San Gabriel River Regional Monitoring Program

Quality Assurance Project Plan

Prepared by
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February 2007

Group A Elements: Project Management
Title & Approval Sheets

Quality Assurance Project Plan

PROJECT: San Gabriel River Regional Monitoring Program

DATE: February 15th, 2007

RESPONSIBLE ORGANIZATION:

: Aquatic Bioassay & Consulting Laboratories
29 N. Olive St.
Ventura, CA 93001

1. APPROVAL SIGNITURES

Grant Organization

_____ _____
Suzanne Dallman Ph.D., Project Director Date
The Los Angeles & San Gabriel Rivers Watershed Council

_____ _____
Scott Johnson, Project Manager Date
Aquatic Bioassay & Consulting Laboratories

_____ _____
Karin Wisenbaker, QA Officer Date
Aquatic Bioassay & Consulting Laboratories

_____ _____
Dr. Eric Stein, Technical Workgroup Representative Date
Southern California Coastal Water Research Project

Funding Organization (Los Angeles County Sanitation District)

_____ _____
Monica Gasca, Contract Manager Date
Los Angeles County Sanitation District

2. TABLE OF CONTENTS

LIST OF TABLES

page

LIST OF FIGURES

page

3. DISTRIBUTION LIST

The final Quality Assurance Project Plan (QAPP) will be kept on file at the Los Angeles and San Gabriel Rivers Watershed Council (LASGRWC) offices. The following individuals will receive copies of the approved QAPP and any subsequent revisions:

Name, Affiliation, Contact Information	Project Title
Suzanne Dallman, Ph.D. The Los Angeles and San Gabriel Rivers Watershed Council 700 N. Alameda St. Los Angeles, CA 90012 suzanne@lasgrwc.org (213) 229-9947	Project Director
Scott Johnson Aquatic Bioassay & Consulting Laboratories 29 N. Olive St. Ventura, CA 93001 scj_aqua@pacbell.net (805) 643 5621	Project Manager
Karin Wisenbaker Aquatic Bioassay & Consulting Laboratories 29 N. Olive St. Ventura, CA 93001 abclabs@pacbell.net (805) 643 5621	Project QC Officer
Rich Gossett CRG Marine Laboratories 2020 Del Amo Blvd., Suite 200 Torrance, CA 90501 310 533 5190 x 105 crglabs@sbcglobal.net	CRG Laboratory Manager/ QC Officer
Eric Stein Southern California Coastal Water Research Project 7171 Fenwick Ln. Westminister, CA 92683 (714) 372-9233 erics@sccwrp.org	Technical Workgroup Representative
Michael Lyons Los Angeles Regional Water Quality Control Board Board 320 W. 4th St, Suite 200 Los Angeles, CA 90013-2343 (213) 576-6718 mlyons@rb4.swrcb.ca.gov	Los Angeles Regional Water Quality Control

4. Project/Task Organization

4.1 Involved Parties and Roles.

LASGRWC is a 501(c)(3) non-profit organization of community groups, government agencies, business and academia working cooperatively to solve resource issues in the watershed. Its mission is: to facilitate an inclusive consensus process to preserve, restore, and enhance the economic, social, and ecological health of the Los Angeles and San Gabriel Rivers Watershed through education, research, and planning. As the lead agency in this project, LASGRWC will oversee and administer the sample collection, analysis of samples and data, the maintenance of contracts with the Los Angeles County Sanitation Districts (LACSD), and all report preparation.

Other agencies participating in the program, either through provision of in kind services, budgetary support or participation on the San Gabriel River Regional Monitoring Program (SGRRMP) Workgroup includes:

Agency
AES Corporation
Aquatic Bioassay and Consulting Laboratories
City of Downey
Friends of the San Gabriel River
Los Angeles County Department of Public Works
Los Angeles County Sanitation Districts
Los Angeles Department of Water and Power
Los Angeles & San Gabriel Rivers Watershed Council
Los Angeles Regional Water Quality Control Board
Orange County Stormwater Program
Rivers and Mountains Conservancy
San Gabriel Mountains Regional Conservancy
Santa Ana Regional Water Quality Control Board
SCCWRP
U.S. Army Corps of Engineers
U.S. EPA
U.S. Forest Service

In addition to these workgroup members, invited experts provided valuable information and advice on a number of key issues.

Aquatic Bioassay and Consulting Laboratories (Aquatic Bioassay) is the lead consultant on this project, responsible for project management, the organization of sample collection, the analysis of samples and data, quality assurance (QA), coordination of stakeholder groups, reporting to the SGRRMP Workgroup, and ensuring the timely completion of all electronic data submittal products and the annual

summary report. In addition, Aquatic Bioassay will collect bioassessment, water and sediment samples, analyze bioassessment samples and perform both aquatic and sediment toxicity tests. Scott Johnson will be the Project Manager for this study and has established a project team for planning and conducting the study (Table1, Figure 1).

Several agencies will be providing field sampling and analytical services to the project including the Los Angeles County Sanitation Districts and the Los Angeles County Agricultural Lab.

CRG Marine Laboratories (CRG Labs), located in Torrance, will perform the water, sediment and tissue chemistry analyses, and the bacteriological analyses for all samples collected during the monitoring program. Rich Gossett will oversee these analyses.

ENTRIX, located in Ventura, will collect fish tissues under the direction of Dr. Camm Swift.

4.2 Quality Assurance Officer Role

Karin Wisenbaker will be the QA Officer. Karin's role is to establish the quality assurance and quality control (QA/QC) procedures found in this QAPP as part of the sampling and analysis procedures. Karin will work with field and laboratory managers by communicating all QA/QC issues contained in this QAPP.

Karin will also review and assess all procedures during the life of the contract against QAPP requirements. Karin will report all findings to Scott Johnson, including all requests for corrective action. Karin may stop all actions, including those conducted by Aquatic Bioassay, CRG Labs, and ENTRIX if there are significant deviations from required practices or if there is evidence of a systematic failure.

4.3 Persons Responsible for QAPP Update and Maintenance.

Changes and updates to this QAPP may be made after a review of the evidence for change by the Project Director, Project Manager, QA Officer, and Technical Workgroup Representative. The Project Manager will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signature.

Table 1. (Element 4) Personnel responsibilities.

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address)
Suzanne Dallman	LASGRWC	Project Director	Tel: (213) 229-9947
			Fax: (213) 229-9952
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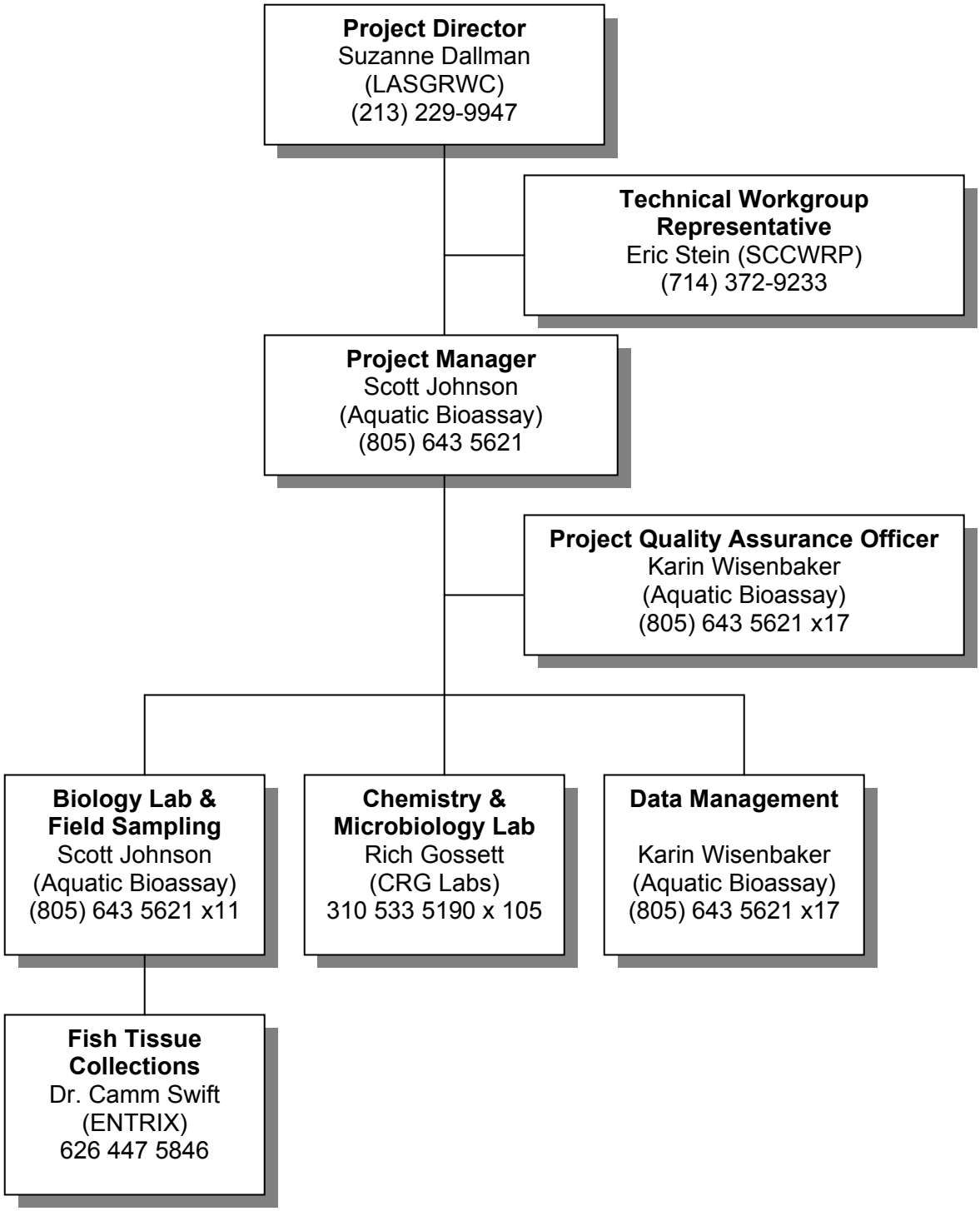
			Fax: (805) 643 2930
			scj_aqua@pacbell.net
Karin Wisenbaker	Aquatic Bioassay	Project QC Officer	Tel: (805) 643 5621 x17
			Fax: (805) 643 2930
			abclabs@pacbell.net
Rich Gossett	CRG Labs	Laboratory QC Officer	Tel: 310 533 5190 x 105
			Fax:
			crglabs@sbcglobal.net

4.4 Organizational Chart and Responsibilities

Figure 1. Organization chart



5. PROBLEM DEFINITION / BACKGROUND

5.1 Problem Statement

The development of a watershed-wide monitoring program for the San Gabriel River watershed is a direct response to a NPDES permit requirement established by the Los Angeles Regional Water Quality Control Board (LARWQCB) for the Los Angeles County Sanitation Districts' (LACSD) Long Beach, Los Coyotes, Whittier Narrows, San Jose Creek, and Pomona Water Reclamation Plants. For purposes of discussion, this program is termed the San Gabriel River Regional Monitoring Program (SGRRMP). This requirement stemmed, not from any specific contamination problem or discharge condition, but instead from a broader desire by LARWQCB staff for more integrated information about ambient conditions across the watershed as a whole and about patterns and trends in those conditions. This was a natural response to the growing awareness that watersheds involve habitats, physical features, and processes (both human and natural) that stretch across typical regulatory and management boundaries and are not well captured by current compliance monitoring systems. The regional monitoring design can be seen as a watershed-scale counterpart to existing larger-scale regional monitoring efforts in the southern California region (e.g., the state's Surface Water Ambient Monitoring Program (SWAMP), U.S. Environmental Protection Agency's (USEPA's) Western Environmental Monitoring and Assessment Program (EMAP), and the regional Bight Program) that attempt to address questions and concerns about regional condition and trends. The program is unique in its intent to incorporate local and site-specific issues within a broader watershed-scale perspective.

The SGRRMP is designed to complement and/or coordinate with the State Water Resources Control Board's SWAMP effort in the San Gabriel River watershed and with USEPA's Western EMAP. This includes both the coordination of sampling effort and the use of consistent field sampling and laboratory analysis methods. In addition, the proposed program uses tools developed by the California Department of Fish and Game (CDFG) and the Southern California Wetlands Recovery Project for the regional assessment of biologic conditions in streams and channels, as well as monitoring design approaches developed by the Stormwater Monitoring Coalition's (SMC) model stormwater monitoring program (Southern California Coastal Water Research Project (SCCWRP) technical report #419, www.sccwrp.org/pubs/techrpt.htm).

The SGRRMP Workgroup identified a subset of the beneficial uses in the region's Basin Plan that served as the central focus for the proposed regional monitoring design. These beneficial uses relate primarily to habitat conditions and to recreational use of the watershed and include:

- Warm Freshwater Habitat (WARM)
- Cold Freshwater Habitat (COLD)

- Estuarine Habitat (EST)
- Wildlife Habitat (WILD)
- Water Contact Recreation (REC1)
- Commercial and Sport Fishing (COMM).

The SGRRMP Workgroup articulated five core management questions, related to the priority beneficial uses:

- Question 1: What is the condition of streams in the watershed?
- Question 2: Are conditions at areas of unique interest getting better or worse?
- Question 3: Are receiving waters near discharges meeting water quality objectives?
- Question 4: Is it safe to swim?
- Question 5: Are locally caught fish safe to eat?

These questions reflect specific concerns about different aspects of the San Gabriel River watershed and the impacts of human activities on these. For each question, the SGRRMP describes a monitoring design, including its overall approach and rationale, indicators to be measured, recommended monitoring sites and frequencies, and expected data products. The SGRRMP also identifies recommended modifications to some existing efforts that would bring them into line with the proposed regional program. The monitoring program document can be obtained from LASGRWC's website (www.lasgrwc.org).

5.2 Decisions or Outcomes

The objective of this monitoring program is to assess the status of five key San Gabriel River watershed beneficial uses that include: the condition of stream health, areas of unique interest, adherence of receiving waters near discharges with water quality objectives, swimming, and fish consumption. The data generated by this monitoring program will be used to assess the condition of each of these beneficial uses over time, so that watershed managers can make decisions regarding the preservation of resources that are found to be unimpaired and the development of best management practices (BMPs) where resources are found to be impaired.

5.3 Water Quality Regulatory Criteria

No numerical water quality criteria are used or apply to this project.

6. PROJECT/TASK DESCRIPTION

6.1 Work Statement and Produced Products

Aquatic Bioassay shall be responsible for the performance of the work as set forth herein below and for the preparation of products and a final report as specified in this Exhibit. The Aquatic Bioassay shall promptly notify the SGRRMP Project Director of events or proposed changes that could affect the scope, budget, or schedule of work performed under this Agreement. Unless otherwise specified in the Agreement, all deliverables shall be provided to the Project Director, Contract Manager and members of the SGRRMP Workgroup.

The monitoring program can be divided into three main components:

Core monitoring includes long-term monitoring, intended to track compliance with specific regulatory requirements or limits, to conduct ongoing assessments, or to track trends in certain important conditions over time. Thus, core monitoring generally occurs at fixed stations that are sampled routinely over time.

Regional monitoring includes cooperative studies that provide a larger-scale view of conditions and can be used to assess the cumulative results of anthropogenic and natural effects on the environment. Regional monitoring also helps to place particular impacts in perspective by comparing local results (i.e. core monitoring) to the breadth and depth of human impacts and natural variability found throughout a larger region.

Special projects include specific targeted studies included as adaptive elements within core or regional monitoring designs. These are shorter-term efforts, with a specified beginning, middle, and end, intended to extend or provide more insight into core monitoring results, for example, by investigating the specific sources that may be contributing to a receiving water problem.

Within this overall structure, the regional program design described here focuses on both core (Questions 2, 3, 4, and 5) and regional (Question 1) monitoring, with references to special projects as needed.

Question 1: What is the Condition of Streams in the Watershed?

In overview, the monitoring design recommended to address such questions has the following elements:

- A randomized, or probabilistic, sampling scheme that includes the entire watershed, with the exception of 1st and 2nd order and ephemeral streams, down to the upper boundary of the estuary

- The watershed is treated as a single stratum, with sample subpopulations defined for the upper and lower watershed, and for the San Gabriel River main stem below Whittier Narrows, to ensure a representative distribution of sampling sites
- Sampling conducted at 30 sites in the first year and then continued with ten new randomly selected sites in each subsequent year
- Monitoring occurring in the spring and structured around the Triad approach, which includes bioassessment, aquatic toxicity, and water chemistry
- Measures of physical habitat characteristics collected coincident with bioassessment, including both the CDFG method and the California Rapid Assessment Method (CRAM).

The types of data products resulting from this monitoring design and appropriate for answering Question 1 may include:

- Cumulative frequency distribution plots of key individual indicators or metrics and of synthesized Triad results or condition scores
- Estimates of the stream reach miles in the watershed above/below benchmarks of interest for key indicators and for synthesized Triad results
- Maps of the areal distribution of monitoring sites in the watershed above/below benchmarks of interest for key indicators and for synthesized Triad results
- Estimates of difference in status between the upper and lower watershed, and between the mainstem and tributaries
- Trends over time in the estimates of watershed condition.

Question 2: Are Conditions at Areas of Unique Interest Getting Better or Worse?

The component of the regional monitoring program to address these questions is intended primarily as a trend monitoring effort and has the following three recommended elements:

- For high value / high risk sites in the freshwater portion of the watershed:
  - A fixed design that focuses on four specific locations and three minimally impacted sites
  - An emphasis on habitat conditions rather than water quality
  - Sampling will take place in the spring to coordinate with monitoring for Question 1
  - Monitoring will be structured around the CRAM approach
- For the estuary:
  - A fixed design including four existing stations monitored by LACSD
  - An emphasis on water quality and sediment quality
  - Sampling of conventional water quality parameters at an undetermined frequency
  - Annual sampling of a broader list of water quality parameters
  - Annual sampling of sediment chemistry, sediment toxicity, and benthic infauna

- For confluence sites where major tributaries enter the main stem:
  - A fixed design that focuses on five specific locations
  - Monitoring based on the Triad of bioassessment, water quality, and aquatic toxicity
  - Sampling will take place in the spring to coordinate with monitoring for Question 1.

The types of data products resulting from this monitoring design and appropriate for answering Question 2 may include:

- For high value / high risk sites in the freshwater portion of the watershed:
  - Site-by-site summaries of the quantitative scoring of CRAM attributes and trends in these over time
  - Site-by-site comparisons of CRAM attributes between high value / high risk and minimally impacted sites
  - Site-by-site interpretations and conclusions of habitat status and trends
- For the estuary:
  - Graphical and map-based descriptions of spatial and temporal patterns of descriptive water mass characteristics (e.g., temperature, salinity)
  - Graphical and mapbased descriptions of spatial and temporal patterns of sediment chemistry, sediment toxicity, and benthic infaunal community structure (sediment Triad)
  - Evaluation of sediment Triad data with reference to the pending statewide Sediment Quality Objectives
- For confluence sites:
  - Descriptions of water quality conditions (e.g., conventional chemistry, total metals, organophosphate pesticides)
  - Comparisons across sites of water quality conditions
  - Trend plots and maps of changes in measures of condition over time.

Question 3: Are Receiving Waters Near Discharges Meeting Water Quality Objectives?

In overview, the monitoring design recommended to address such questions has the following elements:

- Water chemistry monitoring at a regular frequency above and below each LACSD discharge point
- Toxicity testing on a regular frequency above and below each LACSD discharge point
- Bioassessment monitoring on a regular frequency below each LACSD discharge point
- Expanded bioassessment monitoring above each LACSD discharge point if the downstream bioassessment results are below the range expected for that habitat type

- Water, sediment, and biological community monitoring around the power plant discharges in the estuary.

The types of data products resulting from this monitoring design and appropriate for answering Question 3 may include:

- Site-by-site summaries of each sampled data type (tables of individual measurements and relevant averages)
- Site-by-site interpretations and conclusions based on synthesized results (narrative conclusions, decision trees specifying adaptive responses to monitoring results)
- Comparisons across sites for each sampled data type (tables highlighting differences, maps)
- Comparisons across sites for synthesized results (narrative conclusions, decision trees, maps)
- Trend plots over time of increases / decreases in parameters of interest.

Question 4: Is It Safe to Swim?

This information could be used by Los Angeles and Orange County public health agencies to help manage health risk. There is currently only limited monitoring at recreational sites. Monitoring at sentinel sites will be conducted by the regional monitoring program. Monitoring at recreation areas could be conducted in cooperation with volunteer agencies and/or with the respective County health departments.

In overview, the monitoring design recommended to address such questions has the following elements:

- A focus on sites with heavy recreational use
- Monitoring frequency at these sites adjusted in terms of degree of use and proximity to source(s)
- Weekly monitoring at sentinel sites to assess average levels of indicator bacteria throughout the watershed, with weekly monitoring at the head of the estuary
- Use of *E. coli* and perhaps fecal coliforms as indicators.

The types of data products resulting from this monitoring design and appropriate for answering Question 4 may include:

- Frequent (weekly, monthly depending on the circumstance) and site-by-site measures of bacterial indicator values
- Comparisons of bacterial indicator values with relevant standards or objectives on spatial and temporal scales that match sampling scales as closely as possible (e.g., data tables that highlight exceedances)
- Site-by-site and regional trends over time in the numbers of exceedances
- Periodic ratings of the relative risk of swimming at each site

- Ability to adopt new indicators as they are approved.

Question 5: Are Locally Caught Fish Safe to Eat?

In overview, the monitoring design recommended to address such questions has the following elements:

- Initial three-year pilot program to provide the basis for a long-term monitoring design
- Sample annually in summer
- Focus on seven locations (two each in lakes, river, and estuary) where fishing is most frequent
- Focus on fish species most commonly caught and consumed at each site
- Focus on the five chemicals (mercury, DDTs, PCBs, arsenic, and selenium) that contribute most to human health risk in California's coastal and estuarine fishes.

The types of data products resulting from this monitoring design and appropriate for answering Question 5 may include:

- Site-by-site measures of tissue concentrations of key chemical contaminants in commonly consumed fish species
- Site-by-site measures of the frequency with which such tissue concentrations exceed advisory levels and/or critical thresholds of potential human health risk
- Trends over time in both tissue concentrations and the frequency of exceedances of advisory levels and critical thresholds.

6.2 Constituents to be Monitored and Measurement Techniques

Water, sediment and tissue chemistry; water and sediment toxicity; marine and freshwater bioassessments; and bacteria will be used to measure the condition of beneficial uses in the watershed. We will use existing USEPA, SWAMP, and Southern California Regional Monitoring protocols.

Table 2. (Element 6) Analytical constituents and method requirements.

Analyte	Method
Water Chemistry: freshwater	
Ammonia in Water Determination	SM 4500-NH3 D
Dissolved Organic Carbon in Water Determination	EPA 415.1
Nitrate in Water Determination	EPA 300
Nitrite in Water Determination	EPA 300
pH in Water Determination	EPA 150.1
Total Alkalinity in Water Determination	SM 2320 B
Total Hardness as CaCO3 in Water Determination	SM 2340-B
Total Kjeldahl Nitrogen in Water Determination	EPA 351.3
Total Organic Carbon in Water Determination	EPA 415.1
Total Orthophosphate (as P) in Water Determination	SM 4500-P E
Total Phosphate (as P) in Water Determination	SM 4500-P C
Total Phosphorus in Water Determination	SM 4500-P C
Total Suspended Solids in Water Determination	SM 2540-D
Trace metals (total and dissolved): freshwater	EPA 200.8, mercury by EPA 1631
Organophosphorus Pesticides in Water Analysis	EPA 625(m)/8270C(m)
Water Chemistry: Estuary (seawater)	
Ammonia in Water Determination	SM 4500-NH3 D
Dissolved Organic Carbon in Water Determination	EPA 415.1
Nitrate in Seawater Determination	SM 4500-NO3 E
Nitrite in Seawater Determination	SM 4500-NO2 B
pH in Water Determination	EPA 150.1
Total Alkalinity in Water Determination	SM 2320 B
Total Hardness as CaCO3 in Water Determination	SM 2340-B
Total Kjeldahl Nitrogen in Seawater Determination	EPA 351.1
Total Organic Carbon in Seawater Determination	EPA 415.1
Total Orthophosphate (as P) in Water Determination	SM 4500-P E
Total Phosphate (as P) in Water Determination	SM 4500-P C
Total Phosphorus in Water Determination	SM 4500-P C
Total Suspended Solids in Water Determination	SM 2540-D
Trace metals (total and dissolved): seawater	EPA 1641, mercury by EPA 1631
Organophosphorus Pesticides in Water Analysis	EPA 625(m)/8270C(m)

Sediment Chemistry: Estuary	
Trace Metals	EPA 6020 + mercury EPA 245.7
Organophosphorus Pesticides	EPA 8270C(m)
Organochlorine Pesticides & PCBs in Sediment Analysis	EPA 8270C(m)
Poly Aromatic Hydrocarbons (PAHs)	EPA 8270C(m)
Total Kjeldahl Nitrogen in Sediment Determination	EPA 351.3
Total Organic Carbon in Sediment Determination	EPA 9060
Total Phosphate (as P) in Sediment Determination	SM 4110 C
Sediment Particle Size (% fines)	SM 2560 C
Tissue Chemistry: Fish	
Trace Metals	EPA 6020 + mercury EPA 245.7
Organochlorine Pesticides & PCB's	EPA 8270C(m)
Percent Lipids in Tissue Determination	Gravimetric
Indicator Bacteria	
Total Coliform and E. coli in Water Analysis by Colilert	Colilert
Enterococcus in Water Analysis by Enterolert	Enterolert
Water Toxicity: Freshwater or Estuary	
Ceriodaphnia dubia (freshwater)	EPA/821/R/02012
Menidia beryllina (seawater)	EPA/821/R/02012
Sediment Toxicity: Estuary	
Eohaustorius sp. (sediment) 10 day survival	EPA/R-94/025
Mytilus embryo development	Marine Pollution Studies Lab, 2004
Bioassessments	
Freshwater – CSBP Level 1	CSBP (2003)
Marine	SCCWRP (2003)*

* Southern California Regional Monitoring Program, 2003 Field and Laboratory Operating Procedures, SCCWRP.

6.3 Project Schedule

Table 3. (Element 6) Project schedule.

Project Task	Start	End
Project Management and Administration	26-Sep-06	31-Aug-07
Technical Workgroup Meeting	26-Sep-06	28-Aug-07
Monthly Status Reports	29-Sep-06	31-Aug-07
QAPP	21-Aug-06	6-Oct-06
Draft	21-Aug-06	6-Sep-06
Final	20-Sep-06	27-Oct-06
SAP	6-Sep-06	31-Oct-06
Draft	6-Sep-06	6-Oct-06
Final	7-Oct-06	31-Oct-06
Fish Tissue Sampling	25-Sep-06	24-Nov-06
Field Sampling	9-Oct-06	20-Oct-06
Tissue Analysis	20-Oct-06	17-Nov-06
Preliminary Findings	30-Nov-06	30-Nov-06
CRAM Training	11-Apr-07	11-Apr-07
Site Reconnaissance	15-Nov-06	1-May-07
Map Review and Preliminary Selection of Randomized Sites	15-Nov-06	30-Nov-06
Secure entry permits	4-Dec-06	29-Dec-06
Site Reconnaissance	23-Apr-07	27-Apr-07
Present Finalized Station List to TAC	1-May-07	1-May-07
Bacterial Testing	9-Oct-06	26-Sep-07
Sentinel & Swimming Sites	2-May-07	26-Sep-07
Estuary Site	9-Oct-06	30-Aug-07
Watershed Monitoring Sampling	4-Jun-07	15-Jun-07
Estuary	4-Jun-07	4-Jun-07
Water, Sediment Chemisty; Toxicity; Bioassessment; Phab; CRAM	4-Jun-07	4-Jun-07
Lower Watershed	5-Jun-07	8-Jun-07
Water, Sediment Chemisty; Toxicity; Bioassessment; Phab; CRAM	5-Jun-07	8-Jun-07
Upper Watershed	11-Jun-07	15-Jun-07
Water, Sediment Chemisty; Toxicity; Bioassessment; Phab; CRAM	11-Jun-07	15-Jun-07
Laboratory Analyses	6-Jun-07	5-Oct-07
Chemistry: Water & Sediment	18-Jun-07	20-Jul-07
Toxicity Testing: Water & Sediment	6-Jun-07	26-Jun-07
Bioassessment	18-Jun-07	5-Oct-07
Data Management, Analysis & Reporting: 2006 Data Set	2-Oct-07	3-Aug-07
Data Reciept from SCCWRP	2-Oct-06	30-Nov-06
Data QC	4-Dec-06	16-Feb-07
Data Reconciliation & Corrective Actions	18-Dec-06	16-Mar-07
Data Set Finalized	19-Mar-07	30-Mar-07
Data Analysis	2-Apr-07	18-May-07
Data Results Review	21-May-07	31-May-07
Draft Report	4-Jun-07	20-Jul-07
Annual Report Finalized	23-Jul-07	3-Aug-07

6.4 Geographic Setting

The San Gabriel River Watershed is located in the eastern portion of Los Angeles County. It is bound by the San Gabriel Mountains to the north, the San Bernardino Mountains to the east, the watershed is divided with the Los Angeles River to the west, and the Pacific Ocean to the south. The San Gabriel River's headwaters originate in the San Gabriel Mountains and the River terminates at the San Pedro Bay/Los Angeles and Long Beach Harbor complex, which is semi-enclosed by a 7.5 mile breakwater (Figure 2).

