Quality Assurance Project Plan

CITY OF SANTEE
RIVERS AND CREEKS STUDY

May 13, 2010

PREPARED FOR:

CITY OF SANTEE
DEPARTMENT OF DEVELOPMENT SERVICES
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PREPARED BY:

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1. APPROVAL SIGNATURES

Title:	Name:	Signature:	Date:
Project Manager	Helen Perry		
D-MAX Project Manager	Arsalan Dadkhah		

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3. DISTRIBUTION LIST

Title:	Name (Affiliation):	Tel. No.:	QAPP No:
Project Manager	Helen Perry (City of Santee)	(619) 258-4100 x177	1
D-MAX Project Manager	Arsalan Dadkhah (D-MAX Engineering, Inc.)	(858) 586-6600	1

4. PROJECT/TASK ORGANIZATION

4.1 Involved Parties and Roles.

Table 1. (Element 4) Personnel Responsibilities.

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address.)
Helen Perry	City of Santee	Project Manager	(619) 258-4100 x177 *hperry@ci.santee.ca.us*
Arsalan Dadkhah	D-MAX Engineering, Inc.	D-MAX Project Manager	(858) 586-6600 *arsalan@dmaxinc.com*
John Quenzer	D-MAX Engineering, Inc.	QA Program Manager	(858) 586-6600 *jquenzer@dmaxinc.com*
Manouchehr Dadkhah	D-MAX Engineering, Inc.	Senior Scientist	(858) 586-6600 *manouchehr@dmaxinc.com*
Jennifer Beyer	EnviroMatrix Analytical, Inc.	QA Director	(858) 560-7717 *jbeyer@enviromatrixinc.com*

4.2 Quality Assurance Officer Role

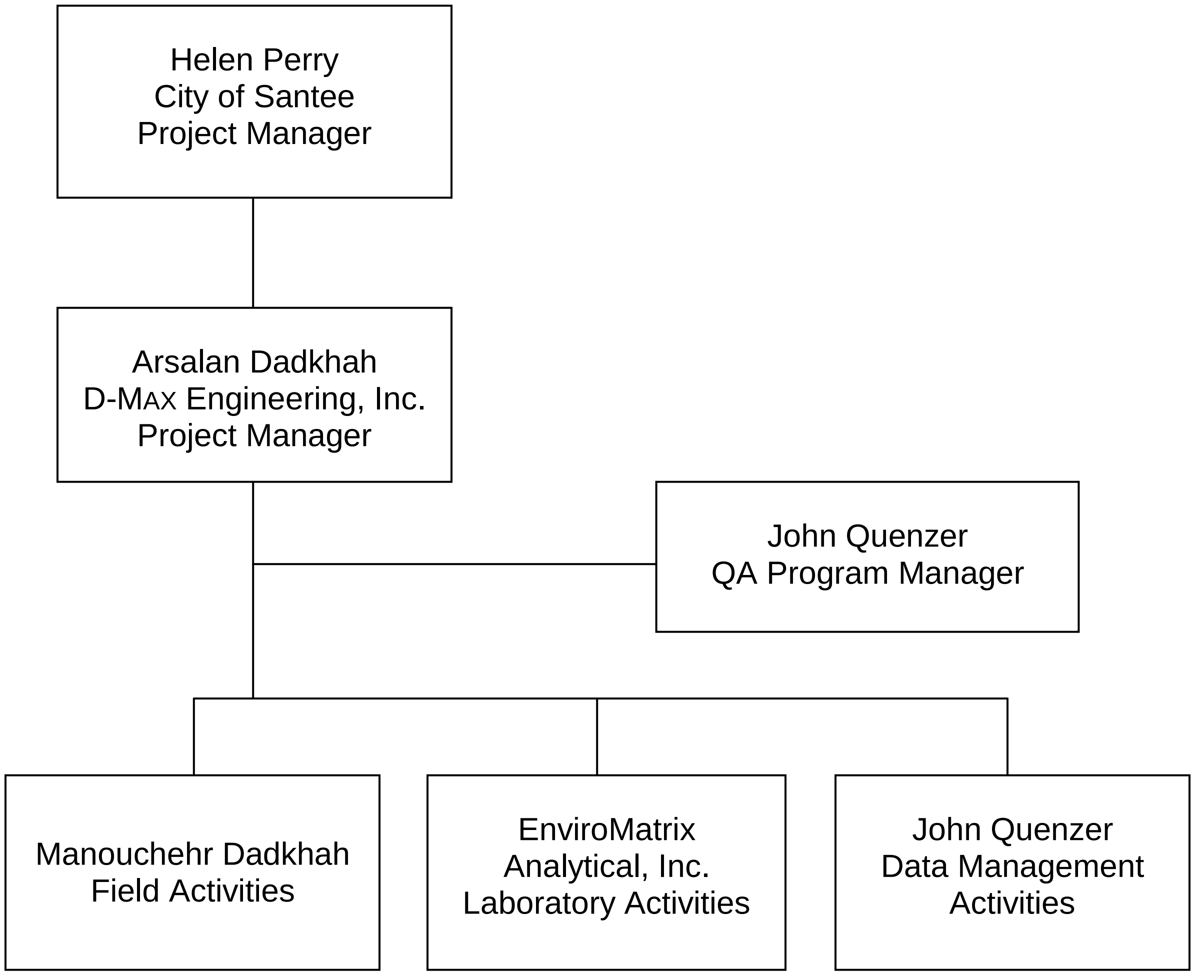
The City of Santee Storm Water Program Manager, Helen Perry, will fill the role of both Project Manager and Project QA Officer. Arsalan Dadkhah is D-Max's Project Manager. John Quenzer is D-Max's sampling and analysis Quality Assurance Manager. This role will include establishing the quality assurance and quality control procedures found in this QAPP as part of the sampling, field analysis, and in-house analysis procedures. Mr. Quenzer will also work with Jennifer Beyer, the Quality Assurance Director for EnviroMatrix Analytical, Inc., by communicating all quality assurance and quality control issues contained in this QAPP to EnviroMatrix. Dr. Dadkhah, in conjunction with Ms. Perry, will also review and assess all procedures during the life of the contract against QAPP requirements.

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 City's Project Manager.

4.4 Organizational Chart and Responsibilities

Figure 1. Organizational Chart.



5. PROBLEM DEFINITION/BACKGROUND

5.1 Problem Statement.

The City of Santee (City) is located entirely within the San Diego River Watershed, Hydrologic Unit (HU) 907. The largest receiving waterbody in the City is the San Diego River, which enters the City in the east and flows west towards the Pacific Ocean. Other major receiving waterbodies include Forester Creek and Sycamore Creek, both of which eventually drain to the San Diego River. Forester Creek enters the City from the southeast and drains into the San Diego River at a location west of Carlton Hills Boulevard. Sycamore Creek enters the City from the north, flows southward, entering the San Diego River just west of Santee Recreation Lakes. All storm water drainage in the City of Santee is routed either directly or indirectly to these creeks and ultimately to the San Diego River.

5.2 Decisions or Outcomes.

The objective of this study is to evaluate water quality in the San Diego River, Forester Creek, and Sycamore Creek, and to assess any change in water quality as they flow through urbanized areas of the City. The City has conducted a study of its receiving water bodies twice each year since 2002 to establish a baseline historical data set against which to compare future monitoring results to help comply with total maximum daily loads and other applicable requirements.

5.3 Water Quality or Regulatory Criteria.

This monitoring is not performed in response to any specific regulatory requirement. However, water samples taken from these receiving waterbodies will be compared to the pertinent water quality objectives (WQO), as listed in the Water Quality Control Plan for the San Diego Basin 9 (Basin Plan).

6. PROJECT/TASK DESCRIPTION

6.1 Work Statement and Produced Products.

The project will perform two rounds of monitoring at five river and creek sites, annually during the dry season. The monitoring sites represent the water quality in the San Diego River, Forester Creek, and Sycamore Creek as they flow through urbanized areas of the City. The five monitoring sites selected for this project are described below.

- Forester Creek, Upstream: located beneath the Prospect Avenue bridge, west of Cuyamaca Street.
- Forester Creek, Downstream: located approximately 200 feet north of the Mission Gorge Road and Fanita Drive intersection, east of Fanita Creek.
- San Diego River, Downstream: located beneath the West Hills Parkway bridge.
- San Diego River, Upstream: located approximately 200 feet downstream of the rock dam at the east end of the RCP service road.
- Sycamore Creek, Downstream: located beneath the Carlton Oaks Drive bridge, west of the Santee Recreation Lakes.

