Stream Pollution Trends Monitoring Program

Quality Assurance Project Plan

State Water Resources Control Board
2021

GROUP A: PROJECT MANAGEMENT

A.1: Title and Approval

Project Title: Surface Water Ambient Monitoring Program (SWAMP) Stream Pollution Trends (SPoT) Monitoring Program Quality Assurance Project Plan (QAPP)

Lead Organization: University of California, Davis Marine Pollution Studies Laboratory at Granite yon (UCD-GC), 34500 Highway One, Monterey, CA 93953; Environmental Laboratory Accreditation Program Certificate No. 2821

Primary Contact:

Katie Siegler, Project Manager (PM)
UC Davis Marine Pollution Studies Laboratory at Granite Canyon
(831) 624-0947
csiegler@ucdavis.edu

Bryn Phillips, Laboratory Director and Quality Assurance Officer (QAO)
UC Davis Marine Pollution Studies Laboratory at Granite Canyon
(831) 624-0947
bmphillips@ucdavis.edu

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Preface: This QAPP document defines procedures and criteria for the SPoT Program that will be used by the staff of SWAMP and all involved parties. The SPoT Program started in 2008 as a means to monitor long-term pollution trends and their effects on stream biota in California. Doing so enables the State and Regional Water Boards to relate this water quality data to land-use and agency management efforts so that appropriate steps can be taken.

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The approvals below were submitted separately, and originals are kept on file by the SWRCB.

Autumn Bonnema
Metals Chemistry Laboratory Quality Assurance Officer, Moss Landing Marine Laboratory Marine Pollution Studies Laboratory

Docusigned by: Autumn Bonnema 09BD16DA0D8A482... Date 2/10/2022

Ali Dunn
Surface Water Ambient Monitoring Program Coordinator, State Water Resources Control Board

Ali Dunn Date 2/10/2022

Tessa Fojut
Surface Water Ambient Monitoring Program Quality Assurance Officer, State Water Resources Control Board

Tessa Fojut Date 1/14/22

Stacey Fry
Organics Chemistry Laboratory Quality Assurance Manager, Babcock Laboratories, Inc.

Stacey A Fry Digitally signed by: Stacey A Fry DN: CN = Stacey A Fry C = US Date: 2022.01.17 22:32:35 -07'00' Date 1/17/2022

Brian Ogg
Project Coordinator, Office of Information Management and Analysis, State Water Resources Control Board

Brian Ogg Date 2/11/2022

Bryn Phillips
Laboratory Director and Quality Assurance Officer, UC Davis Marine Pollution Studies Laboratory at Granite Canyon

Bryn Phillips Date: 2022.01.18 11:10:27 -08'00' Date

Katie Siegler
Project Manager, UC Davis Marine Pollution Studies Laboratory at Granite Canyon

Catherine Siegler Digitally signed by Catherine Siegler DN: cn=Catherine Siegler, o=MPSL, ou, email=csiegler@ucdavis.edu, c=US Date: 2022.01.18 11:55:04 -08'00' Date

Andrew Hamilton
State Water Resources Control Board Quality Assurance Officer

Andrew Hamilton Digitally signed by Andrew Hamilton Date: 2022.01.28 17:09:34 -08'00' Date

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A.3: Distribution List

Table 1. Distribution List

Position	Name	Responsibilities
Region 9 EPA Surface Water Standards Coordinator	Terry Fleming	Oversees SWAMP federal funding and Program outputs.
State Water Resources Control Board Management	Greg Gearheart	Program planning and oversight; project budget allocation and reconciliation with program objectives.
SWAMP Program Coordinator	Ali Dunn	Program planning and oversight and reconciliation with program objectives.
State Water Resources Control Board SPoT Project Coordinator	Brian Ogg	Coordination with the Project Manager; reviewing monitoring plans, QAPP, and reports; participating in project workgroups; and maintaining information available on the SWAMP webpages.
Office of Information Management and Analysis (OIMA) Contract Manager	Chad Fearing	Manages and approves contract deliverables and invoices.
UC Davis Marine Pollution Studies Laboratory at Granite Canyon (UCD-GC) Laboratory Director and Laboratory Quality Assurance Officer	Bryn Phillips	Conducts toxicity analyses; ensures that the laboratory quality assurance plan and QAPP criteria are met through routine monitoring and auditing of the systems; reviews and approves data prior to submission to the SWAMP Information Management and Quality Assurance Center; investigates and conduct laboratory corrective actions.
Project Manager (PM)	Katie Siegler	Generates and maintains project QAPP; ensures all activities are completed within proper timeframes; oversees project deliverables, and entry of field and laboratory-generated data into SWAMP formats.
UCD-GC Sample Manager	Laura McCalla	Manages sample receiving, sub-sampling, maintenance, test set up, and disposal of samples.
UCD-GC Field Crew Manager	Laura McCalla	Confirms sampling schedules, ensures proper field training; assists in planning logistics for each sampling event.
UCD-GC Data Managers	Katie Siegler (field data) and Laura McCalla (toxicity data)	Enters and submits data into SWAMP database; responds to data requests from SWRCB.
State Water Resources Control Board Quality Assurance Officer	Andrew Hamilton	Approves QAPP; reports to U.S. EPA and SWRCB management.
SWAMP Quality Assurance Officer and Database Manager	Tessa Fojut	Reviews and approves QAPP; oversees Data Quality Managers; establishes program-level quality objectives and requirements for project; reports to U.S. EPA and SWRCB management and coordinates with SWRCB QAO.

Position	Name	Responsibilities
SWAMP IQ Data Quality Managers	Kimberly Pham (chemistry data); Brian Ogg (toxicity data)	Reviews, verifies, and loads chemistry and composite data to SWAMP database; reports to SWAMP QAO.
Babcock Laboratories, Inc. Quality Assurance Manager	Stacey Fry	Ensures proper quality assurance and quality control measures are employed for organic chemistry, grain size and total organic carbon (TOC) analyses.
Moss Landing Marine Laboratory Marine Pollution Studies Laboratory (MPSL-DFW) Data Quality Assurance Officer	Autumn Bonnema	Conducts metals and mercury analyses; ensures proper quality assurance and quality control measures are employed.

A.4: Project Organization and Schedule

Field, Laboratory, and Technical Services
UCD-GC staff will organize sample collection, conduct field and laboratory toxicity analyses, and manage sample submission to laboratories for analyses of organic chemistry, trace metals, total organic carbon (TOC), and grain size. The Project Manager (Katie Siegler, UCD-GC) oversees all aspects related to the planning and timely completion of the project. This includes organizing field crews, instructing UCD-GC staff, scheduling sampling days, and interacting with the contract laboratories. Bryn Phillips, the Laboratory Director and QAO of UCD-GC, is in charge of all sediment toxicity analyses. The role of the UCD-GC QAO is to ensure that quality control for all sample processing and data analysis procedures, as described in this QAPP, are maintained throughout the life of the project. The UCD-GC QAO will report all findings to the SWAMP QAO and SPoT Project Coordinator. The SWAMP QAO has the authority to halt actions if there are significant deviations from required procedures or evidence of a systematic failure.

Babcock Laboratories, Inc. is the contract laboratory that subcontracts analyses for all organics, grain size, and TOC analyses, and Stacey Fry is the Babcock QAO. Babcock, and the laboratories it subcontracts with, will analyze samples in accordance with each laboratory's standard operating procedures and all applicable quality assurance and quality control (QA/QC) requirements established in this QAPP.

MPSL-DFW is the contract laboratory for all trace metal analyses, and Autumn Bonnema is the QAO. These laboratories will analyze samples in accordance with all of the applicable QA/QC requirements established in this QAPP.

Project Coordinators
SWAMP IQ Data Quality Managers (Brian Ogg: Toxicity, Kim Pham: Chemistry) will review data received from UCD-GC and the contract laboratories to ensure that they meet all applicable QA/QC requirements established in this QAPP. These data will then be entered into the SWAMP database, which transfers to the California Environmental Data Exchange Network, as it is received and reviewed.

Quality Assurance and Data Management
The SWAMP QAO (Tessa Fojut, SWAMP IQ) assesses the data for compliance with the project QAPP and the SWAMP Quality Assurance Program Plan and ensures that the project meets U.S. EPA requirements for projects receiving federal EPA funds. The SWAMP QAO also works with the State Board QAO to ensure that the project and data meet the requirements of the State Water Board's Quality Management Plan.

Program Managers
U.S. EPA Region 9 Standards Liaison Terry Fleming ensures OIMA is in compliance with federal regulations and approves federal funding for its programs.

The Program Manager, Greg Gearheart (OIMA, Director), oversees programmatic strategic and operational planning, and proposes and approves OIMA budgets and budget changes.

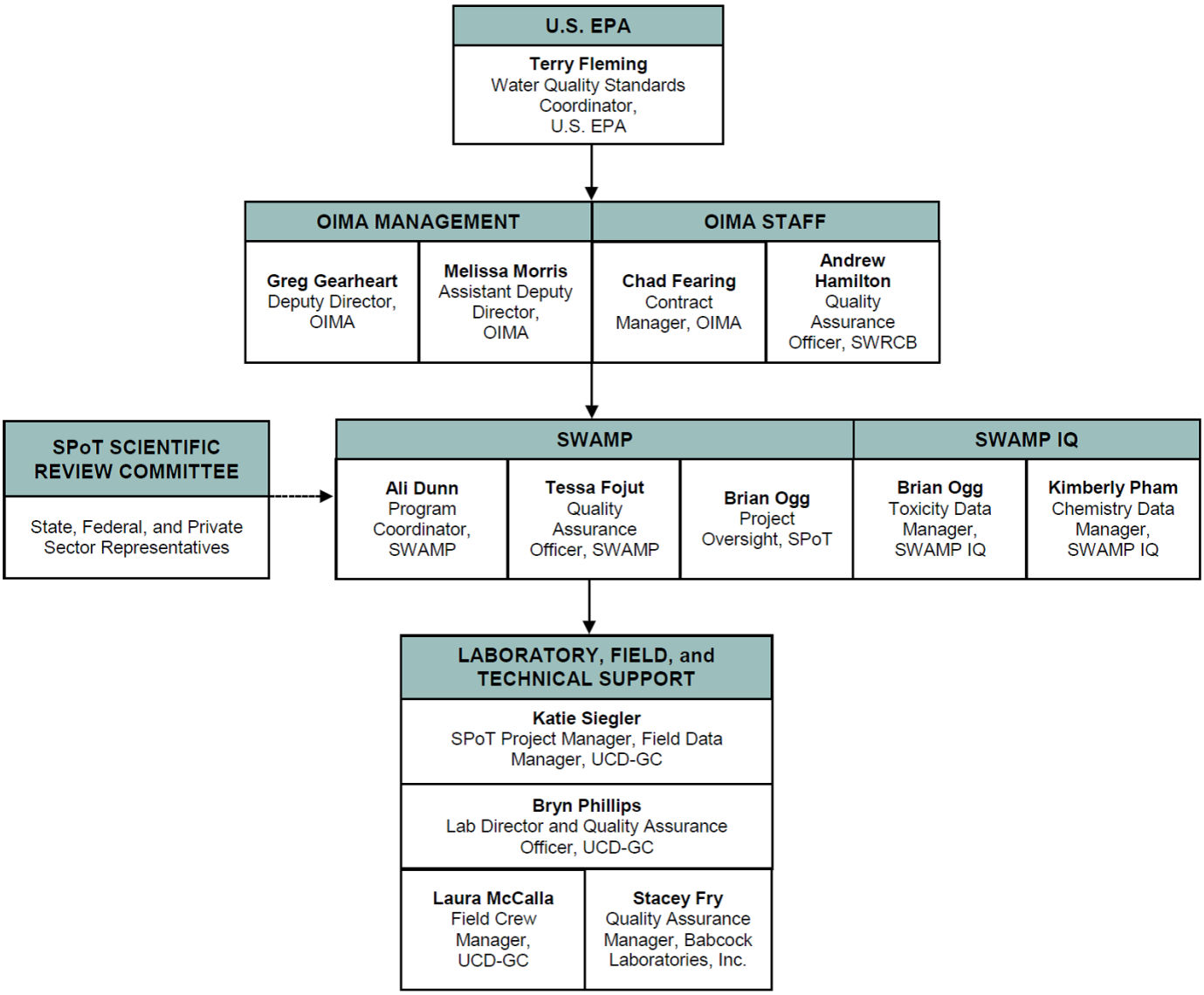
The SWAMP Program Coordinator, Ali Dunn (OIMA), oversees programmatic planning and oversight and works to adapt the program to continue to meet its objectives.

Contract Manager
The OIMA Contract Manager, Chad Fearing, manages the SPoT Program contract, invoices, and approves deliverables.

Scientific Review Committee
The SPoT Scientific Review Committee, comprised of staff from U.S. EPA (Debra Denton), United States Geological Survey (USGS; Michelle Hladik), California Department of Pesticide Regulation (CDPR; Robert Budd) and TDC Environmental (Kelly Moran), reviews the assessment questions, objectives, design, indicators, and methods used in the SPoT Program and provides recommendations as needed.

Project Organizational Chart
The following chart depicts the structure of the SPoT Program. Management responsibilities extend downward, while the flow of data moves upwards from the bottom of the chart.

Figure 1. Organizational Chart



A.5: Problem Definition/Background

The SPoT monitoring program was developed with the purpose of improving our understanding of watersheds and water quality through the monitoring of in-stream contaminants and sediment toxicity. The first annual SPoT survey, carried out in 2008, was documented in the report *Statewide Perspective on Chemicals of Concern and Connections between Stream Water Quality and Land Use* (Hunt et al. 2012). These findings have served as the baseline from which long-term trends in the categories and quantities of pollutants have since been determined.

Focusing on the impacts of land use and development, the SPoT monitoring program compares monitoring results across watersheds throughout the state in order to evaluate changes over time and assess potential risk to aquatic life. In addition, the SPoT Program is designed to help

establish a statewide network of sites that can link together monitoring efforts by storm water agencies, Total Maximum Daily Load (TMDL) programs, irrigated agriculture regulatory programs, and regional monitoring to provide a statewide context for local monitoring. The network is composed of informal collaborations to provide additional information or leverage existing data and makes it possible to relatively compare data among local areas and regions, to indicate the relative magnitude of problems, and to gauge the success of management programs. The SPoT field survey document, *Standard Operating Procedures (SOPs) for Conducting Field Collections of Bed Sediment Samples at Watershed Integrator Sites in the Surface Water Ambient Monitoring Program (SWAMP) Stream Pollution Trend (SPoT) Program*, (Appendix B) has been developed to foster consistency for related monitoring efforts.

A.6: Project Description

Summary

SPoT conducts statewide monitoring to provide information on the condition of California waterways with respect to trends in sediment toxicity and contamination from metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, legacy pesticides, current use pesticides, and emerging contaminants such as fipronil and polybrominated diphenyl ethers in watershed sediments. SPoT data are currently used by the Water Boards to assess the levels to which aquatic life beneficial uses are supported in California streams and rivers. SPoT was initiated in 2008 with three primary goals:

1. Determine long-term, statewide trends in stream contaminant concentrations and effects.
2. Relate key water quality indicators to land-use characteristics and management efforts.
3. Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, and federal monitoring programs and management agencies.

