913	1/21/2012	Guadalupe River	PBDPE
GR-913	1/21/2012	Guadalupe River	PCB
GR-913	1/21/2012	Guadalupe River	Phosphorus as P
GR-913	1/21/2012	Guadalupe River	Suspended Sediment Concentration
GR-914	1/21/2012	Guadalupe River	Mercury
GR-914	1/21/2012	Guadalupe River	Nitrate as N
GR-914	1/21/2012	Guadalupe River	OrthoPhosphate as P
GR-914	1/21/2012	Guadalupe River	PCB
GR-914	1/21/2012	Guadalupe River	Phosphorus as P
GR-914	1/21/2012	Guadalupe River	Suspended Sediment Concentration
GR-920	3/16/2012	Guadalupe River	Survival
GR-920	3/16/2012	Guadalupe River	Total Cell Count
GR-920	3/16/2012	Guadalupe River	Calcium
GR-920	3/16/2012	Guadalupe River	Carbaryl
GR-920	3/16/2012	Guadalupe River	Copper
GR-920	3/16/2012	Guadalupe River	Fipronil
GR-920	3/16/2012	Guadalupe River	Magnesium
GR-920	3/16/2012	Guadalupe River	PYRETHROIDS
GR-920	3/16/2012	Guadalupe River	Selenium
GR-920	3/16/2012	Guadalupe River	Suspended Sediment Concentration
GR-920	3/16/2012	Guadalupe River	Total Hardness (calc)
GR-921	3/16/2012	Guadalupe River	Mercury
GR-921	3/16/2012	Guadalupe River	Mercury, Methyl
GR-921	3/16/2012	Guadalupe River	Nitrate as N
GR-921	3/16/2012	Guadalupe River	OrthoPhosphate as P
GR-921	3/16/2012	Guadalupe River	PCB
GR-921	3/16/2012	Guadalupe River	Phosphorus as P
GR-921	3/16/2012	Guadalupe River	Suspended Sediment Concentration
GR-922	3/17/2012	Guadalupe River	Mercury
GR-922	3/17/2012	Guadalupe River	Mercury, Methyl
GR-922	3/17/2012	Guadalupe River	Nitrate as N
GR-922	3/17/2012	Guadalupe River	OrthoPhosphate as P
GR-922	3/17/2012	Guadalupe River	Phosphorus as P
GR-922	3/17/2012	Guadalupe River	Suspended Sediment Concentration
GR-923	3/17/2012	Guadalupe River	Mercury
GR-923	3/17/2012	Guadalupe River	Mercury, Methyl
GR-923	3/17/2012	Guadalupe River	Nitrate as N
GR-923	3/17/2012	Guadalupe River	OrthoPhosphate as P
GR-923	3/17/2012	Guadalupe River	PCB
GR-923	3/17/2012	Guadalupe River	Phosphorus as P

Sample ID	Sample Date	Station Name	Analyte Name
GR-923	3/17/2012	Guadalupe River	Suspended Sediment Concentration
GR-924	3/17/2012	Guadalupe River	Mercury
GR-924	3/17/2012	Guadalupe River	Mercury, Methyl
GR-924	3/17/2012	Guadalupe River	Nitrate as N
GR-924	3/17/2012	Guadalupe River	OrthoPhosphate as P
GR-924	3/17/2012	Guadalupe River	PCB
GR-924	3/17/2012	Guadalupe River	Phosphorus as P
GR-924	3/17/2012	Guadalupe River	Suspended Sediment Concentration
GR-930	3/27/2012	Guadalupe River	Total Cell Count
GR-930	3/27/2012	Guadalupe River	Survival
GR-930	3/27/2012	Guadalupe River	Calcium
GR-930	3/27/2012	Guadalupe River	Carbaryl
GR-930	3/27/2012	Guadalupe River	Copper
GR-930	3/27/2012	Guadalupe River	Fipronil
GR-930	3/27/2012	Guadalupe River	Magnesium
GR-930	3/27/2012	Guadalupe River	PYRETHROIDS
GR-930	3/27/2012	Guadalupe River	Selenium
GR-930	3/27/2012	Guadalupe River	Suspended Sediment Concentration
GR-930	3/27/2012	Guadalupe River	Total Hardness (calc)
GR-931	3/27/2012	Guadalupe River	Mercury
GR-931	3/27/2012	Guadalupe River	Mercury, Methyl
GR-931	3/27/2012	Guadalupe River	Nitrate as N
GR-931	3/27/2012	Guadalupe River	OrthoPhosphate as P
GR-931	3/27/2012	Guadalupe River	PCB
GR-931	3/27/2012	Guadalupe River	Phosphorus as P
GR-931	3/27/2012	Guadalupe River	Suspended Sediment Concentration
GR-932	3/28/2012	Guadalupe River	Mercury
GR-932	3/28/2012	Guadalupe River	Mercury, Methyl
GR-932	3/28/2012	Guadalupe River	Nitrate as N
GR-932	3/28/2012	Guadalupe River	OrthoPhosphate as P
GR-932	3/28/2012	Guadalupe River	PCB
GR-932	3/28/2012	Guadalupe River	Phosphorus as P
GR-932	3/28/2012	Guadalupe River	Suspended Sediment Concentration
GR-933	3/28/2012	Guadalupe River	Mercury
GR-933	3/28/2012	Guadalupe River	Mercury, Methyl
GR-933	3/28/2012	Guadalupe River	Nitrate as N
GR-933	3/28/2012	Guadalupe River	OrthoPhosphate as P
GR-933	3/28/2012	Guadalupe River	PCB
GR-933	3/28/2012	Guadalupe River	Phosphorus as P
GR-933	3/28/2012	Guadalupe River	Suspended Sediment Concentration

Sample ID	Sample Date	Station Name	Analyte Name
GR-934	3/28/2012	Guadalupe River	Mercury
GR-934	3/28/2012	Guadalupe River	Mercury, Methyl
GR-934	3/28/2012	Guadalupe River	Nitrate as N
GR-934	3/28/2012	Guadalupe River	OrthoPhosphate as P
GR-934	3/28/2012	Guadalupe River	PCB
GR-934	3/28/2012	Guadalupe River	Phosphorus as P
GR-934	3/28/2012	Guadalupe River	Suspended Sediment Concentration
GR-950	6/13/2012	Guadalupe River	Mercury, Methyl
GR-950	6/13/2012	Guadalupe River	Suspended Sediment Concentration
ST-LMarCr-210	1/20/2012	Lower Marsh Creek	Survival
ST-LMarCr-210	1/20/2012	Lower Marsh Creek	Total Cell Count
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Calcium
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Carbaryl
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Copper
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Fipronil
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Magnesium
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	PYRETHROIDS
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Selenium
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-210	1/21/2012	Lower Marsh Creek	Total Hardness (calc)
ST-LMarCr-210-Dup	1/21/2012	Lower Marsh Creek	PYRETHROIDS
ST-LMarCr-210-Dup	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-211	1/20/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-211	1/20/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-211	1/20/2012	Lower Marsh Creek	PCB
ST-LMarCr-211	1/20/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-211	1/20/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-212	1/21/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-212	1/21/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-212	1/21/2012	Lower Marsh Creek	PCB
ST-LMarCr-212	1/21/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-212	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-213	1/21/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-213	1/21/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-213	1/21/2012	Lower Marsh Creek	PCB
ST-LMarCr-213	1/21/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-213	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-214	1/21/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-214	1/21/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-214	1/21/2012	Lower Marsh Creek	PCB