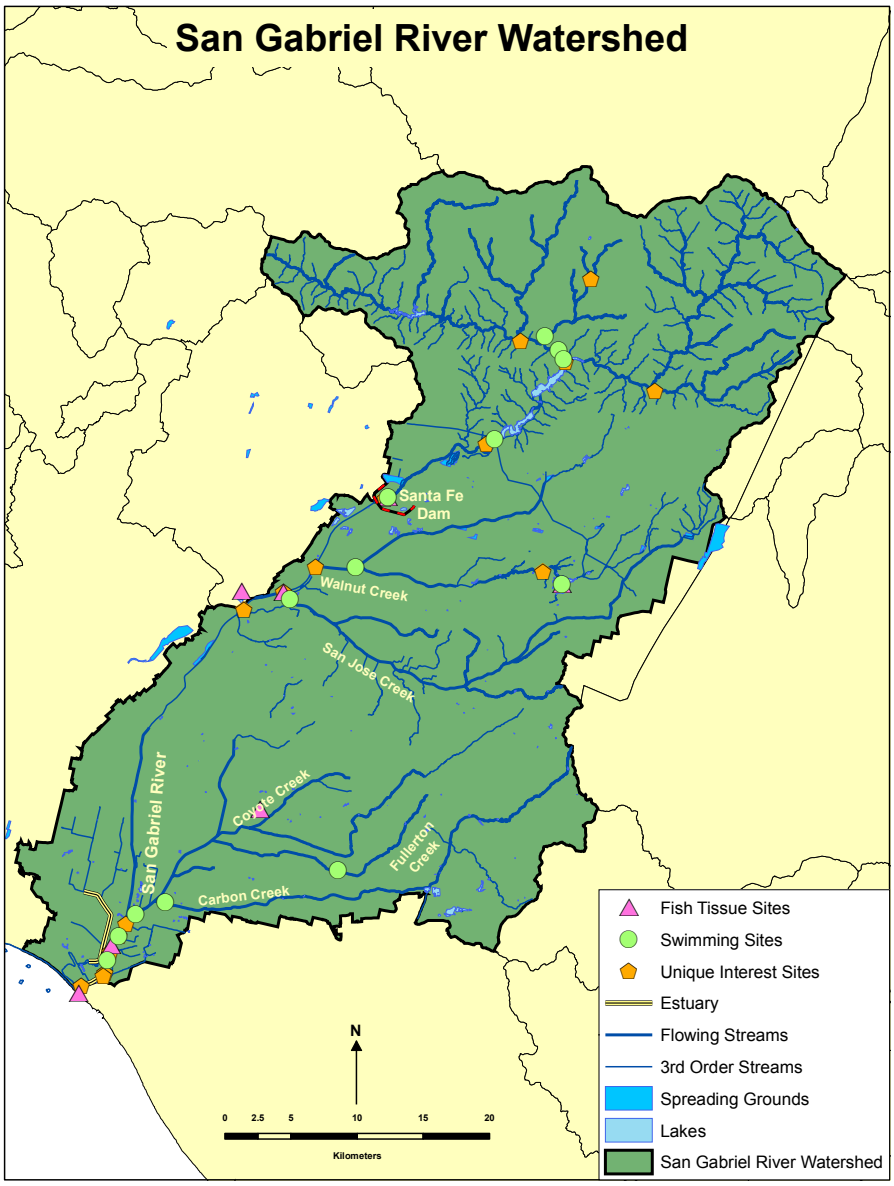


Figure 2. Study watersheds.

6.5 Constraints

The randomized design portion of the program is constrained by the ability of the contractors to access sites located on private, federal and state lands that do not allow public access. To resolve this issue, the team will review the locations of randomly selected sites six months prior to the initiation of sampling and begin work to secure the necessary access permits. If entry approval to a site cannot be obtained, the site will be dropped in favor of a more accessible site.

The bioaccumulation portion of the program is constrained by the availability of targeted fish species in the required size classes. To resolve this issue, the team will adaptively sample so that when the targeted species are not available, other reasonable species will be collected. The list of taxa collected will be presented to the SGRRMP Workgroup for review before chemical analyses are conducted.

7. QUALITY OBJECTIVES AND CRITERIA

7.1 Data Quality Objectives

Measurement or Analyses Type	Applicable Data Quality Objective
Field Measurements	Accuracy, Precision, Completeness
Bacterial Analyses	Precision, Presence/Absence, Completeness
Trace Metals Analyses	Accuracy, Precision, Recovery, Completeness
Synthetic Organic Analyses	Accuracy, Precision, Recovery, Completeness
Organics Sediment Analyses	Accuracy, Precision, Recovery, Completeness
Conventional Analyses	Accuracy, Precision, Recovery, Completeness
Flow	Accuracy, Precision, Completeness

Accuracy describes how close the measurement is to its true value. Accuracy is the measurement of a sample of known concentration and comparing the known value against the measured value. The accuracy of chemical measurements will be checked by performing tests on standards prior to and/or during sample analysis at CRG Labs. A standard is a known concentration of a certain solution. Standards can be purchased from chemical or scientific supply companies. Standards might also be prepared by a professional partner, e.g. a commercial or research laboratory. The concentration of the standards will be unknown to the analyst until after measurements are determined. Accuracy criteria for bacterial testing will be based on presence/absence testing rather than numerical limits owing to the difficulty in preparing solutions of known bacterial concentration. The reliability of toxicity testing results depends on the quality of test organisms, testing conditions and the expertise of laboratory personnel. For each test organism there are numerous test conditions and reference toxicant criteria that must be met before the result can be accepted. A brief description of the criteria used to ensure the quality of toxicity test results are provided below. More detailed summaries can be found in the USEPA protocols for Ceriodaphnia dubia (EPA/821/R/02012), Menidia beryllina (EPA/821/R/02012) and Eohaustorius sp. (EPA/R-94/025).

The precision objectives apply to duplicate and split samples taken during field sampling and laboratory analysis as part of periodic QC checks. Precision describes how well repeated measurements agree. The evaluation of precision described here relates to repeated measurements/samples taken in the field (i.e. field replicates) or the laboratory. The precision objectives for toxicity testing apply to laboratory reference toxicant tests and USEPA DMR studies. Reference toxicant results for each species should fall within ± 2 standard deviations (SD) of the mean of the preceding 20 tests. A reference toxicant test is run with each batch of test samples.

Recovery measurements will be determined by laboratory spiking of a replicate sample with a known concentration of the analyte. The spike level should be at least ten times the Method Detection Limit (MDL).

Completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. There are no statistical criteria that require a certain percentage of data. However, it is expected that 90% of all measurements could be taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems. We will determine completeness by comparing the number of measurements we planned to collect compared to the number of measurements we actually collected that were also deemed valid. An invalid measurement would be one that does not meet the sampling methods requirements and the data quality objectives. Completeness results will be checked quarterly. This will allow us to identify and correct problems.

Method sensitivity is dealt with by the inclusion of the required SWAMP Target Reporting Limits, where such values exist, and by the application of the definition of a Minimum Level as provided by the Inland Surface Water and Enclosed Bays and Estuaries Policy. Target Reporting Limits exist for the metals copper, and iron; and for total coliforms and fecal coliforms. The Target Reporting Limit for hardness was set based on the smallest measurable amount of EDTA titrant and sample volume routinely used, although no sample is expected to be non-detect for hardness. The reporting level for acute toxicity tests is dependent on the sample dilutions tested. In this study, we will be using 100% sample compared to a laboratory dilution water control. Therefore, results could be reported from 0 to 100% survival.

7.2 Field and Laboratory Measurements Data Quality Objectives Tables

Table 4. (Element 7) Data quality objectives for field measurements.

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limit*	*Completeness*
Field testing	Dissolved Oxygen	± 0.5 mg/L	10%	NA	0 mg/L	90%
	Temperature	± 0.5 °C	5%	NA	-5 °C	90%
	Conductivity	± 5%	5%	NA	0-100mS/cm	90%
	pH by meter	± 0.5 units	5%	NA	2-12	90%

NA not applicable

Table 5a. (Element 7) Data quality objectives for laboratory measurements.

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Conventional constituents in water	Ammonia	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05	mg/L	90%
	Dissolved				0.05	mg/L	
	Nitrate				0.05	mg/L	
	Nitrite				0.05	mg/L	
	pH				0.2	pH Unit	
	Total Alkalinity				5	mg/L	
	Total Hardness				5	mg/L	
	Total Kjeldahl Nitrogen				0.5	mg/L	
	Total Organic Carbon				0.5	mg/L	
	Total Orthophosphate				0.01	mg/L	
	Total Phosphorus				0.05	mg/L	
	Total Suspended Solids				5	mg/L	
Conventional constituents in estuary seawater	Ammonia	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05	mg/L	90%
	Dissolved				0.05	mg/L	
	Nitrate				0.05	mg/L	
	Nitrite				0.05	mg/L	
	pH				0.2	pH Unit	
	Total Alkalinity				5	mg/L	
	Total Hardness				5	mg/L	
	Total Kjeldahl Nitrogen				0.5	mg/L	
	Total Organic Carbon				1.0	mg/L	
	Total Orthophosphate				0.01	mg/L	
	Total Phosphorus				0.05	mg/L	
	Total Suspended Solids				5	mg/L	
Trace Metals in water	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD ± 25% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	10.0	µg/L	90%
	Antimony (Sb)				0.5	µg/L	
	Arsenic (As)				0.5	µg/L	
	Barium (Ba)				0.5	µg/L	
	Beryllium (Be)				0.5	µg/L	
	Cadmium (Cd)				0.4	µg/L	
	Chromium (Cr)				0.5	µg/L	
	Cobalt (Co)				0.5	µg/L	
	Copper (Cu)				0.8	µg/L	
	Iron (Fe)				10.0	µg/L	
	Lead (Pb)				0.5	µg/L	
	Manganese (Mn)				0.5	µg/L	
	Mercury (Hg)				0.02	µg/L	
	Molybdenum (Mo)				0.5	µg/L	
	Nickel (Ni)				0.5	µg/L	
	Selenium (Se)				0.5	µg/L	
	Silver (Ag)				1	µg/L	
	Strontium (Sr)				0.5	µg/L	
	Thallium (Tl)				0.5	µg/L	
	Tin (Sn)				0.5	µg/L	
	Titanium (Ti)				0.5	µg/L	
	Vanadium (V)				0.5	µg/L	
	Zinc (Zn)				0.5	µg/L	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Trace Metals in estuary seawater	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD ± 25% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	6.0	µg/L	90%
	Antimony (Sb)				0.015	µg/L	
	Arsenic (As)				0.02	µg/L	
	Beryllium (Be)				0.01	µg/L	
	Cadmium (Cd)				0.01	µg/L	
	Chromium (Cr)				0.05	µg/L	
	Cobalt (Co)				0.01	µg/L	
	Copper (Cu)				0.02	µg/L	
	Iron (Fe)				1.0	µg/L	
	Lead (Pb)				0.01	µg/L	
	Manganese (Mn)				0.02	µg/L	
	Mercury (Hg)				0.02	µg/L	
	Molybdenum (Mo)				0.01	µg/L	
	Nickel (Ni)				0.01	µg/L	
	Selenium (Se)				0.02	µg/L	
	Silver (Ag)				0.04	µg/L	
	Thallium (Tl)				0.01	µg/L	
	Tin (Sn)				0.01	µg/L	
	Titanium (Ti)				0.07	µg/L	
	Vanadium (V)				0.04	µg/L	
	Zinc (Zn)				0.01	µg/L	
Nutrients in estuary sediments	Total Kjeldahl Nitrogen	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25%. RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.50	mg/L	90%
	Total Organic Carbon				0.05	% Dry Weight	
	Total Phosphorus				0.05	mg/L	
Trace metals in estuary sediments	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD 30% RPD. Laboratory duplicate	Matrix spike 75% - 125%.	5	µg/dry g	90%
	Antimony (Sb)				0.05	µg/dry g	
	Arsenic (As)				0.05	µg/dry g	
	Barium (Ba)				0.05	µg/dry g	
	Beryllium (Be)				0.05	µg/dry g	
	Cadmium (Cd)				0.05	µg/dry g	
	Chromium (Cr)				0.05	µg/dry g	
	Cobalt (Co)				0.05	µg/dry g	
	Copper (Cu)				0.05	µg/dry g	
	Iron (Fe)				5	µg/dry g	
	Lead (Pb)				0.05	µg/dry g	
	Manganese (Mn)				0.05	µg/dry g	
	Mercury (Hg)				0.02	µg/dry g	
	Molybdenum (Mo)				0.05	µg/dry g	
	Nickel (Ni)				0.05	µg/dry g	
	Selenium (Se)				0.05	µg/dry g	
	Silver (Ag)				0.05	µg/dry g	
	Strontium (Sr)				0.05	µg/dry g	
	Thallium (Tl)				0.05	µg/dry g	
	Tin (Sn)				0.05	µg/dry g	
	Titanium (Ti)				0.05	µg/dry g	
	Vanadium (V)				0.05	µg/dry g	
	Zinc (Zn)				0.05	µg/dry g	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Organophosphorus Pesticides in estuary sediment	Bolstar (Sulprofos)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	10	ng/dry g	90%
	Chlorpyrifos				10	ng/dry g	
	Demeton				10	ng/dry g	
	Diazinon				10	ng/dry g	
	Dichlorvos				10	ng/dry g	
	Dimethoate				10	ng/dry g	
	Disulfoton				10	ng/dry g	
	Ethoprop (Ethoprofos)				10	ng/dry g	
	Fenchlorophos (Ronnel)				10	ng/dry g	
	Fensulfothion				10	ng/dry g	
	Fenthion				10	ng/dry g	
	Malathion				10	ng/dry g	
	Merphos				10	ng/dry g	
	Methyl Parathion				10	ng/dry g	
	Mevinphos (Phosdrin)				10	ng/dry g	
	Phorate				10	ng/dry g	
	Tetrachlorvinphos (Stirofos)				10	ng/dry g	
	Tokuthion				10	ng/dry g	
	Trichloronate				10	ng/dry g	
Organochlorine Pesticides & PCBs in estuary sediment	4,4'-DDD	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	5	ng/dry g	90%
	2,4'-DDD				5	ng/dry g	
	2,4'-DDE				5	ng/dry g	
	2,4'-DDT				5	ng/dry g	
	4,4'-DDE				5	ng/dry g	
	4,4'-DDT				5	ng/dry g	
	Aldrin				5	ng/dry g	
	BHC-alpha				5	ng/dry g	
	BHC-beta				5	ng/dry g	
	BHC-delta				5	ng/dry g	
	BHC-gamma				5	ng/dry g	
	Chlordane-alpha				5	ng/dry g	
	Chlordane-gamma				5	ng/dry g	
	cis-Nonachlor				5	ng/dry g	
	Dieldrin				5	ng/dry g	
	Endosulfan Sulfate				5	ng/dry g	
	Endosulfan-I				5	ng/dry g	
	Endosulfan-II				5	ng/dry g	
	Endrin				5	ng/dry g	
	Endrin Ketone				5	ng/dry g	
	Heptachlor				5	ng/dry g	
	Heptachlor Epoxide				5	ng/dry g	
	Methoxychlor				5	ng/dry g	
	Mirex				5	ng/dry g	
	Oxychlordane				5	ng/dry g	
	trans-Nonachlor				5	ng/dry g	
	Endrin Aldehyde				5	ng/dry g	
	Toxaphene				50	ng/dry g	
	PCB018				5	ng/dry g	
	PCB028				5	ng/dry g	
	PCB031				5	ng/dry g	
	PCB033				5	ng/dry g	
	PCB037				5	ng/dry g	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Organochlorine Pesticides & PCBs in estuary sediment (continued)	PCB044				5	ng/dry g	
	PCB049				5	ng/dry g	
	PCB052				5	ng/dry g	
	PCB066				5	ng/dry g	
	PCB070				5	ng/dry g	
	PCB074				5	ng/dry g	
	PCB077				5	ng/dry g	
	PCB081				5	ng/dry g	
	PCB087				5	ng/dry g	
	PCB095				5	ng/dry g	
	PCB097				5	ng/dry g	
	PCB099				5	ng/dry g	
	PCB101				5	ng/dry g	
	PCB105				5	ng/dry g	
	PCB110				5	ng/dry g	
	PCB114				5	ng/dry g	
	PCB118				5	ng/dry g	
	PCB119				5	ng/dry g	
	PCB123				5	ng/dry g	
	PCB126				5	ng/dry g	
	PCB128+167				5	ng/dry g	
	PCB138				5	ng/dry g	
	PCB141				5	ng/dry g	
	PCB149				5	ng/dry g	
	PCB153				5	ng/dry g	
	PCB156				5	ng/dry g	
	PCB157				5	ng/dry g	
	PCB158				5	ng/dry g	
	PCB168				5	ng/dry g	
	PCB168+132				5	ng/dry g	
	PCB169				5	ng/dry g	
	PCB170				5	ng/dry g	
	PCB177				5	ng/dry g	
	PCB180				5	ng/dry g	
	PCB183				5	ng/dry g	
	PCB187				5	ng/dry g	
	PCB189				5	ng/dry g	
	PCB194				5	ng/dry g	
	PCB200				5	ng/dry g	
	PCB201				5	ng/dry g	
	PCB206				5	ng/dry g	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Polynuclear Aromatic Hydrocarbons in estuary sediment	1-Methylnaphthalene	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	5	ng/dry g	90%
	1-Methylphenanthrene				5	ng/dry g	
	2,3,5-Trimethylnaphthalene				5	ng/dry g	
	2,6-Dimethylnaphthalene				5	ng/dry g	
	2-Methylnaphthalene				5	ng/dry g	
	Acenaphthene				5	ng/dry g	
	Acenaphthylene				5	ng/dry g	
	Anthracene				5	ng/dry g	
	Benz[a]anthracene				5	ng/dry g	
	Benzo[a]pyrene				5	ng/dry g	
	Benzo[b]fluoranthene				5	ng/dry g	
	Benzo[e]pyrene				5	ng/dry g	
	Benzo[g,h,i]perylene				5	ng/dry g	
	Benzo[k]fluoranthene				5	ng/dry g	
	Biphenyl				5	ng/dry g	
	Chrysene				5	ng/dry g	
	Dibenz[a,h]anthracene				5	ng/dry g	
	Dibenzothiophene				5	ng/dry g	
	Fluoranthene				5	ng/dry g	
	Fluorene				5	ng/dry g	
	Indeno[1,2,3-c,d]pyrene				5	ng/dry g	
	Naphthalene				5	ng/dry g	
	Perylene				5	ng/dry g	
	Phenanthrene				5	ng/dry g	
	Pyrene				5	ng/dry g	
Sediment grain size in estuary sediments	Sediment grain size	± 5% of point standard	Replicates within ± 20%	N/A	gravel sand silt clay	% % % %	90%
Trace Metals in Tissues	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD 30% RPD. Laboratory duplicate	Matrix spike 75% - 125%.	5	µg/wet g	90%
	Antimony (Sb)				0.05	µg/wet g	
	Arsenic (As)				0.05	µg/wet g	
	Barium (Ba)				0.05	µg/wet g	
	Beryllium (Be)				0.05	µg/wet g	
	Cadmium (Cd)				0.05	µg/wet g	
	Chromium (Cr)				0.05	µg/wet g	
	Cobalt (Co)				0.05	µg/wet g	
	Copper (Cu)				0.05	µg/wet g	
	Iron (Fe)				5	µg/wet g	
	Lead (Pb)				0.05	µg/wet g	
	Manganese (Mn)				0.05	µg/wet g	
	Mercury (Hg)				0.02	µg/wet g	
	Molybdenum (Mo)				0.05	µg/wet g	
	Nickel (Ni)				0.05	µg/wet g	
	Selenium (Se)				0.05	µg/wet g	
	Silver (Ag)				0.05	µg/wet g	
	Strontium (Sr)				0.05	µg/wet g	
	Thallium (Tl)				0.05	µg/wet g	
	Tin (Sn)				0.05	µg/wet g	
	Titanium (Ti)				0.05	µg/wet g	
	Vanadium (V)				0.05	µg/wet g	
	Zinc (Zn)				0.05	µg/wet g	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Organochlorine pesticides & PCBs in tissues	4,4'-DDD	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	5	ng/wet g	90%
	2,4'-DDD				5	ng/wet g	
	2,4'-DDE				5	ng/wet g	
	2,4'-DDT				5	ng/wet g	
	4,4'-DDE				5	ng/wet g	
	4,4'-DDT				5	ng/wet g	
	Aldrin				5	ng/wet g	
	BHC-alpha				5	ng/wet g	
	BHC-beta				5	ng/wet g	
	BHC-delta				5	ng/wet g	
	BHC-gamma				5	ng/wet g	
	Chlordane-alpha				5	ng/wet g	
	Chlordane-gamma				5	ng/wet g	
	cis-Nonachlor				5	ng/wet g	
	Dieldrin				5	ng/wet g	
	Endosulfan Sulfate				5	ng/wet g	
	Endosulfan-I				5	ng/wet g	
	Endosulfan-II				5	ng/wet g	
	Endrin				5	ng/wet g	
	Endrin Ketone				5	ng/wet g	
	Heptachlor				5	ng/wet g	
	Heptachlor Epoxide				5	ng/wet g	
	Methoxychlor				5	ng/wet g	
	Mirex				5	ng/wet g	
	Oxychlordane				5	ng/wet g	
	trans-Nonachlor				5	ng/wet g	
	Endrin Aldehyde				5	ng/wet g	
	Toxaphene				5	ng/wet g	
	PCB018				5	ng/wet g	
	PCB028				5	ng/wet g	
	PCB031				5	ng/wet g	
	PCB033				5	ng/wet g	
	PCB037				5	ng/wet g	
	PCB044				5	ng/wet g	
	PCB049				5	ng/wet g	
	PCB052				5	ng/wet g	
	PCB066				5	ng/wet g	
	PCB070				5	ng/wet g	
	PCB074				5	ng/wet g	
	PCB077				5	ng/wet g	
	PCB081				5	ng/wet g	
	PCB087				5	ng/wet g	
	PCB095				5	ng/wet g	
	PCB097				5	ng/wet g	
	PCB099				5	ng/wet g	
	PCB101				5	ng/wet g	
	PCB105				5	ng/wet g	

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Organochlorine pesticides & PCBs in tissues (continued)	PCB110				5	ng/wet g	
	PCB114				5	ng/wet g	
	PCB118				5	ng/wet g	
	PCB119				5	ng/wet g	
	PCB123				5	ng/wet g	
	PCB126				5	ng/wet g	
	PCB128+167				5	ng/wet g	
	PCB138				5	ng/wet g	
	PCB141				5	ng/wet g	
	PCB149				5	ng/wet g	
	PCB153				5	ng/wet g	
	PCB156				5	ng/wet g	
	PCB157				5	ng/wet g	
	PCB158				5	ng/wet g	
	PCB168				5	ng/wet g	
	PCB168+132				5	ng/wet g	
	PCB169				5	ng/wet g	
	PCB170				5	ng/wet g	
	PCB177				5	ng/wet g	
	PCB180				5	ng/wet g	
	PCB183				5	ng/wet g	
	PCB187				5	ng/wet g	
	PCB189				5	ng/wet g	
	PCB194				5	ng/wet g	
	PCB200				5	ng/wet g	
	PCB201				5	ng/wet g	
	PCB206				5.00	ng/wet g	
Percent Lipids in Tissues	Lipids	N/A	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	N/A	0.05	Percent	90%

Table 5b. Data Quality Objectives for biological laboratory analyses.

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Target Reporting Limits*	*Units*	*Completeness*
Bacterial analysis in water and estuary waters	Total Coliforms E. Coli Enterococcus	Laboratory positive and negative cultures – proper positive or negative response. Bacterial sample - –within the stated acceptance criteria.	R_{log} within 3.27*mean R_{log} (reference is section 9020B of 18th, 19th, or 20th editions of *Standard Methods*	N/A	10	MPN/100 mL	90%
Toxicity Testing: water & sediment	Acute Chronic	N/A	Ref Tox ± 2 SD of preceding 20 tests	N/A	N/A	% survival % reproduction % normal development	90%
Bioassessment	Benthic macroinvertebrate identification	Re-sort Frequency: 100% Re-sort Accuracy: > 95% Lab ID Frequency: 10% Lab ID Accuracy: > 95%	Field Duplicates: 5% ± 25% RPD	N/A	SAFIT	N/A	90%

8. Special Training Needs/Certification

8.1 Specialized Training or Certifications

Aquatic Bioassay, ENTRIX and CRG Labs field staffs have completed all applicable training to conduct bioassessment, toxicity, water quality, bacteriological and fish tissue sampling. Aquatic Bioassay and CRG Labs hold certifications for analysis of all the constituents. The Aquatic Bioassay and CRG Labs QA officers provide training to their respective personnel and details of the training are described in the attached Standard Operating Procedures (SOPs) and QA Program Documents attached. Aquatic Bioassay staff will be trained to conduct the CRAM for Wetlands and Riparian Habitats by SCCWRP personnel before field operations begin in June 2007.

Scott Johnson and Karin Wisenbaker will coordinate training of project personnel. Actual field training and day-to-day supervision is the responsibility of Scott Johnson. SOPs for field, laboratory, and data management tasks will be developed and updated on a regular basis in order to maintain procedural consistency.

No formal certifications are available for either field sampling or laboratory analysis.

8.2 Training and Certification Documentation

Aquatic Bioassay and CRG Labs maintain records of their training. Those records can be obtained, if needed, through the Project or Laboratory Directors.

8.3 Training Personnel

Aquatic Bioassay and CRG Labs maintain rigorous field and laboratory training programs based on written, oral and performance-based guidelines. Training and performance are also evaluated on an ongoing basis based, in part, on the QA parameters defined in this plan. SOPs for field, laboratory, and data management tasks have been developed and will be updated on a regular basis in order to maintain procedural consistency (see Appendices). The maintenance of an SOP Manual will provide project personnel with a reference guide for training new personnel as well as a standardized information source that personnel can access.

To ensure consistent and comparable field techniques, this study will include a pre-survey field training and in-situ field audits.

9. DOCUMENTS AND RECORDS

All documents generated by this project will be stored at Aquatic Bioassay during the life of the contract (Table 6). Documents will be transferred to the LASGRWC following completion of the contract. Sampling records will be stored and maintained at Aquatic Bioassay. Laboratory analysis records pertinent to this study will be maintained at Aquatic Bioassay. Copies of all records held by CRG Labs or ENTRIX will be provided to the Project QA Officer or Project Director upon request.

Persons responsible for maintaining records for this project are as follows. Karin Wisenbaker will maintain all sample collection, sample transport, chain of custody, field analyses forms, all records associated with the receipt and analysis of samples analyzed for all parameters, and all records submitted by CRG Labs, ENTRIX and other participating agencies. Rich Gossett will maintain CRG Labs records including water, sediment and tissue chemistry, and bacteriology chains of custody and bench sheets. Camm Swift will maintain the field sheets associated with fish tissue collections. All agencies providing in kind services for chemistry, bacteriology, bioassessment and toxicity testing will maintain their records and make them available to the Project Manager upon request. Scott Johnson will oversee the actions of these persons and will arbitrate any issues relative to records retention and any decisions to discard records.

All field results will be recorded at the time of completion, using standardized field data sheets. Data sheets will be reviewed for outliers and omissions before leaving the sample site. Chain of custody forms will be completed for all samples before leaving each sampling site. Data sheets and chains of custody will be stored by Aquatic Bioassay in hard copy form for five years from the time the study is completed. The directory where electronic files are stored will be backed up nightly on a second hard drive, and backed up monthly off-site.

All data from this project will be made publicly available after approval by the LASGRWC. The final electronic version of the database will be maintained by LASGRWC. Release of data to the public will be in electronic formats only and will include comprehensive documentation. This documentation will include database table structures (including table relationships) and lookup tables used to populate specific fields in specific tables. Release to the public will also include QA classifications of the data (i.e. flags, as appropriate) and documentation of the methods by which the data were collected (metadata). Data will be released to the general public once a final report documenting the study has been prepared. Final deposition of databases and reports will be passed to the Project Director and Contract Manager on CD.

Table 6. (Element 9) Document and record retention, archival, and disposition information.

	Identify Type Needed	Retention	Archival	Disposition
Station Occupation Log	Notebook	Paper	Notebook	5 years
	Field data sheet	Paper	Notebook	5 years
Sample Collection Records	Chain of Custody	Paper	Notebook	5 years
Analytical Records	Lab notebooks	Paper	Notebook	3 years
	Lab Results QA/QC	Paper and electronic	Notebook/Excel	3 years
	Electronic data file	Electronic	Database	3 years
Data Records	Data Entry	Electronic	Database	Indefinite
Assessment Records	QA/QC assessment	Paper and electronic	Document	Indefinite
	Final Report	Paper and electronic	Document	Indefinite

GROUP B DATA GENERATION AND ACQUISITION

10. SAMPLING PROCESS DESIGN

The sampling and analysis design for the program is divided in five components based on the five questions developed by the Technical Workgroup to address the status of beneficial uses in the watershed (Table 7). The design approaches range from a fully randomized, probabilistic design to address stream condition, to a three year pilot study focusing on fixed sites at popular fishing locations to address bioaccumulation issues.

Table 7. (Element 10). Number and frequency of sample sites.

Question	Approach	Sites	Indicators	Frequency
Q1: Stream condition	Randomized design for streams in entire watershed, except 1st and 2nd order streams	30 in Year 1 10 new in each following year	Triad: bioassessment, water chemistry, toxicity	Annually, in spring
Q2: Unique areas	Fixed stations in estuary and freshwater	12 in freshwater • 4 high value – to be determined • 5 confluence of tribs/mainstem • 3 background 4 in estuary	Freshwater: • Riparian habitat • Triad: bioassessment, water chemistry, toxicity • Riparian habitat Estuary: • Conventional water quality • Full suite water quality • Sediment chemistry, toxicity, infauna	Annually, in spring Annually, in spring Annually, in spring Not determined Annually Annually
Q3: Discharges	Improve coordination Improve efficiency Reduce overlap			
Q4: Safe to swim	Focus on high-use areas Defer to health depts. for details	6 lake and river areas	E. coli & perhaps fecal coliform	Adjusted based on degree of use and proximity to source(s)
Q5: Safe to eat fish	3-yr pilot study Focus on: • Popular fishing sites • Commonly caught species • High-risk chemicals	2 each in lakes, river, estuary, plus one additional site for a total of 7.	Commonly caught fish at each location Mercury, DDTs, PCBs, arsenic, selenium	Annually in August

11. SAMPLING METHODS

11.1 Site Characterization

The San Gabriel River watershed is in the eastern part of Los Angeles County and part of western Orange County. It extends from San Pedro Bay north into the San Gabriel Mountains. The watershed has three major tributaries in the southern half of the watershed: Coyote, San Jose, and Walnut Creeks. Flow in the southern half of the watershed is highly controlled by a series of constructed dams, rubber dams, and spreading grounds.