The SPoT Program indicators are measured in stream sediment because this matrix best accommodates program goals. Most trace metal and many organic pollutants that enter streams adhere to suspended sediment particles and organic matter, and this sediment-associated phase is the major pathway for contaminant loading in streams and downstream waterways (DiToro et al. 1991; Foster and Charlesworth 1996; Karickhoff 1984). In addition, sediment measurements are appropriate for long-term trend monitoring because pollutants that accumulate in depositional sediment on the stream bed are much more stable over time (~months to years) than dissolved or suspended pollutants that move downstream in pulses that are highly variable over short time scales (~hours). SPoT surveys are timed to collect sediment from recent stream bed deposits during base flow periods after the high-water season when most sediment and pollutant transport takes place.

Although the core of SPoT monitoring is trends in sediment toxicity and contamination, SPoT conducts water column toxicity monitoring at some sites. This testing is conducted in collaboration with CDPR to detect and track emerging pesticides not associated with sediments.

Monitoring Schedule

All sites are sampled as part of a continuous monitoring effort that began in 2008. Ninety sites are sampled during base flow or near-base flow conditions following annual peak flows (in 2018, 10 of the original 100 sites were removed, as they did not meet Data Quality Objectives). Ideally, sampling occurs before significant contaminant breakdown via hydrolysis or photolysis. Surveys follow index periods, and are scheduled based primarily on regional hydrologic cycles, with Southern California coastal streams, some of which are ephemeral, sampled in spring

(typically starting in May), and other regions sampled later in the year as stream flows recede (typically ending in October).

Analysis and Reporting Schedule
Each calendar year's field work and toxicity testing will be completed by November 15th. Chemical analyses and data submissions to SWAMP IQ are estimated to be completed by no later than February 15th of the following year. Toxicity data analyses will occur within 30 days of test completion, and chemistry data analyses will occur immediately upon receipt of complete data sets..

Geographic Locations
When selecting sampling sites for the SPoT Program, the following geographic characteristics are considered optimal:

- location in a large watershed with heterogeneous land cover;
- location at or near the base of a watershed, defined as the confluence with either an ocean, lake, or another stream of equal or greater stream order; and
- location where site-specific conditions are appropriate for the indicators selected (e.g., depositional areas, sufficient flow, appropriate channel morphology, and substrate).

The availability of existing data on sediment contaminant concentrations, biological impacts, or other relevant water quality parameters is also an important consideration when selecting a site, particularly if SPoT sites can be co-located with key sites from cooperative programs. A list of sampling sites for the 2021 survey is provided in Table 2.

Table 2. SPoT Stations to be Sampled in 2021

Station Code	Station Name	Target Latitude	Target Longitude
105KLAMKK	Klamath River at Kamp Klamath	41.5171	-124.03896
109MAD101	Mad River upstream Hwy 101	40.91763	-124.08946
111EELFRN	Eel River at Fernbridge	40.61129	-124.20407
113NA3269	Navarro at Dimmick St Park	39.15911	-123.63861
114LAGWOH	Laguna de Santa Rosa at Wohler	38.49254	-122.88327
114RRDSDM	Russian River downstream Duncan Mills	38.44750	-123.05583
201WLK160	Walker Creek Ranch	38.17545	-122.82044
204ALA020	Alameda Creek E. of Alvarado Blvd	37.58200	-122.05200
204SLE030	San Leandro Creek at Empire Road	37.72556	-122.18361
204SMA020	San Mateo Creek at Gateway Park	37.57028	-122.31861
205COY060	Coyote Creek at Montague	37.39540	-121.91485
205GUA020	Guadalupe Creek at USGS Gaging Station 11169025	37.37389	-121.93194
206SON010	Sonoma Creek at Hwy 121 bridge	38.24050	-122.45127
207KIR020	Kirker Creek at Floodway	38.01650	-121.83881
207LAU020	Laurel Creek at Pintail Drive	38.24830	-122.00668
207WAL020	Walnut Creek at Concord Ave O.C.	37.98063	-122.05160
304SLRWAT	San Lorenzo River below Water Street	36.97685	122.02390
304SOK	Soquel Creek at Knob Hill Parking Lot	36.98014	-121.95624

Station Code	Station Name	Target Latitude	Target Longitude
305THU	Pajaro River at Thurwachter Bridge	36.87977	-121.79195
307CML	Carmel River at Hwy 1	36.53638	-121.91268
309DAV	Salinas River at Davis Road	36.64681	-121.70139
309TDW	Tembladero Slough at Monterey Dunes Way	36.77218	-121.78660
310ARG	Arroyo Grande Creek at 22nd Street	35.09521	-120.60625
310SLB	San Luis Obispo Creek at San Luis Bay Drive	35.18832	-120.71792
312SMA	Santa Maria River at Estuary	34.96046	-120.64256
313SAI	San Antonio Creek at San Antonio Rd West	34.78233	-120.52997
314SYN	Santa Ynez River at 13th St	34.67677	-120.55442
315ATA	Atascadero Creek at Ward Drive	34.42345	-119.81929
315MIS	Mission Creek at Montecito St	34.41304	-119.69401
402VRB0xx	Ventura River	34.28173	-119.30669
403STCBQT	Bouquet Canyon Creek	34.42782	-118.54022
403STCEST	Santa Clara River Estuary	34.23557	-119.21674
403STCSSP	Sespe Creek	34.39414	-118.94096
404BLNAxx	Ballona Creek Downstream of Sawtelle (Centinela)	33.98600	-118.41700
405SGRA2x	San Gabriel River RA-2	33.78708	-118.09367
408CGCS06	Calleguas Creek Below Camrosa WWTP	34.17978	-119.04053
412LARWxx	LA River near Willow	33.80490	-118.20500
504BCHROS	Big Chico Creek at Rose Ave	39.72716	-121.86308
504SACHMN	Sac R at Hamilton City	39.75110	-121.99798
508SACBLF	Sacramento River at Balls Ferry	40.41762	-122.19334
510LSAC08	Clarksburg Marina	38.38312	-121.52057
511CAC113	Cache Creek at Hwy 113	38.72066	-121.76430
515SACKNK	Sacramento Slough at Karnak	38.78456	-121.65439
515YBAMVL	Yuba River at Maryville	39.13421	-121.59290
519AMNDVY	American River at Discovery Park	38.60094	-121.50550
519BERBRY	Bear River at Berry Rd.	38.96175	-121.54677
519FTRNCS	Feather River at Nicolaus	38.89746	-121.59050
520BUTPAS	Butte Slough Upstream of Pass Road bridge	39.18786	-121.90919
520CBDKLU	Colusa Basin Drain at Knights Landing Upstream	38.79923	-121.72504
520SACLSA	Sacramento River at Colusa near Bridge Street	39.21415	-122.00031
531SAC001	Cosumnes River at Twin Cities Road	38.29083	-121.37583
532AMA002	Sutter Creek at Hwy 49	38.39250	-120.80139
535MER007	Bear Creek near Bert Crane Road	37.25556	-120.65194
535MER546	Merced River at River Road	37.35041	-120.96223
535STC206	Dry Creek at La Loma Rd.	37.64568	-120.98081
535STC504	San Joaquin River at Crows Landing	37.43323	-121.01597
541MER522	San Joaquin River at Lander Avenue	37.29528	-120.85028

Station Code	Station Name	Target Latitude	Target Longitude
541MER542	Mud Slough downstream of San Luis Drain	37.26389	-120.90611
541MERECY	Marsh Creek at E Cypress Rd	37.99107	-121.69626
541SJC501	San Joaquin River at Airport Way	37.67556	-121.26417
541STC019	Orestimba Creek at River Road	37.41389	-121.01417
541STC516	Del Puerto Creek at Vineyard Avenue	37.52139	-121.14861
544SAC002	Mokelumne River at New Hope Road	38.23611	-121.41889
551LKI040	Kings River - S. Fork	36.25580	-119.85510
558CCR010	Cross Creek - Rd. 60 and Hwy 99	36.40437	-119.45697
558PKC005	Packwood Creek in pond upstream of Rd 94	36.27894	-119.35971
558TUR090	Tule River - Rd. 64 bridge	36.08837	-119.42891
603BSP002	Bishop Creek at East Line St	37.36156	-118.38606
631WWKLAR	West Walker River at Larson Lane	38.54679	-119.49494
633WCRSED	West Fork Carson River at Paynesville	38.80885	-119.77725
634UTRSED	Upper Truckee River near inlet to Lake Tahoe	38.93439	-120.00035
635MARSED	Martis Creek near mouth	39.30211	-120.12135
635TRKSED	Lower Truckee River near CA/NV state line	39.46477	-120.00320
635TROSED	Trout Creek (Truckee) near mouth	39.33240	-120.16558
637SUS001	Susan River near Litchfield	40.37771	-120.39514
719CVSCOT	Coachella Valley Stormwater Channel Outlet	33.52444	-116.07778
723ARGRB1	Alamo River Outlet	33.19920	-115.59710
723NROTWM	New River Outlet	33.10472	-115.66361
801CCPT12	Chino (San Antonio) Creek at Euclid/Hwy 83 bridge	33.94016	-117.65427
801SARVRx	Santa Ana River at Prado Basin Park Rd	33.92403	-117.59765
801SDCxxx	San Diego Creek at Campus	33.65556	-117.84472
901SJSJC9	San Juan Creek 9	33.48443	-117.67577
902SSMR07	Santa Margarita at Basilone Rd	33.31117	-117.34538
903SLRRBB	San Luis Rey River at Benet Road Bridge	33.22036	-117.35821
904ESCOxx	Escondido Creek at Camino del Norte	33.04829	-117.22602
905SDSDQ9	San Dieguito River 9	32.97877	-117.23506
906LPLPC6	Los Penasquitos Creek 6	33.90720	-117.23055
907SDRWAR	San Diego River at Ward Rd	32.78032	-117.11046
909SWRWSx	Sweetwater River at Willow St bridge	32.65898	-117.04231
911TJHRxx	Tijuana River at Hollister Rd	32.55142	-117.08394
519SED008	Pleasant Grove Creek Sediment #8	38.79490	-121.37280
901INTSC5	Salt Creek	33.50553	-117.70885

Project Parameters to be Monitored

SPoT tests sediment samples with two invertebrates that are native to California streams, the amphipod *Hyalella azteca* and the midge *Chironomus dilutus*. Both organisms are tested using

standard U.S. EPA protocols, and both are sensitive to a variety of contaminants occurring in ambient waters and sediments.

Sediment from all SPoT sites are analyzed for pyrethroid pesticides, metals, organochlorine pesticides, and polychlorinated biphenyls (PCB). Grain size and total organic carbon are also measured at all sites. A subset of forty Tier II sites, which generally represent the most urban watersheds, are analyzed for polycyclic aromatic hydrocarbons (PAH), polybrominated diphenyl ethers (PBDE), and Fipronil. Metals are measured every 2-3 years, and organochlorines and PCBs are measured every five years.

In 2021, pyrethroids, grain size and TOC were measured at every site, and PAHs, PBDEs and fipronil were measured at Tier II sites. Per- and polyfluoroalkyl substance (PFAS) analysis was also added for Tier II sites.

The pollutants that are measured in sediment are listed in Table B in Appendix E.

The collaboration with CDPR involves conducting water column toxicity tests at co-located SPoT/CDPR sites, as well as CDPR sites that are co-located with monitoring sites from other regional boards. Water column toxicity testing with *H. azteca* (survival) and *C. dilutus* (survival and growth), coupled with CDPR analyses of current-use pesticides in water provided up-to-date information on the risk of emerging contaminants to California watersheds. CDPR uses a combination of gas and liquid chromatography coupled with mass spectroscopy (GC/MS and LC/MS) to analyze water samples for 67 compounds.

Field crews measure dissolved oxygen, pH, conductivity, and temperature on site. Crews also make observations of dominant substrate, presence of plant material, and water clarity and color.

Project Constraints

Weather Constraints
Extreme wet weather can affect sampling by significantly diluting or mobilizing the constituents to be measured. At project sites that have experienced flooding during the sampling year, sample locations may be moved slightly (within 500 meters) in order to ensure collection of representative depositional sediments rather than eroded banks. Extreme dry weather can result in no flow at a sampling location, in which case dry sediments are collected. Freezing weather can cause conditions that adversely affect the constituents to be measured or prevent access to some of the areas where sampling is needed. Freezing conditions that prevent sampling has not yet occurred at a SPoT site, as sample collections occur before winter weather.

Access Constraints
Access to sampling sites may be limited for this project because of unexpected topographical features or legal restrictions. If a site is not accessible, then an alternate site location will be chosen. These alternate locations will be determined on an as-needed basis at the time of sample collection. The alternate location is often selected based on hydrologic changes from the previous year. A change in sampling location may affect conclusions drawn from the data.

Financial Constraints
Funding constraints have reduced the number of sites sampled or analytes measured for SPoT during a sampling year. In SPoT's 2021 monitoring schedule, there will be 90 sites sampled. However, this number may be revised for future sampling years depending on funding.

Pandemic-related Constraints
In 2021, the travel restrictions related to the COVID-19 virus may impact collection of some samples. Sampling crews will adhere to the county and statewide guidelines as they evolve.

Samples of Opportunity
Regional Water Board personnel may find it necessary to collect a sample from a water body or area that is not a part of the SPoT monitoring project or covered in this QAPP to investigate a potential water quality problem. For example, a sample may be taken when a complaint from a concerned citizen is received; when spills are reported; or based on field observations (e.g., odors, color changes, etc.). If an opportunity to conduct unplanned sampling is presented, samples will be collected, labeled, documented, and processed following standard operating procedures in this QAPP, including relevant QA/QC, so that results are comparable to other data collected under this QAPP.

A.7: Quality Objectives and Criteria

Project Objectives/Intended Use of Data
The SPoT monitoring program was developed to:
- Determine long-term trends in stream contaminant concentrations and effects statewide.
- Relate water quality indicators to land use characteristics and management efforts.
- Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, and federal monitoring programs.

SPoT is a statewide monitoring program under SWAMP. Therefore data collected under SPoT must meet the quality objectives documented in the SWAMP Quality Assurance Program Plan (QAPrP). Of the four intended data use categories described in the SWAMP QAPrP, SPoT's data belongs in the Ambient classification, as it is intended to be used for support of Water Quality Control Plans, Integrated Report development, policy development, and other beneficial use assessments.

SPoT data may be used for a variety of other programs outside of SWAMP, including those of other agencies. Analysis of pollutant concentrations in streams aids in the listing and reporting of impaired lotic water bodies under Clean Water Act sections 303(d) and 305(b); provides a possible means of tracking the effectiveness of TMDLs; and may help identify contaminants of emerging concern. Evaluating temporal trends provides useful information for the Water Boards' agriculture and regional storm water programs, as well as the U.S. EPA Watershed Improvement Measure. SPoT data may also be used by the California Department of Pesticide Regulation (CDPR) to survey current pesticide use, reevaluate registrations, and reassess pesticide surface water regulations.