Sample ID	Sample Date	Station Name	Analyte Name
ST-LMarCr-214	1/21/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-214	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-215	1/20/2012	Lower Marsh Creek	Mercury
ST-LMarCr-215	1/20/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-216	1/21/2012	Lower Marsh Creek	Mercury
ST-LMarCr-216	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-217	1/21/2012	Lower Marsh Creek	Mercury
ST-LMarCr-217	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-218	1/21/2012	Lower Marsh Creek	Mercury
ST-LMarCr-218	1/21/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-220	3/16/2012	Lower Marsh Creek	Survival
ST-LMarCr-220	3/16/2012	Lower Marsh Creek	Total Cell Count
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Calcium
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Carbaryl
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Copper
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Fipronil
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Magnesium
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	PYRETHROIDS
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Selenium
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-220	3/17/2012	Lower Marsh Creek	Total Hardness (calc)
ST-LMarCr-220-Dup	3/17/2012	Lower Marsh Creek	Carbaryl
ST-LMarCr-220-Dup	3/17/2012	Lower Marsh Creek	Fipronil
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	PBDPE
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	PCB
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-221	3/16/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-221-Dup	3/16/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	PAHs
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	PCB
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-222	3/16/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-223	3/17/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-223	3/17/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-223	3/17/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-223	3/17/2012	Lower Marsh Creek	Suspended Sediment Concentration

Sample ID	Sample Date	Station Name	Analyte Name
ST-LMarCr-224	3/17/2012	Lower Marsh Creek	Nitrate as N
ST-LMarCr-224	3/17/2012	Lower Marsh Creek	OrthoPhosphate as P
ST-LMarCr-224	3/17/2012	Lower Marsh Creek	PCB
ST-LMarCr-224	3/17/2012	Lower Marsh Creek	Phosphorus as P
ST-LMarCr-224	3/17/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-225	3/16/2012	Lower Marsh Creek	Mercury
ST-LMarCr-225	3/16/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-225	3/16/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-226	3/16/2012	Lower Marsh Creek	Mercury
ST-LMarCr-226	3/16/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-226	3/16/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-227	3/17/2012	Lower Marsh Creek	Mercury
ST-LMarCr-227	3/17/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-227	3/17/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-228	3/17/2012	Lower Marsh Creek	Mercury
ST-LMarCr-228	3/17/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-228	3/17/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-228-Dup	3/17/2012	Lower Marsh Creek	Mercury
ST-LMarCr-228-Dup	3/17/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-240	6/20/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-240	6/20/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-LMarCr-240-Dup	6/20/2012	Lower Marsh Creek	Mercury, Methyl
ST-LMarCr-240-Dup	6/20/2012	Lower Marsh Creek	Suspended Sediment Concentration
ST-SLeaCr-200	11/21/2011	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-200	11/21/2011	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-211	1/20/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-211	1/20/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-211	1/20/2012	San Leandro Creek	PCB
ST-SLeaCr-211	1/20/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-211	1/20/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-212	1/20/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-212	1/20/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-212	1/20/2012	San Leandro Creek	PAHs
ST-SLeaCr-212	1/20/2012	San Leandro Creek	PCB
ST-SLeaCr-212	1/20/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-212	1/20/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-213	1/20/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-213	1/20/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-213	1/20/2012	San Leandro Creek	PBDPE
ST-SLeaCr-213	1/20/2012	San Leandro Creek	PCB

Sample ID	Sample Date	Station Name	Analyte Name
ST-SLeaCr-213	1/20/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-213	1/20/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-214	1/21/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-214	1/21/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-214	1/21/2012	San Leandro Creek	PCB
ST-SLeaCr-214	1/21/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-214	1/21/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-215	1/20/2012	San Leandro Creek	Mercury
ST-SLeaCr-215	1/20/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-216	1/20/2012	San Leandro Creek	Mercury
ST-SLeaCr-216	1/20/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-217	1/21/2012	San Leandro Creek	Mercury
ST-SLeaCr-217	1/21/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-218	1/21/2012	San Leandro Creek	Mercury
ST-SLeaCr-218	1/21/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Calcium
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Magnesium
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Survival
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Total Cell Count
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Carbaryl
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Copper
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Fipronil
ST-SLeaCr-220	2/29/2012	San Leandro Creek	PYRETHROIDS
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Selenium
ST-SLeaCr-220	2/29/2012	San Leandro Creek	Total Hardness (calc)
ST-SLeaCr-221	2/29/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-221	2/29/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-221	2/29/2012	San Leandro Creek	PCB
ST-SLeaCr-221	2/29/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-221	2/29/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-222	2/29/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-222	2/29/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-222	2/29/2012	San Leandro Creek	PCB
ST-SLeaCr-222	2/29/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-222	2/29/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Calcium
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Magnesium
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Survival

Sample ID	Sample Date	Station Name	Analyte Name
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Total Cell Count
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Carbaryl
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Copper
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Fipronil
ST-SLeaCr-230	3/14/2012	San Leandro Creek	PYRETHROIDS
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Selenium
ST-SLeaCr-230	3/14/2012	San Leandro Creek	Total Hardness (calc)
ST-SLeaCr-231	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-231	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-231	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-231	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-231	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-232	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-232	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-232	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-232	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-232	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-233	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-233	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-233	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-233	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-233	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-234	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-234	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-234	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-234	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-234	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-235	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-235	3/14/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-235	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-236	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-236	3/14/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-236	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-237	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-237	3/14/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-237	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-237-Dup	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-237-Dup	3/14/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-237-Dup	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-238	3/14/2012	San Leandro Creek	Mercury

Sample ID	Sample Date	Station Name	Analyte Name
ST-SLeaCr-238	3/14/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-238	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-241	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-241	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-241	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-241	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-241	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-242	3/14/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-242	3/14/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-242	3/14/2012	San Leandro Creek	PCB
ST-SLeaCr-242	3/14/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-242	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-245	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-245	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-246	3/14/2012	San Leandro Creek	Mercury
ST-SLeaCr-246	3/14/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Calcium
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Magnesium
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Survival
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Total Cell Count
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Carbaryl
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Copper
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Fipronil
ST-SLeaCr-250	3/16/2012	San Leandro Creek	PYRETHROIDS
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Selenium
ST-SLeaCr-250	3/16/2012	San Leandro Creek	Total Hardness (calc)
ST-SLeaCr-251	3/16/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-251	3/16/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-251	3/16/2012	San Leandro Creek	PAHs
ST-SLeaCr-251	3/16/2012	San Leandro Creek	PBDPE
ST-SLeaCr-251	3/16/2012	San Leandro Creek	PCB
ST-SLeaCr-251	3/16/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-251	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-252	3/16/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-252	3/16/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-252	3/16/2012	San Leandro Creek	PCB
ST-SLeaCr-252	3/16/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-252	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-253	3/16/2012	San Leandro Creek	Nitrate as N