The watershed is 1,900 km^2 with 300 km^2 of that in Orange County. Overall, the watershed is 54% undeveloped with the majority of that area above the Santa Fe Dam.

The San Gabriel River Estuary's tidal extent extends from downstream of Spring Street for the San Gabriel River and Coyote Creek approximately 4 km to the ocean.

11.2 Bioassessment

Sampling requires the manual collection of composite benthic samples using a D-shaped kick net at each of the monitoring locations. The complete sampling SOP, as defined in the SWAMP QAPP and compiled by Aquatic Bioassay, appears in Appendix A. Sample containers and preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used.

11.3 Water Toxicity

Sampling requires the manual collection of grab water samples using a one gallon wide mouth carboy at each of the monitoring locations. The complete sampling SOP, as defined in the SWAMP QAPP and compiled by Aquatic Bioassay, appears in Appendix B. Sample containers and preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used.

11.4 Sediment Toxicity

Sampling requires the manual collection of grab sediment samples using a petite ponar grab and a one gallon wide mouth carboy at each of the monitoring locations. The complete sampling SOP, appears in Appendix C. Sample containers and preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used.

11.5 Bacteriology

Sampling requires the manual collection of grab water samples using a 100 mL sterile plastic container at each of the monitoring locations. The complete sampling SOP, as defined in the SWAMP QAPP, appears in Appendix D. Sample containers and preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used.

11.6 Chemistry

Sampling requires the manual collection of grab water samples using the containers specified in Table 8. The complete sampling SOP, as defined in the SWAMP QAPP, appears in Appendix D. Sample preservatives are identified in Table 8. Appropriate pre-cleaned sample containers will be used.

The sampling coordinator has responsibility for assessing the safety of sampling teams. A two-person team will conduct all sampling, and the sampling team will have access to a cellular phone in order to alert rescue agencies should an accident occur. Sampling will be postponed if the sampling team determines that the conditions are unsafe.

Failure to collect a sample due to safety concerns or technical issues will be promptly reported to the Project Director, who will determine if any corrective action is needed and make arrangements to collect a replacement sample (if possible). The QA Officer will document sampling failures and the effectiveness of corrective actions. Should field equipment fail, it will be repaired or replaced as soon as possible.

12. Sample Handling and Custody

Samples will be collected and transferred to the analytical laboratories within the holding times specified in Table 8. To provide for proper tracking and handling of the samples, documentation will accompany the samples from the initial collection to the final identification and analysis.

All bottles will be labeled according to the SOP in Appendices A through D. Field data sheets and chains of custody will accompany the collection of samples. An example of the chain of custody form is also shown in the Appendices.

All samples will be marked with a unique number to track their analysis. These identification labels will also be entered directly on to field and laboratory data sheets. All observations recorded in the field as well as information recorded in processing all field samples in the laboratory will be tracked using these identification labels.

The SOP details the procedures for submitting samples to Aquatic Bioassay. These procedures reinforce the use of proper sample containers, chain of custody procedures, and unique station codes and sampling agency identifiers.

Table 8. (Element 11) Sample handling.

Analyte	Bottle Type/Size	Preservative	Maximum Holding Time
Bioassessment	0.5 G Plastic wide mouth with screw top lids	95% Ethanol	5 years
Water Toxicity	1 gallon plastic wide mouth carboy	4 °C	36 hours
Sediment Toxicity	2 L wide mouth polyethylene containers	4 °C	14 days
Bacteriology	100 mL sterile plastic container	4 °C	6 hours
Water Chemistry			
Freshwater metals	250 mL HDPE plastic	4 °C	48 hours
Freshwater & seawater organics	2 L amber glass	4 °C	7 days/40 days
Seawater metals	1 L HDPE plastic	4 °C	48 hours
General Chemistry	250 mL HDPE Plastic *	4 °C	28 days **
Sediment & Tissue Chemistry: trace metals & general chemistry	50 g glass jar	4 °C	6 months

Sediment & Tissue Chemistry: organics	50 g glass jar	4 °C	40 days

* All except: DOC = 250 mL glass; DIC 40 mL VOA; TKN = 500 mL amber glass; TOC = 40 mL VOA; TSS = 1L HDPE plastic
** All except: nitrate/nitrite & orthophosphate = 48 hours; pH = ASAP/24 hours; alkalinity = 14 days; total hardness = 6 months; TSS = 7 days

13. ANALYTICAL METHODS

13.1 Field Analysis Methods

Field measurements will have the accuracy as indicated below.

Table 9. (Element 13) Field analytical methods.

Analyte	*Laboratory / Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Method*		*Achievable Laboratory Limits*
				Analytical Method/ SOP	***Modified for Method yes/no***	***MDLs***
Estuary water						
pH	Field monitoring	6 - 9 pH units	NA	SM 4500 H+B*	None	NA
Conductance	Same	None	NA	SM 2510 B*	None	NA
DO	Same	None	NA	SM 4500 OG*	None	NA
Temperature	Same	None	-5 ^{o} C	SM 2550 B*	None	0.1 ^{o} C

(*)* Standard Methods for the Examination of Water and Wastewater, *20th edition.

13.1 Analysis Methods

The samples will be analyzed for chemistry as indicated below.

Table 10. (Element 13) Laboratory analytical methods.

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Conventional constituents in water	Ammonia	CRG	None	0.05 mg/L	SM4500-NH3 F	No
	Dissolved	CRG	None	0.05 mg/L	SM4500-NH3 F	No
	Nitrate	CRG	None	0.05 mg/L	EPA 300.0	No
	Nitrite	CRG	None	0.05 mg/L	EPA 300.0	No
	pH	CRG	None	0.2 pH Units	EPA 150.1	No
	Total Alkalinity	CRG	None	5 mg/L	SM2320B	No
	Total Hardness	CRG	None	5 mg/L	SM2340B	No
	Total Kjeldahl Nitrogen	CalScience	None	0.5 mg/L	EPA 351.3	No
	Total Organic Carbon	CalScience	None	0.5 mg/L	EPA 415.1	No
	Total Orthophosphate	CRG	None	0.01 mg/L	SM4500-P E	No
	Total Phosphorus	CRG	None	0.05 mg/L	SM4500-P C	No
	Total Suspended Solids	CRG	None	5 mg/L	SM2540D	No
Conventional constituents in estuary seawater	Ammonia	CRG	None	0.05 mg/L	SM4500-NH3 F	No
	Dissolved	CRG	None	0.05 mg/L	SM4500-NH3 F	No
	Nitrate	CRG	None	0.05 mg/L	EPA 300.0	No
	Nitrite	CRG	None	0.05 mg/L	EPA 300.0	No
	pH	CRG	None	0.2 pH Units	EPA 150.1	No
	Total Alkalinity	CRG	None	5 mg/L	SM2320B	No
	Total Hardness	CRG	None	5 mg/L	SM2340B	No
	Total Kjeldahl Nitrogen	CalScience	None	0.5 mg/L	EPA 351.3	No
	Total Organic Carbon	AMS	None	1.0 mg/L	EPA 415.1	No
	Total Orthophosphate	CRG	None	0.01 mg/L	SM4500-P E	No
	Total Phosphorus	CRG	None	0.05 mg/L	SM4500-P C	No
	Total Suspended Solids	CRG	None	5 mg/L	SM2540D	No
Trace Metals in water	Aluminum (Al)	CRG	None	10 µg/L	EPA 200.8	No
	Antimony (Sb)	CRG	None	0.5 µg/L	EPA 200.8	No
	Arsenic (As)	CRG	None	0.5 µg/L	EPA 200.8	No
	Barium (Ba)	CRG	None	0.5 µg/L	EPA 200.8	No
	Beryllium (Be)	CRG	None	0.5 µg/L	EPA 200.8	No
	Cadmium (Cd)	CRG	None	0.4 µg/L	EPA 200.8	No
	Chromium (Cr)	CRG	None	0.5 µg/L	EPA 200.8	No
	Cobalt (Co)	CRG	None	0.5 µg/L	EPA 200.8	No
	Copper (Cu)	CRG	None	0.8 µg/L	EPA 200.8	No
	Iron (Fe)	CRG	None	10 µg/L	EPA 200.8	No
	Lead (Pb)	CRG	None	0.1 µg/L	EPA 200.8	No
	Manganese (Mn)	CRG	None	0.5 µg/L	EPA 200.8	No
	Mercury (Hg)	CRG	None	0.02 µg/L	EPA 1631	No
	Molybdenum (Mo)	CRG	None	0.5 µg/L	EPA 200.8	No
	Nickel (Ni)	CRG	None	0.5 µg/L	EPA 200.8	No
	Selenium (Se)	CRG	None	0.5 µg/L	EPA 200.8	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Trace Metals in water	Silver (Ag)	CRG	None	1 µg/L	EPA 200.8	No
(cont)	Strontium (Sr)	CRG	None	0.5 µg/L	EPA 200.8	No
	Thallium (Tl)	CRG	None	0.5 µg/L	EPA 200.8	No
	Tin (Sn)	CRG	None	0.5 µg/L	EPA 200.8	No
	Titanium (Ti)	CRG	None	0.5 µg/L	EPA 200.8	No
	Vanadium (V)	CRG	None	0.5 µg/L	EPA 200.8	No
	Zinc (Zn)	CRG	None	0.5 µg/L	EPA 200.8	No
Trace Metals	Aluminum (Al)	CRG	None	10 µg/L	EPA 1640	No
in estuary seawater	Antimony (Sb)	CRG	None	0.5 µg/L	EPA 1640	No
	Arsenic (As)	CRG	None	0.5 µg/L	EPA 1640	No
	Beryllium (Be)	CRG	None	0.5 µg/L	EPA 1640	No
	Cadmium (Cd)	CRG	None	0.4 µg/L	EPA 1640	No
	Chromium (Cr)	CRG	None	0.5 µg/L	EPA 1640	No
	Cobalt (Co)	CRG	None	0.5 µg/L	EPA 1640	No
	Copper (Cu)	CRG	None	0.8 µg/L	EPA 1640	No
	Iron (Fe)	CRG	None	10 µg/L	EPA 1640	No
	Lead (Pb)	CRG	None	0.1 µg/L	EPA 1640	No
	Manganese (Mn)	CRG	None	0.5 µg/L	EPA 1640	No
	Mercury (Hg)	CRG	None	0.02 µg/L	EPA 1631	No
	Molybdenum (Mo)	CRG	None	0.5 µg/L	EPA 1640	No
	Nickel (Ni)	CRG	None	0.5 µg/L	EPA 1640	No
	Selenium (Se)	CRG	None	0.5 µg/L	EPA 1640	No
	Silver (Ag)	CRG	None	1 µg/L	EPA 1640	No
	Thallium (Tl)	CRG	None	0.5 µg/L	EPA 1640	No
	Tin (Sn)	CRG	None	0.5 µg/L	EPA 1640	No
	Titanium (Ti)	CRG	None	0.5 µg/L	EPA 1640	No
	Vanadium (V)	CRG	None	0.5 µg/L	EPA 1640	No
	Zinc (Zn)	CRG	None	0.5 µg/L	EPA 1640	No
Nutrients in	Total Kjeldahl Nitrogen	CalScience	None	10 mg/kg	EPA 351.3	No
estuary sediments	Total Organic Carbon	AMS	None	0.01%	EPA 415.1	No
	Total Phosphorus	CRG	None	0.05 mg/kg	SM4500-P C	No
Trace metals in	Aluminum (Al)	CRG	None	5 µg/dry g	EPA 6020	No
estuary sediments	Antimony (Sb)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Arsenic (As)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Barium (Ba)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Beryllium (Be)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Cadmium (Cd)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Chromium (Cr)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Cobalt (Co)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Copper (Cu)	CRG	None	0.05 µg/dry g	EPA 6020	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Trace metals in	Iron (Fe)	CRG	None	5 µg/dry g	EPA 6020	No
estuary sediments	Lead (Pb)	CRG	None	0.05 µg/dry g	EPA 6020	No
(cont)	Manganese (Mn)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Mercury (Hg)	CRG	None	0.02 µg/dry g	EPA 245.7	No
	Molybdenum (Mo)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Nickel (Ni)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Selenium (Se)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Silver (Ag)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Strontium (Sr)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Thallium (Tl)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Tin (Sn)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Titanium (Ti)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Vanadium (V)	CRG	None	0.05 µg/dry g	EPA 6020	No
	Zinc (Zn)	CRG	None	0.05 µg/dry g	EPA 6020	No
Organophosphorus	Bolstar (Sulprofos)	CRG	None	10 ng/dry g	EPA 8270C	No
Pesticides in	Chlorpyrifos	CRG	None	10 ng/dry g	EPA 8270C	No
estuary sediment	Demeton	CRG	None	10 ng/dry g	EPA 8270C	No
	Diazinon	CRG	None	10 ng/dry g	EPA 8270C	No
	Dichlorvos	CRG	None	10 ng/dry g	EPA 8270C	No
	Dimethoate	CRG	None	10 ng/dry g	EPA 8270C	No
	Disulfoton	CRG	None	10 ng/dry g	EPA 8270C	No
	Ethoprop (Ethoprofos)	CRG	None	10 ng/dry g	EPA 8270C	No
	Fenchlorophos (Ronnel)	CRG	None	10 ng/dry g	EPA 8270C	No
	Fensulfothion	CRG	None	10 ng/dry g	EPA 8270C	No
	Fenthion	CRG	None	10 ng/dry g	EPA 8270C	No
	Malathion	CRG	None	10 ng/dry g	EPA 8270C	No
	Merphos	CRG	None	10 ng/dry g	EPA 8270C	No
	Methyl Parathion	CRG	None	10 ng/dry g	EPA 8270C	No
	Mevinphos (Phosdrin)	CRG	None	10 ng/dry g	EPA 8270C	No
	Phorate	CRG	None	10 ng/dry g	EPA 8270C	No
	Tetrachlorvinphos (Stirofos)	CRG	None	10 ng/dry g	EPA 8270C	No
	Tokuthion	CRG	None	10 ng/dry g	EPA 8270C	No
	Trichloronate	CRG	None	10 ng/dry g	EPA 8270C	No
Organochlorine Pesticides	4,4'-DDD	CRG	None	1 ng/dry g	EPA 8270C	No
& PCBs in	2,4'-DDD	CRG	None	1 ng/dry g	EPA 8270C	No
estuary sediment	2,4'-DDE	CRG	None	1 ng/dry g	EPA 8270C	No
	2,4'-DDT	CRG	None	1 ng/dry g	EPA 8270C	No
	4,4'-DDE	CRG	None	1 ng/dry g	EPA 8270C	No
	4,4'-DDT	CRG	None	1 ng/dry g	EPA 8270C	No
	Aldrin	CRG	None	1 ng/dry g	EPA 8270C	No
	BHC-alpha	CRG	None	1 ng/dry g	EPA 8270C	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Organochlorine Pesticides	BHC-beta	CRG	None	1 ng/dry g	EPA 8270C	No
& PCBs in	BHC-delta	CRG	None	1 ng/dry g	EPA 8270C	No
estuary sediment	BHC-gamma	CRG	None	1 ng/dry g	EPA 8270C	No
(cont)	Chlordane-alpha	CRG	None	1 ng/dry g	EPA 8270C	No
	Chlordane-gamma	CRG	None	1 ng/dry g	EPA 8270C	No
	cis-Nonachlor	CRG	None	1 ng/dry g	EPA 8270C	No
	Dieldrin	CRG	None	1 ng/dry g	EPA 8270C	No
	Endosulfan Sulfate	CRG	None	1 ng/dry g	EPA 8270C	No
	Endosulfan-I	CRG	None	1 ng/dry g	EPA 8270C	No
	Endosulfan-II	CRG	None	1 ng/dry g	EPA 8270C	No
	Endrin	CRG	None	1 ng/dry g	EPA 8270C	No
	Endrin Ketone	CRG	None	1 ng/dry g	EPA 8270C	No
	Heptachlor	CRG	None	1 ng/dry g	EPA 8270C	No
	Heptachlor Epoxide	CRG	None	1 ng/dry g	EPA 8270C	No
	Methoxychlor	CRG	None	1 ng/dry g	EPA 8270C	No
	Mirex	CRG	None	1 ng/dry g	EPA 8270C	No
	Oxychlordane	CRG	None	1 ng/dry g	EPA 8270C	No
	trans-Nonachlor	CRG	None	1 ng/dry g	EPA 8270C	No
	Endrin Aldehyde	CRG	None	1 ng/dry g	EPA 8270C	No
	Toxaphene	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB018	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB028	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB031	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB033	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB037	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB044	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB049	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB052	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB066	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB070	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB074	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB077	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB081	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB087	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB095	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB097	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB099	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB101	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB105	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB110	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB114	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB118	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB119	CRG	None	1 ng/dry g	EPA 8270C	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Organochlorine Pesticides	PCB123	CRG	None	1 ng/dry g	EPA 8270C	No
& PCBs in	PCB126	CRG	None	1 ng/dry g	EPA 8270C	No
estuary sediment	PCB128+167	CRG	None	1 ng/dry g	EPA 8270C	No
(cont)	PCB138	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB141	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB149	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB153	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB156	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB157	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB158	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB168	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB168+132	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB169	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB170	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB177	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB180	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB183	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB187	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB189	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB194	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB200	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB201	CRG	None	1 ng/dry g	EPA 8270C	No
	PCB206	CRG	None	1 ng/dry g	EPA 8270C	No
Polynuclear Aromatic	1-Methylnaphthalene	CRG	None	1 ng/dry g	EPA 8270C	No
Hydrocarbons in	1-Methylphenanthrene	CRG	None	1 ng/dry g	EPA 8270C	No
estuary sediment	2,3,5-Trimethylnaphthalene	CRG	None	1 ng/dry g	EPA 8270C	No
	2,6-Dimethylnaphthalene	CRG	None	1 ng/dry g	EPA 8270C	No
	2-Methylnaphthalene	CRG	None	1 ng/dry g	EPA 8270C	No
	Acenaphthene	CRG	None	1 ng/dry g	EPA 8270C	No
	Acenaphthylene	CRG	None	1 ng/dry g	EPA 8270C	No
	Anthracene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benz[a]anthracene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benzo[a]pyrene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benzo[b]fluoranthene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benzo[e]pyrene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benzo[g,h,i]perylene	CRG	None	1 ng/dry g	EPA 8270C	No
	Benzo[k]fluoranthene	CRG	None	1 ng/dry g	EPA 8270C	No
	Biphenyl	CRG	None	1 ng/dry g	EPA 8270C	No
	Chrysene	CRG	None	1 ng/dry g	EPA 8270C	No
	Dibenz[a,h]anthracene	CRG	None	1 ng/dry g	EPA 8270C	No
	Dibenzothiophene	CRG	None	1 ng/dry g	EPA 8270C	No
	Fluoranthene	CRG	None	1 ng/dry g	EPA 8270C	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Polynuclear Aromatic	Fluorene	CRG	None	1 ng/dry g	EPA 8270C	No
Hydrocarbons in	Indeno[1,2,3-c,d]pyrene	CRG	None	1 ng/dry g	EPA 8270C	No
estuary sediment	Naphthalene	CRG	None	1 ng/dry g	EPA 8270C	No
(cont)	Perylene	CRG	None	1 ng/dry g	EPA 8270C	No
	Phenanthrene	CRG	None	1 ng/dry g	EPA 8270C	No
	Pyrene	CRG	None	1 ng/dry g	EPA 8270C	No
Sediment grain size	Sediment grain size	ABC	None	N/A	SM 2560 C	No
in estuary sediments						
Trace Metals in Tissues	Aluminum (Al)	CRG	None	5 µg/wet g	EPA 6020	No
	Antimony (Sb)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Arsenic (As)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Barium (Ba)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Beryllium (Be)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Cadmium (Cd)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Chromium (Cr)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Cobalt (Co)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Copper (Cu)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Iron (Fe)	CRG	None	5 µg/wet g	EPA 6020	No
	Lead (Pb)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Manganese (Mn)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Mercury (Hg)	CRG	None	0.02 µg/wet g	EPA 6020	No
	Molybdenum (Mo)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Nickel (Ni)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Selenium (Se)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Silver (Ag)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Strontium (Sr)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Thallium (Tl)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Tin (Sn)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Titanium (Ti)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Vanadium (V)	CRG	None	0.05 µg/wet g	EPA 6020	No
	Zinc (Zn)	CRG	None	0.05 µg/wet g	EPA 6020	No
Organochlorine Pesticides	4,4'-DDD	CRG	None	1 ng/wet g	EA 8270C	No
& PCBs in	2,4'-DDD	CRG	None	1 ng/wet g	EA 8270C	No
tissues	2,4'-DDE	CRG	None	1 ng/wet g	EA 8270C	No
	2,4'-DDT	CRG	None	1 ng/wet g	EA 8270C	No
	4,4'-DDE	CRG	None	1 ng/wet g	EA 8270C	No
	4,4'-DDT	CRG	None	1 ng/wet g	EA 8270C	No
	Aldrin	CRG	None	1 ng/wet g	EA 8270C	No
	BHC-alpha	CRG	None	1 ng/wet g	EA 8270C	No
	BHC-beta	CRG	None	1 ng/wet g	EA 8270C	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Organochlorine Pesticides	BHC-delta	CRG	None	1 ng/wet g	EA 8270C	No
& PCBs in	BHC-gamma	CRG	None	1 ng/wet g	EA 8270C	No
tissues	Chlordane-alpha	CRG	None	1 ng/wet g	EA 8270C	No
(cont)	Chlordane-gamma	CRG	None	1 ng/wet g	EA 8270C	No
	cis-Nonachlor	CRG	None	1 ng/wet g	EA 8270C	No
	Dieldrin	CRG	None	1 ng/wet g	EA 8270C	No
	Endosulfan Sulfate	CRG	None	1 ng/wet g	EA 8270C	No
	Endosulfan-I	CRG	None	1 ng/wet g	EA 8270C	No
	Endosulfan-II	CRG	None	1 ng/wet g	EA 8270C	No
	Endrin	CRG	None	1 ng/wet g	EA 8270C	No
	Endrin Ketone	CRG	None	1 ng/wet g	EA 8270C	No
	Heptachlor	CRG	None	1 ng/wet g	EA 8270C	No
	Heptachlor Epoxide	CRG	None	1 ng/wet g	EA 8270C	No
	Methoxychlor	CRG	None	1 ng/wet g	EA 8270C	No
	Mirex	CRG	None	1 ng/wet g	EA 8270C	No
	Oxychlordane	CRG	None	1 ng/wet g	EA 8270C	No
	trans-Nonachlor	CRG	None	1 ng/wet g	EA 8270C	No
	Endrin Aldehyde	CRG	None	1 ng/wet g	EA 8270C	No
	Toxaphene	CRG	None	1 ng/wet g	EA 8270C	No
	PCB018	CRG	None	1 ng/wet g	EA 8270C	No
	PCB028	CRG	None	1 ng/wet g	EA 8270C	No
	PCB031	CRG	None	1 ng/wet g	EA 8270C	No
	PCB033	CRG	None	1 ng/wet g	EA 8270C	No
	PCB037	CRG	None	1 ng/wet g	EA 8270C	No
	PCB044	CRG	None	1 ng/wet g	EA 8270C	No
	PCB049	CRG	None	1 ng/wet g	EA 8270C	No
	PCB052	CRG	None	1 ng/wet g	EA 8270C	No
	PCB066	CRG	None	1 ng/wet g	EA 8270C	No
	PCB070	CRG	None	1 ng/wet g	EA 8270C	No
	PCB074	CRG	None	1 ng/wet g	EA 8270C	No
	PCB077	CRG	None	1 ng/wet g	EA 8270C	No
	PCB081	CRG	None	1 ng/wet g	EA 8270C	No
	PCB087	CRG	None	1 ng/wet g	EA 8270C	No
	PCB095	CRG	None	1 ng/wet g	EA 8270C	No
	PCB097	CRG	None	1 ng/wet g	EA 8270C	No
	PCB099	CRG	None	1 ng/wet g	EA 8270C	No
	PCB101	CRG	None	1 ng/wet g	EA 8270C	No
	PCB105	CRG	None	1 ng/wet g	EA 8270C	No
	PCB110	CRG	None	1 ng/wet g	EA 8270C	No
	PCB114	CRG	None	1 ng/wet g	EA 8270C	No
	PCB118	CRG	None	1 ng/wet g	EA 8270C	No
	PCB119	CRG	None	1 ng/wet g	EA 8270C	No
	PCB123	CRG	None	1 ng/wet g	EA 8270C	No

Group	*Analyte*	*Laboratory/ Organization*	*Project Action Limit (units, wet or dry weight)*	*Project Quantitation Limit (units, wet or dry weight)*	*Analytical Methods*	
					Analytical Method/SOP	*Modified for Method yes/no*
Organochlorine Pesticides	PCB126	CRG	None	1 ng/wet g	EA 8270C	No
& PCBs in	PCB128+167	CRG	None	1 ng/wet g	EA 8270C	No
tissues	PCB138	CRG	None	1 ng/wet g	EA 8270C	No
(cont)	PCB141	CRG	None	1 ng/wet g	EA 8270C	No
	PCB149	CRG	None	1 ng/wet g	EA 8270C	No
	PCB153	CRG	None	1 ng/wet g	EA 8270C	No
	PCB156	CRG	None	1 ng/wet g	EA 8270C	No
	PCB157	CRG	None	1 ng/wet g	EA 8270C	No
	PCB158	CRG	None	1 ng/wet g	EA 8270C	No
	PCB168	CRG	None	1 ng/wet g	EA 8270C	No
	PCB168+132	CRG	None	1 ng/wet g	EA 8270C	No
	PCB169	CRG	None	1 ng/wet g	EA 8270C	No
	PCB170	CRG	None	1 ng/wet g	EA 8270C	No
	PCB177	CRG	None	1 ng/wet g	EA 8270C	No
	PCB180	CRG	None	1 ng/wet g	EA 8270C	No
	PCB183	CRG	None	1 ng/wet g	EA 8270C	No
	PCB187	CRG	None	1 ng/wet g	EA 8270C	No
	PCB189	CRG	None	1 ng/wet g	EA 8270C	No
	PCB194	CRG	None	1 ng/wet g	EA 8270C	No
	PCB200	CRG	None	1 ng/wet g	EA 8270C	No
	PCB201	CRG	None	1 ng/wet g	EA 8270C	No
	PCB206	CRG	None	1 ng/wet g	EA 8270C	No
Percent Lipids in Tissues	Lipids	CRG	None	0.10%	Gravimetric	No
Bacterial analysis	Total Coliforms	CRG	None	10 MPN/100mL	Colilert	No
in water and estuary	E. Coli	CRG	None	10 MPN/100mL	Colilert	No
waters	Enterococcus	CRG	None	10 MPN/100mL	Enterolert	No
Toxicity Testing: Water						
Freshwater	Ceriodaphnia: acute/chronic	ABC	None	N/A	EPA/821/R/02012	No
Estuary	Menidia: acute	ABC	None	0-100% survial	EPA/821/R/02012	No
Toxicity Testing: Estuary Sediments	Eohaustorius: acute	ABC	None	0-100% survival	EPA/R-94/025	No
	Mytilus: chronic	ABC	None	development	Marine Pollution	No
					Studies Lab, 2004	
Bioassessment	Benthic	ABC	None	SAFIT QC	CSBP (2003)	No
	macroinvertebrate				SCCWRP (2003)	No
	identification					

13.2 Sample Disposal

After analysis, including QA/QC procedures, sample disposal will follow laboratory protocols. Portions of the bioassessment samples will be retained including unsorted sample (1 year), sorted remnants (5 years), identified sample partitioned into taxa groups (5 years), and a reference collection (indefinitely).

13.3 Corrective Action

Corrective action is taken when an analysis is deemed suspect for some reason. These reasons include exceeding accuracy ranges (chemistry); not meeting test acceptability criteria or control chart criteria (toxicity); not meeting blank checks (bacteriology); and/or problems with sorting and identification (bioassessments). The corrective action will vary on a case-by-case basis, but at a minimum involves the following:

- A check of procedures.
- A review of documents and calculations to identify possible errors.
- Correction of errors based on discussions among analysts.
- A complete re-identification of the bioassessment sample.
- A re-analysis of the sample extract, if sufficient volume is available, to determine if results can be improved.
- A complete reprocessing and re-analysis of additional sample material, if sufficient volume is available and if the holding time has not been exceeded.
- Re-training of staff to ensure the action is not repeated.

The field and laboratory coordinators each have systems in place to document problems and make corrective actions. All corrective actions will be documented to the Project Manager.

Laboratories will be required to provide a three-week turnaround on all deliverables. The deliverable package will include hard copy and Electronic Data Deliverable (EDD). The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions, if any. The following QA/QC elements will be included in the data package: sample collection, extraction, and analysis dates and times, results of method blanks, summary of analytical accuracy, summary of analytical precision, and reporting limits. The electronic data files will contain all information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® workbook files or as Microsoft Access® database files.