A report documenting monitoring results will be provided for the two rounds of monitoring conducted each dry season.

6.2. Constituents to Be Monitored and Measurement Techniques.

Field screening techniques consist of qualitative field observations, flow measurement, and quantitative field analyses of selected water quality parameters. Weather conditions and time since last rainfall are recorded as well. Qualitative field observations include a general site assessment and description of water odor, clarity, the presence of floatable materials, visible deposits or stains, and organisms. Flow measurements can be used to estimate pollutant mass loading. The field method used to estimate the flow rate in this study will consist of measuring the velocity, depth, and width of the flowing water, where feasible.

The field water quality constituents to be analyzed at each site are as follows.

- Temperature
- pH
- Specific conductance
- Dissolved oxygen

Samples collected in sterile bottles will be transported to EnviroMatrix Analytical, Inc., a laboratory certified by the California Department of Health Services, for the following laboratory analyses.

- Nitrate/nitrite as N
- Total Kjeldahl nitrogen
- Total nitrogen
- Orthophosphate as P
- Total phosphorus
- Total dissolved solids (TDS)
- Total selenium
- *Enterococcus* bacteria
- Total coliform bacteria
- Fecal coliform bacteria
- Sulfate

Additionally, samples may be taken for toxicity laboratory analyses for acute or chronic bioassays using test organisms *Hyalella azteca*, *Ceriodaphnia dubia*, and/or *Selenastrum capricornutum*.

6.3 Project Schedule

Note that the project timeline, as shown in Table 2 below, is general and is subject to change each year, based on work scheduling constraints.

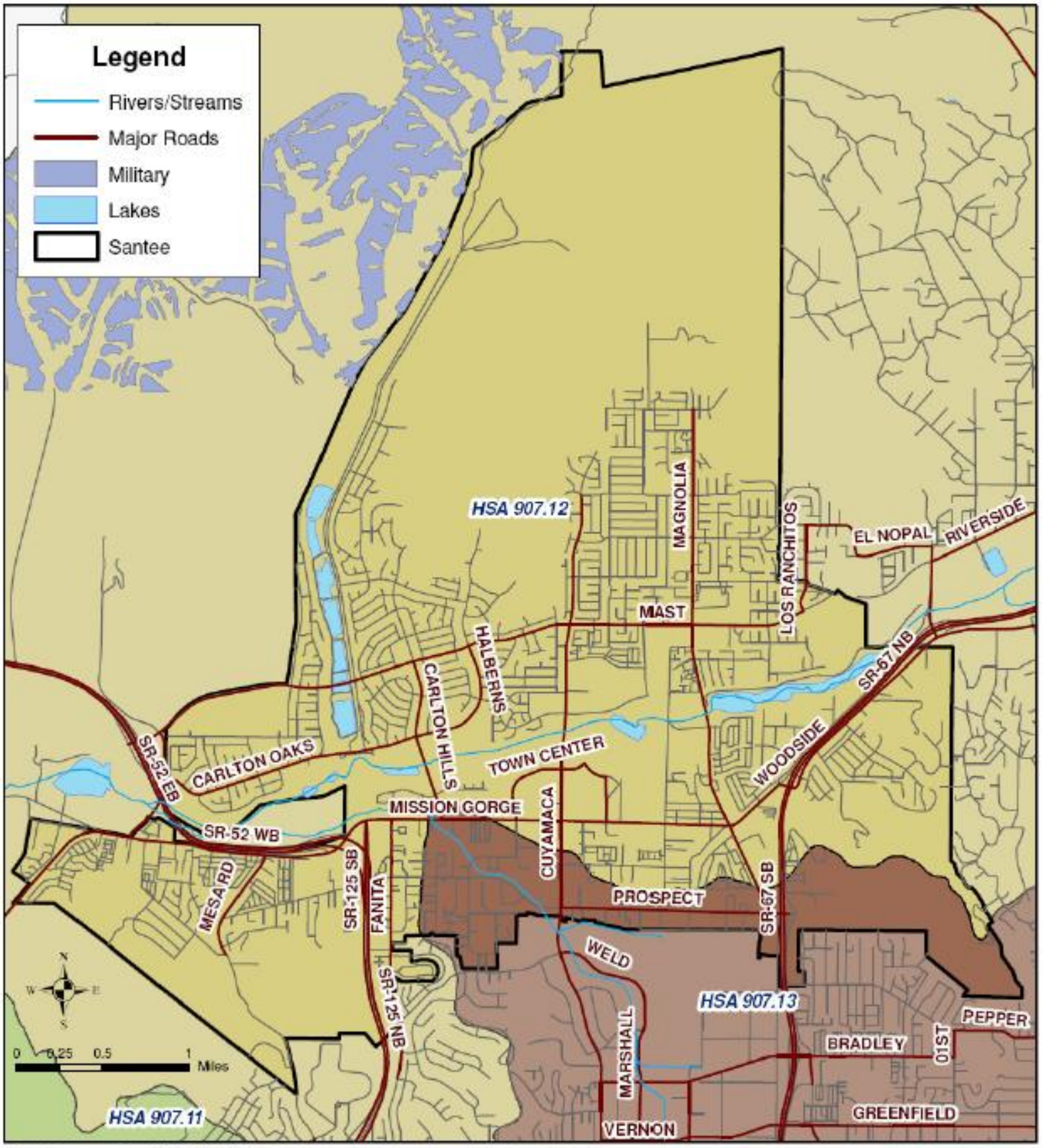
Table 2. (Element 6) Project Schedule Timeline.

Activity	Date		Deliverable	Deliverable Due Date
	Anticipated Date of Initiation	Anticipated Date of Completion		
Annual Monitoring, Round 1	May 1	May 31	Table of Test Results	June 30---
Annual Monitoring, Round 2	September 1	September 30	River and Creek Study Report	November 30

6.4 Geographical Setting

The City of Santee is located entirely within the San Diego River Watershed, Hydrologic Unit (HU) 907. The largest receiving waterbody in the City is the San Diego River, which enters the City in the east and flows west towards the Pacific Ocean. Other major receiving waterbodies include Forester Creek and Sycamore Creek, both of which eventually drain to the San Diego River. Forester Creek enters the City from the southeast and drains into the San Diego River at a location west of Carlton Hills Boulevard. Sycamore Creek enters the City from the north, flows southward, entering the San Diego River just west of Santee Recreation Lakes. All storm water drainage in the City of Santee is routed either directly or indirectly to these creeks and ultimately to the San Diego River. The entire City of Santee, along with the whole of the City of El Cajon and portions of the cities of La Mesa, San Diego, and Poway, lie within the Lower San Diego River Hydrologic Area (HA) 907.1. See Figure 2 for a map of the watersheds and hydrologic subareas for the City of Santee. Figure 3 shows the locations of the monitoring sites for this project.

Figure 2. Watershed Map of the City of Santee Showing Hydrologic Subareas



Data Sources: SanGIS, SANDAG

7. Quality Objectives and Criteria for Measurement Data

7.1 Data Quality Indicators

Measurement or Analyses Type	Applicable Data Quality Indicators
Field Measurement, Conventional Analytes in Water	*Precision, Accuracy, Representativeness, Completeness*
Laboratory Analysis, Conventional Analytes in Water	*Precision, Accuracy, Representativeness, Completeness, Sensitivity*
Laboratory Analysis, Conventional Analytes in Water – Pathogens	*Precision, Accuracy, Representativeness, Completeness, Sensitivity*
Toxicity Testing (General)	*Precision, Accuracy, Representativeness, Completeness, Comparability, Sensitivity*

In depth information about the laboratory assessments and controls for each data quality indicator are available in the QA/QC plan at EnviroMatrix Analytical upon request.

Precision is the degree of agreement among repeated measurements of the same characteristic. For field measurements, one duplicate will be performed to accompany the routine measurements each year, which will be greater than 5% of the total project sample count.

Accuracy measures how close results are to a true or expected value. All instruments will be calibrated according to manufacturer instructions.

Representativeness is the extent to which measurements actually represent the true condition at the time of sample collection. Field measurements will be taken at the centroid of the receiving waterbody, where turbulence and mixing is greatest, to maximize representativeness of water quality at that segment of river or creek. If the center of the waterbody is too far from the shoreline to reach without immersion, the sample will be taken at the narrowest and most quickly moving part of the waterbody in the vicinity of the sampling location.

Completeness is the difference between the planned amount of samples and data and the actual amount collected.

Comparability is the extent to which data can be compared between periods of time within the project or between projects. To ensure comparability within and between years, the monitoring will use the standardized sampling methods, analytical methods, units of reporting, and sampling site selection described in this document.