Sample ID	Sample Date	Station Name	Analyte Name
ST-SLeaCr-253	3/16/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-253	3/16/2012	San Leandro Creek	PCB
ST-SLeaCr-253	3/16/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-253	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-254	3/16/2012	San Leandro Creek	Nitrate as N
ST-SLeaCr-254	3/16/2012	San Leandro Creek	OrthoPhosphate as P
ST-SLeaCr-254	3/16/2012	San Leandro Creek	PCB
ST-SLeaCr-254	3/16/2012	San Leandro Creek	Phosphorus as P
ST-SLeaCr-254	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-255	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-255	3/16/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-255	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-256	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-256	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-257	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-257	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-258	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-258	3/16/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-258	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-259	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-259	3/16/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-259	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-260	3/16/2012	San Leandro Creek	Mercury
ST-SLeaCr-260	3/16/2012	San Leandro Creek	Mercury, Methyl
ST-SLeaCr-260	3/16/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Calcium
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Magnesium
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Suspended Sediment Concentration
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Survival
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Total Cell Count
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Carbaryl
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Copper
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Fipronil
ST-SLeaCr-270	4/12/2012	San Leandro Creek	PYRETHROIDS
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Selenium
ST-SLeaCr-270	4/12/2012	San Leandro Creek	Total Hardness (calc)

Appendix 2. Quality Assurance information

Table A1: Summary of QA data at all sites. This table includes the top eight PAHs found commonly at all sites , the PBDE congeners that account for 75% of the sum of all PBDE congeners, the top nine PCB congeners found at all sites, and the pyrethroids that were detected at any site.

Analyte	Unit	Average Lab Blank	Detection Limit (MDL) (range; mean)	Average Reporting Limit (RL)	RSD of Lab Duplicates (% range; % mean)	RSD of Field Duplicates (% range; % mean)	Percent Recovery of CRM (% range; % mean)	Percent Recovery of Matrix Spike (% range; % mean)
Carbaryl	ug/L	0	0.01-0.01; 0.01	0.02	75.7-75.7; 75.7	83.5-83.5; 83.5	NA	67.4-120.3; 94.8
Fipronil	ug/L	0	0.002-0.005; 0.002	0.012	NA	0-17.7; 9.5	NA	51.5-127.3; 80.9
NH_4	mg/L	0.002	0.01-0.02; 0.015	NA	0-9.9; 1.9	0-9.9; 2.4	NA	78.8-111.9; 93.9
NO_3	mg/L	0	0.002-0.002; 0.002	0.005	0-0; 0	0-0; 0	NA	90-104; 98.3
NO_2	mg/L	0	0.001-0.001; 0.001	0.005	0-0.7; 0.3	0-2.2; 0.4	NA	97.6-107.6; 99.6
TKN	mg/L	0	0.4-0.4; 0.4	NA	0-47.9; 13.7	0-36.4; 15.6	NA	89.5-100.8; 95.6
PO_4	mg/L	0	0.004-0.004; 0.004	NA	0-1.6; 0.9	0-3.2; 0.9	NA	88.3-100.3; 91.5
Total P	mg/L	0	0.02-0.1; 0.049	NA	0-2.4; 0.8	0-14.2; 4.1	NA	86-100; 94.3
SSC	mg/L	0	0.23-6.8; 3.32	NA	NA	0-50.6; 14.9	89.1-114.5; 101.4	NA
Benz(a)anthracenes / Chrysenes, C1-	pg/L	123.225	147-1120; 603.1	NA	4.1-6.8; 5.4	3.8-6.9; 5.6	NA	NA
Benz(a)anthracenes / Chrysenes, C2-	pg/L	170.75	188-1980; 873.3	NA	8.7-16.4; 12.6	7.5-16.4; 9.5	NA	NA
Fluoranthene	pg/L	110	99.8-1410; 661.28	NA	1.3-16; 8.6	16-29.3; 21.4	NA	NA
Fluoranthene/ Pyrenes, C1-	pg/L	467.25	381-3050; 1322	NA	2.9-4.4; 3.6	2.9-20.5; 13	NA	NA
Fluorenes, C3-	pg/L	2076	198-29400; 3373	NA	0.1-5.4; 2.8	0.1-8.6; 6.5	NA	NA
Naphthalenes, C4-	pg/L	4145.25	146-3300; 1305.7	NA	5.9-11; 8.5	5.9-78.8; 36.1	NA	NA
Phenanthrene/ Anthracene, C4-	pg/L	2030.25	534-27100; 6996.9	NA	0-6.4; 3.2	3.5-12.8; 7.8	NA	NA
Pyrene	pg/L	74.65	441-5960; 1251.6	NA	1-14.4; 7.7	13.4-31.8; 21	NA	NA
PBDE 047	pg/L	18.133	0.368-0.407; 0.38	NA	1.2-18.2; 9.7	1.2-13.8; 7	NA	NA
PBDE 099	pg/L	19.067	0.472-5.6; 2.54	NA	3.9-9.9; 6.9	3.9-8.2; 7	NA	NA
PBDE 209	pg/L	110.333	40.9-80.2; 60.68	NA	2.2-19.4; 10.8	2.1-45.2; 16.9	NA	NA
PCB 087	pg/L	0.862	0.184-3.19; 0.68	NA	4.3-31.2; 13.3	4.3-31.2; 12.3	NA	NA
PCB 095	pg/L	0.757	0.184-4.12; 0.8	NA	3.9-38; 15.4	3.9-38; 17.1	NA	NA
PCB 110	pg/L	1.228	0.184-2.85; 0.586	NA	3.1-25.6; 11.7	3.1-25.6; 11.1	NA	NA
PCB 138	pg/L	0.809	0.245-10.9; 1.436	NA	3-25.4; 13.1	3-25.4; 13.2	NA	NA
PCB 149	pg/L	0.366	0.257-13.1; 1.637	NA	2-31.1; 12	2-25.8; 13.4	NA	NA
PCB 151	pg/L	0.062	0.184-2.71; 0.394	NA	0.3-29.2; 9.8	0.3-39.8; 16.6	NA	NA
PCB 153	pg/L	0.587	0.215-9.83; 1.292	NA	1.2-24.4; 11.2	1.2-23.9; 13.2	NA	NA
PCB 174	pg/L	0	0.202-3.89; 0.694	NA	0.3-36.3; 8.8	0.3-37; 13.6	NA	NA
PCB 180	pg/L	0.281	0.184-2.9; 0.473	NA	0.4-29.5; 7.8	0.4-23.7; 9.4	NA	NA
Bifenthrin	pg/L	274	1500-5520; 2830	NA	NA	4.8-35; 16.1	NA	NA