14. QUALITY CONTROL

Samples for QA/QC will be collected both in the field and in the lab. Field QA/QC samples are used to evaluate precision due to sampling bias or field variability. Field QA/QC samples include field duplicates and travel blanks. Lab QA/QC samples are used to evaluate the analytical process for precision and accuracy. Internal laboratory QC checks will include:

- Bioassessments: sample re-sorts and re-identification
- Toxicity: acceptable laboratory controls and reference toxicant test results
- Bacteriology: acceptable laboratory blank and positive controls
- Chemistry: method blanks, laboratory control materials, duplicates, matrix spikes, instrument calibrations and internal standards

14.1 Field Sampling Quality Control

QA/QC activities for sampling processes include the collection of field replicates for bacterial and chemical testing, the preparation of field blanks, and field checks by sampling staff (see Table 12). In order to monitor the sampling process, the Aquatic Bioassay QA Officer will randomly observe sampling processes and compare the actual actions against the sampling SOP. Laboratory results will validate cleanliness of equipment. If contamination of sample by field or equipment occurs during the sampling, the contaminated sample will be discarded.

14.1.5 Travel blanks

Travel blanks will be used to insure that no contaminants are added during manual sampling operations and storage. Bottles will be filled prior to field activities and put on ice, taken into the field during sampling and transported to the lab for analysis.

14.2 Field Duplicates

Field duplicates help quantify potential bias associated with sampling activities. Field duplicates are comprised of a replicate sample taken at 5% of the programs sites. Each result will be recorded along with the average of the two results, the difference between the largest and smallest result, and the percent difference between the largest and smallest result. The percent difference will be calculated as follows.

Relative Percent Difference (RPD) = 100 * (Largest-Smallest) / Average

There are no specific criteria for field duplicate precision, but results with an RPD of ± 25% are generally considered acceptable.

14.2 Bioassessment Sample Re-sorting

Sample re-sorting is used to quantify the sorting accuracy of the laboratory. Once samples are sorted, a second technician will re-sort the sample remnants to ensure

that all organisms have been removed. The acceptable accuracy limits are shown in (Table 5b) Percent sorting accuracy is calculated as:

- Percent Sorting Accuracy = ((number of organisms in re-sort *100)/ number of organisms in original sort)

14.3 Bioassessment Sample Identification

Sample re-identification is used to quantify the identification and enumeration accuracy of the laboratory. Once samples are identified, a second biologist will re-identify the sample to ensure that all organisms have been accurately identified and enumerated. The acceptable accuracy limits are shown in Table 5b. Percent identification and enumeration accuracy are calculated as:

- Percent Identification Accuracy = ((number of organisms misidentified)/ number of organisms in original ID)*100

- Percent Enumeration Accuracy = (number of organisms in re-identification)/number of organisms enumerated in original sample)*100

Identification discrepancies between the laboratories are discussed and resolved by the biologists. The final dataset is modified to reflect the agreed upon resolution.

14.4 Toxicity

- The survival of test organisms in laboratory control water must be at least 90% for acute and 80% for chronic toxicity tests to be considered valid.

- Reference toxicant results must be within ± 2 standard deviations of the average of the previous 20 tests.

- All test acceptability conditions must be within specified limits.

14.5 Bacteriology

- Reagent blank samples must be below detection (<10 MPN/100 mL) for all samples for tests to be valid.

- Positive controls must be within specified ranges for the associated tests to be valid.

14.6 Chemistry

A batch is defined as a group of 20 or fewer samples of similar matrix, processed together under the same conditions and with the same reagents.

QC samples are associated with each batch and are used to assess the validity of the sample analyses. Control limits can be found in Table 5a of this document. Each batch must include the following QC checks:

- Method Blank- A method blank is a sample that contains no analyte of interest. For solid matrices, no matrix is used. The method blank serves to measure contamination associated with processing the sample within the laboratory.

- Laboratory Control Material (LCM) or Certified Reference Material (CRM)- A LCM or CRM is a sample with a matrix similar to the client samples that contains analyte of interest at known or certified concentrations. It is used to determine the accuracy of the results based on the comparison of the measured concentration with the true value. For analyte that are greater than 10 times the MDL, the acceptable percent recovery is presented in Table 5a.

- Duplicate Analyses- Duplicate analyses are samples that have been split and processed within a single batch. They are used to determine the precision of the results based on the percent relative difference (%RSD) between the two sets of results. Control limits for %RSD are presented in Table 5a.

- Matrix Spike/Matrix Spike Duplicates (MS/MSD)- MS/MSD are samples of similar matrix to the client's samples that are spiked with a known amount of analyte. Spike recovery measures the effect of interferences caused by the sample matrix and reflects the accuracy of the determination. The spike level should be at least ten times the MDL. The duplicate spike may be used to determine the precision of the analytical results similar to Section 7,1

- Tuning Check- The tuning of the mass spectrometer is checked at the beginning of each run to insure that it is providing adequate spectra.

- Initial Calibration- Initial calibration is performed by analyzing standards of known levels of concentration. The lowest level should be less than or equal to ten times the MDL and the remaining levels should represent the entire range of expected concentrations in the samples.

- Calibration Verification- When a calibration curve is not performed for each run, a calibration verification is performed with a standard from, preferably a second source, is used to verify that the instrument is still operating within the original calibration curve.

- Internal Standard- An internal standard is a non-target analyte, which is added to samples and QC checks after the preparation of the sample, just

prior to analysis. It is used to compensate for variations in the instrument response from one sample to the next.

- Recovery Surrogate- A recovery surrogate is a non-target analyte or analytes that are added to the sample prior to processing. It is used to indicate the extraction efficiency and instrument variation from sample to sample.

Table 11. (Elements 14 and 16) Quality Control

Analyte	Quality Control	Instrument Calibration
Water Column Samples		
pH	Replicate (3) measurements, check against second pH buffer, plus general maintenance and calibration practices	calibration at the start of each sample run.
Conductance	Replicate (3) measurements, plus general maintenance and calibration practices	
DO		
Temperature		
General Constituents and Nutrients in Water	Blanks – Laboratory and field blanks. No detectable amount of substance in blanks. Frequencies – Accuracy, precision, recovery, and blanks at 1 in 20 (5%) with at least one in every batch. All QA/QC procedures and criteria specified by selected method.	External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \leq 0.995$. Calibration verification every 20 samples after initial calibration. Standard source different that that used for initial calibration. Recovery 80% - 120%.
Organics in Water		External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \leq 0.995$ or RSD < 10%. Calibration verification every 10 samples after initial calibration. Standard source different that that used for initial calibration. Recovery 85% - 115%.
Metals in Water		External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \leq 0.995$. Calibration verification every 20 samples after initial calibration. Standard source different that that used for initial calibration. Recovery 90% - 110%
Toxicity Testing	Control organisms perform within acceptance criteria for each test.	Stock organisms tested using reference toxicants for each batch of tests. Current test must fall within ± 2 SD of last 20 combined reference toxicant tests.
Bacteria indicators	Field and sterility checks (laboratory blanks) no detectable amounts or less than 1/5 of sample amounts for field blanks. Frequency – accuracy at 1 per culture medium or reagent lot. Precision at 1 in 10 (10%) with at least one per batch. All QA/QC procedures found in *Standard Methods* (18th, 19th, or 20th editions) section 9020 and in the selected analytical method including confirmation practices.	Follow the requirements of *Standard Methods* (18th, 19th, or 20th editions) section 9020.
Sediment Samples		
Nutrients in Sediment	Blanks – Laboratory and field blanks. No detectable amount of substance in blanks.	External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample

Organics in Sediment	Frequencies – Accuracy, precision, recovery, and blanks at 1 in 20 (5%) with at least one in every batch. All QA/QC procedures and criteria specified by selected method.	analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \leq 0.995$ Calibration verification every 10 samples after initial calibration. Standard source different that that used for initial calibration. Recovery 90% - 110%
Metals in Sediment	Blanks – Laboratory and field blanks. No detectable amount of substance in blanks. Frequencies – Accuracy, precision, recovery, and laboratory blanks at 1 in 20 (5%) with at least one in every batch. Field blanks – initial demonstration. No further blanks collected if no detectable amount. Otherwise blanks collected at 5% of samples. All QA/QC procedures and criteria specified by selected method.	
Total organic carbon in sediment and sediment grain size	Blanks – no detectable amount or <30% of lowest sample. Frequency – Accuracy for TOC every 15 samples; Precision one per batch; LCM for TOC 1 in 20 (5%) with at least one per batch.	Follow manufacturer's requirements for TOC analyzer. Check weights for balances.

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

15.1 Analytical Instruments

Aquatic Bioassay and CRG Labs maintain their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the method.

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

All laboratory equipment is calibrated based on manufacturer recommendations and accepted laboratory protocol. Aquatic Bioassay and CRG Labs maintain calibration practices as part of the method SOPs.

Aquatic Bioassay maintains calibration practices as part of the method SOPs and details are described in the attached documents. The Aquatic Bioassay QA Officer has reviewed these practices and finds them to be in conformance with the SWAMP requirements.

17. INSPECTION/ACCEPTANCE FOR SUPPLIES AND CONSUMABLES

Glassware, sample bottles, and collection equipment will all be inspected prior to their use. Supplies will be examined for damage as they are received. The following supplies will receive additional checks as follows.

CRG Labs maintains a supply inspection and checking SOP, which has been examined by Aquatic Bioassay's QA officer.

Table 12. (Element 17) Inspection/acceptance testing requirements for consumables and supplies.

Project-Related Supplies / Consumables	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Pre-cleaned sample bottles	Open bottle	Lids on bottles screwed on	100%	Field personnel
Lab glassware	Dirty	Clean	100%	CRG Labs
Nisken bottle	Leakage	Works properly	Prior to survey	Aquatic Bioassay
ENTRIX supplies	Dirty	Clean	100%	ENTRIX

18. NON-DIRECT MEASUREMENTS

The data reports for this study will cite and include monitoring data collected during previous years for this project. These data were collected in accordance with SWAMP protocols. Data collected from other studies in the area will be cited in monitoring report and used for comparative purposes. The data sets have met all QA requirements consistent with this study.

19. DATA MANAGEMENT

The management of bioassessment data will be initiated with the use of field and laboratory data sheets. Analysis results will be compiled in SWAMP compatible electronic formats by Aquatic Bioassay. CRG Labs will submit completed data sets electronically in SWAMP compatible formats to Aquatic Bioassay after QC checks have been completed. The Aquatic Bioassay Project Manager will receive and review data QC reports from the Aquatic Bioassay Data Manager who will screen all internally and externally generated for the following major items:

- A 100 percent check between electronic data provided by the laboratory and the hard copy reports
- Conformity check between the chain of custody Forms and laboratory reports
- A check for laboratory data report completeness
- A check for typographical errors on the laboratory reports
- A check for suspect values (outliers)
- A check for duplicates

The laboratories will provide data in electronic format. The required form of the SWAMP compatible electronic submittals will be provided to the laboratories to ensure the files can be imported into the project database with a minimum of editing. The data will be managed in Aquatic Bioassay's project database, which has a relational structure and is compatible for incorporation into the SWAMP database.

Following the initial screening, a more complete QA/QC review process will be performed, which will include an evaluation of analytical accuracy and precision. Accuracy will be evaluated by reviewing bioassay, chemistry and bacteriology QC results; precision will be evaluated by reviewing field duplicates, and sample completeness will be evaluated by comparing results to chain of custody forms.

Data will be stored on the Aquatic Bioassay network that is backed up daily in-house and off-site. Hard copies of field and lab data will be stored at Aquatic Bioassay for three years from project completion.

GROUP C ASSESSMENT AND OVERSIGHT

20. ASSESSMENTS AND RESPONSE ACTIONS

Scott Johnson, the Project Manager, will be responsible for the day-to-day oversight of the project. Karin Wisenbaker, the Project QA Officer will conduct periodic reviews of the data and relay any problems to the Project Manager.

If an audit discovers any discrepancy, Aquatic Bioassay's QA Officer will discuss the observed discrepancy with the appropriate person responsible for the activity (see organization chart). The discussion will begin with whether the information collected is accurate, what were the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered.

The QA Officer has the power to halt all sampling and analytical work by the Aquatic Bioassay, CRG Labs or ENTRIX if the deviation(s) noted are considered detrimental to data quality.

21. REPORTS TO MANAGEMENT

The status of data collection during this project will be reported by the Project Manager to the Contract Manager on a monthly basis beginning October 1st, 2006 and continuing until the completion of the current contract. A draft final project report will be filed no later than October of each year. The Project QA Officer has complete access to the Project manager on an ongoing basis. Any QA deviations will be detailed in the sample event summary report and draft/final report.

Table 13. (Element 21) QA management report

Report	**Due by**
Monthly progress reports	October 1st, 2006 and monthly thereafter
Sample event summary	Included in the monthly reports
Draft final report for review	July of each year
Final Report	August of each year

GROUP D DATA VALIDATION AND USABLILITY

22. DATA REVIEW, VERIFICATION, AND VALIDATION

Laboratory validation and verification of the data generated is the responsibility of the laboratory. The laboratory manager will maintain analytical reports in a database format as well as all QA/QC documentation for the laboratory.

Aquatic Bioassay will review all data packages received for adherence to the Data Quality Objectives (DQOs) set forth in this QAPP. Chain of custody forms will be reviewed to ensure adherence to collection, transport, and receipt requirements, including test initiation within the required holding time. Toxicity data will be evaluated for completeness, adherence to test methodology, passing acceptability criteria, choice of appropriate statistical methods, and proper reporting.

If results fail to meet any DQO the Project Manager and or the QA Officer will flag them for further review. Batch QA samples will be reviewed to determine the potential cause for failure to meet the DQO. If the cause cannot be readily ascertained, reserve samples will be reanalyzed (if within the designated holding times). If subsequent analyses meet the DQO, the samples will be deemed acceptable.

If samples fail to meet the DQOs a second time, or the cause of the failure cannot be identified and rectified, the data will be excluded from inclusion in the study results. All rejected data will be retained in the project database, and qualified as “rejected”. The ultimate decision of whether to accept or reject a data point will be made by the Project Manager in consultation with the QA Officer.

If the analysis for more than 10% of any given analyte fails to meet the DQOs, the Project Manager and QA Officer shall meet to discuss the appropriateness of the DQO and any potential modifications. All proposed modifications of DQOs shall be reviewed by the QA Officer at the Regional Water Quality Control Board.

Laboratories will conduct a 50 percent raw data versus electronic data audit before delivering results to the final program database held by Aquatic Bioassay. If their error rate is greater than 5%, a 100% raw data audit will be triggered.

23. VERIFICATION AND VALIDATION METHODS

Data collected in the field will be validated and verified by the field coordinator. The laboratory maintains chain of custody and sample manifests.

Laboratory validation and verification of the data generated is the responsibility of the laboratory. The laboratory supervisor will maintain analytical reports in a database format as well as all QA/QC documentation for the laboratory.

Scott Johnson is responsible for oversight of data collection and the initial analysis of the raw data obtained from the field and the laboratory. His responsibilities also include the generation of rough drafts of monthly and final reports. Scott has final oversight on the submission of monthly and final reports.

Karin Wisenbaker will provide technical support on the analysis of raw data. Scott Johnson has final oversight on the submission of final reports.

Reconciliation and correction of any data that fails to meet the project DQOs will be done by the Project Manager in consultation with the QA Officer. Any corrections require a unanimous agreement that the correction is appropriate

24. RECONCILIATION WITH USER REQUIREMENTS

For data that do not meet DQOs, management has two options:

1. Retain the data for analytical purposes, but flag these data for QA deviations.
2. Do not retain the data and exclude them from all calculations and interpretations.

The choice of option is the decision of the Project Manager. If qualified data are to be used, then it must be made clear in the final report that these deviations do not alter the conclusions of the study.

Appendix A.

Standard Operating Procedure for Bioassessments Sampling & Laboratory Analysis

Prepared by
Aquatic Bioassay and Consulting Laboratories

TABLE OF CONTENTS

Part I. Procedures for Field Sampling

1.0 Introduction

Freshwater benthic invertebrates for non-point source studies are sampled from flowing, wadeable streams using a D-shaped kick net. Standard Operating Procedures (SOPs) for sampling, in-field processing, physical habitat, sorting and taxonomy are described in detail below. The SOPs follow the Storm Water Ambient Monitoring Programs Bioassessment Procedures (SOP 001, February 9th, 2007). The physical habitat conditions at sites in the watershed are also assessed using the California Rapid Assessment Method (CRAM) for wetlands.

2.0 Equipment

Physical Habitat	BMI Collection	General/ Ambient Chemistry
• GPS receiver • topographic maps • measuring tape (150-m) • small metric ruler or gravelometer for substrate measurements • digital watch, random number table or ten-sided die • stadia rod • clinometer • autolevel (for slopes < 1%) • handlevel (optional) • current velocity meter • stopwatch for velocity measurements • convex spherical densitometer • flags/ flagging tape • rangefinder	• D-frame kick net (fitted with 500-µ mesh bag) • standard # 35 sieve (500-µ mesh) • wide-mouth 500-mL plastic jars • white sorting pan (enamel or plastic) • 95% EtOH • fine tipped forceps or soft forceps • waterproof paper and tape for attaching labels • 10-20-L plastic bucket for sample elutriation • preprinted waterproof labels (e.g., Rite-in-the-Rain™) • disposable gloves/ elbow length insulated gloves	• sampling SOP (this document) • hip or chest waders, or wading boots/shoes • field forms printed on waterproof paper (e.g., Rite-in-the-Rain™) • clip board and pencils • digital camera • centigrade thermometer • pH meter • DO meter • conductivity meter • field alkalinity meter • water chemistry containers • calibration standards • spare batteries for meters • first aid kit

3.0 Standard Operating Procedures

Sampling Benthic Invertebrates in Flowing Wadeable Streams for Non-Point Source Studies

Sampling and laboratory procedures for this survey follow the SWAMP 2007 protocols. The SWAMP sampling methods replace previous bioassessment protocols referred to as the California Stream Bioassessment Procedure (CSBP, Harrington 1995, 1999, 2002). The SWAMP document describes two standard procedures (TRC and RWB) for sampling benthic macroinvertebrate (BMI) assemblages for ambient bioassessments and procedures for measuring instream and riparian habitats and ambient water chemistry associated with BMI samples.

Reach delineation and water quality

The systematic positioning of transects is essential to collecting representative Regional Board samples and to the objective quantification of physical habitat measures. The standard sampling layout consists of a 150-m reach (length measured along the bank) divided into 11 equidistant transects that are arranged perpendicular to the direction of flow (Figure 1, Figure 2). Ten additional transects (designated "inter-transects" here) located between the main transects give a total of 21 transects per reach. Main transects are designated A through K while inter-transects are designated by their nearest upstream and downstream transects (e.g., AB, BC, etc.). In extreme circumstances, reach length can be shorter than 150 m (e.g., if upstream and downstream barriers preclude a 150-m reach), but this should be avoided whenever possible. If the actual reach length is other than 150 m or 250 m this should be noted and explained on the field forms.

Step 1. Upon arrival at the sampling site, fill out the reach documentation section of the field forms (site and project identification, stream and watershed name, crew members, and date/time). If known at the time of sampling, record the Site Code following SWAMP site code formats. Determine the geographic coordinates of the **downstream end** of the reach (preferably in decimal degrees to at least four decimal places) with a GPS receiver and record the datum setting of the unit (preferably NAD83/ WGS84).

Step 2. Once a site has been identified, make an initial survey of the reach from the stream banks (being sure to not disturb the instream habitat). If TRC samples will be collected, identify all riffle habitats suitable for sampling and note their positions so that a subset can be identified for sampling.

Step 3. Determine if the average wetted width is greater or less than 10 m. If the average wetted width ≤ 10 m, use a 150-m reach length. If the average wetted width > 10 m, use a 250-m reach length.

Step 4. Starting at one end of the reach, establish the position of the 11 main transects (labeled A-K from downstream to upstream) by measuring 15 m (*25 m for streams > 10*

m wetted width) along the bank from the previous transect. The 10 inter-transects should be established equidistant from the adjacent main transects (i.e., 7.5 m from main transects for 150-m reaches, 12.5 m for 250-m reaches). Since the data collection will start at the downstream end, it's often easiest to establish transects starting from the upstream end. For easy setup and breakdown **mark the main transects with** easily removable markers (e.g., large washers tied with strips of flagging, surveyor's flags). ***Note:*** *While it is usually easiest to establish transect positions from the banks (this also reduces disturbance to the stream channel), this can result in uneven spacing of transects in complex stream reaches. To avoid this, estimate transect positions by projecting from the mid-channel to the banks.*

Step 5. Measure and record common ambient water chemistry measurements (pH, DO, specific conductance, alkalinity, water temperature) at the downstream end of the reach (near same location as the GPS coordinates were taken). These are taken with a handheld water quality meter (YSI). Calibration methods and calibration frequency, follow the manufacturer's guidelines.

Step 6. Take a minimum of four (4) photographs of the reach at the following locations: a) Transect A facing upstream, b) Transect F facing upstream, c) Transect F facing downstream, and d) Transect K facing downstream. It may also be desirable to take a photograph at Transect A facing downstream and Transect K facing upstream to document conditions immediately adjacent to the reach. Digital photographs should be used when possible. Record the image numbers on the front page of the field form. ***Note****: When possible, photograph names should follow SWAMP coding conventions ("StationCode_yyyy_mm_dd_uniquecode"). The unique code should include one of the following codes to indicate direction: RB (right bank), LB (left bank), BB (both banks), US (upstream), DS (downstream). SWAMP suggests using unique codes created by the camera to facilitate file organization. Example: 603WQLB02_2004_03_20_RBDS1253.*

Step 7. Record the dominant land use and land cover in the area surrounding the reach (evaluate land cover within 50 m of either side of the stream reach).

Step 8. At the bottom of the form, record evidence of recent flooding, fire, or other disturbances that might influence bioassessment samples. Especially note if flow conditions have been affected by recent rainfall, which can cause significant under-sampling of BMI diversity (see note in the following section). If you are unaware of recent fire or rainfall events, select the "no" option on the forms.

Collect Benthic Macroinvertebrates (Multiple Habitat and Targeted Riffle Protocols)

Once the reach transects have been laid out, and to avoid disturbing the substrate, the biological samples (BMIs and algae if included) should be collected before any other physical habitat measures. Both TRC and RWB methods use 500-µ mesh D-frame nets (see list of BMI sampling equipment in Table 2). The two samples can be collected at

the same time by carrying two D-nets and compositing the material from the two samples in their respective nets. If a two person field crew is responsible for both the physical habitat data and benthic invertebrate samples, it is generally best to collect the benthos at each transect, then immediately record the physical habitat data before moving to the next transect. Obviously, this requires especially careful handling of the D-nets during the course of sampling to avoid loss or contamination of the samples. It can be helpful to clearly label the two D nets as RWB and TRC. Larger field crews may choose to split the sampling between biological team and a physical habitat team and have the biological team go through the reach first. The positions of the TRC and RWB subsampling locations are illustrated in Figure 2.

Sampling Locations – Acceptable Habitat Types

Riffles are the preferred habitat for TRC sampling, but other fast water habitats are acceptable for sampling if riffles are sparse. Common flow-defined habitat types are listed in Table 3 in decreasing order of energy. Most streams contain some or all of the following fast water habitat types: 1) cascades/falls, 2) rapids, 3) riffles, 4) runs. All of these are acceptable for TRC sampling if riffles are not available. ***Note****: Because the common habitat types are arranged on a continuum of high to low energy environments, the categories grade into each other continuously and are not discrete. Thus, determination of habitat types requires somewhat subjective decision-making.*

Sampling Locations – Selecting Habitat Units

A TRC sample is a composite of eight individual kick samples of 1 ft^2 (0.09 m^2) of substrate each. During your initial survey of the reach, take a mental note of the number and position of the main riffles in a reach (and other fast water habitats if needed). Randomly distribute the eight sub-samples among the fast water habitats in the reach, giving preference to riffles where possible. Unless you are sampling in small streams, try to avoid very small riffle units (i.e., <5 ft^2). If fewer than eight riffles are present in a reach, more than one sample may be taken from a single riffle, especially if the riffles are large.

Table 3. Common habitat types in stream channels, arranged in decreasing order of energy

Flow Habitat Type	**Description**
Cascades	Short, high gradient drop in stream bed elevation often accompanied by boulders and considerable turbulence
Falls	High gradient drop in elevation of the stream bed associated with an abrupt change in the bedrock
Rapids	Sections of stream with swiftly flowing water and

	considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles
Riffles	Shallow sections where the water flows over coarse stream bed particles that create mild to moderate surface turbulence
Step-Runs	a series of runs that are separated by short riffles or flow obstructions that cause discontinuous breaks in slope
Runs	Long, relatively straight, low-gradient sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool
Glides	A section of stream with little or no turbulence, but faster velocity than pools
Pools	A reach of stream that is characterized by deep, low-velocity water and a smooth surface

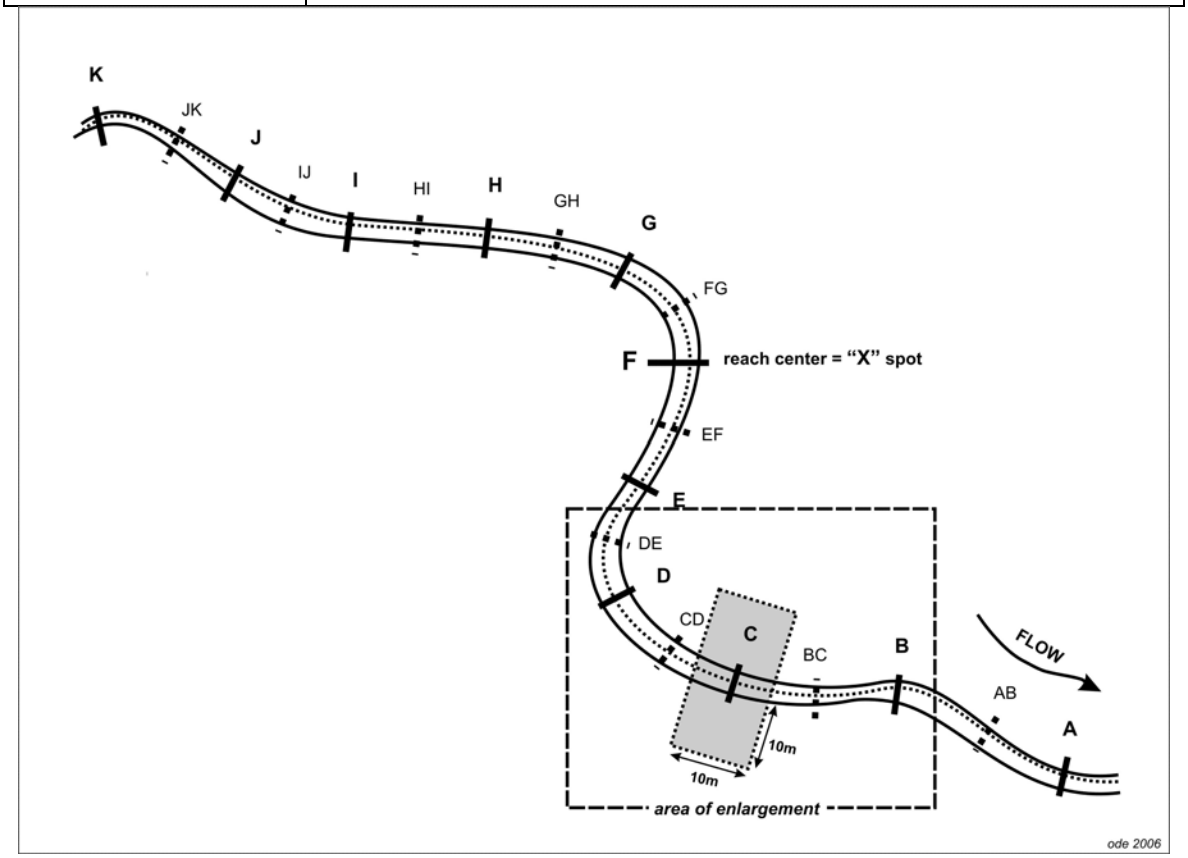


Figure 1. Reach layout geometry for physical habitat and biological sampling showing positions of 11 main transects (A – K) and the 10 supplemental inter-transects (AB- JK). The area highlighted in the figure is expanded in Figure 2. Note: reach length = 150 m for streams ≤ 10-m

average wetted width, and reach length = 250 m for streams > 10-m average wetted width.

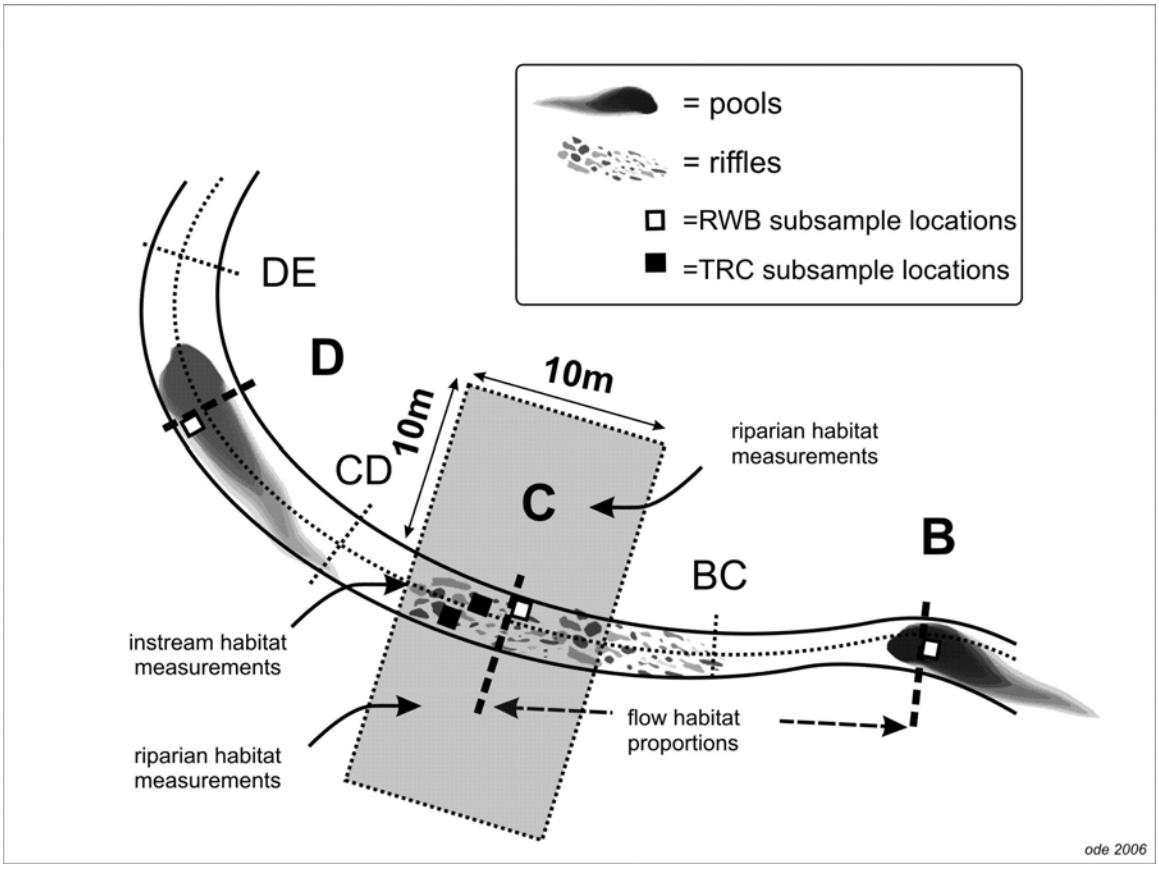


Figure 2. Section of the standard reach expanded from Figure 1 showing the appropriate positions for collecting benthic macroinvertebrate samples, instream and riparian habitat measurements and flow habitat proportion measurements.