Listing Policy Data Requirements
The data collected from SPoT and other SWAMP programs is used by the SWRCB's 303(d) Assessment Unit to develop the biannual California Integrated Report, as directed by the Listing

Policy. This policy establishes data quality requirements for the evaluation of water quality standards attainment:

- *Water Body Specific Information:* Data used to assess water quality standards attainment should be actual data that can be quantified and qualified.
- *Spatial Representation:* Samples should be representative of the water body segment. To the extent possible, samples should be represented statistically or in a consistent, targeted manner in a segment of a water body.
- *Quantitation of Chemical Concentrations:* When available data are less than or equal to the quantitation limit and the quantitation limit is less than or equal to the water quality standard, the value will be considered as meeting the water quality standard, objective, criterion, or evaluation guideline. When the sample value is less than the quantitation limit and the quantitation limit is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis. The quantitation limit includes the minimum level, practical quantitation level, or reporting limit.
- *Evaluation of Data Consistent with the Expression of Numeric Water Quality Objectives, Water Quality Criteria, or Evaluation Guidelines:* If the water quality objectives, criteria, or guidelines state a specific averaging period and/or mathematical transformation, the data should be evaluated in a consistent manner prior to conducting any statistical analysis for placement of the water on the section 303(d) list. If sufficient data are not available for the stated averaging period, the available data shall be used to represent the averaging period.

Data Quality Indicators

Data quality indicators are the quantitative measures and qualitative descriptors used to set limits of acceptable levels of data error. The principal data quality indicators are representativeness, sensitivity, completeness, accuracy, precision, bias and comparability.

Representativeness

Representativeness is the degree to which measurements correctly represent the environmental condition, target organism population, and/or watershed to be studied. SPoT sampling locations are selected at the drainage points of large watersheds across the state to provide representative data in support of a collaborative and statewide watershed-based monitoring program. SPoT staff, in coordination with Regional Water Board monitoring coordinators and storm water agencies, developed a monitoring design to incorporate sample sites that are representative of the major watersheds of the state. The Southern California Stormwater Monitoring Coalition participated in site selection for the southern California SPoT sites. A representative from the Bay Area Stormwater Management Agencies Association served on the SWAMP committee that designed the program, and all SPoT sites in the San Francisco Bay Region are aligned with monitoring sites for the Municipal Regional Stormwater National Pollutant Discharge Elimination Permit (SFBRWQCB 2011). SPoT sites in the Central Coast and Central Valley Regions are shared by the Cooperative Monitoring Program for Agriculture and Irrigated Lands Regulatory Program, respectively. Therefore, in most cases, the SPoT assessments of sediment toxicity and chemistry complement water column measurements made by cooperating programs.

Sensitivity

Analytical sensitivity for chemistry analyses is most commonly defined as the lowest value an instrument or method can measure with reasonable statistical certainty. Babcock Laboratories and their subcontractors must utilize analytical methods with laboratory-determined method detection limits (MDL) and reporting limits (RL) that meet the level of sensitivity required to meet

the Measurement Quality Objectives (MQOs) for this project. For applications requiring a greater degree of statistical confidence, the RL, which is based upon project requirements and proven laboratory capabilities, is used. The RLs for the SPoT Program analytes can be found in Appendix E.

The sensitivity of toxicity tests is primarily dependent on the organism used for testing. SPoT uses two organisms to cover a wide range of sensitivities to metals, industrial chemicals and pesticides. Sensitivity can further be affected by toxicity test methodology, including the number of replicates, the evaluation threshold, and the statistical approach utilized. All toxicity tests will be conducted by UCD-GC and follow U.S. EPA methodology and statistical approaches.

Completeness

Completeness refers to the comparison between the amount of valid data originally planned to be collected, and the actual quantity collected. A minimum of 90 percent completeness of the planned sampling and analyses will be met.

Accuracy

Accuracy refers to the closeness of agreement between a measured or determined value and the true value. The accuracy of instruments is maintained by following the proper SOPs for calibrations and maintenance, while the accuracy of chemical analyses is measured using matrix spikes (and matrix spike duplicates), surrogates, and laboratory control samples:

Matrix spikes are prepared by adding a known quantity of the target analyte to an environmental sample in order to measure method accuracy and analyte recovery.

Surrogates are non-target analytes with chemical properties similar to those of the analyte of interest that are used to evaluate the response of the analyte to sample preparation and analytical procedures, and determine method accuracy.

Laboratory control samples contain an analyte-free matrix that is representative of the environmental sample to be tested and are used to establish intra-laboratory or analyst-specific accuracy.

Accuracy is not evaluated for toxicity tests.

Precision

The precision of a measurement system describes how close the agreement is between multiple measurements. The precision of the processes associated with the chemical analyses will be determined by analyzing field and laboratory duplicates. Field duplicates evaluate precision in the sampling and laboratory processes while laboratory duplicates are used to evaluate of precision of the laboratory processes, including evaluation of variability associated with sub-sampling. Field duplicates must account for at least 5% of the project's total sample count, and each must have a relative percent difference (RPD) less than 30%. At least one laboratory duplicate per analytical batch (defined as 20 samples or less) is required. The RPD between two replicate samples or the relative standard deviation (RSD) between more than two replicate samples will be less than the SWAMP MQOs listed for each analyte of interest. The calculations are as follows:

RPD = Absolute Value (of replicate 1 - replicate 2) x 100/Average (replicate 1, replicate 2)

RSD = Standard Deviation (of all replicate samples) x 100/Average (all replicate samples)

In regards to toxicity testing, laboratory precision is assessed using reference toxicant tests and field duplicates. A reference toxicant test is a toxicity test on a dilution series of a known contaminant, such as copper or cadmium. The test should produce an expected result that evaluates both organism sensitivity and quality, as well as technical expertise. One reference toxicant test per analytical batch is required when using organisms that are either commercially-supplied or wild-caught. Monthly reference toxicant testing is required for laboratories utilizing in-house cultures. The last plotted data point of reference toxicant tests should be within two standard deviations of the cumulative mean, with tests that fall outside of U.S. EPA's recommended control chart limits being evaluated to determine the validity of the associated tests. which must be conducted on a per-batch/monthly basis. Test organisms are obtained from outside vendors, and will meet the age requirements established in the applicable MQO.

Bias

Accuracy is the assessment of the closeness of agreement between a measured or determined value and the true value; bias is the quantitative measure of the difference between those values. Bias can be unintentionally introduced through improper timing, reach selection, sample contamination, and depositional area selection for the surveys. These biases are controlled by ensuring field crews sample in the lowest gradient (i.e., calmest) reaches, and during the base flows that follow the high flow season (i.e., late spring through fall). Field blanks will also be used to measure any contamination introduced during sample collection and handling of water samples. Field blanks must meet the minimum number required for this project and must not produce a statistically different result from that of the controls.

For chemical analyses, bias is evaluated in several ways:

- In addition to measuring method accuracy, matrix spikes and matrix spike duplicates can indicate the potential bias of matrix effects on the target analyte.
- Surrogates can also help determine whether sample preparation and analytical procedures have biased an analysis.
- Laboratory blanks (or "method blanks") are used to determine if target analytes or interferences in the laboratory environment, reagents, or instruments have introduced bias.

Comparability

Comparability expresses the measure of confidence that one dataset can be compared to and combined with another for a decision(s) to be made. The SPoT sample site selection methodology and sampling design were developed to ensure data comparability across years. In addition, all sample collection, analyses, and reporting will be carried out with procedures and methodologies consistent with past SPoT data collection efforts and applicable SWAMP MQOs and Ambient Data Quality Objectives.

A.8: Special Training/Certification

Specialized Training and Safety Requirements

No specialized training or certifications are required for this project. All laboratory staff are required to maintain training per field and laboratory specific requirements and follow the safety protocols established in each of their respective laboratories and applicable SOPs.

Training Provided
The PM trains all field staff in sample collection procedures in a field training day, while the UCD-GC QAO trains new staff in all laboratory procedures related to SPoT toxicity tests. All new staff members are evaluated and supervised in the field and laboratory setting before they are allowed to work independently. All trainings are recorded in a safety training log and available upon request. Babcock staff sign off on applicable SOPs before performing analyses independently.

Laboratory Accreditation
UCD-GC is accredited by the State Water Board's Environmental Laboratory Accreditation Program (ELAP) for the sediment toxicity testing methods used for this project. UCD-GC is not currently accredited for the water toxicity testing methods because SWAMP-modified methods are used instead of strict U.S. EPA methods and they are not currently offered for ELAP accreditation.

Babcock Laboratories and all the subcontract laboratories that will be performing SPoT analyses are accredited by ELAP. However, ELAP accreditation is not offered for analysis of pyrethroids, fipronils, individual PCBs, or PBDEs in the sediment matrix.

All SOPs and documentation pertaining to laboratory safety procedures will be retained by all laboratories involved in the SPoT Program.

A.9: Documentation and Records Requirements

The following section describes the documents, records, and data deliverables required for the SPoT Program.

Planning Documents
Revisions and updates to this QAPP will be carried out by Katie Siegler and Bryn Phillips, with technical input from the Laboratory and SWAMP QAOs. All changes will be considered draft until reviewed and approved by the SPoT Project Coordinator, the SWAMP QAO, and the SWRCB QAO. The QAPP must be reviewed at least annually and revised where necessary. It must meet U.S. EPA, SWRCB, and SWAMP quality system requirements to be approved.

The SPoT Project Coordinator will send an electronic copy of this QAPP to the PM, who will then distribute it to all parties directly involved in this project. Any future amendments to this QAPP will be distributed in the same fashion. Each version of this QAPP will be retained at the SWRCB. QAPPs are reviewed and updated on an annual basis.
Sample Collection and Handling Records

- The SPoT Monitoring Plan will detail the sampling scheme for the upcoming year and will be submitted to the OIMA Contract Manager and SPoT Project Coordinator in an electronic format.
- Hardcopy field data sheets (Appendix D) will be completed by the staff at UCD-GC during each field visit. The hardcopy field data sheets are retained at UCD-GC for 10 years and will be made available to the State and Regional Water Boards upon request.
- An electronic copy of the field data sheet is forwarded to the analyzing laboratory in advance of sample receipt.
- Chain of custody (COC) forms are submitted with all sub-samples sent to analytical laboratories.

Analytical Records
Contract laboratories must maintain all raw data, instrument or equipment maintenance logs, calibrations, and relevant measurements and records for this project. All records must be retained at their respective laboratories for a minimum of 10 years from the contract's cessation (if applicable), and provided to State or Regional Water Board staff upon request.

Laboratory Reports
Laboratory reports for chemical analyses are issued by the laboratories performing the analyses and are submitted to UCD-GC and SWAMP IQ. SWAMP IQ will retain the laboratory reports for a minimum of 10 years from the receipt of the reports and will make them available upon request.

Electronic Data Deliverables
Toxicity test data, chemistry data, and field data collected for the 2021 SPoT survey will be submitted electronically to SWAMP IQ, using the appropriate SWAMP data templates and following the applicable business rules.

Corrective and Preventative Action Reports
Corrective and Preventative Action Reports (CPAR) are developed in response to an incident of non-conformance at any stage of data collection, from site visitation to sample analysis. CPARs are to be filled out by field crew members and laboratory personnel when a deviation from standard or required protocol has occurred, and must include the following information:

- Identification of the non-conformance including, but not limited to, the date, location, analysis/sample(s)/procedure/instrument affected, and the resulting effect.
- Identification of the root cause of the discrepancy or deviation.
- Suggested or summarized corrective actions taken to address the immediate issue and prevent future occurrences.

A CPAR will be provided to the SPoT Project Coordinator and PM via email (a template can be obtained here). CPARs are submitted to the SWAMP QAO for review and approval.

Trend Reporting
SPoT monitoring began in 2008 and the first trend report was written in 2011. Other trend reports followed every two years until year seven. A 10-year trend report was written interpreting the results of data analyses from 2008-2017. SPoT fact sheets are produced to provide easily understandable summaries of key SPoT findings. Future reporting will include summaries of and interpretations of outputs from the SWAMP data dashboard that are currently being developed.

GROUP B: ANALYTICAL METHODS REQUIREMENTS

B.1: Sampling Process Design

The monitoring design of SPoT is based on USGS's National Water Quality Assessment program (USGS, NAWQA: http://water.usgs.gov/nawqa/). NAWQA utilizes "integrator sites" for its sampling, which are areas established near the base of larger, relatively heterogeneous drainage basins with complex combinations of environmental settings, slow water flow, and appropriate micro-morphology to allow deposition and accumulation. These basins are indexed using eight-digit USGS hydrologic unit codes (HUC) and include watersheds for the Russian, South Fork American, Salinas, and Santa Clara Rivers. Sediment samples collected from integrator sites are considered to be a relatively good, and logistically feasible means of assessing large watersheds for long-term trends.

Initially, SPoT sampled 100 sites throughout California on an annual basis. This decreased to 90 sites in 2018. All sites were chosen for geographical representation and decided upon with input from the nine Regional Water Quality Control Boards, as well as local and regional monitoring programs, such as those directed by storm water agencies and coalitions, irrigated lands regulatory programs, and regional monitoring programs.

Surveys are scheduled based on regional hydrologic cycles, with Southern California coastal streams sampled in spring, and other regions sampled progressively later in the year as stream flows recede. A pilot study was conducted in the 2009-2010 SPoT survey in which three additional reaches per watershed were sampled during spring, summer, and fall survey to characterize spatial and temporal variability of the sampling design. The results from the additional samples were then compared to the results from other years using an F-ratio test to determine if seasonal variability was significantly greater than annual variability. It was determined that a single station at the base of the watershed was representative of other stations in the lower part of the watershed and was also seasonally representative.

B.2: Sampling Methods

Sediment samples will be collected in accordance with the SOP for Conducting Field Collections of Bed Sediment Samples at Watershed Integrator Sites in the SWAMP SPoT Program, Revision 2 (Appendix B). Samples are collected along a 100 m reach, with subsamples collected from up to 10 depositional areas, depending on the location of fine sediment deposits. Subsamples are homogenized to address variability and create a sample representative of depositional sediment mobilized within the watershed. Care is taken to sample recent sediment deposits in active areas of the streambed by avoiding banks, beaches, and other areas where sediment may have been deposited more than one year previously.

Sediment is sampled to a depth of up to five centimeters when the entire five centimeter core is homogeneous and appears to have been deposited within the same hydrologic cycle of seasonal high water receding to annual base flow. However, sediment may need to be collected as shallow as one centimeter if there is clear layering indicating deposition over multiple annual cycles.

Water samples will be collected at selected SPoT sites by CDPR, as part of a collaborative study evaluating pesticides and potential toxicity in California and transported to UCD-GC on ice (in accordance with CDPR SOP FSWA017.00).

Equipment
The following items will be used in the field:

- YSI EXO3 multi-parameter sonde
- Sediment core tubes
- Sediment scoops

The YSI EXO3 multi-parameter sonde is used to conduct field measurements of dissolved oxygen, temperature, conductivity, and pH. The sediment core tubes and scoops are to collect sediment samples in accordance with the procedures outlined in Appendix B.