Analyte	Unit	Average Lab Blank	Detection Limit (MDL) (range; mean)	Average Reporting Limit (RL)	RSD of Lab Duplicates (% range; % mean)	RSD of Field Duplicates (% range; % mean)	Percent Recovery of CRM (% range; % mean)	Percent Recovery of Matrix Spike (% range; % mean)
Cypermethrin	pg/L	0	968-5290; 2694.533	NA	NA	27.6-27.6; 27.6	NA	NA
Delta/ Tralomethrin	pg/L	930	185-862; 353.6	NA	NA	23-32.4; 27.7	NA	NA
Total Cu	ug/L	0	0.042-0.421; 0.204	0.51	0.2-2.7; 0.9	0.2-2.7; 0.9	100.7-106.2; 102.5	90.5-105.4; 99.1
Dissolved Cu	Dissolve d	NA	0.042-0.421; 0.204	0.59	NA	0.126	1.007-1.062; 1.025	0.905-1.054; 0.991
Total Hg	ug/L	0	0.0002	0.0002	2-7.7; 4.9	2-31.1; 10	91.9-106.8; 100.1	93-119.9; 107.5
Total MeHg	ng/L	0.015	0.01-0.02; 0.011	0.011	1-5.9; 3.3	0.7-37.5; 9	NA	59-100; 81.4
Totel Se	ug/L	0.008	0.024-0.024; 0.024	0.072	0.3-27; 5.8	0.3-33.1; 10.5	92.6-103.8; 99.7	80.8-121.2; 99.1
Dissolved Se	Dissolve d	NA	0.024-0.024; 0.024	0.072	0.062	0-0.062; 0.021	0.926-1.038; 0.997	0.808-1.212; 0.991
TOC	ug/L	0	35-35; 35	402.222	NA	0-0; 0	NA	90.4-92.8; 91.6

Table A2: Field blank data from San Leandro Creek (the only site that collected field blanks). Note there is no PCB or PBDE field blank data available due to laboratory error with this sample.

AnalyteName	Unit	Average MDL	RL	Minimum Field Blank	Maximum Field Blank	Average Field Blank
Carbaryl	ug/L	0.01	0.02	ND	ND	ND
Fipronil	ug/L	0.002	0.01	ND	ND	ND
Fipronil Desulfinyl	ug/L	0.001	0.005	ND	ND	ND
Fipronil Sulfide	ug/L	0.001	0.005	ND	ND	ND
Fipronil Sulfone	ug/L	0.002	0.01	ND	ND	ND
NH_4	mg/L	0.01	NA	0.01	0.01	0.01
NO_3	mg/L	0.002	0.005	ND	ND	ND
NO_2	mg/L	0.00071	0.005	ND	ND	ND
TKN	mg/L	0.4	NA	ND	ND	ND
PO_4	mg/L	0.0035	NA	ND	ND	ND
Total P	mg/L	0.01	NA	0.018	0.018	0.018
Acenaphthene	pg/L	130	NA	ND	ND	ND
Acenaphthylene	pg/L	118	NA	ND	ND	ND
Anthracene	pg/L	309	NA	ND	ND	ND
Benz(a)anthracene	pg/L	38.8	NA	ND	ND	ND
Benz(a)anthracenes/Chrysenes, C1-	pg/L	34.6	NA	69.5	69.5	69.5
Benz(a)anthracenes/Chrysenes, C2-	pg/L	62.3	NA	393	393	393
Benz(a)anthracenes/Chrysenes, C3-	pg/L	66	NA	389	389	389
Benz(a)anthracenes/Chrysenes, C4-	pg/L	73.3	NA	1030	1030	1030
Benzo(a)pyrene	pg/L	190	NA	ND	ND	ND

AnalyteName	Unit	Average MDL	RL	Minimum Field Blank	Maximum Field Blank	Average Field Blank
Benzo(b)fluoranthene	pg/L	54.1	NA	ND	ND	ND
Benzo(e)pyrene	pg/L	171	NA	ND	ND	ND
Benzo(g,h,i)perylene	pg/L	185	NA	ND	ND	ND
Benzo(k)fluoranthene	pg/L	110	NA	ND	ND	ND
Biphenyl	pg/L	149	NA	552	552	552
Chrysene	pg/L	31.6	NA	86.5	86.5	86.5
Dibenz(a,h)anthracene	pg/L	113	NA	ND	ND	ND
Dibenzothiophene	pg/L	57.2	NA	ND	ND	ND
Dibenzothiophenes, C1-	pg/L	64.3	NA	ND	ND	ND
Dibenzothiophenes, C2-	pg/L	86.2	NA	278	278	278
Dibenzothiophenes, C3-	pg/L	43.1	NA	576	576	576
Dimethylnaphthalene, 2,6-	pg/L	296	NA	ND	ND	ND
Fluoranthene	pg/L	34.6	NA	238	238	238
Fluoranthene/Pyrenes, C1-	pg/L	79.1	NA	82.8	82.8	82.8
Fluorene	pg/L	102	NA	ND	ND	ND
Fluorenes, C1-	pg/L	219	NA	2350	2350	2350
Fluorenes, C2-	pg/L	199	NA	2730	2730	2730
Fluorenes, C3-	pg/L	160	NA	4130	4130	4130
Indeno(1,2,3-c,d)pyrene	pg/L	43.1	NA	ND	ND	ND
Methylnaphthalene, 1-	pg/L	821	NA	ND	ND	ND
Methylnaphthalene, 2-	pg/L	853	NA	ND	ND	ND
Methylphenanthrene, 1-	pg/L	80.4	NA	89.5	89.5	89.5
Naphthalene	pg/L	166	NA	2330	2330	2330
Naphthalenes, C1-	pg/L	152	NA	ND	ND	ND
Naphthalenes, C2-	pg/L	819	NA	1710	1710	1710
Naphthalenes, C3-	pg/L	419	NA	3940	3940	3940
Naphthalenes, C4-	pg/L	460	NA	ND	ND	ND
Perylene	pg/L	221	NA	ND	ND	ND
Phenanthrene	pg/L	60.2	NA	469	469	469
Phenanthrene/Anthracene, C1-	pg/L	80.4	NA	335	335	335
Phenanthrene/Anthracene, C2-	pg/L	71.9	NA	423	423	423
Phenanthrene/Anthracene, C3-	pg/L	91.8	NA	872	872	872
Phenanthrene/Anthracene, C4-	pg/L	187	NA	1100	1100	1100
Pyrene	pg/L	31.4	NA	179	179	179
Trimethylnaphthalene, 2,3,5-	pg/L	134	NA	189	189	189
Allethrin	pg/L	2790	NA	ND	ND	ND
Bifenthrin	pg/L	949	NA	ND	ND	ND
Cyfluthrin, total	pg/L	7020	NA	ND	ND	ND
Cyhalothrin, lambda, total	pg/L	748	NA	ND	ND	ND
Cypermethrin, total	pg/L	997	NA	ND	ND	ND

AnalyteName	Unit	Average MDL	RL	Minimum Field Blank	Maximum Field Blank	Average Field Blank
Delta/Tralomethrin	pg/L	539	NA	ND	ND	ND
Esfenvalerate/Fenvalerate, total	pg/L	845	NA	ND	ND	ND
Fenpropathrin	pg/L	1770	NA	ND	ND	ND
Permethrin, total	pg/L	287	NA	ND	ND	ND
Phenothrin	pg/L	525	NA	ND	ND	ND
Prallethrin	pg/L	7020	NA	ND	ND	ND
Resmethrin	pg/L	653	NA	ND	ND	ND
Tetramethrin	pg/L	1300	NA	ND	ND	ND
Calcium	ug/L	6.32	31.6	ND	ND	ND
Dissolved Cu	ug/L	0.042	0.105	0.681	0.681	0.681
Total Cu	ug/L	0.042	0.105	1.13	1.13	1.13
Magnesium	ug/L	0.63	3.16	0.68	0.68	0.68
Total Hg	ug/L	0.0002	0.0002	ND	ND	ND
Total MeHg	ng/L	0.01	0.01	0.021	0.021	0.021
Dissolved Se	ug/L	0.024	0.072	ND	ND	ND
Total Se	ug/L	0.024	0.072	ND	ND	ND
Total Hardness (calc)	mg/L	0.02	0.09	ND	ND	ND

Table A3: Average RSD of field and lab duplicates at each site.