Sampling Procedure

Begin sampling at the downstream end of the reach at the first randomly selected riffle and work your way upstream.

TRC-Step 1. Determine net placement within each habitat unit by generating a pair of random numbers between 0 and 9. Examples of convenient random number generators include the hundredths place on the stopwatch feature of a digital watch, a 10 sided die and a random number chart. The first number in each pair (multiplied by 10) represents the percent upstream along the habitat unit's length. The second number in each pair represents the percent of the riffle width from right bank. For example, if the two generated random numbers are 4 and 7, you will walk upstream 40% of the distance of the riffle and then go 70% of the distance across the riffle (see Figure 3). This position is the center of the 1 ft^2 (0.09 m^2) sampling quadrat for that

riffle. If you are unable to sample this location because it is too deep or it is occupied by a large boulder, select a new pair of random numbers and pick a new spot.

TRC-Step 2. Position a 500-µ D-net (with the net opening perpendicular to the flow and facing upstream) quickly and securely on the stream bottom to eliminate gaps under the frame. Avoid, and if necessary remove, large rocks that prevent the sampler from seating properly on the stream bottom.

TRC-Step 3. Holding the net in position on the substrate, visually define a square quadrat that is one net width wide and one net width long upstream of the net opening. Since D-nets are 12 inches wide, the area within this quadrat is $1ft^2$ ($0.09\ m^2$). Restrict your sampling to within that area. If desired, a wire frame of the correct dimensions can be placed in front of the net to help delineate the quadrat to be sampled, but it is often sufficient to use the net dimensions to keep the sampling area consistent.

TRC-Step 4. Working backward from the upstream edge of the sampling plot, check the quadrat for heavy organisms such as mussels and snails. Remove these organisms from the substrate by hand and place them into the net. Carefully pick up and rub stones directly in front of the net to remove attached animals. Remove and clean all of the rocks larger than a golf ball within your sampling quadrat such that all the organisms attached to them are washed downstream into your net. Set these rocks outside your sampling quadrat after you have cleaned them. If the substrate is consolidated or comprised of large, heavy rocks, use your feet to kick and dislodge the substrate to displace BMIs into the net. If you cannot remove a rock from the stream bottom, rub it (concentrating on cracks or indentations) thereby loosening any attached insects. As you are disturbing the plot, let the water current carry all loosened material into the net.

Note1: *Brushes are sometimes used to help loosen organisms, but in the interest of standardizing collections, do not use a brush when following this protocol.*

Note 2: *In sandy-bottomed streams, kicking within run habitats can quickly fill the sampling net with sand. In these situations, follow the standard procedures but use care to disturb the substrate gently and avoid kicking.*

TRC-Step 5. Once the coarser substrates have been removed from the quadrat, dig your fingers through the remaining underlying material to a depth of about 10 cm (this material is often comprised of gravels and finer particles). Thoroughly manipulate the substrates in the quadrat. ***Note****: the sampler may spend as much time as necessary to inspect and clean larger substrates, but should take a standard time of 30 seconds to perform Step 5.*

TRC-Step 6. Let the water run clear of any insects or organic material before carefully lifting the net. Immerse the net in the stream several times to remove fine sediments and to concentrate organisms at the end of the net, but be careful to avoid having any water or foreign material enter the mouth of the net during this operation.

TRC-Step 7. Move upstream to the next randomly selected habitat unit and repeat steps one through six, taking care to keep the net wet but uncontaminated by foreign material when moving the net from riffle to riffle. Sometimes, the net will become so full of material from the streambed that it is no longer effective at capturing BMIs. In these cases, the net should be emptied into sample jars as frequently as necessary, following guidelines described below in the

"Preparation of BMI Sample Jars" section. Continue until you have sampled eight $1ft^2$ ($0.09\ m^2$) of benthos.

TRC-Step 8. PROCEED to Section IIc. Filling and Labeling BMI Sample Jars.

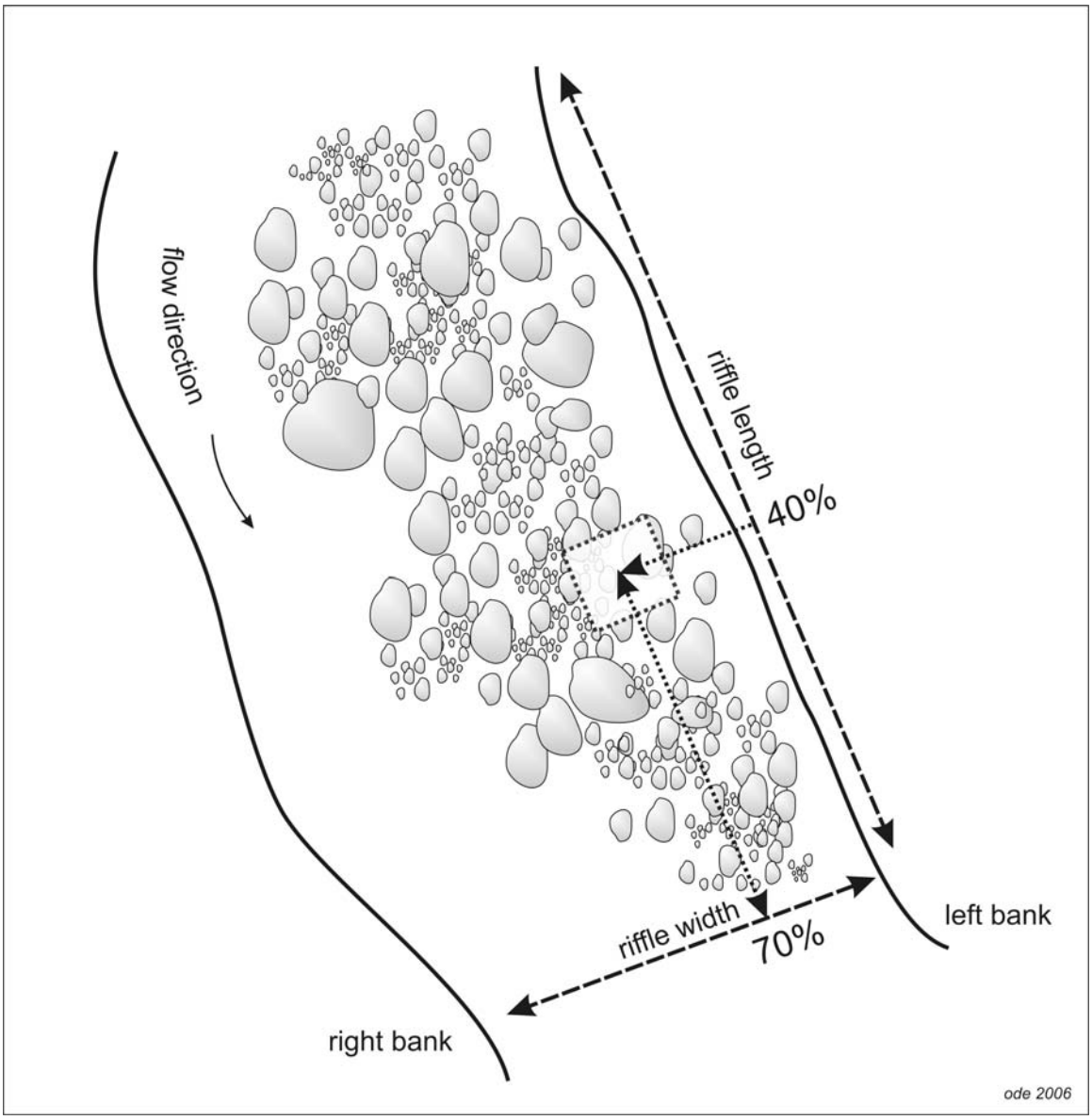


Figure 3. Example showing the method for selecting a subsampling position within a selected riffle under the TRC method. In this example, the random numbers 4 and 7 were selected.

Reachwide Benthos (Multihabitat) Procedure

The RWB procedure employs an objective method for selecting subsampling locations that is built upon the 11 transects used for physical habitat measurements. The RWB procedure can be used to sample any wadeable stream reach since it does not target specific habitats. Because sampling locations are defined by the transect layout, the position of individual sub-samples may fall in a variety of erosional or depositional habitats. ***Note****: Sampling locations should be displaced one meter downstream of the transects to avoid disturbing substrates for subsequent physical habitat assessments.*

RWB -Step1. The sampling position within each transect is alternated between the left, center and right positions along a transect (25%, 50% and 75% of wetted width, respectively) as you move from upstream transect to transect. Starting with the downstream transect (Transect A), identify a point that is 25% of the stream width from the right bank (note that the right bank will be on your left as you face upstream). If you cannot collect a sample at the designated point because of deep water obstacles or unsafe conditions, relocate the point as close as possible to the designated position.

RWB -Step 2. Place a 500-µ D-net net in the water so the mouth of the net is perpendicular to and facing into the flow of the water. If there is sufficient current in the area at the sampling point to fully extend the net, use the normal D-net collection technique to collect the sub-sample (TRC-Step 3 through TRC-Step 6 above). If flow volume and velocity is not sufficient to use the normal collection technique, use the sampling procedure for "slack water" habitats (RWB-Step 3 through RWB-Step 7 below).

RWB -Step 3. Visually define a 1 ft^2 (0.09 m^2) quadrat that is one net-width wide and one net-width long at the sampling point.

RWB -Step 4. Working backward from the upstream edge of the sampling plot, check the quadrat for heavy organisms such as mussels and snails. Remove these organisms from the substrate by hand and place them into the net. Carefully pick up and rub stones directly in front of the net to remove attached animals. Remove and clean all of the rocks larger than a golf ball within your sampling quadrat such that all the organisms attached to them are washed downstream into your net. Set these rocks outside your sampling quadrat after you have cleaned them. Large rocks that are less than halfway into the sampling area should be pushed aside. If the substrate is consolidated or comprised of large, heavy rocks, use your feet to kick and dislodge the substrate to displace BMIs into the net. If you cannot remove a rock from the stream bottom, rub it (concentrating on cracks or indentations) thereby loosening any attached insects.

RWB -Step 5. Vigorously kick the remaining finer substrate within the quadrat with your feet while dragging the net repeatedly through the disturbed area just above the bottom. Keep moving the net all the time so that the organisms trapped in the net will not

escape. Continue kicking the substrate and moving the net for 30 seconds. For vegetation-choked sampling points, sweep the net through the vegetation within a $1ft^2$ ($0.09\ m^2$) quadrat for 30 seconds.

***Note**: If flow volume is insufficient to use a D- net, spend 30 seconds hand picking a sample from $1ft^2$ of substrate at the sampling point, then stir up the substrate with your gloved hands and use a sieve with 500-µ mesh size to collect the organisms from the water in the same way the net is used in larger pools.*

RWB -Step 6. After 30 seconds, remove the net from the water with a quick upstream motion to wash the organisms to the bottom of the net.

RWB -Step 7. PROCEED to Section Filling and Labeling BMI Sample Jars

Filling and Labeling Benthic Macroinvertebrate Sample Jars

Step 1. Once all sub-samples (eight for TRC, 11 for RWB) have been collected, transfer benthos to a 1 gallon wide-mouth plastic sample jar using **one** of the following methods.

Step 1a. *Complete Transfer of all Sampled Material* ~ Invert the contents of the kick net into the sample jar. Perform this operation over a white enameled tray to avoid loss of any sampled material and make recovery of spilled organisms easier. If possible, remove the larger twigs and rocks by hand after carefully inspecting for clinging organisms, but be sure not to lose any organisms. Use forceps to remove any organisms clinging to the net and place these in the sample jar.

Step 1b. *Field Elutriation of Samples* ~ Empty the contents of the net into a large plastic bucket (10-20 L is sufficient). Use forceps to remove any organisms clinging to the net and place these in the bucket. Add stream water to the bucket and gently swirl the contents of the bucket in order to suspend the organic material (being certain to not introduce entrained organisms from the source water). Pour the organic matter from the bucket through a 500-µ sieve (or use the 500-µ net). Repeat this process until no additional material can be elutriated (i.e., only inorganic material is left in the bucket). If possible, remove the larger twigs and rocks by hand after carefully inspecting for clinging organisms, but be sure not to lose any organisms. Transfer all of the material in the sieve (invertebrates and organic matter) into the sample jar. Carefully inspect the gravel and debris remaining in the bottom of the bucket for any cased caddisflies, clams, snails, or other dense animals that might remain. Remove any remaining animals by hand and place them in the sample jar."

Step 2. Place a **completed date/locality label** (see Figure 4) on the **inside** of the jar (**use pencil only** as most "permanent" inks dissolve in ethanol) and completely fill with 95% ethanol. **Place a second label on the outside of the jar.** Note that the target concentration of ethanol is 70%, but 95% ethanol is used in the field to account for dilution from water in the sample. If organic and inorganic material does not accumulate

in the net quickly, it may be possible to transfer all the material in the net into one jar. Otherwise, divide the material evenly among several jars (being careful to clearly label them as part of a set). To ensure proper preservation of benthic macroinvertebrates it is critical that the ethanol is in contact with the BMIs in the sample jar. Never fill a jar more than 2/3 full with sampled material, and **gently** rotate jars that contain mostly mud or sand to ensure that the ethanol is well distributed. If jars will be stored for longer than a month prior to processing, jars should not contain more than 50% sample material.

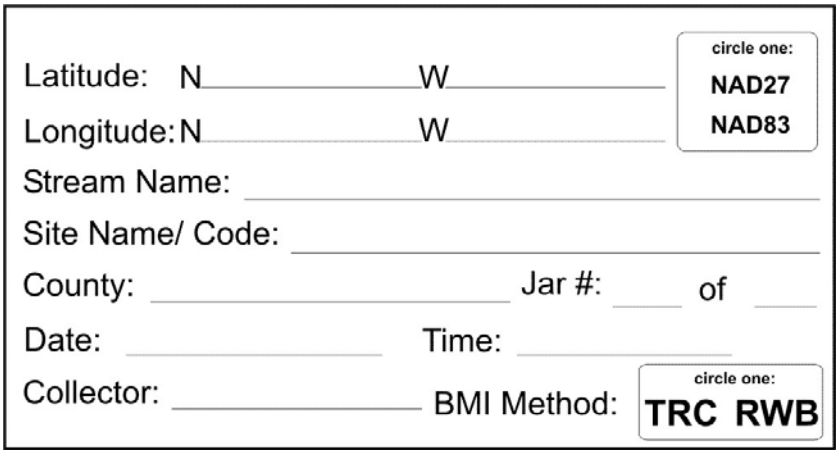


Figure 4. Example date - locality label for all BMI samples.

MAIN CROSS-SECTIONAL TRANSECT MEASURES

Physical Measures

The majority of physical habitat measurements in this protocol are made relative to the main cross-sectional transects (Figure 5). All the measures taken relative to each transect are recorded on forms specific to that transect. Start with the downstream transect (Transect A) and repeat steps 6-15 for all 11 main transects.

Module A. Transect Dimensions: Wetted Width and Bankfull Dimensions

Wetted Width~ The wetted channel is the zone that is inundated with water and the wetted width is the distance between the sides of the channel at the point where substrates are no longer surrounded by surface water. Measure the wetted stream width and record this in the box at the top of the transect form.

Bankfull Width and Depth~ The bankfull channel is the zone of maximum water inundation in a normal flow year (one to two year flood events). Since most channel formation processes are believed to act when flows are within this zone (Mount 1995), bankfull dimensions provide a valuable indication of relative size of the waterbody.

***Note**: Bankfull dimensions are notoriously difficult to assess, even by experienced field crews. It is often useful to discuss the interpretation of bankfull locations among the field crew members to reach a consensus.*

Step 1. Scout along the stream margins to identify the location of the bankfull margins on either bank by looking for evidence of annual or semi-annual flood events. Examples of useful evidence includes topographic, vegetative, or geologic cues (changes in bank slope, changes from annual to perennial vegetation, changes in the size distribution of surface sediments). While the position of drift material caught in vegetation may be a helpful aid, this can lead to very misleading measurements. ***Note**: The exact nature of this evidence varies widely across a range of stream types and geomorphic characteristics. It is helpful to investigate the entire reach when attempting to interpret this evidence because the true bankfull margin may be obscured at various points along the reach. Often the bankfull position is easier to interpret from one bank than the other; in these cases, it is easiest to infer the opposite bank position by projecting across the channel. Additionally, height can be verified by measuring the height from both edges of the wetted channel to the bankfull height (these heights should be equal).*

Step 2. Stretch a tape from bank to bank at the bankfull position. Measure the width of the bankfull channel from bank to bank at bankfull height and perpendicular to the direction of stream flow.

Step 3. Measure bankfull height (the vertical distance between the water height of the water and the height of the bank, Figure 5) and record.

<u>Module B. Transect Substrate Measurements</u>

Particle size frequency distributions often provide valuable information about instream habitat conditions that affect BMI distributions. The Wolman pebble count technique (Wolman 1954) is a widely used and cost-effective method for estimating the particle size distribution and produces data that correlates with costly, but more quantitative bulk sediment samples. The method described here follows the EMAP protocol, which records sizes of 105 particles in a reach (five particles from each of 11 main transects and 10 inter-transects). ***Note:** the size cutoff for the finest particle sizes in the EMAP protocol (<0.06 mm) differs from that used by the Sierra Nevada Aquatic Research Laboratory (SNARL) program (0.25 mm), although the narrative description for this cutoff is the same (the point at which fine particles rubbed between one's fingers no longer feel gritty).*

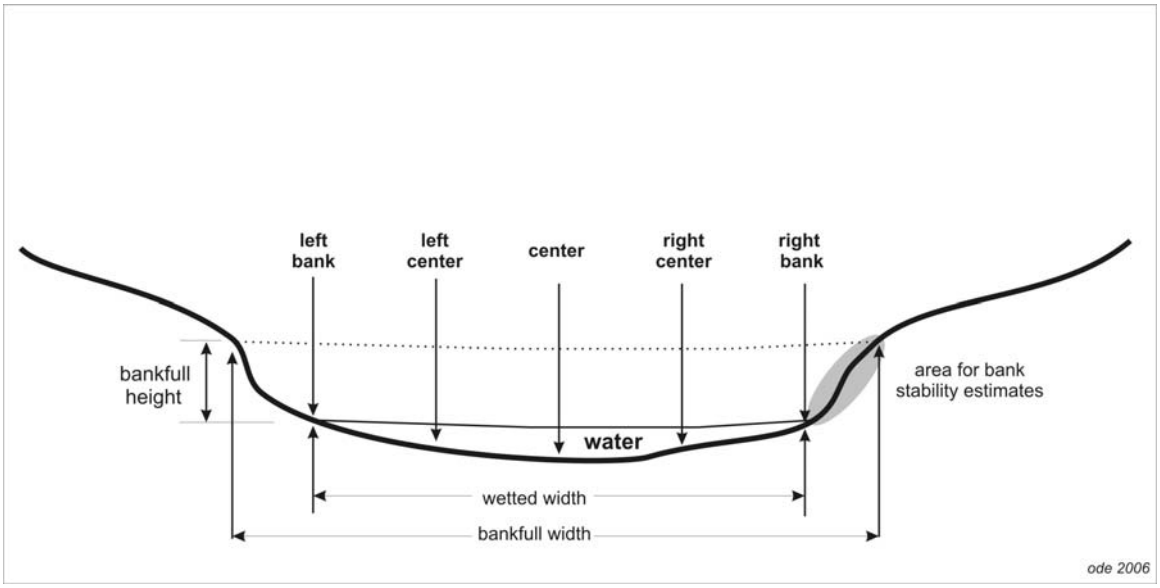


Figure 5. Cross sectional diagram of a typical stream channel showing locations of substrate measurements, wetted and bankfull width measurements, and bank stability visual estimates.

Coarse particulate organic matter (CPOM, particles of organic material such as leaves that are greater than 1.0 mm in diameter) is a general indicator of the amount of allochthonous organic matter available at a site, and its measurement can provide valuable information about the basis of the food web in a stream reach. The presence of CPOM associated with each particle is quantified at the same time that particles are measured for the pebble counts.

Step 1. Transect substrate measurements are taken at five equidistant points along each transect (Figure 5). Divide the wetted stream width by four to get the distance between the five points (Left Bank, Left Center, Center, Right Center and Right Bank) and use a measuring device to locate the positions of these points (a stadia rod is especially helpful here). Once the positions are identified, lower a graduated rod (e.g., a marked ski pole) though the water column perpendicular to both the flow and the transect to objectively select the particle located at the tip of the rod.

Step 2. Measure the depth from the water surface to the top of the particle with the graduated rod and record to the nearest cm.

Step 3. Record the presence or absence of CPOM >1mm within 1 cm of the particle.

Step 4. **If the particle is cobble-sized** (64-250 mm), record the percent of the cobble that is embedded by fine particles (<2 mm) to the nearest 5% (see cobble embeddedness text below).

Step 5. Remove the particle from the streambed, then measure and record the length of its intermediate axis to the nearest mm (see Figure 6). Alternately, assign the particle to one of the size classes listed in the bottom of the transect form. Particle sizes classes can be estimated visually or with a quantitative measuring device (e.g., pass/ no-pass template, "gravelometer"). Regardless of the method, all particles less than 0.06 mm should be recorded as **fines**, all particles between 0.06mm and 2.0 mm recorded as **sand**. Field crews may want to carry vials containing sediment particles with these size ranges until they are familiar with these particles.

Module C. Cobble Embeddedness

The quantification of substrate embeddedness has long been a challenge to stream geomorphologists and ecologists (Klamt 1976, Kelley and Dettman 1980). It is generally agreed that the degree to which fine particles fill interstitial spaces has a significant impact on the ecology of benthic organisms and fish, but techniques for measuring this impact vary greatly (this is summarized well by Sylte and Fischenich 2002, http://stream.fs.fed.us/news/streamnt/pdf/StreamOCT4.pdf). Here we define embeddedness as the volume of **cobble**-sized particles (64-250 mm) that is buried by fine particles (<2.0 mm diameter). ***Note:*** *This method differs from the EMAP method for measuring embeddedness, which measures embeddedness of all particles larger than 2 mm.*

Step 1. Every time a cobble-sized particle is encountered during the pebble count, remove the cobble from the stream bed and visually estimate the percentage of the cobble's volume that has been buried by fine particles. *Since visual estimates of volume and surface area are subject to large amounts of observer error, field crews should routinely calibrate their estimates with each other and with other field crews.*

Step 2. In the spaces to the right of the pebble count data, record the embeddedness of all cobble-sized particles encountered during the pebble count. ***Note:*** *The cobble embeddedness scores* ***do not*** *correspond with the specific particles in the pebble count cells to the left, but are merely a convenient place to record the data.*

Step 3. If 25 cobbles are not encountered during the pebble count, supplement the cobbles by conducting a "random walk" through the reach. Starting at a random point in the reach, follow a transect from one bank to the other at a randomly chosen angle. Once at the other bank reverse the process with a new randomly chosen angle. Record embeddedness of cobble-sized particles in the cobble embeddedness boxes on the transect forms until you reach 25 cobbles. If 25 cobble sized particles are not present in the entire reach, then record the values for cobbles that are present.

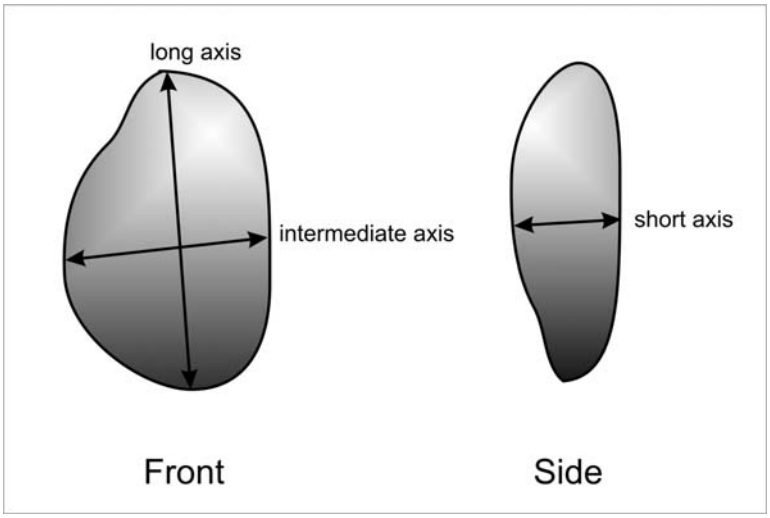


Figure 6. Diagram of three major perpendicular axes of substrate particles. The intermediate axis is recorded for pebble counts.

Table 3. Size class codes and definitions for particle size measurements

Size Class Code	Size Class Description	Common Size Reference	Size Class Range
RS	bedrock, smooth	larger than a car	> 4 m
RR	bedrock, rough	larger than a car	> 4 m
XB	boulder, large	meter stick to car	1 - 4 m
SB	boulder, small	basketball to meter stick	25 cm - 1.0 m
CB	cobble	tennis ball to basketball	64 - 250 mm
GC	gravel, coarse	marble to tennis ball	16 - 64 mm
GF	gravel, fine	ladybug to marble	2 – 16 mm
SA	sand	gritty to ladybug	0.06 – 2 mm
FN	fines	not gritty	< 0.06 mm
HP	hardpan (consolidated fines)		< 0.06 mm
WD	wood		

RC	concrete/ asphalt		
OT	other		

Module D. Canopy Cover

This method uses the Strickler (1959) modification of a convex spherical densiometer to correct for over-estimation of canopy density that occurs with unmodified readings. Read the densiometer by counting the number of line intersections that are obscured by overhanging vegetation (see Figure 7). Taping off the lower left and right portions of the mirror emphasizes overhead vegetation over foreground vegetation (the main source of bias in canopy density measurements). All densiometer readings should be taken with the bubble leveled and 0.3 m (1 ft) above the water surface.

Step 1. Using a modified convex spherical densitometer, take and record four 17-point readings all taken from the center of each transect: a) facing upstream, b) facing downstream, c) facing the left bank, d) facing the right bank. ***Note:*** *this method deviates slightly from that of EMAP (in which two additional readings are taken at the left and right wetted edges to increase representation of bank vegetation).*

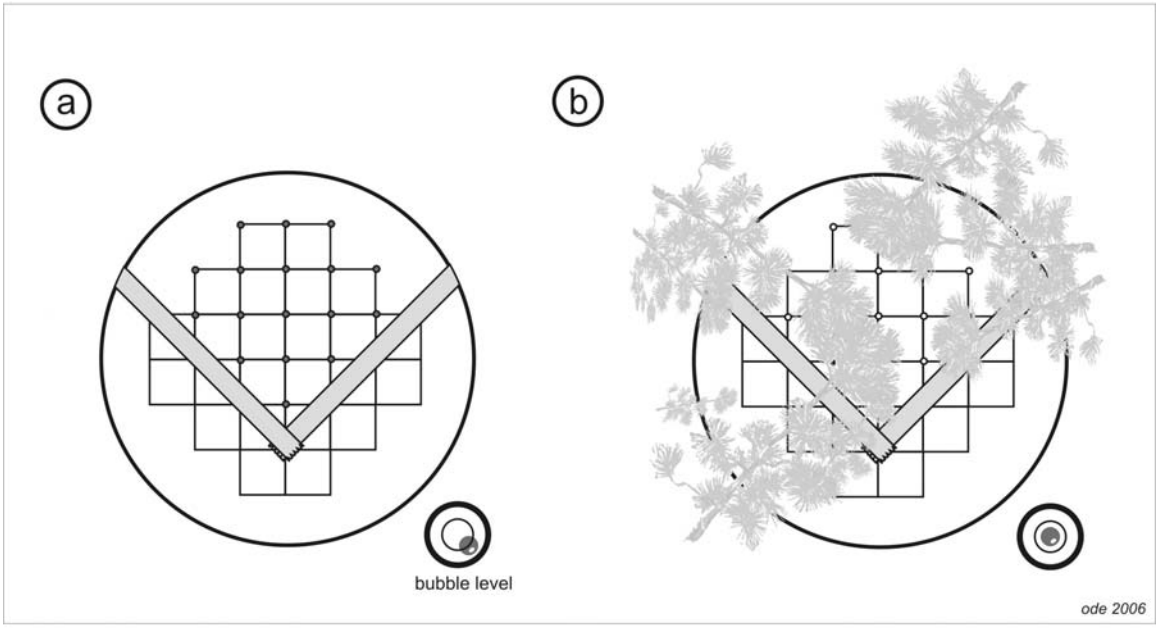


Figure 7. Representation of the mirrored surface of a convex spherical densiometer showing the position for taping the mirror and the intersection points used for the densiometer reading. The score for the hypothetical condition in (b) is 10 covered intersection points out of 17 possible. Note the position of the bubble level in (b) when the densiometer is leveled.