The sediment core tubes and scoops are to collect sediment samples in accordance with the procedures outlined in Appendix B.

Cleaning/Decontamination
It is critical that sample contamination be avoided during collection. All sampling equipment is composed of a non-contaminating material and is thoroughly cleaned before each use, as described in the SOP for Conducting Field Collections of Bed Sediment Samples at Watershed Integrator Sites in the SWAMP SPoT Program, Revision 2 in Appendix B. Sampling personnel wear nitrile gloves whenever taking or processing samples to avoid contact contamination. In addition, airborne contamination is avoided by keeping sample containers appropriately covered when not in use.

B.3: Sample Handling and Custody

Sample Handling Requirements
Sample handling requirements for SPoT analytes were excerpted from SWAMP's MQOs for Conventional Parameters in Freshwater Sediment and Marine Sediment; Inorganic Analytes in Freshwater Sediment and Marine Sediment; Synthetic Organic Compounds in Freshwater Sediment and Marine Sediment; and Freshwater Sediment Toxicity Testing (Table 3).

All samples will be handled, prepared, transported, and stored in a manner so as to minimize bulk loss, analyte loss, contamination, or biological degradation, according to the applicable MQOs (Tables 5 through Table 8), and the SOP in Appendix B. Sample container caps and lids will be checked for tightness and clearly labeled with an indelible marker. Samples are then placed in an insulated cooler with enough dry or wet ice to completely fill the space and then sealed with tape before shipping. Chain of Custody forms are either placed in an envelope and taped to the top of the cooler or placed in a Ziploc plastic bag and taped to the inside of the lid. It is assumed that samples in tape-sealed coolers are secure, whether being transported by staff vehicle, by common carrier, or by commercial package delivery.

Table 3. Sample Handling Requirements for SPoT Analytes in Sediment

Analyte	Recommended Container[1]	Recommended Preservation	Required Holding Time[2]
Grain Size	Glass	Wet ice to ≤ 6 °C in the field, then refrigerate at ≤ 6 °C	1 year
Organic Carbon (Total)	Glass	Cool to ≤ 6 °C; acidify to pH < 2 with HCl, H_3PO_4, or H_2SO_4 within 2 hours	28 days
• Diesel Range Organics • Organochlorine Pesticides • Organophosphate Pesticides • Organotins • Polynuclear Aromatic Hydrocarbons • Surfactants • Wastewater Organochlorine Pesticides	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	1 year; samples must be extracted within 14 days of collection or thawing and analyzed within 40 days of extraction
• Polybrominated Diphenyl Ethers • Polychlorinated Biphenyls (as Congeners/Aroclors)	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	None[3]
Pyrethroids (sediment)	Glass	Short-term storage: ≤ 6 °C in the dark; long-term storage, or storage of remaining sample: ≤ -20 °C in the dark	1 year at ≤ -20 °C in the dark; samples must be extracted within 14 days of collection or thawing and analyzed within 40 days of extraction
Trace Metals[4]	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	1 year; samples must be digested within 14 days of collection or thawing
Freshwater Sediment Toxicity	Amber glass recommended, but clear glass or plastic (polyethylene or polycarbonate) are acceptable	Wet or blue ice in field, 0 - 6 °C refrigeration in laboratory, dark at all times	< 14 days (recommended) or < 8 weeks (required) at ≤ 6 °C in the dark; do not freeze
Freshwater Water Toxicity	Amber glass recommended	Wet or blue ice in field, 0 - 6 °C refrigeration in laboratory, dark at all times	48 hours at 4°C in dark

1 Samples for TOC and grain size analysis can be combined in one 250-mL clear glass jar, and sub-sampled at the laboratory in order to utilize holding time differences for the two analyses. If this is done, the 250 mL combined sediment sample must be refrigerated (not frozen) at ≤6 °C for up to 28 days, during which time the sub-samples must be aliquoted in order to comply with separate storage requirements.

2 Each "Required Holding Time" is based on the assumption that the "Recommended Preservation" (or a method-mandated alternative) has been employed. If a "Required Holding Time" for filtration, preservation, preparation, or analysis is not met, the PM and SWAMP QAO must be notified. Regardless of preservation technique, data not meeting the "Required Holding Time" will be appropriately flagged in the SWAMP database.

3 Holding time:1 year; samples must be extracted within 14 days of collection or thawing and analyzed within 40 days of extraction

4 With the exception of methylmercury

Sample Chain of Custody
Project chain of custody (COC) procedures require that the possession of samples is traceable from the time they are collected until completion and submittal of analytical results. Therefore, a complete COC form will accompany the transfer of samples to each analyzing laboratory and will be forwarded to the PM with the data reporting package (see Appendix C for the UCD-GC COC form; the Babcock Laboratories, Inc. COC can be accessed online.).

The receiving laboratory must have a sample custodian who examines the samples for proper documentation, preservation, and holding times. For SPoT, samples will be collected by UCD-GC personnel so samples will not change custody between field collection and laboratory storage. When samples are transported from UCD-GC to other laboratories, the temperature will be checked at the receiving laboratory using an infrared thermometer in order to determine compliance with the sample preservation methods established in the applicable toxicity test MQOs (e.g. 0 – 6 °C). Contract laboratories will follow the COC procedures outlined in their respective QA plans (available upon request).

Copies of the COCs will be kept by each receiving laboratory. An electronic copy of the COC will be provided to the Contract Manager and SWAMP IQ Data Quality Managers within 10 business days of submission of samples to the laboratory.

Sample Retention and Disposal
All samples must be retained for the entire duration of their required holding times and analyses. Any samples remaining after completion of analyses must be retained until the laboratory has received written confirmation from the UCD-GC PM that the data have been received, reviewed, and verified and disposal of samples is permitted.

It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or chemicals.

B.4: Analytical Methods Requirements

The standardized test methods used to measure the analytes of interest to the SPoT Program are listed in Table 4, along with the responsible laboratories. All toxicity testing and related toxicity water quality analyses are conducted by the University of California Davis Granite Canyon Lab. All metals analyses are conducted by the Department of Fish and Wildlife's Marine Pollution Studies Lab. All organics are analyzed by Babcock Laboratories, or subcontracted to other qualified labs. Organics methods listed are current EPA methods, but subcontracted labs may use modified methods that are considered equivalent provided they meet quality assurance requirements.

Table 4. SPoT Analytes and Methodology

Laboratory/ Organization	Analyte	Method	Unit
UCD-GC	Sediment Toxicity	EPA 600/R-99/064; *Hyalella azteca* - SOP 2.7	Percent Survival, mg/individual
UCD-GC	Sediment Toxicity	EPA 600/R-99/064; *Chironomus dilutus* - SOP 2.8	Percent Survival, mg/individual
UCD-GC	Water Column Toxicity	EPA 821/R-02/012M; *Hyalella azteca* - SOP 2.20	
UCD-GC	Water Column Toxicity	Ingersoll et al. 2013; Kunz et al. 2017; *Chironomus dilutus* - SOP 2.26	Percent Survival, mg/individual
McCampbell Analytical, Inc.	Fipronil	U.S. EPA 8270M – or equivalent	ng/g dw
ALS Group USA - Tucson	Grain Size (% silt/clay)	ASTM D422	%
Weck	Organochlorine Pesticides	U.S. EPA 8081A – or equivalent	ng/g dw
Eurofins Calscience, Inc.	PAH	U.S. EPA 8270C SIM -PAHS (GC/MS SIM) – or equivalent	ng/g dw
ALS Life Sciences - Canada	PBDE	Brominated Flame Retardants by EPA 1614 – or equivalent	ng/g dw
Eurofins Calscience, Inc.	PCB	U.S. EPA 8270C SIM CON – or equivalent	ng/g dw
Babcock Laboratories	PFAS	PFAS by LCMSMS (QSM 5.3 Table B-15 Compliant)– or equivalent	ng/g dw
Eurofins Calscience, Inc.	Pyrethroids	U.S. EPA 8270D TQ-Pyrethroids- GC/MS/MS – or equivalent	ng/g dw
Eurofins Calscience, Inc.	Total Organic Carbon	U.S. EPA 9060A	%
MPSL-DFW	Trace Metals	U.S. EPA 200.8M or 6020bM; U.S. EPA 3052M (Modified for digestion)	mg/kg dw
MPSL-DFW	Mercury	U.S. EPA 7473M	mg/kg dw

Note: Subcontracted laboratories are subject to change depending on what the lab can perform.

B.5: Quality Control

The laboratories participating in the SPoT monitoring program employ multiple approaches to quality control in order to identify possible contamination problem(s), matrix interference, and to evaluate the precision and accuracy of laboratory activities. The results of quality control sample analyses are compared to the SPoT Program MQOs to ensure compliance. The MQOs for the SPoT Program's laboratory and methodology are listed in tables 5 through 8 below.

When control limits are exceeded, the Laboratory QAO will determine the cause(s) by reviewing SOPs and identifying, documenting, and correcting any deficiencies.

Table 5. Quality Control[1] for Inorganic Analytes in Sediment

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Calibration Standard	Per analytical method or manufacturer's specifications	Per analytical method or manufacturer's specifications
Calibration Verification	Per 10 analytical runs	80-120% recovery
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analyte
Reference Material/Lab Control Sample	Per 20 samples or per analytical batch, whichever is more frequent	75-125% recovery
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	75-125% recovery
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	75-125% recovery; RPD<25%
Laboratory Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	RPD<25% (n/a if native concentration of either sample<RL)
Internal Standard	Accompanying every analytical run when method appropriate	60-125% recovery
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Duplicate	5% of total project sample count (Sampling stations for field duplicates are randomly selected.)	RPD <25% (n/a if native concentration of either sample<RL), unless otherwise specified by method
Field Blank, Travel Blank, Equipment Blank	Per method	Blanks<RL for target analyte

1 Unless method specifies more stringent requirements.

Table 6. Quality Control[1] for Synthetic Organic Compounds in Sediment[2]

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Tuning	Per analytical method	Per analytical method
Calibration	Initial method setup or when the calibration verification fails	• Correlation coefficient (r^2 >0.990) for linear and non-linear curves • If RSD<15%, average RF may be used to quantitate; otherwise use equation of the curve • First- or second-order curves only (not forced through the origin) • Refer to SW-846 methods for SPCC and CCC criteria[3] • Minimum of 5 points per curve (one of them at or below the RL)
Calibration Verification	Per 12 hours	• Expected response or expected concentration ±20% • RF for SPCCs=initial calibration[3]
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analytes
Reference Material	Per 20 samples or per analytical batch (preferably blind)	70-130% recovery if certified; otherwise, 50-150% recovery
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	50-150% or based on historical laboratory control limits (average±3SD)
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	50-150% or based on historical laboratory control limits (average±3SD); RPD<25%
Surrogate	Included in all samples and all QC samples	Based on historical laboratory control limits (50-150% or better)
Internal Standard	Included in all samples and all QC samples (as available)	Per laboratory procedure
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Duplicate	5% of total project sample count (Sampling stations for field duplicates are randomly selected.)	Per method
Field Blank, Travel Blank, Equipment Blank	Per method	<RL for target analytes

1 Unless method specifies more stringent requirements; ELISA results must be assessed against kit requirements
2 All detected analytes must be confirmed with a second column, second technique, or mass spectrometry
3 Mass spectrometry only

Table 7. Quality Control[1] for Pyrethroids in Sediment

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Tuning[2]	Per analytical method	Per analytical method
Calibration	Daily, or just prior to analysis; five or more level standards spanning the sample result range[3], with the lowest standard at or below the RL	r ≥0.995 (or r^2 ≥0.995, all curve types not forced through origin)
Calibration Verification	Per 10 analytical samples[4]	80-120%[5]
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analytes
Laboratory Control Sample[6]	Per 20 samples or per analytical batch (preferably blind)	50-150%
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	50-150%
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	50-150%; RPD≤35%
Surrogate[7]	Included in all samples and all QC samples	Based on historical laboratory control limits (50-150% or better)
Internal Standard	Included in all samples and all QC samples (as available)	Per laboratory procedure
Field Quality Control[8]	**Frequency of Analysis**	**Measurement Quality Objective**
Field Duplicate	5% of total project sample count (Sampling stations for duplicates are randomly selected.)	Per method

1 Unless project specifies more stringent requirements
2 Mass spectrometry only
3 Sample results above the highest standard are to be diluted and re-analyzed.
4 Analytical samples include samples only and do not include clean-out or injection blanks.
5 Limit applies to a mid-level standard; low-level calibration checks near the reporting limit may have a wider range that is project-specific.
6 Laboratory control samples must be matrix-specific. A clean sediment, roasted sand, or roasted sodium sulfate may be used for sediments.
7 Laboratory historical limits for surrogate recovery must be submitted to the SWAMP database in the lab result comment section.
8 A technical group consisting of regional, laboratory, and research representatives determined that field blanks do not add technical value to a pyrethroids data set.

Table 8. Quality Control for Sediment Toxicity

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Laboratory Control Water	Laboratory control water consistent with Section 7 of the appropriate EPA method/manual must be tested with each analytical batch.	Laboratory control water must meet all test acceptability criteria (please refer to Section 7 of the appropriate EPA method/manual) for the species of interest.
Conductivity/Salinity Control Water	A conductivity or salinity control must be tested when these parameters are above or below the species tolerance.	Follow EPA guidance on interpreting data and refer to tables below for tolerance ranges.
Additional Control Water	Additional method blanks are required whenever manipulations are performed on one or more of the ambient samples within each analytical batch (e.g., pH adjustments, continuous aeration).	There must be no statistical difference between the laboratory control water and each additional control water within an analytical batch.
Sediment Control	Sediment control consistent with Section 7 of the appropriate EPA method/manual must be tested with each analytical batch of sediment toxicity tests.	Sediment control must meet all data acceptability criteria (please refer to Section 7 of the appropriate EPA method/manual) for the species of interest.

B.6: Instrument/Equipment Testing, Inspection, and Maintenance

Laboratory instruments are inspected and maintained in accordance with laboratory SOPs, which include those specified by the manufacturer and those specified by the method. These SOPs have been reviewed by each respective Laboratory QAO and found to be in compliance with SWAMP criteria. Analysts are responsible for equipment testing, inspection, and maintenance.

The manufacturer's instructions for the laboratory equipment used in the SPoT Program will be followed as a minimum requirement. The results of equipment tests, inspections, maintenance, and repairs will be documented in the appropriate logbook. If an instrument fails to meet the accuracy and/or precision criteria after maintenance has been performed, the manufacturer will be contacted.

All laboratory equipment will be cleaned/decontaminated in accordance with the applicable laboratory's SOP(s). Copies of these SOPs are retained by the SWRCB and will be made available to the Regional Water Boards upon request.

B.7: Instrument/Equipment Calibration and Frequency

Laboratory and field instruments are calibrated, standardized, and maintained according to the analytical method, the manufacturer's specifications, and the applicable MQOs (Table 9). Analytical instruments that fail to meet performance requirements will be checked and recalibrated according to their respective SOP. If the instrument still does not meet specifications, it will be repaired and retested until performance criteria are achieved. In addition, all maintenance activities will be recorded into the instrument's log. If sample analytical information is in question due to instrument performance, the PM will be contacted regarding the proper course of action.