Sensitivity is the capability of a method or instrument to discriminate between different levels of the variable of interest. Method sensitivity is dealt with by the inclusion of the required SWAMP Target Reporting Limits, where such values exist.

EnviroMatrix Analytical, Inc. will retain all quality assurance and quality control records for laboratory analyses. D-MAX Engineering, Inc. will retain all quality assurance and quality control records for field measurements, including field duplicates of laboratory analyses.

7.2 Field and Laboratory Measurement Quality Objectives Tables

Table 3. (Element 7) Measurement Quality Objectives for Field Data.

Group	Parameter	Units	Resolution	Target Reporting Limit	Accuracy
Field Measurement, Conventional Analytes in Water	Dissolved Oxygen	mg/L	0.1	0.2	± 1.5 % of range
Field Measurement, Conventional Analytes in Water	Temperature	°C	0.1	No SWAMP requirement; will use 0.1	± 0.5 °C
Field Measurement, Conventional Analytes in Water	Specific Conductivity	µS/cm	1	2	± 2% of functional sensitivity 1% & 2% of range
Field Measurement, Conventional Analytes in Water	pH	None	0.1	No SWAMP requirement; will use 0.01	± 0.01 pH
Field Measurement	Depth	m	0.01	0.02 m	N/A
Field Measurement	Velocity	ft/s	0.05	0.3 ft/s	N/A

Note: Values in this table are based on SWAMP QAPrP 2008. Field method SOPs are available in Appendix A.

Table 4. (Element 7) Measurement Quality Objectives for Laboratory Data.

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Laboratory Analysis, Conventional Analytes in Water	Nitrate/nitrite as N	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 80% - 120%	0.05mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Total Kjeldahl nitrogen	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 80% - 120%	0.5 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Total nitrogen	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	N/A	0.5 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Orthophosphate as P	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 80% - 120%	0.05 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Total phosphorus	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 80% - 120%	0.05 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Total dissolved solids (TDS)	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	N/A	20 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water	Total selenium	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 75% - 125%	0.5 µg/L	90%

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Laboratory Analysis, Conventional Analytes in Water	Sulfate	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material	Laboratory duplicate 20% RPD.	Matrix spike 80% - 120%	5.0 mg/L	90%
Laboratory Analysis, Conventional Analytes in Water, Pathogens	*Enterococcus* bacteria	Positive results for target organisms. Negative results for non-target organisms	N/A	N/A	2 MPN/100mL	90%
Laboratory Analysis, Conventional Analytes in Water, Pathogens	Total coliform bacteria	Positive results for target organisms. Negative results for non-target organisms	N/A	N/A	2 MPN/100mL	90%
Laboratory Analysis, Conventional Analytes in Water, Pathogens	Fecal coliform bacteria	Positive results for target organisms. Negative results for non-target organisms	N/A	N/A	2 MPN/100mL	90%
Toxicity Testing (General)	Acute toxicity, *Hyalella* 96 hour	Negative controls	N/A	N/A	1	90%
Toxicity Testing (General)	Acute toxicity, *Ceriodaphnia* 96 hour	Negative controls	N/A	N/A	1	90%
Toxicity Testing (General)	Chronic toxicity, 3 species	Negative controls	N/A	N/A	1	90%

8. SPECIAL TRAINING NEEDS/CERTIFICATION

8.1 Specialized Training or Certifications.

There is no specialized training required for water quality monitoring or photo documentation. All sampling will be performed by D-Max personnel who are trained in sample collection, handling, storage, and chain of custody procedures, as discussed in Element 12 of this document. All field personnel are trained or provided with refresher training in proper field sampling and sample handling sampling methods each year prior to the sampling season.

All laboratory analysis will be conducted by EnviroMatrix Analytical, Inc. EnviroMatrix is a certified laboratory by the Environmental Laboratory Accreditation Program (ELAP #2564) through the California Department of Public Health (formerly the Department of Health Services, or DOHS). Details of EnviroMatrix training is discussed in Section 4 of the Lab QA/QC, available from the laboratory upon request.

8.2 Training and Certification Documentation.

There is no specialized training needed for this project. Documentation of field personnel training is maintained at D-MAX Engineering, Inc. Documentation of laboratory certification can be found in the EnviroMatrix QA/QC plan, available from the laboratory upon request.

8.3 Training Personnel.

There are no training personnel applicable to this project.

Table 5. (Element 8) Specialized Personnel Training or Certification.

Specialized Training Course Title or Description	Training Provider	Personnel Receiving Training/ Organizational Affiliation	Location of Records & Certificates
Laboratory certification	California DOHS	EnviroMatrix Analytical, Inc.	Lab QA/QC document

9. DOCUMENTS AND RECORDS

D-MAX Engineering will maintain all records for the field collection and analyses. Samples sent to EnviroMatrix are accompanied by a chain of custody (COC) form. EnviroMatrix generates records for sample receipt and storage, analyses, and reporting. The results of the laboratory analyses are transmitted to D-MAX in electronic form.

D-MAX will record all of the sampling data in an electronic database compatible with the SWAMP information management standards. Laboratory analytical reports will also be saved electronically as pdf files. All field and laboratory electronic files will be backed up within the D-MAX server continuously. A compact disc of each year's data will be produced and included with the hard copy of each year's written program report, which is described below.

A report of collected monitoring data will be submitted to the City of Santee annually. Records of field test results and observations, laboratory analytical reports, sampling locations and GPS coordinates, and photographs of sampling locations will be provided to the City. Electronic and hard copies of this information will be available.

Table 6. (Element 9) Document and Record Retention, Archival, and Disposition Information.

	Identify Type Needed	Retention	Archival	Disposition
Sample Collection Records	Field data sheets	Paper	Paper file	5 years
	Chain of custody forms	Paper, Electronic (.pdf)	Paper file, Hard disk / compact disc	5 years
Field Records	Field data sheets	Paper	Paper file	5 years
	Site photographs	Electronic (.jpg)	Hard disk / compact disc	5 years
Analytical Records	Laboratory reports	Electronic (.pdf)	Hard disk / compact disc	5 years
	Chain of custody forms	Electronic (.pdf)	Hard disk / compact disc	5 years
Data Records	Analytical data	Electronic (.mdb or .xls)	Hard disk	5 years
	Field data sheets	Electronic (.pdf)	Hard disk / compact disc	5 years
Assessment Records	Calibration log sheets	Paper	Paper file	5 years
Data Analysis & Reports	Analysis of data	Electronic	Hard disk	5 years
	Monitoring reports	Electronic (.pdf)	Hard disk / compact disc	5 years
	Monitoring reports	Paper	Bound report	5 years

GROUP B: DATA GENERATION AND ACQUISITION

10. SAMPLING PROCESS DESIGN

This study consists of monitoring conducted at five sites representing three receiving waterbodies in the City of Santee. Monitoring is conducted in two rounds each dry season, which runs from May 1 to September 30 each year. Monitoring sites have been selected to evaluate the water quality where water (1) enters the City at the most upstream locations of the San Diego River and Forester Creek; (2) flows within the tributaries Sycamore Creek and Forester Creek at the most downstream location before they flow into the San Diego River; and (3) leaves the City via the San Diego River at the City's jurisdictional boundary.