Module E. Gradient and Sinuosity

The gradient of a stream reach is one of the major stream classification variables, giving an indication of potential water velocities and stream power, which are in turn important controls on aquatic habitat and sediment transport within the reach. The gradient (slope) of a stream reach is often strongly correlated with many BMI metrics and other physical habitat measures and is therefore very useful when interpreting BMI data.

The "full" physical habitat method uses transect to transect measurements to calculate the average slope through a reach. Although this is a little more time intensive than the reach-scale transect measures used in the "basic" protocol, it results in more precise slope determination and the ability to quantify slope variability within a reach. Sinuosity (calculated as the ratio of the length of the flow path between the ends of the reach and the straight line distance between the ends of the reach, Kaufmann et al. 1999) is measured at the same time as slope. These two measurements work best with two people, one taking the readings at the upstream transect ("backsighting") and the other holding a stadia rod at the downstream transect. If you cannot see the mid point of the next transect from the starting point, use the **supplemental sections** (indicating the proportion of the total length represented by each section). Otherwise, leave these blank.

Note*: An auto level should be used for reaches with a percent slope of less than or equal to 1%. All methods (clinometer, hand level, or auto level) may be used for reaches with a percent slope of greater than 1%. The following description is for clinometer-based slope measurements, but the same principles apply to use of an auto or hand level.*

Note 2: *In reaches that are close to 1%, you will not know whether you are above or below the 1% slope cutoff. In these cases, default to use of an autolevel.*

Step 1. Beginning with the upper transect (Transect K), one person (the measurer) should stand at the water margin with a clinometer held at eye level. A second person should stand at the margin of the next downstream transect (Transect J) with a stadia rod flagged at the eye level of the person taking the clinometer readings. Be sure you mark your eye level while standing on level ground! Adjust for water depth by measuring from the same height above the water surface at both transects. This is most easily accomplished by holding the base of the pole at water level. ***Note:*** *an alternative technique is to use two stadia rods pre-flagged at the eye-height of the person taking the readings.*

Step 2. Use a clinometer to measure the percent slope of the water surface (not the streambed) between the upstream transect and the downstream transect by sighting to

the flagged position on the stadia rod. The clinometer reads both percent slope and degree of the slope. Be careful to read and record percent slope rather than degrees slope (the measurements differ by a factor of ~2.2). Percent slope is the scale on the right hand side as you look through most clinometers. ***Note****: If an auto level or hand level is used, record the elevation difference (rise) between transects and the segment length (run) instead of the percent slope.*

Step 3. If the stream reach geometry makes it difficult to sight a line between transects, divide the distance into two or three sections and record the slope and the proportion of the total segment length between transects for each of these sections in the appropriate boxes on the slope form (**supplemental segments**). Do not measure slope across dry land (e.g., across a meander bend).

Step 4. Take a compass reading from the center of each main transect to the center of the next main transect downstream and record this bearing to the nearest degree on the slope and bearing section of the form. Bearing measurements should always be taken from the upstream to downstream transect.

Step 5. Proceed downstream to the next transect pair (I-J) and continue to record slope and bearing between each pair of transects until measurements have been recorded for all transects.

Visual Estimates of Human Influence, Instream Habitat, and Riparian Vegetation

The transect based approach used here permits semi-quantitative calculations from visual estimates even though most are categorical data (i.e., either presence/ absence or size classes) because we can calculate the percentage of transects that fall into different categories. These modules are adapted directly from EMAP protocols with some modifications as noted.

<u>Module F. Human Influence</u>
The influence of human activities on stream biota is of critical concern in bioassessment analyses. Quantification of human activities for these analyses is often performed with GIS techniques, which are very useful but are not capable of accounting for human activities occurring at the reach scale. Reach scale observations are often critical for explaining results that might seem anomalous on the basis of only remote mapping tools.

Step 1. For the left and right banks, estimate a 10 x 10 m riparian area centered on the edges of the transect (see Figure 2). Record the presence of 11 human influence categories in three spatial zones relative to this 10 x 10 m square (between the wetted edge and bankfull margin, between the bankfull margin and 10 m from the stream, and between 10 m and 50 m beyond the stream margins): 1) walls/rip-rap/dams, 2)

buildings, 3) pavement/cleared lots, 4) roads/railroads, 5) pipes (inlets or outlets), 6) landfills or trash, 7) parks or lawns (e.g., golf courses), 8) row crops, 9) pasture/ rangelands, 10) logging/ timber harvest activities, 11) mining activities, 12) vegetative management (herbicides, brush removal, mowing), 13) bridges/ abutments, 14) orchards or vineyards. Circle all combinations of impacts and locations that apply, but be careful to not double-count any human influence observations.

Step 2. Record the presence of any of the 11 human influence categories in the stream channel within a zone 5 m upstream and 5 m downstream of the transect.

Module G. Riparian Vegetation

Riparian vegetation has a strong influence on the composition of stream communities through its roles in directly and indirectly controlling the food base, moderating sediment inputs and acting as a buffer between the stream channel and the surrounding environment. These methods provide a cursory survey of the condition of the riparian corridor. Observations are made in the same 10 x 10 m riparian area used for assessing human influence (see Figure 2).

The riparian vegetation categories used here were condensed from the EMAP version, which further breaks the canopy classes into different components. However, because we have consolidated EMAP categories into fewer categories rather than creating new categories, existing EMAP data can be easily converted to this format simply by combining the appropriate categories.

Step 1. Divide the riparian zone into three elevation zones: 1) ground cover (<0.5 m), 2) lower canopy (0.5 m - 5 m), and 3) upper canopy (>5 m). Record the density of the following riparian classes: 1) Upper Canopy – Trees and Saplings, 2) Lower Canopy – Woody Shrubs and Saplings, 3) Woody Ground Cover – Shrubs, Saplings, 4) Herbaceous Ground Cover – Herbs and Grasses, and 5) Ground Cover – Barren, Bare Soil and Duff. Artificial banks (e.g., rip-rap, concrete, asphalt) should be recorded as barren.

Step 2. Indicate the areal cover (i.e., shading) by each riparian vegetative class as either: 1) absent, 2) sparse (<10%), 3) moderate (10-40%), 4) heavy (40-75%), or 5) very heavy (>75%).

Module H. Instream Habitat Complexity

Instream habitat complexity was developed by the EMAP program to quantify fish concealment features in the stream channel, but it also provides good information about the general condition and complexity of the stream channel. Estimates should include features within the banks and outside the wetted margins of the stream.

Step 1. Record the amount of nine different channel features within a zone 5m upstream and 5m downstream of the transect (see Figure 2): 1) filamentous algae

(long-stranded algal forms that are large enough to see with the naked eye), 2) aquatic macrophytes (include mosses and vascular plants), 3) boulders (>25 cm), 4 and 5) woody debris (break into two classes- larger and smaller than 30 cm diameter), 6) undercut banks, 7) overhanging vegetation, 8) live tree roots and 9) artificial structures (includes any anthropogenic objects including large trash objects like tires and shopping carts). Indicate the areal cover of each feature as either: 1) absent, 2) sparse (<10%), 3) moderate (10-40%), 4) heavy (40-75%), or 5) very heavy (>75%).

Module I. Bank Stability

The vulnerability of stream banks to erosion is often of interest in bioassessments because of its direct relationship with sedimentation.

Step 1. For each transect, record a visual assessment of bank vulnerability in the region between the wetted width and bankfull width of the stream margins and between the upstream and downstream inter-transects. Choose one of three vulnerability states: eroded (evidence of mass wasting), vulnerable (obvious signs of bank erosion or unprotected banks), or stable.

INTER-TRANSECT MEASURES

While most measures are taken at or relative to the main transects, a few measures are recorded at transects located at the midpoint between main transects. These are called "inter-transects".

Module B (continued) Pebble Counts (same as for transects, but no cobble embeddedness measures)

Step 1. Divide the wetted stream width by four to get the distance between the five points (Left Bank, Left Center, Center, Right Center and Right Bank) and use a measuring device to locate the positions of these points (a stadia rod is especially helpful here, see Figure 5). Once the positions are identified, lower a graduated rod though the water column perpendicular to both the flow and the transect to objectively select the particle located at its tip.

Step 2. With the graduated rod, measure the depth from the water surface to the top of the particle and record to the nearest cm.

Step 3. Remove the particle from the streambed, then measure and record the length of its intermediate axis to the nearest mm (see Figure 6). Alternately, assign the particle to one of the size classes listed in the bottom of the transect form (see Table 3 for a list of size classes). Particle size classes may be estimated visually or with a quantitative measuring device (e.g., pass/ no-pass template, gravelometer). Regardless of the method, all particles less than 0.25 mm should be recorded as **fines**, while all particles between 0.25 mm and 2.0 mm should be recorded as **sand**. Field crews may want to

carry vials containing sediment particles with these size ranges until they are familiar with these particle size classes.

Step 4. Record the presence (P) or absence (A) of any CPOM within 1 cm of each particle.

Module J. Flow Habitats

Because many benthic macroinvertebrates prefer specific flow and substrate microhabitats, the proportional representation of these habitats in a reach is often of interest in bioassessments. There are many different ways to quantify the proportions of different flow habitats (for example, see text on EMAP's "thalweg profile" below). Like the riparian and instream measures listed above, this procedure produces a semi-quantitative measure consisting of 10 transect-based visual estimates. ***Note:*** *The categories used here are based on those used in the EMAP protocol, with pools combined into one class and cascades and falls combined into another class.*

Step 1. At each transect, identify the proportion of six different habitat types in the region between the upstream inter-transect and downstream inter-transect: 1) cascades/falls, 2) rapids, 3) riffles, 4) runs/ glides, 5) pools, 6) dry areas. Record percentages to the nearest 5% — the total percentage of surface area for each section must total 100%. At transects A and K, include area immediatly upstream and downstream of the reach in the habitat estimates.

DISCHARGE

Stream discharge is the volume of water that moves past a point in a given amount of time and is generally reported as either cubic meters per second (cms) or cubic feet per second (cfs). Because discharge is directly related to water volume, discharge affects the concentration of nutrients, fine sediments and pollutants; and discharge measurements are critical for understanding impacts of disturbances such as impoundments, water withdrawals and water augmentation. Discharge is also closely related to many habitat characteristics including temperature regimes, physical habitat diversity, and habitat connectivity. As a direct result of these relationships, stream discharge is often also a strong predictor of biotic community composition. Since stream volume can vary significantly on many different temporal scales (diurnal, seasonal, inter-annually), it can also be very useful for understanding variation in stream condition.

This procedure (modified from the EMAP protocol) provides for two different methods for calculating discharge. It is preferable to take discharge measurements in sections where flow velocities are greater than 0.15 m/s and most depths are greater than 15 cm, but slower velocities and shallower depths can be used. If flow volume is sufficient for a transect-based "velocity-area" discharge calculation, this is by far the preferred

method. If flow volume is too low to permit this procedure or if your flow meter fails, use the "neutrally buoyant object/ timed flow" method. ***Note****: Programs that sample fixed sites repeatedly may want to consider installing permanent discharge estimation structures (e.g., stage gauges, wiers).*

Module K. Discharge: Velocity Area Method

The layout for discharge measurements under the velocity-area (VA) method is illustrated in Figure 8. Flow velocity should be measured with either a Swoffer Instruments propeller-type flow meter or a Marsh-McBirney inductive probe flow meter.

VA-Step 1. Select the best location in the reach for measuring discharge. To maximize the repeatability of the discharge measurement, choose a transect with the most uniform flow (select hydraulically smooth flow whenever possible) and simplest cross-sectional geometry. It is acceptable to move substrates or other obstacles to create a more uniform cross-section before beginning the discharge measurements.

VA-Step 2. Measure the wetted width of the discharge transect and divide this into 10 to 20 equal segments. The use of more segments gives a better discharge calculation, but is impractical in small channels. A minimum of 10 intervals should be used when stream width permits, but interval width should not be less than 15 cm.

VA-Step 3. Record the distance from the bank to the end of the first interval. Using the top-setting rod that comes with the flow velocity meter, measure the median depth of the first interval.

VA-Step 4. Standing downstream of the transect to avoid interfering with the flow, use the top-setting rod to set the probe of the flow meter (either the propeller or the electromagnetic probe) at the midpoint of each interval, at 0.6 of the interval depth (this position generally approximates average velocity in the water column), and at right angles to the transect (facing upstream). See Figure 8 for positioning detail.

VA-Step 5. Allow the flow velocity meter to equilibrate for 10-20 seconds then record velocity to the nearest m/s. If the option is available, use the flow averaging setting on the flow meter. ***Note:*** *Under very low flow conditions, flow velocity meters may register readings of zero even when there is noticeable flow. In these situations, record a velocity of 0.5x the minimum flow detection capabilities of the instrument.*

VA-Step 6. Complete Steps 3 through 5 on the remaining intervals. ***Note:*** *The first and last intervals usually have depths and velocities of zero.*

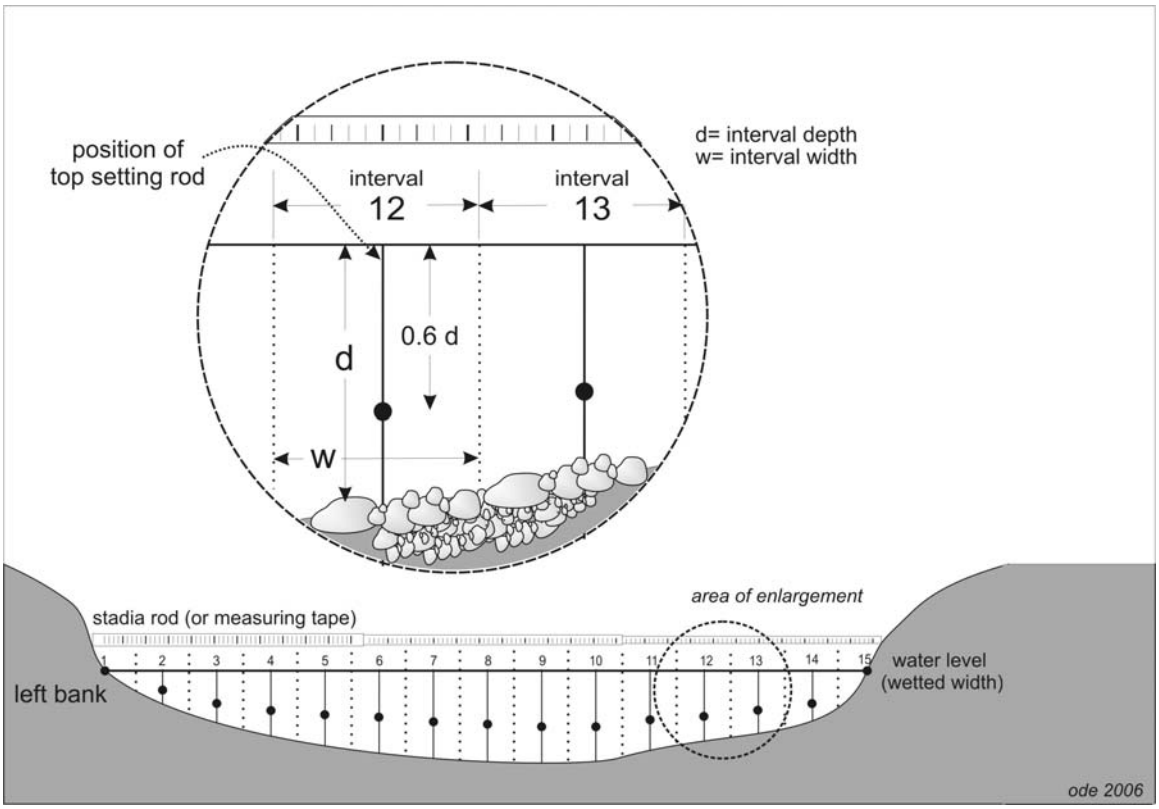


Figure 8. Diagram of layout for discharge measurements under the velocity-area method showing proper positions for velocity probe (black dots).

POST-SAMPLING OBSERVATIONS

Module M. Rapid Bioassessment Procedures Visual Assessment Scores (**for Basic Physical Habitat**, **or optional supplement**)
EPA's Rapid Bioassessment Procedures (RBPs, Barbour et al. 1999) include a set of 10 visual criteria for assessing instream and riparian habitat. The RBP has been used in the CSBP since its first edition (1995) and thus, this information is often valuable for comparison to legacy datasets. The criteria also have a useful didactic role since they help force the user to quantify key features of the physical environment where bioassessment samples are collected.

Module N. Additional Habitat Characterization (**Full Physical Habitat only**)
The RBP stream habitat visual estimates described in Step 1 are not included in the Full Physical Habitat version because they are generally replaced by more quantitative measurements of similar variables. However, we have found that three of the RBP measures are reasonably repeatable and include them in the reachwide assessment portion of the Full Physical Habitat version. ***Note:*** *This is the only case in which a measurement included in the basic procedure is not included in the full.*

QUALITY ASSURANCE/ QUALITY CONTROL PROCEDURES

The SWAMP bioassessment group is currently developing guidelines for quality assurance and quality control for bioassessment procedures. Future revisions to this document will include guidance covering personnel qualifications, training and field audit procedures, procedures for field calibration, requirements for measurement precision, health and safety warnings, cautions (actions that would result in instrument damage or compromised samples), and interferences (consequences of not following the standard operating procedure, SOP).

4.0 Invasive Species

1. The recent collection of the New Zealand mudsnail (NZMS) (*Potamopyrgus antipodarum*) in southern California watersheds is of immediate environmental concern. These invasive gastropods are small (<6 mm), reproduce through the asexual process of parthenogenesis, are capable of surviving a wide range of environmental conditions and can pass through the intestine of fishes unharmed. As a result they have spread rapidly from the Great Lakes to the western US in under 10 years.

2. To control the distribution of this species to other watersheds and locations within a watershed, the following process must be adhered to by each member of the field team.

   a. After entry into each sampling location boots, gloves and nets (as well as all other equipment and clothing that could harbor NZMS) will be sprayed with 409 and then scrubbed using a brush.

   b. All of the above will be rinsed in a bucket of freshwater.

   c. Sampling nets will be rotated so that a clean dry net will be used one time per day wherever possible. Nets will be allowed to dry over night after being treated with 409.

5.0 Health and Safety Considerations

1. **Dangerous Animals.** Employees will be aware of the types of toxic and dangerous animals likely to be encountered. Terrestrial habitats may harbor rattlesnakes as well as venomous insects and toxic plants. Employees must take precautions to avoid injury in remote areas, and will always bring a cell phone.

2. **Adverse Weather.** When performing fieldwork, employees will be prepared for extreme weather conditions. Adequate clothing for cold, windy, or rainy weather will be used. Field operations may be suspended during severe wind and lightning storms. Temperature in inland valleys can be quite high and employees should dress in layers and bring a hat, sun block, and plenty of water.

3. **Uneven/Unstable Terrain.** Employees shall use caution when negotiating steep muddy banks, particularly while transporting heavy equipment across such terrain.

4. **Lifting Heavy Equipment.** Employees shall use proper lifting techniques when transporting heavy equipment from the office to the field. Employees should not overexert themselves and should know their limitations. Employees need to get help when moving very heavy items.

5. **Personal Security.** When performing work near transient camps or areas in which personal safety is in question, employees shall work in pairs and should carry items such as pepper spray and cell phones. If a situation is deemed too dangerous, employees should leave the area, as personal safety takes priority over work assignments.

6. **Contaminated Water.** At sites where human waste or other unsanitary water conditions occur, extra precautions for disinfecting hands and equipment will be implemented. Chlorine sprays, bactericidal lotions and ethanol wash may be used, in addition to special gloves. Personal protective gear such as face masks, tyvek suits, and rubber boots may also be required. Employees should avoid touching the eyes or mouth after contacting contaminated water. If exposure occurs, employees shall seek medical attention at the first sign of symptoms (gastrointestinal problems, infections of the ear/nose/throat, skin lesions).

6.0 Personnel

Sampling teams will consist of two employees, and will have at least one biologist who has received training in the CDFG CSBP.

7.0 Quality Assurance

The lead biologist shall be the primary person responsible for conducting field sampling and ensuring that procedures are followed according to the sampling protocol and safety requirements.

8.0 Reference Documents

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Part II. Procedures for Laboratory Analysis

1.0 Scope

Freshwater benthic invertebrates are sorted into designated taxonomic categories, including Ephemeroptera, Plecoptera, Trichoptera, Diptera, Other Insects, Mollusca, Crustacea, and Other Phyla. Taxonomists identify each of the organisms in the sample to Level 1 specifications of the CSBP (2003).

2.0 Health and Safety Considerations

The laboratory technician works under a hood to rinse and then transfer the sample to water. The technician will utilize ergonomically sound seating with proper posture when sorting for long periods, resting and stretching frequently. Armrests are available if requested.

3.0 Equipment

Dissecting microscope
Standard size No. 35 sieve (0.5 mm)
Caton Grid tray
Sorting tray
Forceps
Squeeze bottles for DI water and ethanol
Glass vials
Vial Labels
Stream Bioassessment Sorting Sheet
95% ethanol

4.0 Sample Sorting Procedure

Level 1 Taxonomic Effort is the professional level equivalent which requires subsampling 500 BMIs into the major taxonomic groups. The number of animals sorted from a sample depends on the sampling design for each program. Check with the Sorting Lab Lead or Biology Lab Supervisor if you are not sure how many animals to select.

A. Sample Receiving

1. Log in samples in laboratory log book.

2. Fill out BMI Subsampling and Taxonomy Tracking Sheet and the BMI Subsampling and QC sheet.

B. BMI Sample Cleaning

1. Check out sample on the BMI Subsampling and Taxonomy Tracking Sheet.

2. Empty contents into a 0.5 mm sieve (#35) and rinse material with DI water (be careful not to damage animals or splash any debris from the sieve). Once

sample is rinsed, remove debris larger than ½ inch. Remove green leaves, twigs and rocks, but do not pick out filamentous algae and skeletonized leaves. Make sure there are **no animals** on the material you pick out.

3. Put sample into a caton tray with equal sized, numbered grids. Do not allow any excess water into the tray. **Make sure there are no animals left on the sieve**. Clean the sieve with a brush or Teflon sponge before putting it away.

4. Label the tray with colored tape. **The label will be written in pencil** and include the program, station ID, replicate and the sorters first name.

5. Spread the cleaned debris on the bottom of the caton tray using as many grids necessary to obtain an approximate thickness of ½ inch. More or fewer grids can be used to spread out the material into the required thickness by using an additional girded tray or using fewer grids in a single tray.

C. Subsampling Procedures

1. Fill out BMI Subsampling and QC Sheet. Make sure you record the number of possible subsampling grids.

2. Randomly choose six or more grid numbers. Record the numbers on the BMI Subsampling and QC Sheet.

3. Starting with the first grid, remove all the material from the grid and place it in a clean Petri dish. You may use a razor to cut the debris around the edge of the grid (be careful not to cut any of the animals).

4. Systematically go through the Petri dish. Remove, count and place the animals in another clean Petri dish. When you are sure there are no animals left in the material, record the number total number of animals in the grid on the BMI Subsampling and QC Sheet.

    a. Procedures for animal fragments:
        i. Aquatic Worms (annelids and oligochaets) and other worm-like animals: Pick out and count if the animal has a head (look for mouth and eyes or eye spots).
        ii. Insects: Pick out whole animals only.
        iii. Misc. Arthropods: Pick out whole animals only.
        iv. Molluscs: Pick out if they were alive when collected (no empty shells)
        v. **If you are in doubt, pick it out but do not count towards 500 BMIs**.

5. Place the grundge from its grid into a small jar. Label the jar with program, sample date, station, replicate, grid number, and sorter's initials (do this for each additional grid used)

6. Use as many additional grids as necessary to remove a total of 500 animals, depending on the sampling design. Once you have either 500 animals, continue counting the remaining animals in the last grid and place the animals in a remnant vial.

7. The total count of BMIs must come from at least 3 randomly selected grids within a subsampling tray. If you notice there are a large number of animals/grid, your grids are too big (use ½ or ¼ grids if you need to).

8. Place the remaining contents of the tray into its original sample jar.

9. Animals collected should be separated into vials based on taxonomic group. Taxonomic groups include: Annelids, Molluscs, Other Phyla, Misc. Arthropods, Ostracods and Insecta. The vials will have an internal and external label **written in pencil**. The label will include: Program, Station, Replicate, Sample Date and Taxonomic Group.

10. **DO NOT LEAVE MATERIAL IN THE TRAY** for long periods of time. If you do not think you will be able to finish subsampling before you leave for the day:

    a. Estimate the number of animals/grid.
    b. Use this number to estimate the number of grids you will need to sub-sample 500 BMIs.
    c. Randomly choose the rest of the grids (note the order of the randomly chosen grids).
    d. Put the material of each grid in its own labeled jar (program, sample date, station, replicate, grid number, sorters initials) and fill with alcohol.
    e. Place the remaining material in the tray back into the original sample container, fill with alcohol.
    f Sort the material in the jars in the order you randomly selected the grids.
    g. If there are unsorted grids (in the jars) left after you have completed subsampling, put the material from the **UNSORTED** jars back into the original container. Remember; keep the grundge separate from the sorted material.

11. If you notice any unusual animals that were not included in the subsampling, you may pick them out and put the animal in its own labeled vial. These animals are not counted in the 500 BMI count.

12. Complete the BMI Subsampling and Taxonomy Tracking Sheet and the BMI Subsampling and QC Sheet.

D. Quality Assurance/Quality Control (QA/QC)

1. The CSBP requires fixed count subsampling with a +/- 10% accuracy.

2. Resort the grundge from each grid. Write the number of animals found in the resort on the BMI Subsampling and QC Sheet (write "0" if no animals are found). **There should be less than 15 animals found in the grundge from a 300 BMI sample** for no QC action to be taken. **There should be less than 25 animals found in the grundge from a 500 BMI sample** for no QC action to be taken. Any animal found in resort should be placed in the vials that are sent to the taxonomist to be identified. If many animals are found in the resort, talk to Scott or Karin to determine the appropriate QC action.

3. Once the QC is complete, the grundge can be combined into one container. The small jars can be cleaned and reused.

4. **Corrective Action**- Any QC parameter that is considered out of range should be followed by a standard corrective action that includes two levels. Level I corrective action includes an investigation for the source of error or discrepancy derived from the QC parameter. Level II corrective action includes checking all samples for the error derived from the QC parameter but is initiated only after the results of the Level I process justify it. Any corrective action will be noted on the BMI Subsampling and QC Sheet.

5.0 Taxonomy Procedures

Level 1 Taxonomic Effort is the professional level equivalent which requires subsampling 500 BMIs into the major taxonomic groups. The samples are then given to a taxonomist and identified to the lowest possible taxon, usually to genera and/or species level. The number of animals sorted from a sample depends on the sampling design for each program. Check with the Sorting Lab Lead or Biology Lab Supervisor if you are not sure how many animals to select.

1. Taxonomic identification of all freshwater BMI samples shall follow the guidelines set forth in the CSBP (2003) and the by the Southwestern Association of Freshwater Invertebrate Taxonomists (SAFIT).

2. All taxonomy by Aquatic Bioassay biologists will be to CDFG Level 1 (professional level). When a client asks for identifications to a level less than this standard, it must be signed off by the Environmental Programs Director.

3. Each species identified should be placed in its own vial with a cotton stopper and must contain an internal label with program, sample date, station and replicate. Once all species are identified, enumerated and placed in a small vial, all vials from the same station and replicate will be placed in a larger container and filled with 95% ethanol until all smaller vials are covered. An internal label must be included in the large container with program, sample date, station and replicate.

4. The taxonomist must voucher at least one individual from each species for each program. This requires that the historic voucher collection for the program be reviewed. The voucher taxa list for the program must also be updated as specimens are added. The voucher collection must be immediately available to any client wishing to review its contents.

5. A set of reference material and taxonomic keys are available in the laboratory. As new references become available they should be purchased as soon as possible.

6. As organisms are identified they are added to the electronic taxa list.

7. All Aquatic Bioassay taxonomists are required to participate in SAFIT and be a regular attendee at meetings (at least in southern California).

8. Ten percent of all program samples must be sent to the CDFG laboratories in Rancho Cordova, CA for a QC check. Samples for QC should be randomly chosen. Even when there are less than five samples collected per year for a program, one sample should be sent for QC. Send samples to:

   California Department of Fish and Game
   Aquatic Bioassessment Laboratory-Chico
   c/o Brady Richards
   CSU Chico
   Chico, CA 95929-0555

9. Identification discrepancies that are reported by the CDFG taxonomists must be immediately resolved through email and voice correspondence with the CDFG taxonomist. When necessary the resolved identification should be updated in electronic version of the taxa list. When these changes create significant changes in the calculated biological metrics, the Director and client must be notified immediately.

6.0 Personnel

Initial sorting is performed by a laboratory technician; QA/QC is performed by a senior technician. Determinations of corrective actions to be taken are made by the laboratory supervisor. Taxonomy is performed by experienced biologists with at least 5 years working experience and a college degree.

Appendix B

Acute Toxcity
Standard Laboratory Operating Procedures
(USEPA 5th edition)

Prepared by
Aquatic Bioassay & Consulting Laboratories

STANDARD OPERATING PROCEDURE FOR ACUTE EFFLUENT TOXICITY TESTS (USEPA 5th Edition Methodology)

ENDPOINT DESCRIPTION

Juvenile fish or invertebrates are exposed to various concentrations of effluent for 24-96 hours. The endpoint is mortality.

DILUTION WATER

Water used for this test is reconstituted fresh or saltwater. Known amounts of reagent grade salts or standard sea salts are added to high quality D.I. water until the dilution hardness and alkalinity or salinity is equal to that of the effluent.