Analyte	San Leandro		Sunnyvale Channel		Lower Marsh Creek		Guadalupe River	
	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD
Carbaryl							83.5%	75.7%
Fipronil	17.7%				0.0%		10.9%	
Fipronil Desulfinyl	10.9%		0.0%		20.2%			
Fipronil Sulfide	0.0%							
Fipronil Sulfone	0.0%							
NH_4	3.1%	0.0%	1.8%	1.5%	4.0%	4.9%	0.0%	0.0%
NO_3	0.0%	0.0%	0.0%	0.0%	0.0%		0.0%	0.0%
NO_2	1.5%	0.7%	0.0%	0.0%	0.0%		0.0%	0.0%
TKN	10.2%	3.4%			24.2%	23.9%	13.7%	
PO_4	0.4%	0.8%	0.9%	0.9%	0.6%		1.5%	1.1%
Total P	7.1%	0.0%	0.0%	0.0%	2.4%	2.4%	0.0%	0.0%
SSC	11.5%		7.2%		34.2%		8.6%	
Acenaphthene	22.9%						0.4%	0.4%
Acenaphthylene	16.7%						18.1%	18.1%
Anthracene	9.3%		24.6%	9.4%			23.4%	23.4%
Benz(a)anthracene	29.8%							
Benz(a)anthracenes/ Chrysenes, C1-	3.8%		6.9%	4.1%			6.8%	6.8%
Benz(a)anthracenes/ Chrysenes, C2-	8.1%		7.5%	8.7%			16.4%	16.4%
Benz(a)anthracenes/ Chrysenes, C3-	36.4%		6.3%	6.9%			8.9%	8.9%
Benz(a)anthracenes/ Chrysenes, C4-	3.2%		25.2%	20.6%			7.0%	7.0%
Benzo(a)pyrene	20.4%		19.5%	7.0%			6.5%	6.5%
Benzo(b)fluoranthene	10.5%		10.2%	2.7%			5.2%	5.2%
Benzo(e)pyrene	14.8%		7.0%	4.4%			5.9%	5.9%
Benzo(g,h,i)perylene	21.6%		8.8%	0.0%			5.3%	5.3%
Benzo(k)fluoranthene	36.4%		20.6%	1.8%			2.8%	2.8%
Chrysene	12.7%		11.6%	1.3%			7.5%	7.5%
Dibenz(a,h)anthracene	39.9%		31.9%	9.9%				
Dibenzothiophene			8.5%	2.1%			13.0%	13.0%
Dibenzothiophenes, C1-	2.2%		6.3%	1.7%			2.9%	2.9%
Dibenzothiophenes, C2-	6.7%		3.8%	0.7%			2.9%	2.9%
Dibenzothiophenes, C3-	5.3%		7.3%	2.1%			0.8%	0.8%
Dimethylnaphthalene, 2,6-	33.7%		4.7%	1.6%			13.8%	13.8%
Fluoranthene	29.3%		16.3%	1.3%			16.0%	16.0%
Fluoranthene/Pyrenes, C1-	20.5%		10.5%	4.4%			2.9%	2.9%
Fluorene	11.8%						9.1%	9.1%

Analyte	San Leandro		Sunnyvale Channel		Lower Marsh Creek		Guadalupe River	
	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD
Fluorenes, C2-	21.8%		7.3%	8.9%			1.2%	1.2%
Fluorenes, C3-	7.7%		8.6%	5.4%			0.1%	0.1%
Indeno(1,2,3-c,d)pyrene	24.4%		14.5%	0.4%			5.3%	5.3%
Methylnaphthalene, 2-	14.0%		3.3%	1.1%			6.3%	6.3%
Methylphenanthrene, 1-	21.6%		12.7%	13.6%			10.7%	10.7%
Naphthalene	15.3%		7.6%	1.5%			3.8%	3.8%
Naphthalenes, C1-	23.6%						5.7%	5.7%
Naphthalenes, C3-	33.5%		1.3%	1.9%			11.2%	11.2%
Perylene	21.3%		20.8%	4.2%			8.6%	8.6%
Phenanthrene	2.9%		33.9%	6.1%			26.5%	26.5%
Phenanthrene/ Anthracene, C1-	46.8%		12.0%	2.1%			0.2%	0.2%
Phenanthrene/ Anthracene, C2-	21.1%		6.0%	8.4%			8.1%	8.1%
Pyrene	31.8%		13.4%	1.0%			14.4%	14.4%
Trimethylnaphthalene, 2,3,5-	22.1%		3.6%	0.3%			9.0%	9.0%
PBDE 007								11.2%
PBDE 008	8.3%	4.7%						
PBDE 010								
PBDE 011								
PBDE 012								11.7%
PBDE 013								
PBDE 015	11.7%	9.5%					3.2%	4.3%
PBDE 017	4.7%	12.7%	7.6%					
PBDE 025								
PBDE 028	3.9%	7.0%	0.9%				15.6%	20.7%
PBDE 030								
PBDE 032								
PBDE 033								
PBDE 035								
PBDE 047	3.2%	1.2%	5.9%				13.8%	18.2%
PBDE 049	3.3%	0.7%	1.7%				10.2%	8.6%
PBDE 051	5.7%	5.7%						
PBDE 066	2.6%	0.5%	1.0%				13.8%	14.1%
PBDE 071	1.9%	1.9%						
PBDE 075	0.7%	0.7%	9.8%					
PBDE 077	15.8%	15.8%						
PBDE 079	16.4%	16.4%						
PBDE 085	8.0%	5.2%	5.7%				4.6%	5.7%
PBDE 099	6.8%	3.9%	6.2%				8.1%	9.9%

Analyte	San Leandro		Sunnyvale Channel		Lower Marsh Creek		Guadalupe River	
	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD
PBDE 100	4.3%	0.3%	6.5%				9.2%	11.7%
PBDE 105								
PBDE 116								
PBDE 119	6.8%	6.3%						21.0%
PBDE 120								
PBDE 126								
PBDE 128								
PBDE 140							12.1%	12.5%
PBDE 153	8.6%	6.6%	5.5%				6.2%	7.1%
PBDE 155	8.1%	12.5%					6.4%	7.8%
PBDE 166								
PBDE 181								
PBDE 183	21.3%	1.5%					27.4%	32.6%
PBDE 190								
PBDE 197	42.2%	12.3%	15.8%					
PBDE 203	41.6%	17.6%						3.3%
PBDE 204								
PBDE 205								
PBDE 206	9.0%	23.9%	8.8%				6.1%	7.6%
PBDE 207	12.8%	25.5%	5.8%				2.0%	2.1%
PBDE 208	17.6%	23.7%	13.0%				3.5%	4.1%
PBDE 209	36.6%	19.4%	2.2%				2.1%	2.2%
PCB 008	7.0%	7.0%	12.1%	12.1%			4.7%	0.3%
PCB 018	5.3%	5.3%	13.2%	13.2%			6.2%	0.7%
PCB 020								
PCB 021								
PCB 028	16.1%	16.1%	7.2%	7.2%			5.1%	1.2%
PCB 030								
PCB 031	11.8%	11.8%	6.7%	6.7%			6.1%	0.7%
PCB 033	5.9%	5.9%	9.3%	9.3%			5.6%	0.4%
PCB 044	12.2%	12.2%	7.7%	7.7%			10.0%	13.3%
PCB 047								
PCB 049	11.3%	11.3%	5.4%	5.4%			9.6%	13.6%
PCB 052	17.2%	17.2%	5.6%	5.6%			10.2%	14.4%
PCB 056	4.1%	4.1%	29.4%				9.3%	12.0%
PCB 060	3.1%	3.1%	31.6%				10.8%	13.6%
PCB 061								
PCB 065								
PCB 066	8.4%	8.4%	11.7%	11.7%			11.1%	15.0%