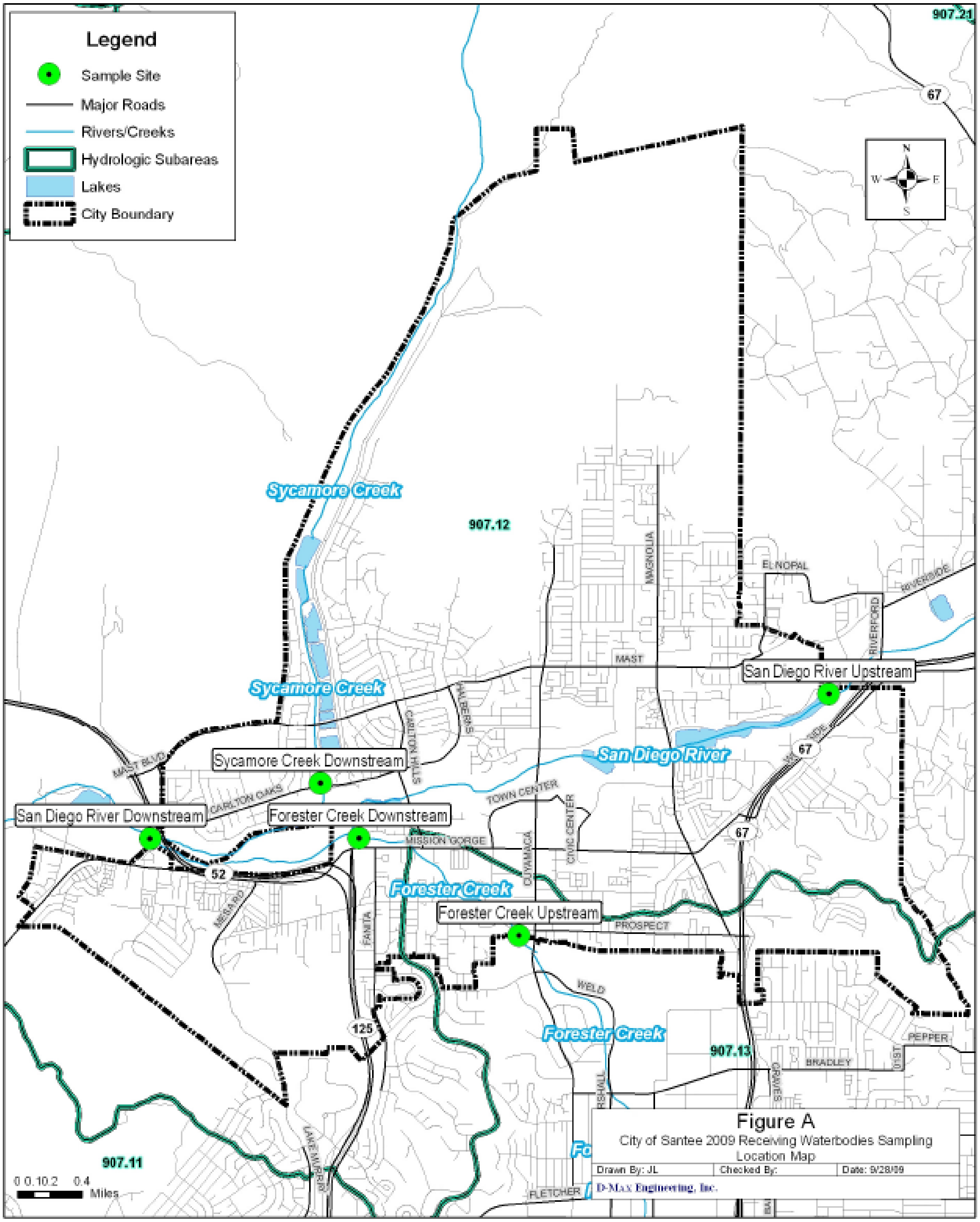
The five monitoring sites selected for this study are described below.

- Forester Creek, Upstream: located beneath the Prospect Avenue bridge, west of Cuyamaca Street.
- Forester Creek, Downstream: located approximately 200 feet north of the Mission Gorge Road and Fanita Drive intersection, east of Fanita Creek.
- San Diego River, Downstream: located beneath the West Hills Parkway bridge.
- San Diego River, Upstream: located approximately 200 feet downstream of the rock dam at the east end of the RCP service road.
- Sycamore Creek, Downstream: located beneath the Carlton Oaks Drive bridge, west of the Santee Recreation Lakes.

At each site, all field and laboratory analyses will be performed once per round of monitoring. If for some reason a specific site is inaccessible during the desired monitoring period, a sample will be taken from the nearest accessible point upstream. See Figure 3, below, for a map of the receiving waterbodies and monitoring sites.

Field method SOPs, available in Appendix A, are based on *Standard Operating Procedures (SOPs) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in SWAMP* (2007), SOP Procedure Number 1.0.

Figure 3. Receiving Waterbodies and Monitoring Locations Map



Data Sources: SanGIS, SANDAG, City of Santee

11. SAMPLING METHODS

Field method SOPs, available in Appendix A, are based on *Standard Operating Procedures (SOPs) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in SWAMP* (2007), SOP Procedure Number 1.0.

At each site, measurements of flow, pH, temperature, specific conductance, and dissolved oxygen are performed. These measurements will be taken in-situ, where feasible, otherwise a clean sample container, rinsed with distilled water and sample water, will be used. In addition, grab samples will be collected for laboratory analysis for the analytes described in Table 7 below.

When collecting water samples, field personnel will wear clean latex gloves to protect themselves and to prevent contamination of the samples. Samples will be taken by direct collection into the sample container by field personnel. Samples will be collected by manual grab sampling at an approximate depth of six inches below the water surface, pointing the bottle opening upstream, and avoiding floating debris. If stream disturbance or wading is necessary, the sample will be taken upstream of the disturbance. A clean syringe may also be used to collect water in very low flow or in ponded water.

Samples for laboratory analysis are stored in an ice cooler at ≤ 4 °C, in appropriate sample containers with appropriate preservatives. All samples are to be transported to the laboratory within the specified holding times.

Field data sheets (Appendix B) are completed for each site visit. The empirical observations of the site and water quality characteristics include: meteorological conditions at the time of sampling; odor, water clarity, presence of floatable matter, visible deposits/ stains and biological status. Each site is also photographed annually to document any alterations in site conditions.

Table 7, below, lists the analytical parameters assessed to represent water quality per year. Water samples at all sites are analyzed for all of the listed parameters. If any of the samples cannot be taken or analyses cannot be performed for any reason, the QA/QC Officer will be notified. Any appropriate corrective actions will be documented.

Table 7. (Element 11) Sampling Locations and Sampling Methods.

Analytical Parameter	# Samples (with field duplicates)	Analytical Method	Sample Volume	Container size and type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ analysis
pH	11	Analyzed in Field	N/A	N/A	N/A	N/A
Temperature	11	Analyzed in Field	N/A	N/A	N/A	N/A
Specific conductance	11	Analyzed in Field	N/A	N/A	N/A	N/A
Dissolved oxygen	11	Analyzed in Field	N/A	N/A	N/A	N/A
Nitrate/Nitrite as N	11	SM4500 NO3 E	150 mL	Polyethylene Bottles	Cool to 4 °C and store in the dark. Acidify with H2SO4 to pH<2	48 hours or 28 days if acidified
TKN	11	SM4500 N C	600 mL	Polyethylene Bottles	Cool to 4 °C and store in the dark. Acidify with H2SO4 to pH<2	7 days or 28 days if acidified

Analytical Parameter	# Samples (with field duplicates)	Analytical Method	Sample Volume	Container size and type	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ analysis
Total Nitrogen	11	Calculation	N/A	N/A	N/A	N/A
Orthophosphate as P	11	SM4500 P E	150 mL	Polyethylene Bottles	Filter; Cool to 4 °C and store in the dark	48 hours
Total Phosphorus as P	11	SM4500 P B, E	150 mL	Polyethylene Bottles	Cool to 4 °C and store in the dark	48 hours
Total Dissolved Solids	11	SM2540 C	1000 mL	Polyethylene Bottles	Cool to 4 °C and store in the dark	7 days
Selenium, Total	11	EPA 200.8	60 mL	60-mL acid-cleaned polyethylene bottle	Cool to 4 °C in the dark; Acidify to pH<2 with pre-tested HNO_3 within 48 hours	6 months at room temperature following acidification
Sulfate	11	SM4500 SO4 E	300 mL	Polyethylene Bottles	Cool to 4 °C and store in the dark	28 days
Enterococcus	11	SM9230 A, B	100 mL	125 mL sterile plastic (high density polyethylene or polypropylene) container	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Total Coliform	11	SM9221 B, E	100 mL	125 mL sterile plastic (high density polyethylene or polypropylene) container	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Fecal Coliform	11	SM9221 B, E	100 mL	125 mL sterile plastic (high density polyethylene or polypropylene) container	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Acute toxicity, Hyalella 96 hour bioassay	Optional	EPA-821-R-02-012	1 gal	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	Cool to 4 °C and store in the dark	24 hours
Acute toxicity, Ceriodaphnia 96 hour bioassay	Optional	EPA-821-R-02-012	1 gal	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	Cool to 4 °C and store in the dark	24 hours
Chronic toxicity, 3 species bioassays	Optional	EPA-821-R-02-013	5 gal	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	Cool to 4 °C and store in the dark	24 hours

12. SAMPLE HANDLING AND CUSTODY

The grab samples collected during monitoring events are labeled with site location, date, sample time, analysis to be performed, sample preservation (if any) and field sampler's name. For each site visit, the time, date, site, and event type are recorded on a field data sheet. Sample bottles are stored and transported at ≤ 4 °C in an ice cooler until processed. Samples are delivered to EnviroMatrix Analytical, Inc. within specific holding times (Table 8, below).