At a minimum, all calibration procedures will meet the requirements specified in the U.S. EPA-approved methods of analysis. The means and frequency of calibration recommended by the manufacturer of the equipment or devices, as well as any instruction given specifically for an analytical method, will be followed. When such information is not specified by the method, instrument calibration will be performed at least once daily, and continuing calibration will be performed on a ten percent basis thereafter (with the exception of analysis by GC/MS). It is also required that records of calibration be kept by the person performing the calibration and be accessible for verification during a laboratory or field audit.

Table 9. Project Inspection/Acceptance Requirements for Field Supplies and Consumables

Instrument Name/Model	Date Purchased	Inspection/ Calibration Specifications	Acceptance Criteria	Frequency
YSI EXO3 multi-parameter sonde (field water quality)	2008	Per manual	Standards must read within 10% of target	Calibrated before each field run; dissolved oxygen calibrated before each measurement
Accumet XL60 (toxicity test water quality)	2013	Per manual		Calibrated with standards daily
Hach DR/2010 spectrophotometer (lab ammonia)	2005	Per manual	Standards must read within 10% of target	Calibrated with standards for each use

B.8: Inspection/Acceptance of Supplies and Consumables

All supplies will be examined for damage as they are received. Laboratory personnel will review all supplies as they arrive to ensure the shipment is complete and intact. All chemicals are logged into the appropriate logbook and dated upon receipt. All supplies are stored appropriately and are discarded upon expiration date. If items are not found to be in compliance with accuracy, precision, and contamination criteria, they will be returned to the manufacturer.

B.9: Non-direct Measurements

Data from non-direct measures will not be used in this study.

B.10: Data Management

Field data will be collected and documented on data field sheets (Appendix D) and entered into a data entry shell database by Katie Siegler upon return to the laboratory. These shell databases are then uploaded to the Water Boards' FTP site where the data contained therein are automatically transferred to the SWAMP Database. Original field sheets will be retained in a log book.

Raw toxicity data are entered upon test completion by Laura McCalla and then UCD-GC staff populate SWAMP templates for eventual input to the SWAMP Database. All toxicity data are reviewed for accuracy by the Laboratory QAO and/or the PM. Babcock staff populate SWAMP templates for submission of chemical analysis data to the SWAMP Database. Toxicity and chemical analysis laboratory data are checked using the SWAMP Online Data Checker using a SWAMP template EDD format to ensure compliance with SWAMP business rules. If the data do not receive an error message from the SWAMP Online Data Checker, then the EDD will be submitted to the OIMA Helpdesk inbox for the SWAMP IQ Data Quality Managers to verify the data.

All raw and statistically analyzed data are subject to a 100% check for accuracy by the PM, Laboratory QAOs (or Laboratory Managers or Leads), and SWAMP IQ. Data are reviewed for accuracy and checked against the QAPP and applicable MQOs before being uploaded into the

SWAMP Database by SWAMP IQ Data Quality Managers. Completeness of the data will be tracked through the SWAMP Database. See section D.1 for more information.
Original hard copies of all laboratory and field data are filed in a secure cabinet until requested by the SPoT Project Coordinator or SWAMP QAO. Original copies of the field sheets, laboratory logs, and data generated at UCD-GC are stored there for 20 years.

GROUP C: ASSESSMENTS

C.1: Assessments and Response Actions

Project Kickoff (Readiness Review)
Prior to the start of each sampling season, the PM will arrange a teleconference or web conference with the Laboratory QAOs from each of the participating laboratories, applicable SWAMP IQ Data Quality Managers, SWAMP QAO, Project Coordinator, and the OIMA Contract Manager. These meetings will facilitate coordination of project planning and logistics, and should address the following topics: the project work order, field sheets, COC forms, sample collection timing, sample handling (shipping), laboratory turnaround times, and data submission.

Real-Time Data Audits
Data will be reviewed by each Laboratory QAO prior to submission of each batch to the PM or SWAMP Database. Field crew audits will be conducted once per sampling season, and a review of sampling procedures will be made by the Sample Manager and the PM, should problems arise. As SOPs are updated and refined, additional reviews will be made. Each laboratory data technician is responsible for flagging data that does not meet established QA/QC criteria.

If a reviewer discovers any discrepancy, the Laboratory QAO will discuss it with the personnel responsible for the activity. The discussion will include the accuracy of the information, potential factors leading to the deviation, how the deviation might impact data quality, and the corrective actions that might be considered. If the discrepancy is not resolved, the Laboratory QAO will issue a stop work order until the problem is fixed.

Internal quality checks are conducted by the Laboratory QAO, and minor errors are addressed by discussing issues with lab staff and reviewing training. If major discrepancies are observed, analytical equipment fails, or quality check samples fall outside of acceptability limits, personnel are to record the problem, according to their documentation protocols, and take the necessary actions to correct and resolve the issue. Corrective actions will be documented and provided in a Corrective and Preventative Action Report at the request of the SPoT Project Coordinator, SWAMP QAO, or the Contract Manager. The SWAMP QAO will review the report and may request additional information or actions to be taken. The laboratory shall respond with an amended Corrective and Preventative Action Report within the timeframes agreed upon in the current contract. The laboratory will notify the SPoT Project Coordinator, SWAMP QAO, and Contract Manager before proceeding with an analysis. Associated data resulting from a corrective action shall be flagged accordingly.

Technical System Audit

Field Procedures
The Field Crew Manager shall conduct random field procedure audits to ensure adherence to the standard operating procedures, field health and safety requirements, and sample handling and custody procedures.

Laboratory Procedures
The Laboratory Director or QAO shall conduct laboratory systems audits per the Laboratory Quality Management Plan.

Deviations and Corrective Actions

Analyses are conducted according to procedures and conditions recommended by the U.S. EPA, and described in laboratory SOPs, with the exception of those reported herein. Beyond those identified, deviations from these recommended conditions are reported to the Laboratory QAO. The Project Coordinator and the SWAMP QAO will also be notified within 48 hours of a deviation.

In the event of an SOP/QAPP deviation or corrective action, a Corrective and Preventative Action Report will be prepared, completed, and signed, and the Project Coordinator and the SWAMP QAO will both be notified. Best professional judgment will be used in interpretation of results obtained when deviations in the test conditions have occurred. All deviations and associated interpretations will be reported in interim and final reports. Protocol amendments will be submitted to the Laboratory QAO, SWAMP QAO, and Project Coordinator. Upon approval, protocol amendments will be employed.

Table 10. Recommended Corrective Actions for SPoT Analytes in Sediment

Analyte	Laboratory Quality Control	Recommended Corrective Action
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Calibration Standard	Recalibrate the instrument. Affected samples and associated QC must be reanalyzed following successful instrument recalibration.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Calibration Verification	Reanalyze the calibration verification to confirm the result. If the problem continues, halt analysis and investigate the source of the instrument drift. The analyst should determine if the instrument must be recalibrated before the analysis can continue. All of the samples not bracketed by acceptable calibration verification must be reanalyzed.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Laboratory Blank	Reanalyze the blank to confirm the result. Investigate the source of contamination. If the source of the contamination is isolated to the sample preparation, the entire batch of samples, along with the new laboratory blanks and associated QC samples should be prepared and/or re-extracted and analyzed. If the source of contamination is isolated to the analysis procedures, reanalyze the entire batch of samples. If reanalysis is not possible, the associated sample results must be flagged to indicate the potential presence of the contamination.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Reference Material	Reanalyze the reference material to confirm the result. Compare this to the matrix spike/matrix spike duplicate recovery data. If adverse trends are noted, reprocess all of the samples associated with the batch.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Matrix Spike	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Reanalyze the matrix spike to confirm the result. Review the recovery obtained for the matrix spike duplicate. Review the results of the other QC samples (such as reference materials) to determine if other analytical problems are a potential source of the poor spike recovery.

Analyte	Laboratory Quality Control	Recommended Corrective Action
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Matrix Spike Duplicate	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Reanalyze the matrix spike duplicate to confirm the result. Review the recovery obtained for the matrix spike. Review the results of the other QC samples (such as reference materials) to determine if other analytical problems are a potential source of the poor spike recovery.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Laboratory Duplicate	Reanalyze the duplicate samples to confirm the results. Visually inspect the samples to determine if a high RPD between the results could be attributed to sample heterogeneity. For duplicate results due to matrix heterogeneity, or where ambient concentrations are below the reporting limit, qualify the results and document the heterogeneity.
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Internal Standard	Check the response of the internal standards. If the instrument continues to generate poor results, terminate the analytical run and investigate the cause of the instrument drift.
• Synthetic Organic Compounds in Sediment	Surrogate	Analyze as appropriate for the utilized method. Troubleshoot as needed. If no instrument problem is found, samples should be re-extracted and reanalyzed if possible.
Analyte	**Field Quality Control**	**Recommended Corrective Action**
• Inorganic Analytes in Sediment • Synthetic Organic Compounds in Sediment	Field Duplicate	Visually inspect the samples to determine if a high RPD between results could be attributed to sample heterogeneity. For duplicate results due to matrix heterogeneity, or where ambient concentrations are below the reporting limit, qualify the results and document the heterogeneity. All failures should be communicated to the project coordinator, who in turn will follow the process detailed in the method.

Table 11. Recommended Corrective Actions for Pyrethroids

Laboratory Quality Control	Recommended Corrective Action
Calibration Standard	Affected samples and associated quality control must be reanalyzed following successful instrument recalibration.
Calibration Verification	Initial calibration is analyzed immediately after calibration and should be from a source different than the calibration curve. Bracketing continuing calibration standards are used every ten sample runs for quantitation per method protocol. The analysis must be halted, the problem investigated, and the instrument recalibrated. All samples after the last acceptable continuing calibration verification must be reanalyzed.
Laboratory Blank	The sample analysis must be halted, the source of the contamination investigated, the samples along with a new laboratory blank prepared and/or re-extracted, and the sample batch and fresh laboratory blank reanalyzed. If reanalysis is not possible due to sample volume, flag associated samples.
Laboratory Control Sample	The LCS is analyzed in the same manner as an environmental sample and the spike recovery demonstrates the accuracy of the method. Affected samples and associated quality control must be reanalyzed following LCS troubleshooting and resolution. After troubleshooting, compare to matrix spike/matrix spike duplicate recovery data. If adverse trends are noted, reprocess all samples associated with the batch.

Laboratory Quality Control	Recommended Corrective Action
Matrix Spike	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Appropriately spiked results should be compared to the matrix spike duplicate to investigate matrix interference. If matrix interference is suspected, the matrix spike result must be flagged. Appropriately spiked results should be compared to the matrix spike duplicate to investigate matrix interference. If matrix interference is suspected and LCS recoveries are acceptable, the matrix spike and matrix spike duplicate results must be flagged.
Matrix Spike Duplicate	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Appropriately spiked results should be compared to the matrix spike to investigate matrix interference. If matrix interference is suspected and LCS recoveries are acceptable, the matrix spike duplicate result must be flagged.
Surrogate	Analyze as appropriate per method. Trouble shoot as appropriate, if no instrument problem is found samples should be re-extracted and re-analyzed if possible.
Internal Standard	Analyze as appropriate per method. Troubleshoot as appropriate. If, after trouble-shooting, the responses of the internal standards remain unacceptable, the analysis must be terminated and the cause of drift investigated.
Field Quality Control	**Recommended Corrective Action**
Field Duplicate	For duplicates with a heterogeneous matrix or ambient levels below the reporting limit, failed results may be flagged. All failures should be communicated to the project coordinator, who in turn will follow the process detailed in the method.

Table 12. Recommended Corrective Actions for Freshwater Sediment Toxicity Tests

Laboratory Quality Control	Recommended Corrective Action
Laboratory Control Water	If tested with in-house cultures, affected samples and associated quality control must be retested within 24 hours of test failure. If commercial cultures are used, they must be ordered within 16 hours of test failure for the earliest possible receipt. Retests must be initiated within 30 hours of receipt, depending on the need for organism acclimation. The laboratory should try to determine the source of the control failure, document the investigation, and document the steps taken to prevent a recurrence.
Conductivity Control Water	Affected samples and associated quality control must be flagged.
Additional Control Water	Based on the objectives of the study, a water sample that has similar qualities to the test sample may be used as an additional control. Results that show statistical differences from the laboratory control should be flagged. The laboratory should try to determine the source of variation, document the investigation, and document the steps taken to prevent a recurrence. This is not applicable for TIE method blanks.
Sediment Control	Based on the objectives of the study, a sediment sample that has similar qualities to the test sample may be used as an additional control. Results that show statistical differences from the laboratory control should be flagged. The laboratory should try to determine the source of variation, document the investigation, and document the steps taken to prevent a recurrence.
Positive Controls: Reference Toxicant Tests	If the LC50 exceeds +/- two standard deviations of the running mean of the last 20 reference toxicant tests, the test should be flagged.

Field Quality Control	Recommended Corrective Action
Field Duplicate	For duplicates with a heterogeneous matrix, results that do not meet SWAMP criteria should be flagged. The project coordinator should be notified so that the sampling team can identify the source of variation and perform corrective action prior to the next sampling event.
Field Blanks	If contamination of the field blanks and associated samples is known or suspected, the laboratory should flag the affected data. The project coordinator should be notified so that the sampling team can identify the contamination source(s) and perform corrective action prior to the next sampling event.
Equipment Blanks	If contamination of the field blanks and associated samples is known or suspected, the laboratory should flag the affected data. The project coordinator should be notified so that the sampling team can identify the contamination source(s) and perform corrective action prior to the next sampling event.

Data Quality Assessment

A data quality assessment is conducted at the end of each sampling season and includes the following:

- Initial review of analytical and field data for complete and accurate documentation, COC procedures, compliance with analytical holding times, and required frequency of laboratory QA samples;
- Review of data verification of results;
- Reconciliation with corrective actions; and
- Discussion of any remaining issues and potential improvements for the following sampling season.

A summary of the data quality assessment shall be developed and included with the final project report.

C.2: Reports to Management

Corrective and Preventative Action Reports

Corrective actions are documented in the laboratory record. If a failure is not resolved, it is conveyed to the Laboratory QAO who determines if the failure compromised associated results. The nature and disposition of the problem will be documented in the report sent to the Project Coordinator.

GROUP D: DATA VALIDATION AND USABILITY

D.1: Data Review, Verification and Validation Requirements

All data reported for SPoT will be checked for errors in transcription, calculation, and computer input by the Laboratory Director, Sample Manager, and/or Laboratory QAO. Additionally, the Laboratory QAO will review sample logs and data forms to ensure that requirements for sample preservation, sample integrity, equipment calibration, and data quality have been met. Data that do not meet these requirements will either not be reported or will be reported with qualifiers, which serve as an explanation of any necessary considerations.

D.2: Verification and Validation Methods

Field data will be submitted electronically to the Water Boards' FTP site through the use of a shell database. Field crews will check the entered data for typos and errors before the Laboratory QAO and PM verify the data to ensure proper flagging for equipment failures and impossible values.