Analyte	San Leandro		Sunnyvale Channel		Lower Marsh Creek		Guadalupe River	
	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD
PCB 069								
PCB 070	14.6%	14.6%	10.1%	10.1%			11.3%	15.5%
PCB 074								
PCB 076								
PCB 083								
PCB 086								
PCB 087	13.6%	13.6%	8.2%	8.2%			12.6%	17.6%
PCB 090								
PCB 093								
PCB 095	17.1%	17.1%	6.7%	6.7%			22.3%	18.8%
PCB 097								
PCB 098								
PCB 099	14.5%	14.5%	5.3%	5.3%			13.3%	18.7%
PCB 100								
PCB 101	11.6%	11.6%	4.2%	4.2%			25.4%	18.6%
PCB 102								
PCB 105	9.6%	9.6%	12.4%	12.4%			14.1%	19.2%
PCB 108								
PCB 110	12.0%	12.0%	4.1%	4.1%			13.2%	18.2%
PCB 113								
PCB 115								
PCB 118	10.6%	10.6%	6.3%	6.3%			14.7%	20.8%
PCB 119								
PCB 125								
PCB 128	8.3%	8.3%	0.0%	0.0%			19.3%	26.9%
PCB 129								
PCB 132	10.2%	10.2%	0.2%	0.2%			22.8%	25.8%
PCB 135								
PCB 138	12.4%	12.4%	3.0%	3.0%			19.6%	25.2%
PCB 141	12.0%	12.0%	2.0%	2.0%			25.3%	22.9%
PCB 147								
PCB 149	8.9%	8.9%	2.0%	2.0%			25.8%	31.1%
PCB 151	6.1%	6.1%	1.5%	1.5%			39.8%	29.2%
PCB 153	10.1%	10.1%	1.2%	1.2%			23.9%	24.4%
PCB 154								
PCB 156	10.9%	10.9%	0.8%	0.8%			17.7%	25.1%
PCB 157								
PCB 158	11.9%	11.9%	2.7%	2.7%			18.4%	24.8%
PCB 160								

Analyte	San Leandro		Sunnyvale Channel		Lower Marsh Creek		Guadalupe River	
	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD	Avg Field RSD	Avg Lab RSD
PCB 163								
PCB 166								
PCB 168								
PCB 170	4.9%	4.9%	0.6%	0.6%			20.1%	24.7%
PCB 174	2.1%	2.1%	1.2%	1.2%			37.0%	36.3%
PCB 177	3.1%	3.1%	2.9%	2.9%			30.1%	
PCB 180	1.9%	1.9%	3.5%	3.5%			23.7%	29.5%
PCB 183	3.8%	3.8%	3.7%	3.7%			33.1%	31.6%
PCB 185								
PCB 187	2.9%	2.9%	3.4%	3.4%			37.9%	34.9%
PCB 193								
PCB 194	3.6%	3.6%	6.0%	6.0%			27.3%	38.7%
PCB 195	1.5%	1.5%	4.1%	4.1%			24.2%	26.9%
PCB 201	2.4%	2.4%	1.7%	1.7%			28.8%	
PCB 203	6.4%	6.4%	6.8%	6.8%			30.7%	44.1%
Allethrin								
Bifenthrin	35.0%				8.5%		4.8%	
Cyfluthrin, total								
Cyhalothrin, lambda, total								
Cypermethrin, total					27.6%			
Delta/Tralomethrin					32.4%		23.0%	
Esfenvalerate/ Fenvalerate, total								
Fenpropathrin								
Permethrin, total	12.9%		2.4%		10.6%		2.1%	
Phenothrin								
Prallethrin								
Resmethrin								
Calcium	0.5%	0.4%			0.5%	0.5%	1.0%	1.0%
Total Cu	1.1%	1.1%	0.2%	0.2%	0.8%	0.8%		
Dissolved Cu	12.6%							
Magnesium	0.8%	0.6%	0.3%	0.3%	0.5%	0.5%	1.3%	1.3%
Total Hg	21.4%	2.1%			2.4%		6.6%	
Total MeHg	20.8%	4.1%	3.1%		5.5%		3.7%	2.6%
Dissolved Se	2.1%	6.2%						
Total Se	17.4%	10.1%			1.5%	1.5%	1.4%	1.4%
Total Hardness (calc)	0.4%							
TOC	0.0%							

Appendix E

Status Report - Sediment Delivery Estimate/Budget (Provision C.8.e.vi)

Sediment Delivery Estimate/Budget:

Status Review and Proposed Modifications

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For

Bay Area Stormwater Management Agencies Association (BASMAA)

And

Regional Monitoring Program for Water Quality in San Francisco Bay (RMP)
Sources Pathways and Loadings Workgroup (SPLWG)
Small Tributaries Loading Strategy (STLS)

Final: February 28, 2013

1. Introduction

San Francisco Bay is impaired by mercury and PCBs (SFRWRCB 2006; SFRWRCB, 2008) and urban runoff from local watersheds has been identified as a significant pathway for these and many pollutants of concern (POC) (Municipal Regional Stormwater Permit (MRP); SFRWRCB, 2009). The permit contains several provisions that require management actions and studies to address information gaps for mercury, PCBs, legacy pesticides, PBDEs, and selenium (portions of provisions C.8, C.11, C.12, and C.14). Provision C.8.e requires permitees to, among other things, determine which Bay tributaries (including stormwater conveyances) contribute most to Bay impairment from POCs and to provide improved estimates of annual average loads or concentrations of POCs from tributaries to the Bay. To address these and other requirements, a Multi-Year-Plan (MYP) has been written and updated (STLS, 2011; STLS, 2012). Included in the MYP are rationale for modeling using the regional watershed spreadsheet model (RWSM) to estimate regional scale loads (Lent and McKee, 2011; Lent et al., 2012; Gilbreath et al., in preparation).

Fine suspended sediments (functionally defined as <0.0625mm), eroded from industrial areas and other components of the urban environment, are known to be enriched with these hydrophobic pollutants (Lent and McKee, 2011). During rainstorms, pollutant-enriched fine sediments are easily entrained into sheet flow and find their way into the stormwater collection systems where they are quickly conveyed to the Bay. Given this, hydrophobic POCs may be best modeled using hybrid RWSM modeling structures that include the ability for the user to select water or sediment transport processes as the basis for each land use or source area (Lent and McKee, 2011). Consistent with this premise, MRP Provision C.8.e(vi) requires permittees to design a robust sediment delivery estimate/sediment budget for local tributaries and urban drainages.