EFFLUENT CONCENTRATIONS

Test dilutions are typically prepared at 100%, 50%, 25%, 12.5%, and 6.25%. If needed, lower dilutions can be set at ranges where a dilution is at least 50% that of the next highest concentration. If the toxicity of the sample is unknown, a 24-hour preliminary range-finding test using a wider range of concentrations can be prepared. A control using the same dilution water is included with all tests.

Test chambers are new or pre-cleaned, glass beakers, ranging in size from 30-250 mL (depending upon the species chosen). For rainbow or brook trout, 5-liter disposable glass aquaria are used. Test solution volumes range from 25-200 mL (or 4 liters for trout). Each beaker or aquarium is labeled with a lab number and effluent concentration. Test containers are placed on wire racks in a constant temperature room of either 19-21 or 24-26 °C (11-13 °C for trout). Beginning with the lowest concentration, graduated cylinders are used to pour the proper amount of the well-mixed effluent in each beaker. Dilution water is then poured in each container to the desired volume.

Solutions are not aerated unless oxygen values fall below 4.0 mg/l (6.0 mg/l for trout). Rate of aeration should not exceed 100 bubbles per minute.

TEST ORGANISMS

Juvenile animals are obtained from licensed breeders or collectors (Thomas Fish Company at Anderson, Ca., Brezina and Associates at Dillon Beach, Ca., or Aquatox in Hot Springs, Arkansas) and are delivered by Greyhound bus, UPS, or Federal Express. Upon arrival, the condition of the animals and number of mortalities during shipment are recorded.

Ages of organisms used and test temperatures in bioassays are:
Ceriodaphnia dubia less than 24 hours@25ºC
Daphnia spp. less than 24 hours@25ºC

Pimephales promelas 1-14 days; less than or equal to 24-h range in age @ 25ºC
Oncorhynchus mykiss 15-30 days (after yolk sac absorption to 30 days) @ 12ºC
Mysidopsis bahia 1-5 days; less than or equal to 24-h range in age, @20ºC ± 1ºC or 25ºC ± 1ºC, Salinity @5-30ppt ± 10%
Menidia beryllina 9-14 days; less than or equal to 24-h range in age, @20ºC ± 1ºC or 25ºC ± 1ºC, Salinity @1-32ppt ± 10%
Holmesimysis costata 3-4 days post-hatch juveniles; @15ºC ± 1ºC, Salinity @34ppt ± 2ppt
Atherinops affinis 7-15 days @21ºC, Salinity @10-30ppt

PERCENT SURVIVAL TESTS

Occasionally, only a percent survival test in undiluted effluent is required. The same procedures apply in this test as a standard bioassay, except that only undiluted waste and the control are used. Tests are reported as percent survival in undiluted sample instead of LC50.

CHEMICAL AND PHYSICAL PARAMETERS

Dissolved oxygen, pH, and temperature are measured in all controls and concentrations before introducing fish, and at 24-hour intervals thereafter. The hardness and alkalinity are measured in the control and highest concentration at the beginning and end of each test. Residual chlorine and conductivity or salinity are measured in the control and highest treatment concentration at the beginning of the test. Calibrated thermographs continuously record temperatures throughout the test. A uniform photoperiod of 16 hours light and 8 hours dark at an intesity of 50-100 foot-candles is maintained.

DELIVERY OF ORGANISMS AND TEST DURATION

Within one hour after the preparation of test solutions, typically 10 randomly chosen animals are delivered to each duplicate test tank using a small-mesh dip-net or disposable pipette (total of 20 animals per concentration). The test begins when animals are introduced into the test chambers and continues for 24, 48, or 96 hours, depending upon requirements. Test solutions are renewed at 48 hours. Animals are fed at 48 hours, with the exception of *Oncorhynchus mykiss* which are not fed and *Mysidopsis bahia* are fed 0.2 mL concentrated suspension of Artemia nauplii ≤ 24-h old daily, if the test lasts longer than this. Mortalities and chemical measurements are recorded every 24 hours, and dead animals are removed as soon as they are observed. Excess food is removed after feeding.

DISPOSAL OF FISH AND TANKS

At the end of the test, animals are destroyed before being disposed of by placing them in a zip-lock bag with ethanol. Effluents are poured down the drain unless they are highly toxic, in which case the client is asked to pick up the sample and any dilutions. Test tanks and aeration pipets are broken down and disposed of at a local landfill.

ANALYSIS

A review of concentration-response relationships is conducted on all multi-concentration tests following guidelines in EPA821-B-00-004, July 2000, *Method Guidance and Recommendations for Whole Effluent Toxicity (Wet) Testing (40 CFR Part 136).*
The flowchart shown in Figure 6 of the method reference (USEPA 2002) is used for determining the LC50 statistical test. When an LC50 can be determined, the toxicity of the waste is also expressed as toxic units, where:

$$TC(tu) = \frac{100}{96\text{ hr LC50}}.$$

When there is less than 50% mortality in 100% waste, the toxic units are expressed as:

$$TC(tu) = \frac{\text{Log (\% Mortality)}}{1.7}$$

TEST VALIDITY

1) Mortality cannot exceed 10% in the controls.
2) Test must be set within 36 hours of collection.
3) D.O. above or equal to 4 mg/l (6 mg/l for trout).
4) Loading limits must not exceed 1.1 g/l at 25 °C, 0.65 g/l at 20 °C, and 0.4 g/l at 25 °C.

REFERENCES

USEPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*. (5th ed). EPA-821-R-02-012.

EPA-821-B-00-004, July 2000, *Method Guidance and Recommendations for Whole Effluent Toxicity (Wet) Testing (40 CFR Part 136).*

Revised 3/10/2006

Appendix C

10 Day Sediment Survival and Growth Test With Hyalella azteca (EPA, 2nd Ed.) Standard Laboratory Operating Procedures

Prepared by
Aquatic Bioassay & Consulting Laboratories

STANDARD OPERATING PROCEDURES FOR THE 10 DAY SEDIMENT SURVIVAL AND GROWTH TEST WITH *Hyalella azteca* (EPA, 2nd Ed.)

ENDPOINT DESCRIPTION

7-14 day old *Hyalella azteca* are exposed in a static renewal system to test solutions of sediment and control water for ten days. The endpoints are survival and growth (increase in weight) of the *Hyalella* compared to controls.

SAMPLE COLLECTION

Samples are collected and placed into a 1 liter high density polyethylene (HDPE) containers. Samples can be stored for up to eight weeks in the dark at 4ºC.

TEST ORGANISMS

Hyalella azteca are supplied by Aquatic Biosystems Inc. in Fort Collins, Colorado. The test organisms must be between 7 to 14 days in age and within 1-2 day range in age. Organisms are acclimated for a period greater than 96 hours and less than 14 days.

OVERLYING WATER

Overlying water used for the test is: 1) receiving water, water collected from areas in the vicinity of outfall,. 2) Reconstituted fresh water.

SEDIMENT PREPARATION

The day before the sediment test is started (Day -1) each sediment is thoroughly homoginized by passing it through a sifting screen. 100 mL of the sediment is then added to the chambers. 175 mL of overlying water is then added to each of the test chambers. Suspension of the sediment can be avoided by carefully pouring the water down the side of the test chamber. Chemical analysis should be taken on the initial (Day 0) and (Day 9) of the test including: pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, and ammonia. All other dates require monitoring of the temperature and dissolved oxygen.

REFERENCE TOXICANT CONCENTRATIONS

Reference toxicants are mixed from a stock copper solution of 10.0 mg/L supplied by Environmental Resource Associates. The reference toxicants are mixed in concentrations of: 20, 40, 80, 120, 160, and 200µg/L.

RENEWAL OF OVERLYING WATER

Renewal of overlying water is achieved by intermittent volume additions of 150 mL every 12 hours.. Water is changed out on days 2, 4, 6, and 8. Test containers are maintained at 23ºC with a variation of ±1ºC.

PLACING ORGANISMS IN TEST CHAMBERS

7 to 14 day old *H. azteca* are pipetted directly into test chambers. 10 organisms are used per chamber. 8 replicates are used per treatment.

FEEDING

For each test chamber 1.0 mL of YCT is added daily from Day 0 to Day 9.

MONITORING A TEST

All chambers are checked daily and observations are made to assess organism behavior such as cediment avoidance. Overlying water is monitored with daily measurement of dissolved oxygen and temperature. Conductivity, hardness, alkalinity, pH, and ammonia are checked at the beginning and end of the test.

ENDING A TEST

The final water quality analyses are taken in the test chambers. The sediment in each of the test chambers is poured through a #40 sieve to isolate the test organisms. Mobile organisms are counted as alive. Survival information is logged on a tracking sheet for the test.

TEST DATA ANALYSIS

Survival and growth are measured at the end of the 10-d sediment toxicity test with *H. azteca.* Survival endpoints are reported as the percent of surviving organisms in the treatment. Growth of amphipods is often a more sensitive toxicity endpoint. Dry weight of amphiopds is determined by pooling all living organisms from a replicate and drying the sample at 60ºC-90ºC to a constant weight. The sample is brought to room temperature in a dessicator and weighed to the nearest 0.01mg to obtain mean weight per surviving organism.

REFERENCES

US EPA. March 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*. Section 11. EPA/600/R-99/064.

Revised 1/23/2007

Appendix D

Sediment-Water Interface Exposure System
Mytilus Development Test
Standard Laboratory Operating Procedures
(Marine Pollution Studies Laboratory, December 2004)

Prepared by
Aquatic Bioassay & Consulting Laboratories

1.0 OBJECTIVE

The purpose of the Sediment-Water Interface (SWI) test is to assess toxicity of solid phase sediment samples using the embryo/larval stages of marine and estuarine invertebrates and vertebrates. In this procedure, sediment samples are placed into test chambers that are then filled with uncontaminated overlying seawater. Screen tubes are then placed into the test chambers so that the screen is almost in contact with the sediment. After a 24-h equilibration period, test organisms are inoculated into the screen tubes, where they develop in proximity to the sediment. The size of the screen is small enough to retain embryos but large enough to allow for passive diffusion of chemicals into the screen tube. At the termination of the test the screen tube is removed and the animals are washed into a separate container for microscopic evaluation. In this test system most of the animals are retained, allowing for accurate quantification of developmental abnormalities (Anderson et al. 1996).

At the Marine Pollution Studies Laboratory at Granite Canyon (MPSL) this sediment exposure method has been developed for marine and estuarine applications using the sea urchin or mussel embryo development protocols. This exposure system may be used to assess the toxicity of intact (undisturbed) sediment core samples, thereby eliminating artifacts that result from the manipulation of sediment and pore water samples. The exposure system may be combined with analyses of toxicant flux measures to provide biological information on the effects of contaminated sediments on the water column.

2.0 EQUIPMENT

The following equipment is necessary to conduct the toxicity test at MPSL. The word "clean" here and throughout this procedure means that the item has been cleaned according to the MPSL glassware cleaning procedures outlined in a separate standard operating procedure (MPSL SOP 1.3).

2.1 Organism Collection and Culture

• Tanks, trays, or aquaria for holding organisms, e.g. standard seawater aquarium with appropriate filtration and aeration system.
• Air pump, airlines, and air stones -- for aerating water containing adult urchins (for static systems and emergency aeration for flow-through systems).

2.2 Test Initiation

• Polycarbonate tubing for sediment cores (7.5 cm ID, AIN Plastics, Santa Clara, CA)

• Polyethylene plastic caps for cores (7.5 cm, AIN Plastics, Santa Clara, CA)
• Polycarbonate tubing for exposure screen tubes (e.g., 5 cm ID, Laird Plastics, CA)
• Plastic Cement for screen construction (Craftics® Brand, Chicago, II)
• Polyethylene (PECAP®) screen (AREA, Homestead FL)
• Parafilm® for sealing cores
• Beakers, 1,000 mL borosilicate glass
• Wash bottles - for dilution water and distilled water.
• Constant temperature chambers or water baths.
• Pipettes, automatic - adjustable, to cover a range of delivery volumes from 10 to 1000 µL.
• Hemacytometer
• Sedgwicke-Rafter counting cell
• Mixing Plunger (for mixing gametes)
• Graduated cylinders - Class A, borosilicate glass or non-toxic plastic lab ware.
• Tape, colored - for labeling tubes and other containers.
• Polypropylene Spoons
• Markers, waterproof - for marking containers, etc.
• Gloves, disposable - for personal protection from contamination.

2.3 Test Termination

• Inverted and compound microscope for inspecting gametes and making counts of embryos and larvae.
• Data sheets.
• Formaldehyde, 37% (Concentrated Formalin) for preserving embryos and larvae.
• Fume hood to protect the analyst from effluent or formaldehyde fume
• Counter, two unit, for recording counts of embryos and larvae.

2.4 Water Quality

• Meters and probes for measuring pH, dissolved oxygen, and ammonia
• Refractometer for measuring salinity
• Thermometers (glass mercury thermometer and continuously recording chart thermometer)
• Graduated pipettes (10 mL) and hand pipette pump for water quality sampling
• Gloves and appropriate safety gear (see MPSL lab safety manual)

2.5 Dilution Water

For tests at MPSL, dilution water is ambient Granite Canyon seawater, filtered to 1 µm, at ambient salinity (33-34‰). This water is used to prepare eggs and sperm for toxicity tests, and for diluting test solutions.

3.0 EXPERIMENTAL DESIGN AND PREPARATION

3.1 Sampling Procedures

The following procedures are divided into sections for testing homogenized sediment and intact (non-homogenized) surficial sediment samples. The SWI method has been used primarily for testing marine and estuarine sediment samples and the screen tubes described here were designed for exposing invertebrate and vertebrate embryos larger than 25 µm in diameter.

3.2 Screen Tube Construction

Screen tubes are constructed from clear, polycarbonate stock. Screen tube size will very with species and protocols; for using the sea urchin embryo/larval protocol screen tubes are constructed from 4 cm (ID) diameter stock that is cut into 15 cm high sections on a conventional band saw. The wall thickness is 3 mm. A 1-cm section is cut from the bottom of the tube and this serves as the pedestal that sits on the sediment surface. Polyethylene (PECAP®) screen is glued to the tube using clear-thickened acrylic plastic glue and the pedestal is then glued back on the tube to sandwich the screen. A small hole is drilled into the side of the pedestal that is used to purge any air trapped under the screen during immersion. Screen size will vary depending upon the application. Twenty-five micron screen is appropriate for the sea urchin and mussel embryo development protocol. Polyethylene mesh is stronger than conventional nylon mesh and better withstands repeated solvent rinses.

Polycarbonate core tubes are used for collecting intact, unhomogenized samples (see below). Cores are constructed by cutting 7.3-cm (ID) stock into 20-cm high sections. Polyethylene caps are used to seal samples inside the tubes.

3.3 Homogenized Sample Handling

The following procedures are for conducting solid-phase SWI tests using the embryo development protocols. Sediment collection and processing procedures follow guidelines described in ASTM (1993). It is assumed that test sediments are homogenized according to this method prior to loading into the test containers. Sediment and overlying water are added to the cores 24-hour prior to inoculation of the test organisms to allow samples to equilibrate.

Prior to loading homogenized sediment into the cores, polyethylene caps are placed on one end of each core and this end is sealed with Parafilm®. After labeling, the cores are arranged in groups of 5 replicates per sample with one extra core per sample to be used for interstitial sulfide and ammonia measurements at the termination of the test.

Samples to be tested are identified and the interstitial water salinity of each sample is checked.

Using a polypropylene spoon, sediment is placed into each tube forming a layer 5-cm deep. Lower a clean plastic disc (attached to a pipette) into the tube approximately 1 cm above the surface of the sediment. Add 300 mL of "clean" overlying seawater (ambient salinity, 15°C) so as not to disturb the sediment. Slowly lift the disc out as the water is added. The cores are arranged in a constant temperature room and covered with acrylic sheets containing glass pipettes that deliver gentle aeration (1 bubble/second). The sediment and overlying water are allowed to equilibrate overnight before introduction of the screens and test organisms. A screen tube is added to each core container the following morning. The screen tube is gently placed in the core so that the bottom collar rests on the substrate, this leaves the screen itself 1 cm above the substrate. The water in the outer core tube should be 12 cm deep, resulting in 150 mL of water in the screen tube itself.

3.4 Intact Sediment Sample Handling

Methods for handling intact core samples are essentially the same as those described above, with the following modifications designed to minimize disturbance of the sample.

The core may be taken directly from the sampling device, by hand from an intertidal sampling site or, sub-tidally using divers, directly from the sediment surface. Depth of the sample will depend on the study goals. At MPSL, we generally take 5 cm deep cores because this is the practical sampling depth of the modified Van Veen grab sampler used at our laboratory. The core is pressed into the sediment and a pre-cleaned acrylic plate or a gloved hand is inserted under the bottom of the core to prevent leakage of sample or interstitial water as the sample is removed. It is convenient to mark the 5-cm height for reference using a plastic cable tie wrapped around the outside of the core. After the core is removed from the sediment, the bottom is capped quickly; then the top is capped. A small hole in the top cap relieves positive pressure on the sample and minimizes leakage as the cap is attached. Sample integrity is verified by the presence of sediment overlying water. If an inordinate volume of interstitial water or sediment leaks out, the sample is discarded and a new one collected. The outside of the tube is dried and the bottom wrapped tightly in Parafilm® to prevent leakage. The core is then stored upright and iced.

Approximately 24 hours prior to initiation of the toxicity test, the overlying water in the core (from the sample site) is gently siphoned off of the top of the sample leaving about 0.5 cm of water remaining to minimize disturbance of the sediment surface microlayer. Three hundred milliliters of "clean" overlying seawater (ambient salinity, 15°C) is then introduced into the cores using acrylic disks to minimize sample disturbance, as described above. Unlike homogenized samples, salinity of interstitial water may not be adjusted in the intact samples. As described above for homogenized samples, the

cores are usually arranged in groups of 5 replicates per sample with one extra core per sample to be used for interstitial sulfide and ammonia measurements at the termination of the test. Screen tubes are gently added to the cores at the beginning of the day of the test. The test is run under ambient laboratory lighting conditions.

4.0 TOXICITY TESTING PROCEDURES

The following procedures are patterned after USEPA 1995. The purpose of the embryo/larval development tests are to determine if sediment samples cause abnormal development of exposed embryos relative to embryos exposed to control or reference samples. For details, refer to MPSL SOP for the appropriate test organism.

5.0 REFERENCES

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U.S. Environmental Protection Agency. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. Office of Research and Development. EPA/600/R-95/136. August 1995

Appendix E.

Field Sampling
Quality Assurance and Standard Operating Procedure for Water and Sediment Chemistry & Bacteriology

Prepared by Aquatic Bioassay and Consulting Laboratories

INTRODUCTION

Aquatic Bioassay and Consulting Laboratories collects water and sediment chemistry, and bacteriological samples from both freshwater and marine systems throughout southern California. This standard operating procedure for the collection of chemistry and bacteriological samples is specific to the San Gabriel River Regional Monitoring Program. Weekly samples for bacteria and annual sampling in the spring and summer for water and sediment chemistry are collected from locations throughout the watershed including the San Gabriel River estuary and mainstem, lower watershed below Santa Fe Dam and in the upper watershed above the dam. Samples collected for monitoring purposes are transported back to the laboratory in an appropriate manner to accurately represent the integrity of the watershed.

1 Scope and Application

1.1 Receiving water samples are collected weekly for bacteria and annually in the spring and summer for water and sediment chemistry in adherence with guidelines set forth in the San Gabriel River Regional Monitoring Program Design Document.
1.2 Collection of samples may be accompanied by sample collection for various physical, chemical and/or biological measurements.

2 Summary of Procedure

2.1 Obtain sampling equipment based on sampling needs (refer to sampling equipment checklist).
2.2 Annual chemistry samples for water and sediments must be coordinated with the SGRRMP Workgroup, as several other agencies may be sampling concurrently as part of the program.
2.3 Obtain appropriate sample containers from either Aquatic Bioassay store rooms or CRG Laboratories.
2.4 Samples are collected at various stations throughout the watershed. Map and coordinates for these locations can be obtained through the SGRRMP Project Manager, Scott Johnson.
2.5 Some samples may require chemical preservation (e.g., ammonia samples need to be preserved with 5.0 ml H_2SO_4 for every 1000 ml of sample).
2.7 Some samples will need to be quantified for total residual chlorine, pH, temperature, dissolved oxygen, and salinity immediately following collection.
2.8 Samples are preserved on ice and transported back to the laboratory for analysis.

3 Handling & Preservation

3.1 Latex gloves must be worn when working with acids and when working with the bomb sampler.
3.2 Some samples require chemical preservation

3.2.1 Ammonia samples must be preserved with 5.0 ml H_2SO_4 for every 1000 ml of sample (1 vial per 1 liter sample).
3.2.2 Total phosphate samples must be preserved with 2.5 ml HNO_3 for every 500 ml of sample (1/2 a vial per 500 ml sample).
3.2.3 Total Hardness must be preserved with 1.25 ml HNO_3 for every 250 ml of sample (1/4 vial per 250 ml sample).

3.3 Leave headspace in the sample containers that require metals, TKN, and/or microbiological analysis.
3.4 Samples are preserved on ice and transported back to either the CRG or Aquatic Bioassay laboratory for analysis, depending on the analysis.
3.5 Upon returning to either the CRG or Aquatic Bioassay laboratory, the samples are taken from the coolers, logged and stored in the appropriate refrigerator or freezer.

4 Interferences

4.1 Used or tampered containers may result in contamination of the sample.
4.2 If the bomb sampler's plunger is opened to air before it is ready for sample collection, it is considered contaminated and a new, sterile sampler must be used
4.3 Coliform samples have a six-hour holding time. These samples must be turned into the CRG Microbiology lab within six hours of sample collection.
4.4 The sampling station at College Park Drive in the San Gabriel River Estuary, should be sampled at mid-tide (2.7') ±15 minutes. Other water quality sampling must be scheduled accordingly.

5 Apparatus & Equipment

5.1 Obtain the following equipment and supplies as necessary (see Appendix 3 for river specific sampling requirements):

5.1.1 Fultz pump and hose reel (pump head, batteries, connector hose)
5.1.2 Stainless steel bucket
5.1.3 Safety Vest
5.1.4 Rope
5.1.5 Hardhat
5.1.6 Stop watch
5.1.7 Thermometer
5.1.8 Phone and pager
5.1.9 Coolers with ice
5.1.10 Safety glasses
5.1.11 Boots
5.1.12 Refractometer
5.1.13 Tape measure
5.1.14 Compass

5.1.15 Boat, oars, flotation vest, anchor, pump, safety line
5.1.16 Bomb sampler with thin and thick ropes
5.1.17 Funnel

6 Reagents & Consumable Materials (See SGRRMP QAPP, Section 12)

7 Sampling Procedure

7.1 Rinse sampling equipment (sampling pump, bucket, funnel, etc.) with sample prior to sampling.
7.2 Label all containers, with a minimum of sample location, date and time of collection, sample type (grab or composite), and initials of the sampler.
7.4 Collect the sample using the appropriate method.

7.4.1 Grab: Water samples from river and creek stations are collected using one of the following grab techniques.

7.4.1.1 Immersion grab: Facing upstream of flow, completely immerse suitable container in receiving water and lift out when filled.
7.4.1.2 Field submersible sampling pump: Completely submerge pump head into sample water and purge sampler tubing for approximately one minute or until the pump has been sufficiently purged prior to sample collection.
7.4.1.3 Stainless steel bucket: Rinse bucket at least three times prior to filling bucket with sample. Face upstream and partially immerse bucket in stream and lift out when filled. Pour sample in container.
7.4.1.4 Bomb sampler *(Used weekly for coliform sample collection at swimming sites and the College Park Dr. site in the estuary)*

7.4.1.4.1 Before the bomb sampler is used, it must be cleaned with warm tap water and liquinox, rinsed with deionized water, and autoclaved by the CRG microbiology group.
7.4.1.4.2 Bring two bomb samplers for each station, a primary and an additional bomb sampler for backup. Do not re-use the bomb sampler after the plunger has been opened.
7.4.1.4.3 To set the bomb sampler at mid-depth, first use the lead weight with the thicker of the two ropes to find the depth to the bottom. Mark or hold onto the place on the rope when the weight hits bottom and then retrieve the weight to the water surface. Mark or hold the place on the rope when the weight is at the surface. Now find the midpoint between the bottom mark and surface mark on the rope and this will be the mid-depth. Retrieve the weight.

7.4.1.4.4 Disconnect the lead weight from the thick rope and connect the bomb sampler. Gloves must be worn to avoid contamination of the sampler.

7.4.1.4.5 Connect the thinner rope to the plunger on the bomb sampler. Be careful not to open the plunger until the sampler is set at mid-depth. Allow yourself plenty of slack in the thinner rope.

7.4.1.4.6 Before lowering, remove aluminum foil. Lower the sampler by the thicker rope to the previously found mid-depth.

7.4.1.4.7 Once at mid-depth, pull the thinner plunger rope to allow water to enter into the sampler. You should see some bubbles rise to the surface.

7.4.1.4.8 Retrieve the sampler by the thicker rope. Avoid any tension on the thinner plunger line because this will release the sample.

7.4.1.4.9 Once retrieved, the sample can be expelled out the bottom of the sampler and into a sample bottle by slowly pulling the plunger.

7.4.2 Coliform samples must be collected using a sterile sampling technique.

7.4.2.1 Freshwater samples must be collected using the immersion grab technique.

7.4.2.2 Marine stations must be collected using the bomb sampler.

7.4.2.3 Coliform samples must be returned to the microbiology lab within six hours of the time in which they were collected.

7.4.3 Sediment Sampling in the estuary (Chemistry & Toxicity)

7.4.3.1 The sediment in the San Gabriel River estuary will be collected either by hand when the tide is ± 0.0 ft. or by using a petite ponar (0.5 m^2) grab from a small boat (AVON).

7.4.3.1.1 When the tide is ± 0.0 ft. sediment is to be collected with the use of a stainless steel scoop (e.g., an ice scoop). The sediment should be sampled under the surface of the receiving water. Sediment is placed into a stainless steel bucket and homogenized. Excess water is decanted off. Homogenize and decant repeatedly until most of the excess water was been removed. Scoop sample into appropriate containers.

7.4.3.1.2 When sediments must be sampled from the small boat, a chain rigged petite ponar grab will be used. The grab will be thoroughly rinsed with lab, then receiving water prior to use. The grab will be lowered to until it bites into the

bottom sediments, then raised slowly so that the jaws close completely. The grab will be raised slowly to the boat. The top of the grab is opened and checked to ensure a good sample was collected. A stainless steel scoop is used to sample the top 2 inches of the sediment surface which is placed in a stainless steel bucket and homogenized. Excess water is decanted off. Homogenize and decant repeatedly until most of the excess water was been removed. Scoop sample into appropriate containers.

7.5 Make on-site observations and take water quality readings as necessary.

7.5.1 Fill out the field observation sheet with the required information for all water samples and stations.

8 Quality Control

8.1 All samples collected require a chain of custody/log-in sheet to track the sample. Observations are also documented to record the current conditions at the time of sample collection.
8.2 All samples are checked when they are relinquished to ensure that they meet the temperature requirements and are in the same condition as they were upon sample collection.

9 Method Performance

9.1 The sampler (e.g. bucket, pump, etc.) must be thoroughly rinsed with receiving water before the sample is collected to avoid contamination among receiving water samples.
9.2 Sample containers must be new and clean to avoid contamination.
9.3 Bomb samplers must be autoclaved and sterile to avoid contamination.
9.4 All samples must be transported to the SJCWQL in ice, and upon arrival, samples should be <5.0ºC.
9.5 Sample bottles that are leaking or damaged will not be submitted for chemical analysis.

Appendix F.

Quality Assurance and Standard Operating Procedure for Laboratory Analysis of Water, Sediment and Tissue Chemistry & Bacteriology

Prepared by CRG Laboratories

QUALITY ASSURANCE PROGRAM DOCUMENT

Approved by:

_____ _____

Richard Gossett, Laboratory Director Date

1.0 TABLE OF CONTENTS

2.0 INTRODUCTION

2.1 CRG Marine Laboratories, Inc., Torrance, CA (CRG) is committed to providing quality environmental analytical services to all of its clients. To maintain this high level of quality, an extensive Quality Assurance (QA) Program has been implemented within CRG. The purpose of this manual is to document the QA practices utilized by CRG. It describes the applications and concepts employed to assure that results generated by CRG are in control, scientifically valid, of known highest possible quality, and can be used with a high degree of confidence by the client or user.

2.2 CRG is certified by the California Environmental Laboratory Accreditation Program (ELAP) for the analyses of inorganics, toxic chemical elements and organics in wastewater, Certificate No. 2261.

2.3 The format of this manual is patterned after that outlined in the California Department of Health Services Application for Environmental Laboratory Accreditation.

2.4 This document is intended for use as a reference document to CRG's QA Program. It is designed to assist all staff members to perform the operations necessary to comply with all client and contractual requirements and to ensure that data produced by CRG conforms to the highest standards set by state and/or federal regulations.

3.0 ORGANIZATIONS AND RESPONSIBILITY

3.1 CRG operates two environmental laboratories at the following locations:

2020 Del Amo Blvd, Suite 200
Torrance, CA 90501

355 Van Ness, Suite 115
Torrance, California 90501

3.2 Quality Assurance Staff Responsibilities

The Laboratory Director is ultimately responsible and accountable for all activities related to the generation of technical data by or for CRG. In order to carry out these QA responsibilities and facilitate the integration of QA into all data generation activities, certain responsibilities have been delegated to other CRG employees.