Laboratory data will be sent electronically to SWAMP IQ for verification and inclusion in the SWAMP Database. SWAMP IQ will follow the SWAMP SOPs and Data Management Plans when reviewing submitted data and determining compliance with the applicable SWAMP MQOs. Discrepancies in flagged data, noted during the data verification process, will be communicated to the SWAMP QAO, Laboratory QAO, and PM prior to loading. Excessive amounts of data discrepancies may warrant corrective action, as described in section C.1.

D.3: Reconciliation with User Requirements

Sediment toxicity and chemistry data are collected annually. Toxicity data are analyzed using SWAMP hypothesis testing methods that involve separate-variance t-tests and comparisons to a threshold value based on the control. These results are submitted to the SWAMP Database. Additional analysis using the Test for Significant Toxicity (U.S. EPA 2010) is conducted for trend reporting. Single samples are categorized based on the magnitude of toxicity ("non-toxic," "toxic," and "highly toxic"). Toxicity responses are also summarized for each site and categorized as "no toxicity," "some toxicity," "moderate toxicity," and "high toxicity." Sites with no toxic samples are non-toxic; sites with at least one toxic sample have some toxicity; sites with at least one sample below the high toxicity threshold (38.6%) have moderate toxicity, and sites with an average survival less that the high toxicity threshold have high toxicity. Toxicity responses are also compared to chemical concentrations within land uses using Spearman's rank correlation, and further compared to individual chemical thresholds based on median lethal concentrations. Significant trends of toxicity and chemical concentrations at individual sites, within land uses, and statewide are determined using the Mann-Kendall analysis.

Potential anomalies that might occur during analysis include loss of data due to contract labs not meeting quality assurance requirements, or constantly evolving analyte lists based on inconsistent use of the same contract lab. Examples of this include the loss of the 2019 PCB data set because the contract laboratory violated business rules set forth by SWAMP and within this document. These data were omitted from trend analysis. Another example includes differing abilities among contract labs to measure a single set of PCB congeners. This has led to

recalculations of sum PCB values for data analysis. These anomalies are reported to the SWAMP QAO.

APPENDIX A: LIST OF ACRONYMS AND INITIALISMS

COC:	Chain of Custody
ELAP:	Environmental Laboratory Accreditation Program
GC/MS:	Gas Chromatography/Mass Spectrometry
GC/MS/MS:	Gas chromatography coupled to tandem mass spectrometry
HUC:	Hydrologic Unit Codes
MDL:	Method Detection Limit
MQO:	Measurement Quality Objectives
NAWQA:	National Water Quality Assessment
NCI:	Negative Chemical Ionization
OIMA:	Office of Information Management and Analysis
PM:	Project Manager
QA:	Quality Assurance
QAO:	Quality Assurance Officer
QAPP:	Quality Assurance Project Plan
QC:	Quality Control
RPD:	Relative Percent Difference
RL:	Reporting Limit
RSD:	Relative Standard Deviation
SOP:	Standard Operating Procedures
SPoT:	Stream Pollution Trends Monitoring Program
SWAMP:	Surface Water Ambient Monitoring Program
SWAMP IQ:	Surface Water Ambient Monitoring Program Information Management and Quality Assurance Center
SWRCB:	State Water Resources Control Board
TMDL:	Total Maximum Daily Load
TOC:	Total Organic Carbon

UCD-GC:	University of California, Davis, Marine Pollution Studies Laboratory at Granite Canyon
U.S. EPA:	U.S. Environmental Protection Agency
USGS:	U.S. Geological Survey

APPENDIX B: STANDARD OPERATING PROCEDURES (SOPS) FOR CONDUCTING FIELD COLLECTIONS OF BED SEDIMENT SAMPLES AT WATERSHED INTEGRATOR SITES IN THE SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP) STREAM POLLUTION TREND (SPOT) PROGRAM

Marine Pollution Studies Laboratory (MPSL) – Granite Canyon

Revision 2

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Field Collection Procedures for Bed Sediment Samples in the SWAMP SPoT Program

Fundamental Considerations

1. The SWAMP SPoT Program monitoring at Watershed Integrator Sites is based on the concept that sediment collected from stream depositional areas serves as an indicator of recent pollutant mobilization throughout the upstream watershed. It is therefore critical that sediments are collected from multiple streambed areas where active deposition occurs. Field crews are trained in the field to be well acquainted with stream geomorphology to distinguish between areas of recent deposition (within the past year), and areas where benches, failed banks, or other features indicate older deposits.

2. Contaminants washed from watershed surfaces predominantly adsorb to and are transported with fine particulate matter. Thus it is also critical for contaminant detection and method standardization over time that only fine grained sediments are sampled. Ideally, only fine sediments of less than 64 um in diameter would be collected. In practice, the target is for fine-grained sediments to make up more than 50% of the sample (>50% fines). Before collection, sediment grain size should be checked in the field. Sediment that feels smooth when rubbed between gloved fingers is preferred, and sediment that feels gritty should be rejected unless finer sediment is unavailable in depositional areas at suitable integrator sites.

If suitable depositional areas for collecting sediments cannot be found at a target site, the project scientist (Bryn Phillips or designee) may decide to search the general area for an alternate integrator site where fine sediment is deposited. If an alternate location is sampled, the project scientist will notify collaborating institutions (Regional Monitoring Coordinators, stormwater agencies, etc.) of the change in location. This may result in renaming of the site, and may affect trends analyses. If no suitable depositional areas can be found, sampling personnel should not collect the sediment sample, and should discuss alternatives with the project scientist and collaborators. In this case, a note is added to the cruise report so that the missing sample is accounted for in the reconciliation of monitoring events. Sites that are routinely difficult to collect should be considered for elimination or relocation from the sample schedule, if appropriate.

Field Data Sheets

Field data sheets are used to record specific information about site location, number of depositional areas sampled, types of analyses to be conducted, collection method, and other information. The entries discussed below and on the field data sheets are recorded at each sampling site.

Notes to Standardize SWAMP Field Data Sheets

(For in the field use)

Key Reminders to identify samples:

1. **Sample Time** is the SAME for all samples (Water, Sediment, & Probe) taken at the sampling event. Use time of FIRST sample as it is important for the chain of custody (COC).
2. **Left Bank/Right Bank**
   Left bank is defined as the bank to the left of the observer when facing downstream, and the *right bank* is to the right of the observer when facing downstream.

Field Observations: (each one of these observations has a *Comment* field in the database so use comment space on data sheet to add information about an observation if necessary)

1. **Dominant Substrate**: If possible; describe DOMINANT substrate type; use UNK if you cannot see the dominant substrate type.
2. **Wadeability**: In general, is the water body being sampled wadeable to the average person at the point of sample?

Sample Details:

1. **Event Type**: Note the event type based on which type of media is being collected. For integrator sites, this will always be "WQ."
2. **Personnel**: First initial and last name (J. Smith, S. Ride). The first person listed is crew leader.
3. **Target Lat/Long**: Refers to the existing station location that the sampling crew is trying to achieve; can be filled out prior to sampling
4. **Actual Lat/ Long**: is the location of the current sample event. Record coordinates for both upstream extent of sampled reach [Pt1 (U/S)] and downstream extent of sampled reach. [Pt2 (D/S)] Sampling that occurs more than 500m from the target site, due to access issues or lack of fine sediments, may be designated as a separate sampling site.
5. **Occupation Method**: Circle descriptor of how the site is accessed.
6. **Sample Type**: For integrator sites, this will always be "Integrated."
7. **Number of Containers Filled**: Record the number of containers filled for each analysis type.
8. **Depositional Area Sample Information**: For each depositional area sampled, circle the appropriate notations in each column. "Under" indicates sediment was submerged; "P" = present; "A" = absent; the "DepthCollec" is the thickness of the sediment layer removed; "SS" = stainless steel; "PC" = polycarbonate; "PE" = polyethylene.
9. **Comments**: In the comments box, draw a rectangle to indicate the shape of the reach sampled, and mark an "x" within it to show the approximate distribution of depositional areas sampled. Record the approximate average water depth, and add any comments about observed inputs or conditions that might affect sediment quality.

Site Summaries
After each field survey, text describing the following characteristics of the site and collection process should be recorded for the cruise report:

1. Site location: Provide details (beyond lat longs and other information on the field data sheet) that would allow future field crews or analysts to understand the nature of the sediment sampled, such as water depth, flow, and whether sediment was collected under a bridge, behind an obstruction, within vegetation patches, inside bends, etc.

2. Access: Provide information to help with future access, such as contact information for permissions, information about gates and locks, specific location of access paths, etc.

3. Representativeness of depositional areas: Since sediment deposition depends on stream morphology, not all streams will allow collection of sediment from multiple areas along a 100 meter reach. If sediment is collected from other types of depositional areas, the configuration of the depositional area(s) sampled should be described, and a justification should be given as to how the sampled area is expected to contain the range of fine material representative of that generally transported by the stream over the target time period.

Bed Sediment Sample Collection
If samples of water and bed sediment (hereafter termed "sediment") are taken in the same 100m reach, water samples are collected first. Care must be taken not to sample sediments that have been walked on or disturbed in any manner by field personnel. Sediment samples from all depositional areas within a site are placed into the same 4-liter composite jar, which is filled at least three quarters full. Once all depositional areas at a site have been sampled, the jar is sealed and placed on ice in a cooler. Once sample jars arrive at MPSL, they are thoroughly homogenized, and then aliquoted into separate jars for chemical or toxicological analysis. Sediment samples for organics are submitted to the respective analytical laboratories in separate glass jars, which have been pre-cleaned according to laboratory protocol.

Labeling
Label the jars with the station ID, sample code, matrix type, project ID, time, and date of collection, as well as the type of analysis requested (e.g., conventionals, organics, or archives).

Characteristics of Ideal Sediment Material to be Collected
Many of the chemical constituents of concern are adsorbed onto fine particles. One of the major objectives in selecting a sample site, and in actually collecting the sample while on site, is to obtain recently deposited fine sediment, to the extent possible. Avoid hard clay, bank deposits, gravel, disturbed and/or filled areas. In following this guidance, the collection of sediment is purposefully being biased for fine materials, which must be discussed thoroughly in any subsequent interpretive reporting of the data, in regards to representation of the collected sample to the environment from which it was collected.

Characteristics of an Ideal Site
Quiescent areas are conducive to the settling of finer materials (EPA/USACOE, 1981). Within the 100-meter reach of the site, choose depositional areas with lower hydrologic energy, such as the inner (depositional) side of bends or eddies where the water movement may be slower. Impoundments, reservoirs and estuaries are also generally depositional environments.

Selecting the Appropriate Sediment Type for Analysis
Sediment will vary from site to site and can vary between sample events at a particular site.

Streams and Rivers: Sediment collection in flowing streams is often a challenge. In areas of frequent scouring, there may not be sufficient sediment for collection during or following periods of high flow. Sediment collection during these times may prove unsuccessful and may have to be rescheduled or cancelled.

More often than not, a dredge or mechanical grab device does not function well for collection of sediment in smaller streams. In many cases, sediment will have to be collected using a pre-cleaned polyethylene scoop or polycarbonate core tube. Collect the top 1 to 5 cm for analysis, depending on the homogeneity of the sediment. If the sediment exhibits clear layering, collect only the upper-most layer. If the sediment appears vertically homogeneous, the entire top 5 cm may be collected. Sediment is collected from 5 to 10 depositional areas within a 100-m reach and these are composited within the sample jar.

Reservoirs, ponds, and other impoundments: Collect the top 1 to 5 cm for analysis, as above. Five to 10 grabs are composited for the sediment sample, with grabs spaced within an area comparable to a 100 meter reach that would be expected to yield fine sediment representative of that transported by the stream.

General Procedure for Collection of Bed Sediment
After choosing appropriate depositional areas within the site reach, collect the sample using one or more of the following procedures, depending on the setting. Access to the sediment often depends on the type of protective clothing worn by field crews. Field crews generally wear chest waders. Wet suits and other diving gear are generally avoided due to hygiene considerations in contaminated streams. When crews can reach the stream bottom with their hands (without diving), short core tubes are preferred. When water is more than about half a meter deep, longer cores tubes are preferred. Core tubes are preferred over scoops because tubes minimize the loss of fine material from the sediment surface. Scoops may be used when debris makes cores ineffective, or when sampling dry or damp sediment that is no longer submerged. Grabs are used when water is too deep to wade, or when long cores are ineffective.

The goal is to collect the top 1 to 5 cm of recently-deposited fine sediment only. Survey the sampling area for appropriate fine-sediment depositional areas before stepping into the stream to avoid disturbing possible sediment collection sub-sites. Carefully enter the stream and start sampling at the closest appropriate reach, then continue sampling UPSTREAM. Advancing downstream may in some cases lead to sampling disturbed sediment.

A. Hand Core Method – primary method for shallow streams

1. Short cores:

- The short hand core sampler consists of a 10-cm-diameter polycarbonate core approximately 50 cm long.
- One method of using short core tubes is to:

    a. Push the tube vertically into the sediment to beyond the desired sample depth
    b. Cap the bottom with a polyethylene core cap or by placing a gloved hand underneath the tube to hold the sediment in place
    c. Pull the core out of the sediment
    d. Slowly decant off overlying water
    e. Push the sediment out of the tube, discarding all but the top 5 cm (or less), and
    f. Place the remaining surficial sediment in the collection jar

- A second method for using short core tubes is to slide the tube horizontally along the sediment, with the bottom edge 5 cm or less below the sediment surface. The core is thus used as a scoop, but has better control and retention of fine surficial material. Both ends of the core are then covered with gloved hands, the core is raised out of the water, overlying water is slowly decanted off, and the sediment sample is placed in the jar.

2. Long cores:

- The long hand core sampler consists of a 5-cm-diameter polycarbonate core approximately 1.5 meters long.
- To collect samples with a long core:

    a. Push the tube vertically into the sediment to beyond the desired sample depth
    b. Cap the top of the core with a gloved hand to create suction
    c. Pull the core out of the sediment
    d. Slowly decant off overlying water
    e. Push the sediment out of the tube, discarding all but the top 5 cm (or less), and

f. Place the remaining surficial sediment in the collection jar

B. Sediment Scoop Method – Alternate Method for Shallow Streams with Debris

In situations where the target fine sediment is found among plants, rocks, sand, shells, or other debris, a scoop may be the best way to collect. Use a separate pre-cleaned polyethylene scoop for each site. The same scoop may be used for multiple depositional areas within a site. Push the scoop up to 5 cm below the sediment surface and gently slide it along until it is just full of sediment. Place a gloved hand over the sediment as the scoop is brought to the water surface to minimize loss of fine material. Place the sediment into the collection jar.

In situations where adequate depth and quantities of homogeneous fine sediment is found beneath mats of vegetation, the sediment may be scooped with a gloved hand, brought to the surface, and placed in the jar. If necessary, vegetation and other debris may be removed with a gloved hand.