The objective of this short report is to briefly review and critically evaluate previous regional estimates of fine suspended sediment loads to the Bay and to highlight weaknesses in relation to POC loads modeling and any other proposed information uses. Modifications are proposed to address weaknesses, task priorities are proposed, and next steps are generally identified.

2. Status review

2.1.History of estimates

The first estimates of suspended sediment loads entering the Bay from local tributaries within the nine-county Bay Area were based on field measurements made by the USGS in a few larger watersheds (Napa, Sonoma, San Francisquito, Guadalupe, and Alameda) during three water years (1957-1959) (Krone, 1979). These were later modified by Porterfield (1980), who included a longer time period of 10 water years in some of the watersheds (1957-1965) and an additional two watersheds (Walnut Creek and Colma Creek). To estimate regional sediment load, both authors scaled the measured sediment loads for the measured watershed areas by an area ratio although the estimate by Porterfield (1980) applied a slightly more sophisticated technique that took into account a recognition of “areas of negligible contribution” that were unlikely to functionally supply sediment through rainfall run-off induced fluvial processes. These estimates remained the best estimates until the Regional Monitoring

Program for Water Quality in San Francisco Bay (RMP) provided funding in 2000-2002 to review existing sediment loads estimates in relation to supply of pollutants to the Bay from the Central Valley via the Sacramento – San Joaquin River Delta (McKee et al 2002), and from local small tributaries in the nine County Bay Area (McKee et al 2003). The estimates by McKee et al (2003) followed the same methodology as Krone (1979) and Porterfield (1980) with the following improvements:

1) Data on suspended sediment concentrations and loads was compiled up to and including the year 2000 thus incorporating data from a much greater number of watersheds (21) and covering wider climatic variability,
2) The data were climatically averaged by applying a flow weighted mean concentration (FWMC) for each measured watershed by estimates of annual average flow (based only on available data) for each watershed to estimate an annual average suspended sediment load.

However, despite these improvements, it was recognized that the existing USGS data sets were lacking information on sediment loads in urban areas, the simple area interpolation methodology did not take into account storage variations between basins of varying size (conceptually modeled as a delivery ratio that relates decreasing sediment yield (mass per unit area) to increasing basin area), and better spatial definition and regional loads estimates would provide an improved dataset for estimating: pollutant loads to the Bay; modeling pollutant processes in the Bay; and possibly uptake into the Bay food web. As such, the RMP funded another effort in 2008 to make improved regional sediment loads estimates. The following improvements were described in the resulting RMP technical report (Lewicki and McKee, 2009):

1) Data on suspended sediment concentrations and loads was compiled up to and including the year 2007 thus incorporating data from a yet greater number of watersheds (29) and covering wider climatic variability than McKee et al. (2003),
2) Loads for watersheds that directly drain the Bay where empirical measurements were made were climatically weighted for a 50-year period,
3) For other agriculturally dominated large watersheds, sediment loads were estimated using measured flow or estimates of flow over a 50 year period (using Alameda and Napa as the index watersheds) combined with sediment rating relationships specific to 3 sub-regions (North Bay, East Bay, and peninsular/South Bay),
4) Sediment loads from urban areas were estimated using the methods used in the HSPF model (unit area sediment erosion in relation to land use) taking into account delivery ratio (NRSC),
5) Sediment loads were estimated for 482 individual watersheds based on improved urban storm drain mapping, Contra Costa Creek and watershed maps, and a 10 m digital elevation model (DEM) before being summed to subregional scale estimates for each RMP Bay segment.

2.2. Likely uses of improved sediment loads information

The RWSM contains structural elements and equations that allow computation of POC loads based on:

1) spatial data for watershed boundaries, imperviousness, land use, and source areas, slope or flow accumulation,

2) estimates of annual average rainfall,
3) imperviousness, land use, or source area-based run-off coefficients (the proportion of rainfall that is converted to run-off), and
4) land use, or source area based pollutant concentrations (annually averaged event mean concentrations (EMCs)).

Depending upon the properties of the pollutant, POC could be modeled primarily as a function of hydrology, primarily as a function of sediment erosion and transport, or perhaps ideally as a hybrid where some land uses or source areas would be modeled using hydrology and others using sediment transport. The primary use of an improved robust sediment delivery estimate/sediment budget for local tributaries and urban drainages called for in MRP Provision C.8.e(vi) is to provide an improved basis for POC loads estimates. Secondary uses include the provision of improved sediment load estimates for modeling pollutant processes on the Bay margin in the context of the RMP modeling strategy, and information to support permitee questions in relation to creek beneficial uses (e.g. supporting anadromous fish populations). There are many tertiary uses of improved sediment loading that involve third parties using the data for management goals in relation to flood control, navigation in the Bay, and wetland restoration. However, these will not be discussed further here nor are driving factors for improved information.

2.3.Weaknesses in current estimates in relation to likely priority uses and proposed modification methods

Although considerable improvements were made over the last decade primarily through RMP efforts, given the objectives have been primarily focused on subregional and regional sediment loads estimates (McKee et al., 2003; Lewicki and McKee (2009)), there remain a few important weaknesses in the current suspended sediment loads estimates that are particularly pertinent to the proposed priority uses in relation to the MRP. A summary of proposed modification methods and a suggested priority in relation to weaknesses is provided (Table 1). This tabular summary is intended to be the basis for a suspended sediment RWSM workplan to assist BASMAA to address MRP Provision C.8.e(vi). Since all of the weaknesses are important in relation to the likely priority uses, once ratified by the Small Tributaries Loading Strategy (STLS) team, we propose to implement improvements to the model focusing on the highest priority aspects first and work down the table as far as budget allows.

A. Larger and agriculturally dominated watersheds are modeled as a single entity (lumped). The effort by Lewicki and McKee (2009) provided very robust estimates for 12 watersheds with empirical flow and suspended sediment measurements covering 56% of the nine-county Bay Area, and moderately robust estimates for a further 11 watersheds using empirically-based flow information and regional sediment rating curves. This lumped approach is inconsistent with the RWSM structure, and presently necessitates modeling POC loads from these large agricultural watersheds based on a watershed wide averaged particle concentration (mass of POC per mass of sediment, functionally ng/mg equivalent to grams/metric tonne). The objective is the proposed improvement is to split these watersheds into individual land use based components (see B for method) and incorporate calibration using a subset of watersheds.