An example chain of custody form is attached in Appendix C.

Table 8. (Element 12) Sample Handling and Custody.

Analytical Parameter	Container size and type	Sample Volume	Preservation (chemical, temperature, light protected)	Maximum Holding Time: Preparation/ analysis
Nitrate/Nitrite as N	Polyethylene Bottles	150 mL	Cool to 4 °C and store in the dark. Acidify with H2SO4 to pH<2	48 hours or 28 days if acidified
TKN	Polyethylene Bottles	600 mL	Cool to 4 °C and store in the dark. Acidify with H2SO4 to pH<2	7 days or 28 days if acidified
Total Nitrogen	N/A	N/A	N/A	N/A
Orthophosphate as P	Polyethylene Bottles	150 mL	Filter; Cool to 4 °C and store in the dark	48 hours
Total Phosphorus as P	Polyethylene Bottles	150 mL	Cool to 4 °C and store in the dark	48 hours
Total Dissolved Solids	Polyethylene Bottles	1000 mL	Cool to 4 °C and store in the dark	7 days
Selenium, Total	60-mL acid-cleaned polyethylene bottle	60 mL	Cool to 4 °C in the dark; Acidify to pH<2 with pre-tested HNO_3 within 48 hours	6 months at room temperature following acidification
Sulfate	Polyethylene Bottles	300 mL	Cool to 4 °C and store in the dark	28 days
Enterococcus	125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Total Coliform	125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Fecal Coliform	125 mL sterile plastic (high density polyethylene or polypropylene) container	100 mL	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4 °C in the dark.	6 hours
Acute toxicity, Hyalella 96 hour bioassay	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	1 gal	Cool to 4 °C and store in the dark	24 hours
Acute toxicity, Ceriodaphnia 96 hour bioassay	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	1 gal	Cool to 4 °C and store in the dark	24 hours
Chronic toxicity, 3 species bioassays	1 gal polyethylene bag in cardboard box (e.g., Cubitainer)	5 gal	Cool to 4 °C and store in the dark	24 hours

13. Analytical Methods

Field and laboratory analytical methods are given below in tables 9 and 10, respectively. The standard operating procedures for the field methods can be found in Appendix A. Laboratory analyses are performed in accordance with the approved method number listed.

Table 9. (Element 13) Field Analytical Methods.

Analyte	Laboratory / Organization	Analytical Method / SOP	Reporting Limit	Units
pH	Field monitoring by D-Max Engineering staff	Hanna Instruments HI 991301 Portable pH/EC/TDS/Temperature Meter	0.01	pH units
Specific Conductance	Field monitoring by D-Max Engineering staff	Hanna Instruments HI 991301 Portable pH/EC/TDS/Temperature Meter	0.01	mS/cm
Temperature	Field monitoring by D-Max Engineering staff	Hanna Instruments HI 991301 Portable pH/EC/TDS/Temperature Meter	0.1	°C
Dissolved Oxygen	Field monitoring by D-Max Engineering staff	Hanna Instruments HI 9145 Portable Dissolved Oxygen Meter	0.00	mg/L

Table 10. (Element 13) Laboratory Analytical Methods.

Analyte	Laboratory / Organization	Analytical Method / SOP	Minimum Detection Limit	Reporting Limit	Units
Nitrate/Nitrite as N	EnviroMatrix Analytical, Inc.	*SM4500 NO3 E	0.009	0.05	mg/L
TKN	EnviroMatrix Analytical, Inc.	*SM4500 N C	0.299	0.5	mg/L
Total Nitrogen	EnviroMatrix Analytical, Inc.	Calculation	0.5	0.5	mg/L
Orthophosphate as P	EnviroMatrix Analytical, Inc.	*SM4500 P E	0.007	0.05	mg/L
Total Phosphorus as P	EnviroMatrix Analytical, Inc.	*SM4500 P B, E	0.02	0.05	mg/L
Total Dissolved Solids	EnviroMatrix Analytical, Inc.	*SM2540 C	1.0	20	mg/L
Selenium, Total	EnviroMatrix Analytical, Inc.	EPA 200.8	0.02	0.5	µg/L
Sulfate	EnviroMatrix Analytical, Inc.	*SM4500 SO4 E	1.0	5.0	mg/L
Enterococcus	EnviroMatrix Analytical, Inc.	*SM9230 A, B	2	2	MPN/100 mL
Total Coliform	EnviroMatrix Analytical, Inc.	*SM9221 B, E	2	2	MPN/100 mL
Fecal Coliform	EnviroMatrix Analytical, Inc.	*SM9221 B, E	2	2	MPN/100 mL
Acute toxicity, Hyalella 96 hour bioassay	EnviroMatrix Analytical, Inc.	EPA-821-R-02-012	N/A	N/A	%
Acute toxicity, Ceriodaphnia 96 hour bioassay	EnviroMatrix Analytical, Inc.	EPA-821-R-02-012	N/A	N/A	%
Chronic toxicity, 3 species bioassays	EnviroMatrix Analytical, Inc.	EPA-821-R-02-013	N/A	N/A	%

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

14. QUALITY CONTROL

Quality control samples will be collected both in the field and in the lab to verify that valid data are recorded. Proper collection of all samples, using clean disposable gloves and appropriate clean containers and preservative, is primary in ensuring the quality of collected data. Field instruments will be calibrated prior to each day of sampling, and records will be retained by D-MAX Engineering, Inc. An example calibration log sheet is included in Appendix D.

Field duplicates help quantify intrinsic variability associated with sampling activities. Field duplicate samples will be used to replicate field measurements as well as laboratory analyses. Field duplicates are comprised of a second sample taken at 10% of all sampling sites. There are no specific criteria for field duplicate variability, but these data are evaluated in the data analysis/assessment process.

Laboratory blanks, duplicates, matrix spikes and laboratory control standards (LCS) are used to ensure proper sample handling, identify bias, check for consistent analysis of samples, and verify correct operation of laboratory equipment. All contract laboratory analysis will be performed in accordance with the guidelines of the QA/QC plan of EnviroMatrix Analytical, Inc.

Table 11. (Element 14) Sampling (Field) QC.

Matrix: Water		
Sampling SOP: SWAMP Procedure No. 1.0		
Analytical Parameter(s): Conventionals in Water, Including Pathogens		
Analytical Method/SOP Reference: N/A		
# Sample locations: All locations		
Field QC	**Frequency/Number per sampling event**	**Acceptance Limits**
Cooler Temperature	4 °C	0 – 6 °C
Field Duplicate Pairs	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)

Table 12. (Element 14) Analytical QC.

Matrix: Water		
Sampling SOP: SWAMP Procedure No. 1.0		
Analytical Parameter(s): Conventionals in Water, Including Pathogens		
Analytical Method/SOP Reference: N/A		
# Sample locations: All locations		
Laboratory QC	**Frequency/Number**	**Acceptance Limits**
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent (Pathogens: per batch of bottles or reagents)	<RL for target analyte (Pathogens: no growth on filter)
Lab. Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	RPD<25% (n/a if native concentration of either sample<RL)
Lab. Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	80-120% recovery
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	80-120% recovery RPD<25% for duplicates
Filter Sterility Check (Pathogens)	Perform one filter sterility check each day samples are analyzed	No growth on filter
Filtration Blank (Pathogens)	Per 20 samples or per analytical batch, whichever is more frequent	No growth on filter
Positive Control (Pathogens)	Per 20 samples or per analytical batch, whichever is more frequent	80-120% recovery
Negative Control (Pathogens)	Per 20 samples or per analytical batch, whichever is more frequent	No growth on filter

If any of the quality control acceptance limits are not met for field measurements or laboratory analysis, the corresponding batch of data will be flagged to be excluded from analysis and the Project Manager will be notified. The Project Manager will determine whether to re-analyze the sample, if holding times have not been exceeded, or to re-sample at the monitoring location(s).

15. Instrument/Equipment Testing, Inspection, and Maintenance

Field measurement equipment will be checked for operation in accordance with the manufacturer's specifications. Spare instruments and parts are kept in the field sampling vehicle and at the D-MAX office in the City of San Diego. Quality control for data collected in the field will be accomplished by proper calibration and care of the instruments used to take the readings and by proper handling of sampling equipment and containers, as described in Section 16 below.

EnviroMatrix maintains its equipment in accordance with its QA/QC procedures, which are available at the laboratory upon request..

Table 13. (Element 15) Testing, Inspection, Maintenance of Sampling Equipment and Analytical Instruments.