C. Sediment Grab Method — Alternate method for deeper waters.

Description of sediment grab equipment:

- A mechanical sediment grab such as a stainless steel “Young-modified Van Veen" or “Petite Ponar” is suitable.
- The mechanical grab is deployed primarily from a boat, and is used in deeper, non-wadeable waters.
- It is also deployed by field personnel from land in settings which allow its use: primarily from bridges; from smaller vessels in deep streams or drainage channels.
- Smaller grabs (e.g. Petite Ponar) may be deployed while wading in channels if necessary.

Deploying and retrieving the grab:

- Slowly lower the grab to the bottom with a minimum of substrate disturbance.
- Retrieve the closed dredge at a moderate speed (e.g., less than two feet per second).
- Upon retrieval, open the lids of the sediment grab, examine the sample to ensure that the sediment surface is undisturbed, that fine-grained material has been collected, and that the sample should not be rejected.

Rejection Criteria—reject the sample if the following are not met:

- Mud surface must not be pressing out of the top of the sampler. If it is, lower the grab more slowly.
- Overlying water must not be leaking out along the sides of the sediment in the grab. This ensures the surficial sediment is not washed out.
- Sediment surface is flat and level in the sampler. If it is not level, the grab has tilted over before closing.

Processing the sediment sample from the grab equipment:

- The water overlying the sediment in the grab is very gently decanted by slightly tipping the grab with the lid closed until the water runs out the top.

- The decanting process should remove all of the overlying water but not remove the surficial sediments. The laboratory reports percent water for the sample, so overlying water is not included in the sample container.
- The sediment is examined for depth of penetration, color and thickness of top aerobic zone, and texture. These observations are recorded in the logbook.
- Use a pre-cleaned polyethylene scoop to collect the top 1 to 5 cm from at least five sub-samples, and otherwise, exclude the bottom-most layer.

Cleaning the Grab Equipment and Protection from Potential Contaminating Sources:

- The sediment sampler will be cleaned prior to sampling EACH site by: rinsing all surfaces with ambient water; scrubbing all sediment sample contact surfaces with Micro™ or equivalent detergent; rinsing all surfaces with ambient water; rinsing sediment sample contact surfaces with 5% HCl; and rinsing all sediment sample contact surfaces with methanol.
- The sediment grab will be scrubbed with ambient water between successive deployments at ONE site, in order to remove adhering sediments from contact surfaces possibly originating below the sampled layer, thus preventing contamination from areas beyond target sampling area.
- Sampling procedures will attempt to avoid exhaust from any engine aboard any vessel involved in sample collection. An engine will be turned off when possible during portions of the sampling process where contamination from engine exhaust may occur. It is critical that sample contamination be avoided during sample collection. All sampling equipment (e.g., siphon hoses, scoops, containers) will be made of non-contaminating material and will be appropriately cleaned before use. Samples will not be touched with un-gloved fingers. In addition, potential airborne contamination (e.g., from engine exhaust, cigarette smoke) will be avoided.

General Procedure for Processing of Bed Sediment Samples, Once They are Collected

Transport of Sample Jars:

- Make sure all containers are capped tightly and stored in a cooler on cube ice at 4 °C.
- Check cooler temperature and record in log book every 8-12 hours or whenever sampler suspects that the temperature has not been maintained at 4 °C.

Sediment Homogenization, Aliquoting and Transport

Sediment samples from the multiple depositional areas within a reach may be put in the collection jar, sealed, and placed in coolers for transport without field homogenization. Immediately place the labeled jar on ice, cool to 4 °C, and keep in the dark at 4 °C until delivery to the laboratory. Once samples arrive at the laboratory, the sediment in the container is homogenized and aliquoted. All sample identification information (station numbers, etc.) will be recorded prior to homogenizing and aliquoting. The sample is stirred with a polyethylene scoop or spoon for at least 2 min, but longer if necessary, until sediment/mud appears homogeneous. The sediment sample is then aliquoted, using a clean plastic scoop, into appropriate containers for trace metal chemistry, organic chemistry, and toxicity testing, as described in the table below.

Summary of Sample Container, Volume, Preservation, and Storage Requirements for Bed Sediment Samples (for contaminant analysis)

Sample Handling: Inorganic Analytes in Freshwater Sediment and Marine Sediment

Parameter	Recommended Container[1]	Recommended Preservation	Required Holding Time[2]
Grain Size	Glass	Wet ice to ≤ 6 °C in the field, then refrigerate at ≤ 6 °C	1 year
Organic Carbon (Total)	Glass	Cool to ≤ 6 °C or freeze to ≤ -20 °C	28 days at ≤ 6 °C; 1 year at ≤ -20 °C

[1] Samples for total organic carbon and grain size analysis can be combined in one 250-mL clear glass jar, and sub-sampled at the laboratory in order to utilize holding time differences for the two analyses. If this is done, the 250 mL combined sediment sample must be refrigerated only (not frozen) at ≤ 6 °C for up to 28 days, during which time the sub-samples must be aliquoted in order to comply with separate storage requirements.

[2] Each "Required Holding Time" is based on the assumption that the "Recommended Preservation" (or a method-mandated alternative) has been employed. If a "Required Holding Time" for filtration, preservation, preparation, or analysis is not met, the Project Manager (PM) and SWAMP Quality Assurance Officer (QAO) must be notified. Regardless of preservation technique, data not meeting the "Required Holding Time" will be appropriately flagged in the SWAMP database.

Sample Handling: Inorganic Analytes in Freshwater Sediment and Marine Sediment

Analyte	Recommended Container	Recommended Preservation	Required Holding Time[1]
Methylmercury	Glass	Freeze to ≤ -20 °C immediately	1 year
Trace Metals[2]	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	1 year; samples must be analyzed within 14 days of collection or thawing

[1] Each "Required Holding Time" is based on the assumption that the "Recommended Preservation" (or a method-mandated alternative) has been employed. If a "Required Holding Time" for filtration, preservation, preparation, or analysis is not met, the PM and SWAMP QAO must be notified. Regardless of preservation technique, data not meeting the "Required Holding Time" will be appropriately flagged in the SWAMP database.

[2] With the exception of methylmercury

Sample Handling: Synthetic Organic Compounds in Freshwater Sediment and Marine Sediment

Analyte	Recommended Container	Recommended Preservation	Required Holding Time[1]
Diesel Range Organics **Organochlorine Pesticides** **Organophosphate Pesticides** **Polynuclear Aromatic Hydrocarbons** **Surfactants** **Wastewater Organochlorine Pesticides**	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	1 year; samples must be extracted within 14 days of collection or thawing and analyzed within 40 days of extraction
Polybrominated Diphenyl Ethers **Polychlorinated Biphenyls** (as Congeners/Aroclors)	Glass	Cool to ≤ 6 °C within 24 hours, then freeze to ≤ -20 °C	None
Pyrethroids	Glass	Short-term storage: ≤ 6 °C in the dark; long-term storage, or storage of remaining sample: ≤ -20 °C in the dark	1 year at ≤ -20 °C in the dark; samples must be extracted within 14 days of collection or thawing and analyzed within 40 days of extraction

[1] Each "Required Holding Time" is based on the assumption that the "Recommended Preservation" (or a method-mandated alternative) has been employed. If a "Required Holding Time" for filtration, preservation, preparation, or analysis is not met, the PM and SWAMP QAO must be notified. Regardless of preservation technique, data not meeting the "Required Holding Time" will be appropriately flagged in the SWAMP database.

Sample Handling: Sediment Toxicity in Freshwater Sediment and Marine Sediment

Analyte	Recommended Container	Recommended Preservation[2]	Required Holding Time[1]
Sediment Toxicity in Freshwater Sediment	Glass (amber)	Cool to ≤ 6 °C with wet or blue ice in the field, store at ≤ 6 °C refrigeration in the dark at all times	< 14 days (recommended) or <8 weeks (required) at ≤ 6 °C in the dark; do not freeze
Sediment Toxicity in Marine Sediment	Glass (amber)	Cool to ≤ 6 °C with wet or blue ice in the field, store at ≤ 6 °C refrigeration in the dark at all times	< 14 days (recommended) or < 8 weeks (required) at ≤ 6 °C in the dark; do not freeze

[1] Each “Required Holding Time” is based on the assumption that the “Recommended Preservation” (or a method-mandated alternative) has been employed. If a “Required Holding Time” for filtration, preservation, preparation, or analysis is not met, the PM and SWAMP QAO must be notified. Regardless of preservation technique, data not meeting the “Required Holding Time” will be appropriately flagged in the SWAMP database.

APPENDIX C: UCD-GC CHAIN OF CUSTODY FORM

University of California, Davis - Marine Pollution Studies Laboratory							
Chain of Custody							
34500 Highway One				Contact: Katie Siegler			
Monterey, CA 93940				Phone: 831-624-0947			
Final Destination:				Contact:			
				Phone:			
Sample Name	Sample ID	Date	Analysis	Quantity			
	Number	Sampled					
	Date	Signature		Time	Location		
Relinquished by:							
Received by:							
Relinquished by:							
Received by:							
Relinquished by:							
Received by:							

APPENDIX D: FIELD DATA SHEET

SWAMP Field Data Sheet (Sediment Chemistry) - Integrator Study (EventType=WQ)										Entered in d-base (initial/date)				Pg of Pgs
*StationID:			*Date (mm/dd/yyyy): / /							*Group:				*Agency: UCD-GC
*Funding:			*SampleTime (1st sample):							*Project: SWB_SPoT_2020			*Protocol: SWAMP_SPoT	
Personnel:			*Purpose (circle all that apply): SedChem SedTox FieldObs							*PurposeFailure:				
*Location: Reach			*GPS/DGPS		Lat (dd.ddddd)			Long (ddd.ddddd)		Corrections/Changes				
GPS Device: Garmin 64st			Target:					–						
Datum: NAD83		Accuracy (ft/m):	*Pt1 (Upstream):					–						
Sonde: YSI Exo3 Calibr. Date			*Pt2 (Downstream):					–						

Field Observations (SampleType = FieldObs)	WADEABILITY: Y / N / Unknown	Field Dup: YES / NO	SampleType=Integrated; LABEL_ID = FieldQA; create collection record upon data entry
DOMINANTSUBSTRATE: Bedrock, Concrete, Cobble, Gravel, Sand, Mud, Unk, Other		OCCUPATION METHOD: Walk-in R/V _____	
WATER CLARITY: Clear (see bottom), Cloudy (>4" vis), Murky (<4" vis)	WATER COLOR: Colorless, Green, Yellow, Brown		
PLANT PRESENCE: Vascular, Nonvascular, Benthic Algae, Filamentous, Periphyton Layer, None	D.O. (mg/L)	pH	Cond.(uS/cm) Temp. (°C)

Depositional Area Sample Information

Area	Overlying Water	Sample Debris	DepthCollec (cm)	Equipment Used			Notes
1	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
2	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
3	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
4	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
5	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
6	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
7	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
8	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
9	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	
10	Under / Damp / Dry	P A		Scoop (PE)	Core (PC)	Gloved Hand	

COMMENTS: SAMPLE 5-10 DEPOSITIONAL AREAS WITHIN A 100 METER AREA, DRAW A BOX (USING 'X' FOR SAMPLE AREAS) WITH AN IDEA OF THE SPACING; SEDIMENT SHOULD BE FINE-GRAIN AND NOT FEEL GRITTY; ADD COMMENTS ABOUT OUTFALLS, PIPES, DRAINS, AND TRIBUTARIES

DO Probe Calibration QA	
% Sat Pre Sample	
% Sat Post Sample	
Bar. Pressure	

APPENDIX E: REPORTING LIMITS AND SAMPLING STATION ANALYTES

Target analytes and reporting limits (RLs) are listed as programmatic goals. Current analytes and reporting limits are listed based on what the current analysis lab is capable of achieving.

Table A. Laboratory Reporting Limits for SPoT Analytes in Sediment.

Analyte Group	Target Analyte	Target RL	Current RL	Unit
Metals	Arsenic (total)	0.3	0.27	mg/kg dw
Metals	Cadmium (total)	0.1	0.03	mg/kg dw
Metals	Chromium (total)	1	0.75	mg/kg dw
Metals	Copper (total)	2	1.92	mg/kg dw
Metals	Lead (total)	1	0.93	mg/kg dw
Metals	Manganese (total)	3	0.90	mg/kg dw
Metals	Mercury (total)	0.006	0.006	mg/kg dw
Metals	Nickel (total)	1.2	1.17	mg/kg dw
Metals	Silver (total)	0.2	0.06	mg/kg dw
Metals	Zinc (total)	10	3.96	mg/kg dw
Organochlorine	Aldrin (total)	1	0.1	ng/g dw
Organochlorine	Chlordane (cis-; total)	1	0.1	ng/g dw
Organochlorine	Chlordane (trans-; total)	1	0.1	ng/g dw
Organochlorine	Dacthal (total)	1	NA	ng/g dw
Organochlorine	DDD (o,p'; total)	1	0.1	ng/g dw
Organochlorine	DDD (p,p'; total)	1	0.1	ng/g dw
Organochlorine	DDE (o,p'; total)	2	0.1	ng/g dw
Organochlorine	DDE (p,p'; total)	2	0.1	ng/g dw
Organochlorine	DDMU (p,p'; total)	3	0.1	ng/g dw
Organochlorine	DDT (o,p'; total)	3	0.1	ng/g dw
Organochlorine	DDT (p,p'; total)	5	0.1	ng/g dw
Organochlorine	Dieldrin (total)	0.5	0.1	ng/g dw
Organochlorine	Endosulfan I (total)	2	0.1	ng/g dw
Organochlorine	Endosulfan II (total)	5	0.1	ng/g dw
Organochlorine	Endosulfan Sulfate (total)	5	0.1	ng/g dw
Organochlorine	Endrin Aldehyde (total)	2	0.1	ng/g dw
Organochlorine	Endrin Ketone (total)	2	0.1	ng/g dw
Organochlorine	Endrin (total)	2	0.1	ng/g dw
Organochlorine	HCH (alpha-; total)	0.5	0.1	ng/g dw
Organochlorine	HCH (beta-; total)	1	0.1	ng/g dw
Organochlorine	HCH (gamma-; total)	0.5	0.1	ng/g dw
Organochlorine	Heptachlor Epoxide (total)	1	0.1	ng/g dw
Organochlorine	Heptachlor (total)	1	0.1	ng/g dw
Organochlorine	Hexachlorobenzene (total)	0.2	0.1	ng/g dw
Organochlorine	Methoxychlor (total)	3	0.1	ng/g dw