B. Smaller and urban land use dominated watersheds are not modeled using locally derived coefficients and equations. The effort by Lewicki and McKee (2009) provided much less robust estimates for the remaining 459 watersheds based on combining the typical erosion rates described by Donigian and Love (2003) and the HSPF manual (EPA, 2008) to compute gross sediment erosion. A sediment delivery ratio equation described by the NRCS, (1983) was then used to estimate the fraction of gross sediment erosion occurring in a land-use segment that reaches the channel ("edge of stream" inputs). The governing equation was:

$$Watershed\ Load = \sum_{1}^{n}(LU_n * A_n) * DR$$

Based on the commentary in the NRCS report, though there was a wide scatter, the data did show "some similarity in sediment delivery ratios throughout the country". "Rough estimates of the sediment delivery ratio can be made…, but any such estimate should be tempered with judgment, and other factors such as texture, relief, type of erosion, sediment transport system, and areas of deposition within the drainage area should be considered. For example, if the texture of the upland soils is mostly silt or clay, the sediment delivery ratio will be higher than if the texture is sand." Given the tectonically active geology, Mediterranean climate, unique history of land use and water management, and the clay loam soils that prevail in the Bay Area, it seems likely that the coefficients and equations developed in other parts of the US may not be entirely applicable to:

i. the low land dominantly urban portions of Bay Area watersheds, or
ii. the steeper dominantly agricultural or open space dominated upland portions of our smaller and dominantly urban land use watersheds where processes such as landslides, gully formation, and bed incision and bank erosion are known to occur.

We are now aware of a greater amount of local data on urban suspended sediment loads collected by Balance Hydrologics Inc. on behalf of local public agency clients that can be incorporated with geologically based erosion coefficients to create locally derived model parameters. In addition, ongoing advancements in regional digital elevation models make it now possible to generate accurate slope and convergence metrics for our less steep and urban watersheds, and improved digital landslide maps are now available. The objective of the improvement would be to develop and apply a new model that incorporates land use, new local geological factors (GF), perhaps a watershed slope/convergence factor (SCF), and perhaps an improved delivery ratio equation:

$$Watershed\ Load = \sum_{1}^{n}(LU_n * GF_n * A_n) * DR_{Local} * SFC$$

C. Suspended sediment estimation methods developed previously are not currently incorporated into the RWSM. Since the RWSM was developed during 2010-2012, and is based on hydrology, the sediment erosion coefficients and equations that comprise the spreadsheet model developed by Lewicki and McKee (2009) are not yet incorporated into the RWSM. Therefore, presently it is not possible to develop POC models based on either suspended sediment or a hybrid of suspended sediment and water flow using the RWSM geoprocessing tool.

D. Water reservoirs in smaller and urban land use dominated watersheds are modeled assuming no fine sediment retention. Sediment storage and larger reservoirs in larger and agriculturally dominated watersheds of the nine-county Bay Area was taken into account through the use of empirical flow and suspended sediment concentration data in 12 watersheds. In contrast, the computations completed by Lewicki and McKee (2009) who focused on subregional and regional scale loads, did not need to account for sediment storage (the assumed 100% transmission) in reservoirs in the remaining 44% of the Bay Area drainage. As such, loads estimates for the watersheds of Walnut Creek, San Leandro Creek, San Pablo Creek, San Mateo Creek, Corte Madera Creek, Stevens Creek and Novato Creek need to be revisited.

E. All watersheds are presently modeled assuming zero storage in flood control infrastructure. The computations completed by Lewicki and McKee (2009) did not take into account sediment storage in flood control channels and sediment detention basins. Some of our larger flood control channels are known to trap sediment of mixed grain size including some sediment finer than 0.0625 mm (Collins, 2006).

3. Next steps

1. The Small Tributaries Loading Strategy local team reviews and ratifies the proposed steps,

2. SFEI RMP STLS staff contact a small group of local experts for input on geologically based erosion/gradient coefficients[1],

3. SFEI RMP STLS staff implement steps in order of priority providing regular updates to the STLS local team,

4. SFEI RMP STLS staff complete model documentation (<10 page memo on methods and results), including a discussion of uncertainty and data limitations and recommendations regarding potential improvements and/or data collection, and relevance to potential use scenarios by Water Board or BASMAA.

[1] There are conceptually several types of sediment production in relation to the episodic nature of landslide and the underlying geology:
1. Sediment production chronically based on landuse/geology/vegetation
2. Sediment production based on landslides/episodic events that supply pulses of sediment to a given system
3. Active gullying/bank erosion of streams
It may be possible to separate out hillslope erosion from fluvial erosion or we could use a slope and convergence type model for routing hillslope sediment though stream networks (e.g. Benda et al., 2007) based on just slope, convergence, and flow accumulation through the drainage network. Another idea is to make an “episodic index” for watersheds based on landsliding rates and geologic formations (Franciscan gets highest etc), and then a “chronic index” based on land use, vegetation, geology, and slope. The result would be two coefficients and use the chronic one for most of the time and the episodic one for very wet years.

Table 1. Model weaknesses, proposed modification steps, and proposed priorities for designing a robust sediment delivery estimate/sediment budget in local tributaries and urban drainages in relation to MRP Provision C.8.e(vi) through the Regional Watershed Spreadsheet Model (RWSM) and associated user interface.

Model weaknesses addressed	Proposed modification steps		Priority
	Step	Description	
A. Larger and agriculturally dominated watersheds are modeled as a single entity (lumped); and B. Smaller and urban land use dominated watersheds are not modeled using locally derived coefficients and equations	1.	Enhance existing watershed sediment loads database (currently 38 watersheds) with data collected by Balance Hydrologics Inc. on behalf of local public agency clients.	High
	2.	Climatically average the sediment loads estimates at each location to a consistent climatic period.	
	3.	Compile watershed boundary information, land use, slope and other physical factors specific to the sampling locations of each suspended sediment loads dataset.	
	4.	Compile geologic and landslide maps at the appropriate scale taking into account geologic formations occurring in reasonable proportions (>5%) of > 10 watersheds in the sediment loads database.	
	5.	Develop locally applicable geologic erosion coefficients based on previous studies by SFEI and others in addition to local expert judgment.	
	6.	Check the validity of the "national" NRCS (1983) sediment delivery equation using local data and possibly develop a local equation.	
	7.	Apply parameter estimation (also known as inverse optimization) methods to derive local land use/geology erosion coefficients and test.	
	8.	Model loads by applying new coefficients and equations to all watersheds in the Bay Area using a subset of watersheds from the suspended sediment loads database (for example the downstream locations in some of the watersheds with nested data) and/or from recent STLS POC loads monitoring sites for verification.	
C. Suspended sediment estimation methods developed previously are not currently incorporated into the RWSM	9.	Develop a new RWSM geoprocessing tool for the robust sediment delivery estimate/sediment budget model structure and parameterization (locally derived land use/geological sediment erosion coefficients and equations)	High
D. Water reservoirs in smaller and urban land use dominated watersheds are modeled assuming no fine sediment retention	10.	Develop a watershed boundary layer for all reservoirs in the Bay Area that are included in the Department of water resources, division of safety of dams database (DWR, 2012). Assume all sediment upstream from dams is trapped.	Medium
	11.	Research trapping capacity of reservoirs by speaking to state and local experts. Possibly incorporate the commonly used trapping equation (Brune, 1953; White, 1990; Verstraeten and Poesen, 2000; Jothiprakash and Garg, 2008) into the suspended sediment RWSM allowing the user to select this option through the user interface.	Medium
E. All watersheds are presently modeled assuming zero storage in flood control infrastructure	12.	Complete EPA grant awarded to SFEI in partnership with SFEP, BCDC, and SFBJV working with BAFPAA agencies. Possibly incorporate sediment trapping coefficients specific to each Bay Area flood control channel derived from the database developed as part of this grant into the suspended sediment RWSM allowing the user to select this option through the user interface.	Low

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