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Hanna Instruments HI 991301 Portable pH/EC/TDS/Temperature Meter	Clean, inspect, check with pH buffer solutions, check with standard conductivity solution, check/replace batteries	D-MAX field staff	Daily inspection and replacement as necessary	SWAMP Procedure Number 1.0
Hanna Instruments HI 9145 Portable Dissolved Oxygen Meter	Clean, inspect, check against atmospheric oxygen level, check/replace membrane or batteries	D-MAX field staff	Daily inspection and replacement as necessary	SWAMP Procedure Number 1.0
Field Camera	Clean, inspect, check/replace batteries	D-MAX field staff	Daily inspection and replacement as necessary	Appendix A

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

The field meters used to measure pH, temperature, specific conductance, and dissolved oxygen will be calibrated and checked as recommended by the manufacturer. The sensors and membranes will be kept moist to preserve the instruments' accuracy during field work.

EnviroMatrix Analytical, Inc. maintains calibration practices as part of its QA/QC procedures, which are available at the laboratory upon request.

Table 14. (Element 16) Instrument/Equipment Calibration and Frequency.

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person
Hanna Instruments HI 991301 Portable pH/EC/TDS/Temperature Meter	SWAMP Procedure Number 1.0	Calibrate and check with pH 4, pH 7, and pH 10 solutions and with EC 12.880 mS/cm solution	Calibrate and check before each field day, post-field check also for pH	D-MAX field staff
Hanna Instruments HI 9145 Portable Dissolved Oxygen Meter	SWAMP Procedure Number 1.0	Calibrate and check against atmospheric oxygen	Calibrate and check before each use	D-MAX field staff

If a field instrument does not pass inspection, the instrument should be recalibrated following its manufacturer's cleaning and maintenance procedures. If measurements continue to fail measurement quality objectives, affected data should not be reported and the instrument should be returned to the manufacturer for maintenance. All troubleshooting and corrective actions should be recorded in the calibration and field data records.

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies necessary for this project include calibration standard solutions, reagents, and sample collection bottles provided by EnviroMatrix Analytical, Inc. Upon receipt, all supplies are inspected for leaks or broken seals. Supplies are stored in accordance with manufacturer's recommendations in a secure location. If these chemicals do not meet the acceptance criteria or whenever they exceed their manufacturer recommended shelf life, they are disposed of appropriately and replaced.

EnviroMatrix Analytical, Inc. maintains its laboratory supplies in accordance to their QA/QC procedures, which are available at the laboratory upon request.

Table 15. (Element 17) Inspection/Acceptance Testing Requirements for Consumables and Supplies.

Project-Related Supplies / Consumables	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Calibration standard solutions	Check containers and seals for breakage; check expiration dates; ensure proper storage	Containers and seals intact; stored closed in proper conditions; shelf life not exceeded	Upon receipt and each use	D-MAX field staff
Reagents	Check containers and seals for breakage; check expiration dates; ensure proper storage	Containers and seals intact; stored closed in proper conditions; shelf life not exceeded	Upon receipt and each use	D-MAX field staff
Sample collection bottles	Check containers and seals for breakage; ensure proper storage	Containers and seals intact; stored closed in proper conditions	Upon receipt and each use	D-MAX field staff

18. NON-DIRECT MEASUREMENTS (EXISTING DATA)

Potential non-direct measurements may be made using historical data collected during previous years of river and creek monitoring or by the Dry Weather Field Screening and Analytical Monitoring Program. Regional Water Quality Control Board Surface Water Ambient Monitoring Program (RWQCB SWAMP) data or data obtained from other agencies may also be used. In addition, photo documentation, topographical maps, land use maps, and hydrological maps generated from San Diego Association of Governments (SANDAG) GIS database, may be used.

Data collected during previous years of river and creek monitoring, the Dry Weather Field Screening and Analytical Monitoring Program, RWQCB SWAMP, and data acquired from other agencies will be reviewed against data quality objectives stated in Section 7, and only those data that meet all of the criteria may be used in this project.

19. DATA MANAGEMENT

Field data sheets will be checked at the end of the day by D-MAX field staff. Electronic data is also reviewed by D-MAX, following data entry, for completeness, accuracy, and errors in data entry or transcription.

Data will be maintained as previously discussed in Element 9. All document and data hard copies will be retained in a project file, and all document and data electronic copies will be stored on a backed up hard disk at the office of D-MAX Engineering, Inc. EnviroMatrix Analytical, Inc. will also retain records of all transmitted laboratory reports.

GROUP C: ASSESSMENT AND OVERSIGHT

20. ASSESSMENTS & RESPONSE ACTIONS

Laboratory data will be reviewed for consistency as they are received from the laboratory by D-MAX. D-MAX will also conduct an internal review of the collected field data each month. Further, the City of Santee Project Manager will review the data as reported by D-MAX on a monthly basis. If a review discovers any discrepancy, the reviewer will discuss the observed discrepancy with the appropriate person responsible for the activity (see organization chart). EnviroMatrix has a defined process for corrective action outlined in their QA/QC document, which are available at the laboratory upon request. In the case of a discrepancy in the data, the D-MAX QA Officer will consult with EnviroMatrix and/or the City of Santee Project Manager, as appropriate, to discuss 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. Depending on the type of discrepancy, corrective actions may include, but are not limited to, review of data entry practices, additional training for laboratory personnel, or re-sampling.

The City of Santee Project Manager has the power to halt all sampling and analytical work if the deviation(s) noted are considered detrimental to data quality of the project

21. Reports to Management

At each site visit, the field crew will complete a field data sheet. The data sheet contains information regarding site identification and location, weather conditions, visual observations, and field measurement results. The City of Santee will be notified immediately in the event that there is visual or numeric evidence of a significant threat to water quality. Monitoring results from laboratory analyses will be reviewed immediately after being received from EnviroMatrix. If any of the results indicate evidence of a threat to water quality, the City will be notified immediately.

A summary report of monitoring data will be prepared annually and presented to the City of Santee Program Manager. Records of sampling locations and GPS coordinates, field measurement results and observations, laboratory analytical reports, and photographs of sampling locations will be included in the report. The report will include tabular presentations of field measurement, visual observation, and laboratory analytical data, as well as graphs of numerical data. The monitoring results will be compared to the applicable WQO listed in the Basin Plan. Statistical analyses, such as medians, means, maximums, and minimums will be conducted as appropriate to provide the City with the capability of comparing the test results with other published results. Both electronic and hard copies of the summary report will be prepared.

Table 16. (Element 21) QA Management Reports.

Type of Report	Frequency	Projected Delivery Dates(s)	Person(s) Responsible for Report Preparation	Report Recipients
Summary Report	Annually	November 30	Arsalan Dadkhah, D-MAX Program Manager	Helen Perry, Program Manager

Note that the projected delivery date is general and may be subject to minor variations in timing each year.

GROUP D: DATA VALIDATION AND USABILITY

22. DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

Data generated by project activities will be reviewed against the data quality objectives previously cited in Element 7 and the quality assurance/quality control practices cited in Elements 14, 15, and 16. Data will be separated into three categories: data meeting all data quality objectives, data failing to meet precision or recovery criteria, and data failing to meet accuracy criteria. Data meeting all data quality objectives, but with failures of quality assurance/quality control practices will be set aside to determine the impact of the failure on data quality. Once determined, the data will be moved into either the first category (meeting all data quality objectives) or the last category (failing to meet quality control practices).

Data in the first category is considered usable by the project. Data falling in the last category is considered unusable. Data falling in the second category will be assessed before it used in the project. If sufficient evidence is found supporting data quality for use in this project, the data will be moved to the first category, but will be flagged with a "J" as per EPA specifications.

23. Verification and Validation Methods

D-Max will review all collected data and the D-Max QA Officer will review the lab reports, notifying the EnviroMatrix QA Director in the case of an inconsistency.

Any issues that arise will be noted. Reconciliation and correction will be done by a committee composed of the City of Santee QA Officer & Project Manager, the D-Max Project Manager, the D-Max QA Officer & Data Manager, and the EnviroMatrix Laboratory Manager/QA Director. D-Max will keep the City of Santee informed of any pertinent data inconsistencies as they arise. The committee will attempt to reach unanimous consent on any issues, but the City of Santee Project Manager will make the determination if agreement cannot be reached.

24. Reconciliation with User Requirements

The project needs adequate numbers of data points, as represented by the completeness data quality objective in order to do perform statistical analyses, such as means, medians, maximums, and minimums. The sampling frequencies that have been developed should provide sufficient data points to complete the necessary analysis.