Analyte Group	Target Analyte	Target RL	Current RL	Unit
Organochlorine	Mirex Total (total)	1.5	0.1	ng/g dw
Organochlorine	Nonachlor (cis-; total)	1	0.1	ng/g dw
Organochlorine	Nonachlor (trans-; total)	1	0.1	ng/g dw
Organochlorine	Oxadiazon (total)	1	NA	ng/g dw
Organochlorine	Oxychlordane (total)	1	NA	ng/g dw
PAH	Acenaphthene (total)	2	0.1	ng/g dw
PAH	Acenaphthylene (total)	2	0.1	ng/g dw
PAH	Anthracene (total)	2	0.1	ng/g dw
PAH	Benz(a)anthracene (total)	2	0.1	ng/g dw
PAH	Benzo(a)pyrene (total)	5	0.1	ng/g dw
PAH	Benzo(b)fluoranthene (total)	2	0.1	ng/g dw
PAH	Benzo(e)pyrene (total)	5		ng/g dw
PAH	Benzo(g,h,i)perylene (total)	5	0.1	ng/g dw
PAH	Benzo(k)fluoranthene (total)	5	0.1	ng/g dw
PAH	Biphenyl (total)	2		ng/g dw
PAH	Chrysene (total)	2	0.1	ng/g dw
PAH	Chrysenes, C1- (total)	2		ng/g dw
PAH	Chrysenes, C2- (total)	2		ng/g dw
PAH	Chrysenes, C3- (total)	2		ng/g dw
PAH	Dibenz(a,h)anthracene (total)	5	0.1	ng/g dw
PAH	Dibenzothiophene (total)	2		ng/g dw
PAH	Dibenzothiophenes, C1- (total)	2		ng/g dw
PAH	Dibenzothiophenes, C2- (total)	2		ng/g dw
PAH	Dibenzothiophenes, C3- (total)	2		ng/g dw
PAH	Dimethylnaphthalene, 2,6- (total)	2		ng/g dw
PAH	Dimethylphenanthrene, 3,6- (total)	2		ng/g dw
PAH	Fluoranthene/Pyrenes, C1- (total)	2		ng/g dw
PAH	Fluoranthene (total)	2	0.1	ng/g dw
PAH	Fluorene (total)	2	0.1	ng/g dw
PAH	Fluorenes, C1- (total)	2		ng/g dw
PAH	Fluorenes, C2- (total)	2		ng/g dw
PAH	Fluorenes, C3- (total)	2		ng/g dw
PAH	Indeno(1,2,3-c,d) pyrene; (total)	5	0.1	ng/g dw
PAH	Methyldibenzothiophene, 4- (total)	2		ng/g dw
PAH	Methylfluoranthene, 2- (total)	2		ng/g dw
PAH	Methylfluorene, 1- (total)	2		ng/g dw
PAH	Methylnaphthalene, 1- (total)	2		ng/g dw
PAH	Methylnaphthalene, 2- (total)	2		ng/g dw
PAH	Methylphenanthrene, 1- (total)	2		ng/g dw
PAH	Naphthalene (total)	5	0.1	ng/g dw
PAH	Naphthalenes, C1- (total)	5		ng/g dw

Analyte Group	Target Analyte	Target RL	Current RL	Unit
PAH	Naphthalenes, C2- (total)	5		ng/g dw
PAH	Naphthalenes, C3- (total)	5		ng/g dw
PAH	Naphthalenes, C4- (total)	5		ng/g dw
PAH	Perylene (total)	5		ng/g dw
PAH	Phenanthrene/Anthracene, C1- (total)	5		ng/g dw
PAH	Phenanthrene/Anthracene, C2- (total)	5		ng/g dw
PAH	Phenanthrene/Anthracene, C3- (total)	5		ng/g dw
PAH	Phenanthrene/Anthracene, C4- (total)	5		ng/g dw
PAH	Phenanthrene; Total (total)	5	0.1	ng/g dw
PAH	Pyrene; Total (total)	2	0.1	ng/g dw
PAH	Trimethylnaphthalene, 2,3,5- (total)	2		ng/g dw
PBDE	PBDE 017 (total)	0.2	0.1	ng/g dw
PBDE	PBDE 028 (total)	0.2	0.1	ng/g dw
PBDE	PBDE 030 (total)	0.2	0.1	ng/g dw
PBDE	PBDE 047 (total)	0.2	0.1	ng/g dw
PBDE	PBDE 049 (total)	0.2		ng/g dw
PBDE	PBDE 066 (total)	0.2	0.1	ng/g dw
PBDE	PBDE 085 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 099 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 100 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 138 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 153 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 154 (total)	0.4	0.1	ng/g dw
PBDE	PBDE 179 (total)	1	0.1	ng/g dw
PBDE	PBDE 183 (total)	1	0.1	ng/g dw
PBDE	PBDE 184 (total)	1	0.1	ng/g dw
PBDE	PBDE 188 (total)	1	0.1	ng/g dw
PBDE	PBDE 190 (total)	1	0.1	ng/g dw
PBDE	PBDE 200 (total)	0.8	0.1	ng/g dw
PBDE	PBDE 201 (total)	0.8	0.1	ng/g dw
PBDE	PBDE 202 (total)	0.8	0.1	ng/g dw
PBDE	PBDE 203 (total)	0.8	0.1	ng/g dw
PBDE	PBDE 206 (total)	2	0.1	ng/g dw
PBDE	PBDE 207 (total)	2	0.1	ng/g dw
PBDE	PBDE 208 (total)	2	0.1	ng/g dw
PBDE	PBDE 209 (total)	10	0.1	ng/g dw
PCB	PCB 008 (total)	0.2	NA	ng/g dw
PCB	PCB 018 (total)	0.2	NA	ng/g dw
PCB	PCB 027 (total)	0.2	NA	ng/g dw
PCB	PCB 028 (total)	0.2	NA	ng/g dw
PCB	PCB 029 (total)	0.2	NA	ng/g dw

Analyte Group	Target Analyte	Target RL	Current RL	Unit
PCB	PCB 031 (total)	0.2	NA	ng/g dw
PCB	PCB 033 (total)	0.2	NA	ng/g dw
PCB	PCB 044 (total)	0.2	NA	ng/g dw
PCB	PCB 049 (total)	0.2	NA	ng/g dw
PCB	PCB 052 (total)	0.2	NA	ng/g dw
PCB	PCB 056 (total)	0.2	NA	ng/g dw
PCB	PCB 060 (total)	0.2	NA	ng/g dw
PCB	PCB 066 (total)	0.2	NA	ng/g dw
PCB	PCB 070 (total)	0.2	NA	ng/g dw
PCB	PCB 074 (total)	0.2	NA	ng/g dw
PCB	PCB 087 (total)	0.2	NA	ng/g dw
PCB	PCB 095 (total)	0.2	NA	ng/g dw
PCB	PCB 097 (total)	0.2	NA	ng/g dw
PCB	PCB 099 (total)	0.2	NA	ng/g dw
PCB	PCB 101 (total)	0.2	NA	ng/g dw
PCB	PCB 105 (total)	0.2	NA	ng/g dw
PCB	PCB 110 (total)	0.2	NA	ng/g dw
PCB	PCB 114 (total)	0.2	NA	ng/g dw
PCB	PCB 118 (total)	0.2	NA	ng/g dw
PCB	PCB 128 (total)	0.2	NA	ng/g dw
PCB	PCB 137 (total)	0.2	NA	ng/g dw
PCB	PCB 138 (total)	0.2	NA	ng/g dw
PCB	PCB 141 (total)	0.2	NA	ng/g dw
PCB	PCB 149 (total)	0.2	NA	ng/g dw
PCB	PCB 151 (total)	0.2	NA	ng/g dw
PCB	PCB 153 (total)	0.2	NA	ng/g dw
PCB	PCB 156 (total)	0.2	NA	ng/g dw
PCB	PCB 157 (total)	0.2	NA	ng/g dw
PCB	PCB 158 (total)	0.2	NA	ng/g dw
PCB	PCB 170 (total)	0.2	NA	ng/g dw
PCB	PCB 174 (total)	0.2	NA	ng/g dw
PCB	PCB 177 (total)	0.2	NA	ng/g dw
PCB	PCB 180 (total)	0.2	NA	ng/g dw
PCB	PCB 183 (total)	0.2	NA	ng/g dw
PCB	PCB 187 (total)	0.2	NA	ng/g dw
PCB	PCB 189 (total)	0.2	NA	ng/g dw
PCB	PCB 194 (total)	0.2	NA	ng/g dw
PCB	PCB 195 (total)	0.2	NA	ng/g dw
PCB	PCB 200 (total)	0.2	NA	ng/g dw
PCB	PCB 201 (total)	0.2	NA	ng/g dw
PCB	PCB 203 (total)	0.2	NA	ng/g dw
PCB	PCB 206 (total)	0.2	NA	ng/g dw

Analyte Group	Target Analyte	Target RL	Current RL	Unit
PCB	PCB 209 (total)	0.2	NA	ng/g dw
Pyrethroid	Bifenthrin (total)	0.25	0.1	ng/g dw
Pyrethroid	Cyfluthrin (total)	1.25	0.1	ng/g dw
Pyrethroid	Cyhalothrin, Lambda (total)	0.5	0.1	ng/g dw
Pyrethroid	Cypermethrin (total)	1	0.1	ng/g dw
Pyrethroid	Deltamethrin/Tralomethrin (total)	1	0.1	ng/g dw
Pyrethroid	Esfenvalerate/Fenvalerate (total)	0.5	0.1	ng/g dw
Pyrethroid	Fenpropathrin (total)	0.25	0.1	ng/g dw
Pyrethroid	Permethrin (cis-; total)	1.25	0.1	ng/g dw
Pyrethroid	Permethrin (trans-; total)	2.5	0.1	ng/g dw
Pyrethroid	Permethrin (total)	4	0.1	ng/g dw
Phenylpyrazole	Fipronil	2	0.05	ng/g dw
Phenylpyrazole	Fipronil desulfinyl	2	0.05	ng/g dw
Phenylpyrazole	Fipronil sulfide	2	0.05	ng/g dw
Phenylpyrazole	Fipronil sulfone	2	0.05	ng/g dw

Table B. Target Analytes by Sampling Station

Station	Pyrethroids	PAH	PBDE	Fipronil	PFAS	Grain Size	TOC
105KLAMKK	X					X	X
109MAD101	X					X	X
111EELFRN	X					X	X
113NA3269	X					X	X
114LAGWOH	X					X	X
114RRDSDM	X					X	X
201WLK160	X					X	X
204ALA020	X	X	X	X	X	X	X
204SLE030	X	X	X	X	X	X	X
204SMA020	X	X	X	X	X	X	X
205COY060	X	X	X	X	X	X	X
205GUA020	X	X	X	X	X	X	X
206SON010	X					X	X
207KIR020	X	X	X	X	X	X	X
207LAU020	X	X	X	X	X	X	X
207WAL020	X	X	X	X	X	X	X
304SLRWAT	X	X	X	X	X	X	X
304SOK	X	X	X	X	X	X	X
305THU	X	X	X	X	X	X	X
307CML	X					X	X
309DAV	X					X	X
309TDW	X					X	X

Station	Pyrethroids	PAH	PBDE	Fipronil	PFAS	Grain Size	TOC
310ARG	X	X	X	X	X	X	X
310SLB	X					X	X
312SMA	X					X	X
313SAI	X					X	X
314SYN	X					X	X
315ATA	X	X	X	X	X	X	X
315MIS	X	X	X	X	X	X	X
402VRB0xx	X	X	X	X	X	X	X
403STCBQT	X	X	X	X	X	X	X
403STCEST	X					X	X
403STCSSP	X					X	X
404BLNAxx	X	X	X	X	X	X	X
405SGRA2x	X	X	X	X	X	X	X
408CGCS06	X	X	X	X	X	X	X
412LARWxx	X	X	X	X	X	X	X
504BCHROS	X	X	X	X	X	X	X
504SACHMN	X					X	X
508SACBLF	X					X	X
510LSAC08	X					X	X
511CAC113	X					X	X
515SACKNK	X					X	X
515YBAMVL	X	X	X	X	X	X	X
519AMNDVY	X	X	X	X	X	X	X
519BERBRY	X					X	X
519FTRNCS	X					X	X
520BUTPAS	X					X	X
520CBDKLU	X					X	X
520SACLSA	X	X	X	X	X	X	X
531SAC001	X					X	X
532AMA002	X					X	X
535MER007	X					X	X
535MER546	X					X	X
535STC206	X	X	X	X	X	X	X
535STC504	X					X	X
541MER522	X					X	X
541MER542	X					X	X
541MERECY	X	X	X	X	X	X	X
541SJC501	X					X	X
541STC019	X					X	X

Station	Pyrethroids	PAH	PBDE	Fipronil	PFAS	Grain Size	TOC
541STC516	X					X	X
544SAC002	X					X	X
551LKI040	X					X	X
558CCR010	X					X	X
558PKC005	X					X	X
558TUR090	X					X	X
603BSP002	X	X	X	X	X	X	X
631WWKLAR	X					X	X
633WCRSED	X					X	X
634UTRSED	X	X	X	X	X	X	X
635MARSED	X					X	X
635TRKSED	X					X	X
635TROSED	X	X	X	X	X	X	X
637SUS001	X					X	X
719CVSCOT	X					X	X
723ARGRB1	X					X	X
723NROTWM	X					X	X
801CCPT12	X	X	X	X	X	X	X
801SARVRx	X					X	X
801SDCxxx	X	X	X	X	X	X	X
901SJSJC9	X	X	X	X	X	X	X
902SSMR07	X	X	X	X	X	X	X
903SLRRBB	X	X	X	X	X	X	X
904ESCOxx	X	X	X	X	X	X	X
905SDSDQ9	X	X	X	X	X	X	X
906LPLPC6	X	X	X	X	X	X	X
907SDRWAR	X	X	X	X	X	X	X
909SWRWSx	X	X	X	X	X	X	X
911TJHRxx	X	X	X	X	X	X	X

APPENDIX F: REFERENCES

Deng, X. and M. Ensminger. 2021. CDPR SOP FSWA017.00: Procedures for Collecting Water and Sediment Samples for Pesticide Analysis. SOP FSWA017.00

DiToro DM, Zarba CS, Hansen DJ, Berry WJ, Swartz RC, Cowan CE, Pavlou SP, Allen HE, Thomas NA, Paquin PR. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals by using equilibrium partitioning. Environ Toxicol Chem. 10:1541-1583.

Foster IDL, Charlesworth SM. 1996. Heavy metals in the hydrological cycle: Trends and explanation. Hydrological Processes 10:227-261.

Hunt JW, Phillips BM, Anderson BS, Siegler C, Lamerdin S, Sigala M, Fairey R, Swenson S, Ichikawa G, Bonnema A, et al. 2012. Statewide perspective on chemicals of concern and connections between water quality and land use. Surface Water Ambient Monitoring Program – Stream Pollution Trends (SPoT) Program. California State Water Resources Control Board. Sacramento, CA.

Karickhoff SW. 1984. Organic pollutant sorption in aquatic systems. J Hydraulic Engineering. 110:707-736.

SFBRWQCB. 2011. Municipal regional stormwater NPDES permit order R2-2009-0074; NPDES permit no. Cas612008. California Regional Water Quality Control Board- San Francisco Bay Region. Adopted October 14, 2009; revised November 28, 2011.

U.S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates. EPA/600/r-99/064. Office of Research and Development, Washington D.C.

U.S. EPA. 2002. Methods for Measuring Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms. EPA-821-R-02-012. Washington, D.C.: Office of Research and Development.

U.S. EPA. 2010. National Pollutant Discharge Elimination System Test of Significant Toxicity Technical Document. EPA 833-R-10-004. Office of Wastewater Management. Washington, DC.