3.2.1 The **Laboratory Director** is responsible for the following activities:

A. Provides leadership and technical direction for the organization

B. Removes barriers that limit the ability of individuals to obtain their goals and introduces change as a positive opportunity for the growth of the individual and CRG

C. Ensures that adequate Quality Assurance/Quality Control (QA/QC) provisions are developed and incorporated into all laboratory data generation activities

D. Ensure that adequate resources are provided to meet these objectives

E. Ensure that specific QC procedures conform to the requirements specified by the client or project manager

F. Participates in appropriate certification programs and audit programs to establish credibility and demonstrate proficiency

G. Ensure that deficiencies or problems identified through audits are corrected as expeditiously as possible

H. Ensure that all routinely used analytical and administrative procedures are covered by well-written Laboratory Operating Procedures (LOP)

I. Ensure that all staff members are adequately qualified and trained to perform assigned tasks

J. Ensure that equipment is adequately maintained for the intended use

K. Ensure that the laboratory is a safe, efficient, and productive work environment.

3.2.2 The **Quality Assurance Specialist** is responsible for the following activities:

A. Maintain and update the QA Program and this QA Manual

B. Serve as a QA liaison with clients and project managers

C. Coordinate accreditation/certification and auditing activities

D. Assess the adequacy of QC activities within the laboratory and keep the Laboratory Director informed of their effectiveness

E. Ensure that data is validated with respect to QC criteria

F. Ensure that all chain of custody requirements are met

G. Issue and evaluate the analyses of performance evaluation samples

H. Ensure that audit results are communicated with the appropriate staff and corrective actions are taken when needed

I. Identify and recommend staff training needs

J Work with the various laboratory staff to assure that LOPs are documented and meet the established quality standards

3.2.3 The **Organics Supervisor** is responsible for the following activities:

A. Develop, update, and implement modern state-of-the-art instrumental analysis techniques to cost-effectively meet CRG's requirements

B. Provide organic analytical testing services including priority pollutants and other regulated organic chemicals to CRG's clients

C. Validate data generated by the Organic Chemistry Section to assure that all quality objectives are met

D. Responsible for financial performance of the Organic Chemistry Section

E. Provide necessary training for all subordinates

F. Provide a safe working environment.

3.2.4 The **Inorganics Supervisor** is responsible for the following activities:

A. Develop, update, and implement modern state-of-the-art instrumental analysis techniques to cost-effectively meet CRG's requirements

B. Provide inorganic analytical testing services including metals and wet chemistry to CRG's clients

C. Validate data generated by the Inorganic Chemistry Section to assure that all quality objectives are met

D. Responsible for financial performance of the Inorganic Chemistry Section

E. Provide necessary training for all subordinates

F. Provide a safe working environment.

3.2.5 The **Microbiology Supervisor** is responsible for the following activities:

A. Develop, update, and implement modern state-of-the-art analytical techniques to cost-effectively meet CRG's requirements

B. Provide Microbiology analytical testing services including indicator bacteria, bacterial viruses and other microorganisms CRG's clients

C. Validate data generated by the Microbiology Section to assure that all quality objectives are met

D. Responsible for financial performance of the Microbiology Section

E. Provide necessary training for all subordinates

F. Provide a safe working environment.

3.2.5 The **Sample Custodian** is responsible for the following activities:

A. Receipt, login, and storage of all analytical chemistry samples

B. Review all chain of custody forms, record sample condition, and resolve inconsistencies and problems

C. Serve as liaison between Project Managers and Analysts with respect to handling rush orders

D. Purchase, label, preserve, pack, and ship all appropriate sample containers provided to clients

E. Ensure that all laboratory samples are ultimately disposed of according to the laboratory guidelines.

4.0 QA OBJECTIVES FOR MEASUREMENT DATA

4.1 Data Quality Objectives (DQOs) for the data collection activity describe the overall level of uncertainty that a decision-maker is willing to accept in results derived from environmental analyses. The objective of CRG's QA Program is to ensure that the validity and reliability of the data meets client's requirements in terms of DQOs. The program follows the guidelines established by the California Department of Health Services and the U.S. Environmental Protection Agency (USEPA).

Since DQOs often vary with individual projects, CRG sets internal specifications that are strict enough to meet a majority of client's requirements. Project-specific DQO's can be found in the Quality Assurance Project Plans (QAPPs) for that project.

4.2 DQOs for analytical determinations are expressed in terms of accuracy, precision, detection limits, completeness, and comparability. Section 11 of this manual describes the types of QC checks used to measure these objectives and the procedures used to derive them. Table 1 outlines typical accuracy, precision, and MDL objectives for each field of testing. Specific DQOs for each parameter are contained within the LOP used for anlaysis.

5.0 SAMPLING PROCEDURES

CRG provides trained staff for sample collection purposes. Proper sampling includes using appropriate equipment, containers, and preservation as well as following strict procedures for collection, storage, and transport to prevent cross contamination and loss of sample integrity.

CRG provides appropriate containers and sampling procedures to those clients who choose to perform their own sampling. CRG staff refers to USEPA guidelines published in the Federal Register, 40 CFR Part 136.3 and Standard Methods for the Examination of Water and Wastewater, 20th Edition, for container selection and preservation.

6.0 SAMPLE CUSTODY

To produce legally defensible data, CRG maintains and demonstrates custody control of all samples. Two components of custody are addressed: physical possession and documentation.

6.1 Documentation begins with field records, including a chain of custody form, which follows the physical sample from the field to the laboratory. The Sample Custodian checks to insure that:

A. The sample container is clearly marked and agrees with the information provided on the chain of custody sheet

B. The evidence tape is unaltered and the container is intact

C. The sample was supplied in the proper type of container

D. The sample has not exceeded its maximum holding time

E. Sufficient sample volume exists to perform the requested analyses

F. Samples requiring analysis by a contract laboratory are packaged with an ice substitute and dunnage, and are shipped in an ice chest to the contract laboratory. A chain of custody sheet accompanies all samples shipped from CRG.

6.2 If samples are delivered without a chain of custody, one is completed at the laboratory prior to acceptance of the samples. The Sample Custodian shall note on the chain of custody any discrepancies between the physical sample and the custody record.

6.3 Once received, each sample is assigned a unique laboratory ID number and logged into a bound Sample Receiving Logbook. Key characteristics are recorded into the logbook, the chain of custody is filed with the project file, and the sample is placed in the appropriate storage location until analysis.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 All instrumentation is calibrated at a frequency that ensures the validity of the results. These procedures are carried out following USEPA guidelines and the recommendations of the instrument manufacturer.

7.2 Calibration standards are prepared either from purchased stock standards or from stock standards prepared in-house utilizing reagents suitable for

the preparation of standards. When available, calibration standards are prepared from starting materials that are certified traceable to the National Institute of Standards Technology (NIST).

7.3 The following is a brief summary of the instrumentation calibration procedures employed at CRG. Detailed descriptions of these procedures are contained with the appropriate method.

7.3.1 The gas chromatograph or gas chromatograph mass spectrometer is calibrated using either an external calibration procedure or internal standard. For each parameter of interest, at least three to five different concentrations of standards are employed. One of the concentrations is near the Method Detection Limit (MDL) for each parameter. Concentrations of the remaining standards correspond to the expected range of concentrations found in the samples analyzed. Calibration standards are prepared by utilizing secondary dilution standards and/or stock solutions. Calibration standards may include a set of internal standards at a known constant amount. The base peak m/z shall be used as the primary m/z for quantification of the standards. Sensitivity of the instrument is checked every 10 samples by analyzing the external reference samples. If the result is not within a predetermined range, the problem is corrected, and the samples immediately following the last acceptable check are reanalyzed

7.3.2 The Inductively Coupled Mass Spectrometer (ICPMS) is calibrated before each use. For each parameter of interest, at least three to five different concentrations of standards are employed. One of the concentrations is near the MDL for each parameter. Concentrations of the remaining standards correspond to the expected range of concentrations found in the samples analyzed. Calibration standards are prepared by utilizing secondary dilution standards and/or stock solutions. Calibration standards may include a set of internal standards at a known constant amount. Sensitivity of the instrument is checked every 10 samples by analyzing the external reference samples. If the result is not within a predetermined range, the problem is corrected, and the samples immediately following the last acceptable check are reanalyzed

7.3.3 The performance of the balances is monitored against a set of calibration weights that are traceable to NIST (a log is maintained of these inspections)

7.3.4 Temperature records are maintained for all refrigerators, incubators, water baths, ovens. The temperatures are monitored at

a frequency determined by how often the equipment is placed in service.

8.0 ANALYTICAL PROCEDURES

Analytical procedures are determined by current environmental regulations set forth by both state and federal guidelines. Analytical methods are published in CRG's Laboratory Operating Procedures Manual (LOPM). Revisions and updates of the LOPMs are developed as required. The LOPMs are numbered to correspond with their standard reference method.

8.1 The manual includes the methods employed by CRG for the analyses required to support CRG's clients

8.2 The format of the LOPM is patterned after those listed in the Code of Federal Regulations (CFR).

8.3 The LOPMs are prepared by senior members of the technical staff and approved by the Laboratory Director.

8.4 The LOPM is a controlled document. Each manual is assigned to an individual who has custodial responsibilities. Revised LOPMs are issued with a new revision letter. The custodian updates the manual and is responsible for replacing the previous section(s) with the revised section(s). This insures that the analyst is always working to the latest revision of test procedures and protocols. A history file is maintained of all revisions to the LOPM. A memorandum is attached to each revision in the history file summarizing the reason for the change.

8.5 Research and development projects and methods development projects are documented in bound laboratory notebooks.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Laboratory results are communicated to CRG's clients through the analytical report delivered either electronically or by mail. This document is based on the client's laboratory order or by group of related samples.

9.1 Data reduction- Data reduction is the process by which the analyst translates raw data into a reported result that is reviewed by a second party then approved by the section supervisor before being released in the final report. Specific calculations and verification processes are summarized in the respective LOPMs.

All determinations are performed by dedicated instrumentation equipped with a microcomputer. Results are stored in a computer file, reported in a printed report and then electronically transferred to the database. A sequence logs containing the sample position, and order of analysis is kept both electronically and hardcopy. Sample results are tracked by the computer filename cross-referenced to the unique sample ID number.

9.2 Data validation - Data validation involves ensuring the correct assignment of sample labels before instrument operation, checking the performance of the instrument, verification of successful completion of all QC checks, and fitness of the calculations performed by the computer.

9.3 Data Management **-** Sample analytical data including ID, date and time of collection and analyses, type of requested field and laboratory analyses, and results are entered into a Laboratory Information Management System (LIMS), which is a Microsoft Access-based database system. After data entry, all results from sample analyses and QA/QC are reviewed for accuracy and completeness and any reporting of laboratory results are based on queries from the LIMS.

9.4 Reports **-** Electronic and/or hard copy reports are provided based on client's need. The basic report includes a header containing the CRG sample ID number, date collected, date received, date processed, prepared, date analyzed, client sample information, batch ID number, replicate number, and instrument identification. Electronic data deliverables can be designed to meet any client requests and based upon queries of the LIMS database. The section supervisor prior to release to the client reviews the final report.

9.5 Records Storage - CRG archives all client final reports and instrument files in electronic format (pdf and/or Excel) for a period of 7 years following completion of project. CRG archives all laboratory records including raw data, charts, printouts and data books in hard copy format for a period of 7 years following completion of project.

10.0 INTERNAL QUALITY CONTROL CHECKS

QC measurements verify the integrity of the analytical results. While the goal of all QC procedures remains constant, specific QC procedures vary from method to method. Every analyst is responsible for a thorough understanding of the goals of each QC measurements and the control analyses as required per method.

10.1 A batch is defined as a group of 20 or fewer samples of similar matrix, processed together under the same conditions and with the same

reagents. QC samples are associated with each batch and are used to assess the validity of the sample analyses. Control limits can be found in Table 5a. of this document. Each batch must include the following QC checks:

10.1.1 Method Blank- A method blank is a sample that contains no analytes of interest. For solid matrices, no matrix is used. The method blank serves to measure contamination associated with processing the sample within the laboratory.

10.1.2 Laboratory Control Material (LCM) or Certified Reference Material (CRM)- A LCM or CRM is a sample with a matrix similar to the client samples that contains analytes of interest at known or certified concentrations. It is used to determine the accuracy of the results based on the comparison of the measured concentration with the true value. For analytes that are greater than 10 times the MDL, the acceptable percent recovery is presented in Table 5a.

10.1.3 Duplicate Analyses- Duplicate analyses are samples that have been split and processed within a single batch. They are used to determine the precision of the results based on the percent relative difference (%RSD) between the two sets of results. Control limits for %RSD are presented in Table 5a.

10.1.4 Matrix Spike/Matrix Spike Duplicates (MS/MSD)- MS/MSD are samples of similar matrix to the client's samples that are spiked with a known amount of analyte. Spike recovery measures the effect of interferences caused by the sample matrix and reflects the accuracy of the determination. The spike level should be at least ten times the MDL. The duplicate spike may be used to determine the precision of the analytical results similar to Section 10.1.3.

10.1.5 Tuning Check- The tuning of the mass spectrometer is checked at the beginning of each run to insure that it is providing adequate spectra.

10.1.6 Initial Calibration- Initial calibration is performed by analyzing standards of known levels of concentration. The lowest level should be less than or equal to ten times the MDL and the remaining levels should represent the entire range of expected concentrations in the samples.

10.1.7 Calibration Verification- When a calibration curve is not performed for each run, a calibration verification is performed with a standard from, preferably a second source, is used to verify that the instrument is still operating within the original calibration curve.

10.1.8 Internal Standard- An internal standard is a non-target analyte, which is added to samples and QC checks after the preparation of the sample, just prior to analysis. It is used to compensate for variations in the instrument response from one sample to the next.

10.1.9 Recovery Surrogate- A recovery surrogate is a non-target analyte or analytes that are added to the sample prior to processing. It is used to indicate the extraction efficiency and instrument variation from sample to sample.

11.0 PERFORMANCE AND SYSTEM EVALUATIONS

CRG is dedicated to the continuous improvement of all of its operational systems. This is an essential part of everyone's job within CRG. Internal evaluations are conducted by staff from the Laboratory and are performed on a periodic basis.

11.1 CRG employs the philosophy of Continuous Measurable Improvement systems to evaluate its process performance and to identify opportunities for improvement on a continual basis. Five key elements are essential for the Continuous Measurable Improvement system to work efficiently. The first is to establish open and honest communication among all personnel. The second is to encourage decision making by delegating responsibility to the lowest appropriate levels of the work force. The third is to provide positive recognition for achievements and to strive continuously to identify and strengthen areas needing improvements. The fourth is to provide employees with the knowledge, skills, motivation, and working environment to meet their full potential and find personal satisfaction in their work. The fifth is to accept the concept of change as a positive opportunity for growth for both the individual and the organization.

11.2 With the five key elements of this philosophy in place, all levels of personnel can develop a true quantitative measurement system for assessing the status of meeting target goals in a wide variety of processes (i.e. improved accuracy, precision, training, safety, working environment, etc.). The system begins with a quantitative evaluation of the process based on a review of both historical and current capability and performance. Individual processes are selected as proposed projects based on whether they are in statistical control, predictable, and have attained target goals. CRG then prioritizes the selected projects based on frequency and magnitude of problem recurrence. Root-cause analysis is employed to establish control and eliminate the true sources of problems. Corrective actions are taken and the process is rerun to verify stability,

capability and quality. If necessary, new target goals are set for the process and the system is repeated until the acceptable goal is achieved.

12.0 PREVENTIVE MAINTENANCE

12.1 Service contracts may be maintained for the major instrumentation and equipment that are no longer under warranty. The gas chromatographs, ICPMS instrumentation, ion chromatograph and balances are typical examples of equipment that might be covered by a maintenance contract. Records of maintenance are kept by the person responsible for the equipment. Specific examples of routine preventive maintenance are further discussed in the following sections:

A. Hewlett Packard 5972 Gas Chromatograph/Mass Spectrometer System

1. Every six months, replace the MSD foreline pump oil and foreline trap pellets. During the fluid exchange, replace the outlet mist filter

2. Every year, check and if necessary replace the diffusion pump fluid

3. As needed, clean the ion source of the MSD (typically every six months)

4. As needed, the glass injector sleeve and injector septum for the split-splitless injector is replaced (typically once per month)

5. As needed, the gas purifiers and filters for the carrier gas are replaced

B. Hewlett Packard 4500 ICPMS System

1. Every six months, replace the oil and foreline trap pellets for the rough pumps. During the fluid exchange, replace the outlet mist filter

2. Every year check and replace the turbo molecular pump fluid

3. Once per month, clean the sample and skimmer cones

4. Once per week, replace the peripump tubing

5. As needed, clean the ion source of the mass spectrometer

6. Every three months, clean the nebulizer

13.0 ASSESSMENT OF PRECISION AND ACCURACY

13.1 CRG utilizes several methods to monitor precision and accuracy. These are designed to determine the reproducibility of the analysis (precision) or agreement of the result to the actual value of the analyte (accuracy). CRG routinely performs analysis of blind samples. This procedure is explained in section 14. The following definitions describe the types of analyses performed to assess precision and accuracy:

A. Duplicate analyses involve performing two separate analyses of a particular parameter on the same sample. Precision is measured by the degree of agreement between the two sample results. Duplicate analyses are designed to measure the precision of a determination when the sample contains detectable amounts of the constituent

B. Laboratory control material or certified reference material are samples that have known concentrations of the target analytes. These concentrations are either based on a series of analyses or are certified by an external laboratory such as NIST. Accuracy is determined by comparing the measured amount of analyte recovered during analysis to the known value

C. Sample spikes are samples that a known amount of the analyte has been added. Accuracy is determined by the amount of the added material recovered during analysis

D. Blank spikes or water spikes are used if poor recovery from a spiked sample occurs, analysis of blank spikes is useful to determine if the poor performance is a function of the sample matrix or the analytical process. These consist of the usual sample portion of deionized water spiked with the constituent at a concentration equivalent to that of the sample spike

E. Replicate spike analyses are employed to determine the precision and accuracy of an analysis when some or all of the parameters being determined are below the detection limit. The replicate spike procedure involves analyzing the sample and two portions of the sample spiked with a measured portion of the same analyte. Relative precision of the spikes can be determined as well as the accuracy of the analysis. Spike concentrations are sufficient to

eliminate the bias that would be created by the undetectable quantity of the parameter being determined

13.2 One set of duplicate samples or spike duplicates, a LCM or CRM sample, and a method blank are analyzed with each batch of samples.

13.3 The ongoing evaluation of relative precision and accuracy performance is accomplished by the generation of control charts. Employing a minimum of 20 results, control limits are generated utilizing the mean and standard deviation of the data set. Upper and lower “warning" limits are twice the standard deviation from the mean of the set of results for accuracy charts and twice the standard deviation from the origin for precision charts. Upper and lower "out of control" limits are three times the standard deviation from the mean for accuracy charts and three times the standard deviation from the origin for precision charts. When relative precision or accuracy results suggest atypical performance, an investigation into the problem is initiated. If a sample result is outside the out-of-control limits, the sample is reanalyzed. If samples cannot be reanalyzed, the result is flagged.

14.0 CORRECTIVE ACTIONS AND TRAINING

14.1 Corrective Actions

14.1.1 Corrective action is the process of defining- root-cause, identifying and implementing corrective action plans, educating - and training to provide system-wide solutions, and verifying that the improved system is being followed. Corrective action responses are divided into three separate categories based on the time required to complete the- corrective action. An immediate corrective action occurs when a response that fully meets closure criteria can be carried out in the same time frame that the observation of the discrepancy occurs. An intermediate corrective action is one that will require a maximum of 30 days to complete the response satisfactorily. A long-term corrective action requires a time period greater than 30 days to provide a complete response. Long-term corrective actions typically involve cooperation of additional organizational elements.

14.1.2 Both intermediate and long-term corrective actions require a detailed corrective action plan showing clearly defined milestones, task descriptions, and responsibilities. CRG's QA Specialist must approve all intermediate and long-term corrective action plans. Closure of corrective actions require verifiable, objective evidence that the corrective action be thorough, comprehensive, and will

permanently prevent the problem from reoccurring. Corrective actions result from a wide variety of situations including:

A. Inspection of the sample indicates the: samples are 1) not representative of their source, 2) deteriorated, 3) improperly labeled, 4) damaged in transport, or 5) collected in an inappropriate container. In this case, the CRG Sample Custodian or QA Specialist will notify the sample collector of the- problem(s) and request a new sample(s) to be collected following proper sample collection and handling methods

B. Samples that are not properly preserved, stored at incorrect temperatures, or exhibit deficiencies in the chain of custody records are not analyzed. The CRG Sample Custodian or QA Specialist reviews the discrepancy with appropriate personnel and new samples are collected employing correct methods

C. The required LOPM has not been followed correctly. The supervisor reviews the Method with the analyst and requests the analyst to rerun the analysis, per the method, under the supervisor's direct observation. The analyst repeats the procedure until it is correctly performed. The analyst's performance of the method's protocol and results are evaluated randomly over a minimum of a two week period to ensure adherence to all requirements of the method

D. Instrumentation malfunctions are immediately noted in the instrument logbook and the supervisor is notified. Senior technical staff with specific in-depth knowledge of the particular instrument reviews the problem and attempt to fix the instrument. Major problems may require trained field service personnel from the manufacturer to be brought in to fix the problem. If the projected downtime will extend beyond the samples required holding time, the sample will be either analyzed on another instrument or sent to an approved contract laboratory for analysis

E. When duplicate results, spike recovery results, or QA reference samples are outside their acceptance limits, the supervisor is notified and the complete analytical procedure is reviewed with the analyst. The data entry and calculations are reviewed for transcription errors. Reagents and standards are checked to see if they were properly prepared and whether they are within their shelf life. The equipment is examined for proper performance. The calibration and maintenance record is reviewed to ensure the instrumentation is performing

optimally. The methodology is reviewed to make sure that it is properly applied. Sampling and sample handling protocols are verified to ensure that the sample was collected properly and the recommended preservation and holding times were observed. If the cause of the problem is found, the QA Specialist sends a QA reference sample to the analyst for analysis. If the QA check sample is acceptable, the duplicate or spike analysis is reanalyzed. However, if the same result is obtained in the repeat analysis, the problem is probably due to matrix interference effect. The results of the sample batch are reported with an accompanying explanation of possible matrix interference. If the precision of duplicate spike analyses improves and are in control, the sample batch run with the initial duplicate spike analysis sample is reanalyzed. A different scenario must be followed in circumstances such as insufficient sample or analysis of the sample after the prescribed holding time exists. In these situations, the original result is reported and accompanied by a failure report stating the circumstances that occurred in the initial and repeat analysis. If the results for the QA reference sample are not satisfactory, a team will be formed to identify and correct the problem. The analysis will not be resumed until the system is in control

F. CRG's internal evaluation and corrective action program and external agency audits can result in corrective actions. The response to these evaluation studies requires a written corrective action plan that has been accepted by the QA Specialist. Closure requires objective evidence that the corrective action be thorough, complete, and will permanently solve the problem

G. CRG's Continuous Measurable Improvement program is designed to identify opportunities for improvements systematically. This program leads to specific corrective actions initiated by either a combination of senior technical staff and analysts or a team established to address the specific problem. A quantitative measurement is applied to ensure that the corrective action has had a positive impact on eliminating the problem.

14.2 Training

14.2.1 Educational background- the minimum qualification for conducting analyses in the laboratory is two years of college-level course work in science and two years of related analytical work experience or an

equivalent combination of education and experience. These education and experience requirements provide the analysts with a proper background in the fundamentals of chemistry to assist in understanding the principles behind work that they perform.

14.2.2 Orientation- CRG provides a general orientation to working in an environmental chemistry laboratory. CRG also provides a basic safety orientation, which includes lab coats, specific safety instructions, approved footwear, location of first aid supplies, location of eyewash stations, location of emergency showers, and location of fire extinguishers

14.2.3 Ongoing Training- CRG maintains a technical library of key journals and books for staff's use. Staffs are encouraged to join professional societies, attend conferences, and receive additional training in their technical fields.

14.2.4 Discrete Job Training- CRG Provides:

A. On-the-job training to new analysts or analysts assuming additional responsibilities.

B. Maintains a file for each employee which contains all information relating to the analysts education and training including:

Resume
Certificates from training classes and courses
Completed Training Documentation Forms
Related data

C. The following approach is used for providing staff on-the-job training:

1. Read the appropriate LOPM which details the analytical procedure

2. Review the associated material safety data sheets if you are not knowledgeable of the safety hazards of the reagents used in the analysis

3. Observe the procedure in use by an analyst who is approved for performing this analysis

4. Perform the analysis under the direct supervision of a qualified analyst who will certify the successful completion of training

5. Demonstrate proficiency using the method by analyzing blind check samples

6. Document the successful completion of your training using the following Training Documentation Form:

CRG Marine Laboratories, Inc.
2020 Del Amo Boulevard, Suite 2020
Torrance, California 90501-1206

TRAINING DOCUMENTATION FORM

EMPLOYEE NAME _____

METHOD NUMBER	DATE COMPLETED	CERTIFIED BY
COMMENTS:		

15.0 QA REPORTS

Numerical results of QC analyses are delivered as part of the analytical report package. Reports that discuss corrective actions, Quality accomplishments, control charts, and ad-hoc inquiries are generated internally on a regular basis and made available to clients upon request.

Appendix H

Field Data Sheets
Chains of Custody

Prepared by
Aquatic Bioassay & Consulting Laboratories

From:	Aquatic Bioassay and Consulting Labs. 29 N. Olive St. Ventura, CA 93001	**Phone:** **Fax:** **Project ID:**	(805) 643-5621 (805) 643-2930 **VCWPD** **Fall 05**	**To:**	**Company:** Kim Kratz **Address:** 17114 Tualatin St. Lake Oswego, OR 97035 **Phone:** **503 231 2155**

						ANALYSIS									
Sample I.D. No.	**Sample Date**	**Time**	**Matrix**	**Volume/ No.**	**Reps**	**Annelids**	**Misc. Arthropods**	**Insects**	**Ostracods**	**Mollusca**	**Other Phyla**	**Unusual Animals***	**Remnants**		

Special Instructions: *Animal found in grids that were not sorted. Animals should not be counted in final data set.

RELINQUISHED BY: DATE: TIME:	RECEIVED BY: DATE: TIME:	RELINQUISHED BY: DATE: TIME:	RECEIVED BY: DATE: TIME:

Figure E-1. Example chain of custody.

Aquatic Bioassay & Consulting Laboratories
Field Data Sheets and Chain of Custody

Watershed/Stream: _____ **Station ID:** _____

Client: _____ **Date/Time:** _____

Sampling Crew: _____ **Site Description:** _____

Elevation/Ecoregion: _____ _____

☐ **High Gradient** ☐ **Low Gradient** **% Gradient:**_____ **Reach Length (feet):** _____ **Physical Habitat Quality Score:** _____

Water Quality

Water Temperature (°C): _____
Specific Conductance (µS/cm): _____
Dissolved Oxygen (ppm): _____
pH: _____

Low Gradient Streams (%)

Hard Substrate[1] _____ Submerged Vegetation _____
Soft Substrate[2] _____ Stream Bank Vegetation _____
Woody Debris _____

Transect #	Transect Location (ft)	Latitude (Degrees and Decimal Minutes)	Longitude (Degree Decimal Minutes)	Datum	Velocity (ft-m/sec)	Substrate Consolidation	Avg. Riffle Length (ft)[3]	Avg. Riffle Width (ft)	Avg. Depth (cm)	Comments
1										
2										
3										

			Substrate Composition					Densiometer				
Transect #	Substrate Complexity	Embed-dedness	Fines (<0.1")	Gravel (0.1-2")	Cobble (2-10")	Boulder (>10")	Bedrock (solid)	Upstream	Left Bank[4]	Down-stream	Right Bank[4]	% Canopy Cover[5]
1												
2												
3												

Comments: _____

1. Hard substrate of natural rock or cement. 2. Soft substrate of sand or mud. 3. High gradient streams only. Average length for low gradient streams=6 ft.
4. To determine left and right bank, always face downstream. 5. % Canopy Cover: 17 square, # coverecd

Figure E-2. Bioassessment field data sheet.

Project ID: _____ **Vessel:** _____

Station: _____ Date: _____ Arrive Time: _____ Depart Time: _____ Depth (m): _____

* Latitude: _____

* Longitude: _____

Weather (Chk One)
☐ Clear ☐ Rain
☐ Overcast ☐ Drizzle
☐ Prtly Cldy ☐ Fog
☐ Thunderstorm

Sea State (Chk One)
☐ Calm
☐ Choppy
☐ Rough

Van Veen Type
☐ Single Van Veen
☐ Tandem Van Veen

Visibility (km): _____ Wind Spd (Kts): _____ Wind Dir[1]: _____ Station Fail Code[2]: _____

Swell Ht (ft): _____ Swell Dir[1]: _____ Period (sec): _____ Water Color[3]: _____ Turbidity: _____

Comments: Crew:

Grab No. (rep) / Time	Grab Fail Code[4]	Volume (L)	Sediment Comp[5]	Surface Color[6]	Subsurface Color[6]	Sediment Odor[7]	Odor Strength[8]	Sample Type: Infauna	Sed Chem	Grain Size	Sed Tox	Sample In Relaxant (time)	Sample In Formalin (time)
1								☐	☐	☐	☐		
2								☐	☐	☐	☐		
3								☐	☐	☐	☐		
4								☐	☐	☐	☐		
5								☐	☐	☐	☐		
6								☐	☐	☐	☐		
7								☐	☐	☐	☐		
8								☐	☐	☐	☐		

[1] Direction in compass headings: N, S, E, W, NE, NW, SE, SW
[2] Station Failure List: rocky bottom, kelp bed, reef, obstructions, <3m (bay), <6m (ocean), >120m
[3] Water Color: Blue, Green, Blue-Green, Brown, Red Tide (note strength)
[4] Grab Failure Codes: A = canted, B = washed out, C = poor closure, D = disturbed surface, E = <5cm
[5] Sediment Composition: coarse sand, fine sand, silt/clay, cobble, gravel, mixed (include shell hash if appr.)
[6] Sediment Color: brown, black, gray, olive green, red
[7] Sediment odor: none, petroleum, hydrogen sulfide, other
[8] Odor Strength: weak, moderate, strong
* If subsequent grab positions differ form the position above, record those on back of page.

Figure E-3. Estuary sediment field data sheet.