REFERENCES

Marine Pollution Studies Lab – Department of Fish and Game. 2007. Standard Operating Procedures (SOPs) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in SWAMP. SOP Procedure Number 1.0. Prepared by MPSL-DFG Field Sampling Team. Accessed at: http://swamp.mpsl.mlml.calstate.edu/wp-content/uploads/2009/04/swamp_sop_field_measures_water_sediment_collection_v1_0.pdf. May 5, 2010.

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Appendix A. Field Measurement Standard Operating Procedures

Field Measurement Standard Operating Procedures

Adapted from SOP Procedure Number 1.0, “Standard Operating Procedures (SOPs) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in SWAMP” (2007)

Field Data Logbook

A field data logbook or a *f*ield folder is taken into the field on each sampling trip. The use of bound or loose-leaf notebooks is left up to the entity conducting the monitoring. A good safety precaution against the loss of a bound field data logbook is to photocopy the current pages upon returning from the field. These pages are kept on file at the specific sample collection entity’s office. If a loose-leaf notebook is used, take care to remove original field data log sheets from the notebook and file in the office. Copies of the field data log sheets may be left in the notebook for future reference. The entry’s discussed below are recorded at each sampling site.

Field Data Logbooks (bound or loose leaf sheets) are maintained on file indefinitely in the office. They are never discarded, since the logbook may be the only written record of field measurements.

Record of Data Submission
A *Field Data Logbook* must indicate in some manner whether data recorded in the logbook has been transcribed onto data forms and submitted to the data management staff.

Site Photo

Digital photos are taken to help document the actual sampling site. The convention is to take photos facing downstream, overlooking the site. Right bank and left bank are thus defined in this downstream-facing direction. Document any discrepancies from this convention. Only one photo is necessary, if both, left and right bank, fit into one frame. Record all photos in the field data sheet.

Field Observations

Upon arrival at a sampling site, record visual observations on the appearance of the water and other information related to water quality and water use.

Left Bank/Right Bank
Left bank is defined as the bank to the left of the observer when facing downstream, and the *right bank* is to the right of the observer when facing downstream.

Other Observations

Water Appearance - Color, unusual amount of suspended matter, debris or foam, etc.

Sediment Appearance - Color and sediment composition should be noted.

Weather - Note recent meteorological events that may have impacted water quality; heavy rains, cold front, very dry, very wet, etc.
Biological Activity - Note excessive macrophyte, phytoplankton, or periphyton growth. The observation of water color and excessive algal growth is very important in explaining high chlorophyll-*a* values. Other observations such as presence of fish, birds, and spawning fish are noted.
Unusual Odors - Note if hydrogen sulfide odor, musty odor, sewage odor, etc. This should be recorded for sediment as well.
Comments - Specific comments about the sample itself that may be useful in interpreting the results of the analysis. For example, if the sample was collected for a complaint, make a note of this in the observation section. If a scheduled parameter or group of parameters is not collected, make some note of this in the comments

Field Measurements

After collecting water samples, record appropriate field measurements. When field measurements are made with a multiparameter instrument, it is preferable to place the probe in the body of water to be sampled and allow it to equilibrate in the dissolved oxygen (DO) mode while water samples are collected. Field measurements are made at the centroid of flow if the stream visually appears to be completely mixed from shore to shore. *Centroid* is defined as the midpoint of that portion of the stream width which contains 50% of the total flow. When measurements cannot be taken *in situ*, the sample should be taken from as close to the centroid as possible.

Recommended Depths for Conducting Field Data Measurements

Water Depth Less than 5 feet (<1.5m)	If the water depth is less than 5 feet (1.5m), grab samples for water are taken at approximately 0.1m (4 inches), and multi-probe measurements are taken at approximately 0.2m (8 in). This is because all sensors have to be submerged, so 0.1m would not be deep enough. But taking a grab sample at 0.2m is not always feasible, as it is difficult to submerge bottles to that depth, and in many cases the bottle will hit the stream bottom.
Water Depth Greater than 5 feet (>1.5m)	If the water depth at the sampling point exceeds 5 feet (1.5m) in depth, a vertical profile of dissolved oxygen, temperature, pH and specific conductance are made using the multiparameter probe equipment. The depth of the sonde at the time of measurement is most accurately determined from the depth sensor on the multiparameter sonde rather than depth labels on the cable.

<u>WATER TEMPERATURE (°C)</u>

Water temperature data are recorded for each visit in final form in a Field Data Logbook and submitted to the data management staff

Temperature Measuring Equipment

- Centigrade Thermometer
- Electronic Temperature Sensor

Temperature Sampling Procedures

Temperature is measured in-stream at the depth(s) specified in "Field Measurements" above. Measuring temperature directly from the stream by immersing a multiprobe instrument or thermometer is preferred.

<u>Hand Held Centigrade Thermometer</u>

If an electronic meter is not available, the temperature is measured with a hand-held, centigrade thermometer (Rawson, 1982).

- In wadeable streams, stand so that a shadow is cast upon the site for temperature measurement.
- Hold the thermometer by its top and immerse it in the water. Position the thermometer so that the scale can be read.
- Allow the thermometer to stabilize for at least one minute, then without removing the thermometer from the water, read the temperature to the nearest 0.1 °C and record.
- Do not read temperature with the thermometer out of the water. Temperature readings made with modern digital instruments are accurate to within $\pm$ 0.1 °C

Temperature Measurement from a Bucket

When temperature cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic. Care must be taken to insure a measurement representative of in-stream conditions.

The following conditions must be met when measuring temperature from a bucket:

- The bucket must be large enough to allow full immersion of the probe or thermometer.
- The bucket must be brought to the same temperature as the water before it is filled.
- The probe must be placed in the bucket immediately, before the temperature changes.
- The bucket must be shaded from direct sunlight and strong breezes prior to and during temperature measurement.
- The probe is allowed to equilibrate for at least one minute before temperature is recorded.
- After these measurements are made, this water is discarded and another sample is drawn for water samples which are sent to the laboratory.

Temperature Instrument Operation

1. Remove storage cap from the calibrated temperature meter and rinse the electrode with distilled water.
2. Turn on the meter and place the probe in the water sample and wait approximately one minute.
3. Once the reading has stabilized record the temperature.
4. Remove the probe and turn off the meter.
5. Rinse the electrode with distilled water and replace the cap.

pH (STANDARD UNITS)

pH data is recorded for each visit in final form in a Field Data Logbook and submitted to the project data management staff.

pH Sampling Equipment

The pH meter should be calibrated according to the Standard Field Equipment Calibration Procedures document

pH Sampling Procedure

Calibrate the pH sensor. The pH function is calibrated each day of use for multiparameter instruments.

In-stream Method

Preferably, pH is measured directly in-stream at the depth(s) specified earlier in this document. Allow the pH probe to equilibrate for at least one minute before pH is recorded to the nearest 0.1 pH unit.

pH Measurement from a Bucket

When pH cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic, following precautions outlined under “Temperature Measurement from a Bucket” above.

Potential Problems

- If the pH meter value does not stabilize in several minutes, out gassing of carbon dioxide or hydrogen sulfide, or the settling of charged clay particles may be occurring (Rawson, 1982).
- If out gassing is suspected as the cause of meter drift, collect a fresh sample, immerse the pH probe and read pH at one minute.
- If suspended clay particles are the suspected cause of meter drift, allow the sample to settle for 10 minutes, then read the pH in the upper layer of sample without agitating the sample.
- With care, pH measurements can be accurately measured to the nearest 0.1 pH unit.

pH Instrument Operation

1. Remove storage cap from the calibrated pH meter and rinse the electrode with distilled water.
2. Turn on the meter and place the probe in the water sample and wait approximately one minute.
3. Record the reading once the displayed value has stabilized.
4. Remove the probe and turn off the meter.
5. Rinse the electrode with distilled water and replace the cap.

SPECIFIC CONDUCTANCE (µmhos/cm)

Specific conductance should be recorded for each visit in final form in a Field Data Logbook or field form and submitted to the project data management staff.

Specific Conductance Sampling Equipment

Conductivity meter, calibrated according to the Standard Field Equipment Calibration Procedures document.

Specific Conductance Sampling Procedure

In-stream Method

Preferably, specific conductance is measured directly in-stream at the depth(s) specified on prior pages. Allow the conductivity probe to equilibrate for at least one minute before specific conductance is recorded to three significant figures (if the value exceeds 100). The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers. The presence of air in the probe is indicated by unstable specific conductance values fluctuating up to $\pm$100 µmhos/cm. The entrainment of air can be minimized by slowly, carefully placing the probe into the water; and when the probe is completely submerged, quickly move it through the water to release any air bubbles.

Specific Conductance Measurement from a Bucket

If specific conductance cannot be measured in-stream, it should be measured in the container used for collection of water samples (a bucket) using the precautions outlined on prior pages, under the "Temperature Measurement from a Bucket" section.

Conductivity Instrument Operation

1. Turn on the calibrated conductivity meter, ensuring the electrode is moist. If the electrode is dry, recalibrate the meter using standard solutions.
2. Rinse the probe with distilled water.
3. Immerse the probe in the sample water and wait approximately one minute.
4. Record the reading once the displayed value has stabilized.
5. Remove the electrode and turn off the meter.
6. Rinse the electrode with distilled water and replace the cap.

DISSOLVED OXYGEN (mg/L)

Dissolved oxygen (DO) data is recorded for each visit in final form in a Field Data Logbook and submitted to the project data management staff.

Dissolved Oxygen Sampling Equipment

Dissolved oxygen meter, calibrated according to the Standard Field Equipment Calibration Procedures document.

Dissolved Oxygen Sampling Procedure

Multiprobe Instrument

Calibrate the DO sensor on the multiprobe instrument. Preferably, DO is measured directly in-stream at the depth(s) specified in Field Measurements section above. The DO probe must equilibrate for at least 90 seconds before DO is recorded to the nearest 0.1 mg/L. If the DO probe has an operable, automatic stirrer attached, the DO probe does not have to be manually stirred. However, if the probe is not equipped with an automatic stirrer, manual stirring must be provided by raising and lowering the probe at a rate of 1 ft/s (0.3m/sec) without agitating the water surface. If the stream velocity at the sampling point exceeds 1 ft/s, the probe membrane can be pointed upstream into the flow and manual stirring can be avoided (Rawson, 1982).

DO Measurement from a Bucket

When DO cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic, following precautions outlined in Temperature Measurement from a Bucket on prior pages. During equilibration and reading, water should be moved past the membrane surface at a velocity of one ft/s (0.3m/sec), either by automatic stirrer or manual stirring. If stirred manually in a bucket, the water surface is not agitated (Rawson, 1982).

FLOW (cfs or gpm)

Flow data is recorded for each visit in final form in a Field Data Logbook and submitted to the project data management staff. Flow information for over 200 USGS sites is available on the Internet. The address is **http://water.usgs.gov/index.html**. Site San Diego River Downstream has a USGS stream gauge site nearby; data from the USGS site can be used to provide flow information for this monitoring location.

Flow (ft3/s)

If requested, flow data should be recorded for each monitoring visit to non-tidal, flowing streams. Flow data should be recorded in final form on a Field Data Sheet and submitted to data management staff. The following are two exceptions to the flow reporting requirement:

- **No Flow/ Pools:** If there is no flow at a stream site and accessible, isolated pools remain in the stream bed, collect and report the required field data and laboratory samples from the pools and report instantaneous flow. Under these conditions, flow (ft3/s) should be reported as zero. The reported flow severity value should be one. Pools may represent natural low-flow conditions in some streams and the chemistry of these pools will reveal natural background conditions.
- **Dry:** If the stream bed holds no water, the sampling visit is finished. Report that the stream was "dry" in the observations. No value is reported for flow since there is no water.

Instantaneous Flow Measurement

Water quality monitoring visits to sites where there are no nearby USGS flow gauges will require water quality monitoring personnel to measure flow.

Flow Measurement Procedure (USGS, 1969)

Select a stream reach with the following characteristics:

- Straight reach with laminar flow (threads of velocity parallel to each other) and bank to bank. These conditions are typically found immediately upstream of riffle areas or places where the stream channel is constricted.
- The site should have an even streambed free of large rocks, weeds, and protruding obstructions that create turbulence. The site should not have dead water areas near the banks, and a minimum amount of turbulence or back eddies.

Flat Streambed Profile (cross section)

Stretch the measuring tape across the stream at right angles to the direction of flow. When using an electronic flow meter, the tape does not have to be exactly perpendicular to the bank (direction of flow). When using a propeller or pigmy type meter, however, corrections for deviation from perpendicular must be made.

If necessary and possible, modify the measuring cross section to provide acceptable conditions by building dikes to cut off dead water and shallow flows, remove rocks, weeds, and debris in the reach of stream one or two meters upstream from the measurement cross section. After modifying a streambed, allow the flow to stabilize before starting the flow measurement.

The following information should be recorded by the field sampling team for each flow measurement:

- Station Location and Station ID
- Date
- Time measurement is initiated and ended
- Name of person(s) measuring flow
- Note if measurements are in feet or meters
- Total stream width and width of each measurement section
- For each cross section, record the mid-point, section depth and flow velocity

- Measure and record the stream width between the points where the tape is stretched (water's edge to water's edge).

Determining the Number of Flow Cross Sections

Determine the spacing and location of flow measurement sections. Some judgment is required depending on the shape of the stream bed. Measurements must be representative of the velocity within the cross-section. If the stream banks are straight and the depth is nearly constant and the bottom is free of large obstructions, fewer measurements are needed, because the flow is homogeneous over a large section. Flow measurement sections do not have to be equal width. However, they should be unless an obstacle or other obstruction prevents an accurate velocity measurement at that point. Typically, except when small flow rates are observed, no flow measurement section should have greater than 10% of the total flow.

If the *stream width is less than 5 ft*, use flow sections with a width of 0.5 ft (See example 1 on page 23 of this document). If the *stream width is greater than 5 ft*, the minimum number of flow measurements is 10. The preferred number of flow measurement cross sections is 20-30 (See Example 2 on page 24 on this document). The total stream width is 26 ft with 20 measurements, section widths will be 1.3 ft (26/20 = 1.3).

Determining the Mid-Point of the Cross Section

To find the mid-point of a cross section, divide the cross section width in half. Using Example 2 (see forms at end of document);

- The total stream width is 26 ft with 20 cross sections and each cross section width is equal to 1.3 ft.
- Divide 1.3 ft in half and the mid-point of the first section is 0.65 ft. In this example the tape at water's edge is set at zero (0) ft.
- By adding 0.65 to zero the mid-point of the first section is 0.65 ft.
- Each subsequent mid-point is found by adding the section width (1.3 ft) to the previous mid-point. For example; MIDPOINT #1 is 0.65 + 0.0 = 0.65; MIDPOINT #2 is 0.65 + 1.3= 1.95 ft; MIDPOINT #3 is 1.95 + 1.3 = 3.25 ft and ....MIDPOINT # 20 is 24.05 +1.3.
- Place the top setting wading rod at 0.65 ft for the first measurement.
- Using a top setting wading rod, measure the depth at the mid-point of the first flow measurement section and record to the nearest 0.01 ft.

Calculating Flow

To calculate flow, multiply the width x depth (ft2) to derive the area of the flow measurement section. The area of the section is then multiplied by the velocity (ft/s) to calculate the flow in cubic feet per second (cfs or ft3/sec) for that flow measurement section. When flow is calculated for all of the measurement sections, they are added together for the total stream flow (see Figure 2).

Q=Total Flow (or discharge), W=Width, D=Depth, V=Velocity.

$$Q = (W1 * D1 * V1) + (W2 * D2 * V2) + \ldots\ldots (Wn * Dn * Vn)$$

What to Do with Negative Values

Do not treat cross sections with negative flow values as zero. Negative values obtained from areas with back eddies should be subtracted during the summation of the flow for a site.

Flow Estimate (ft3/s)

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by one of the methods described above. Flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities. If flow cannot be measured at a routine non-tidal station, a new site should be selected where flow can be measured.

Flow Estimate Procedure

- Observe the stream and choose a reach of the stream where it is possible to estimate the stream cross section and velocity.
- Estimate stream width (ft) at that reach and record.

- Estimate average stream depth (ft) at that reach and record. Estimate stream velocity (ft/s) at that reach and record. A good way to do this is to time the travel of a piece of floating debris. If doing this method from a bridge, measure the width of the bridge. Have one person drop a floating object (something that can be distinguished from other floating materials present); the other staff at the downstream side of the bridge will stop the clock when the floating object reaches the downstream side of the bridge. Divide the bridge width by the number of seconds to calculate the velocity. The velocity can be measured at multiple locations along the bridge. These velocities are averaged. If this is done alone, watch for road traffic.
- Multiply stream width (ft) by average stream depth (ft) to determine the cross sectional area (in ft2) which when multiplied by the stream velocity (in ft/s) and a correction constant, gives an estimated flow (ft3/s).

Example*:* A stream sampler conducted a sampling visit to a stream while the flow meter was being repaired. The sampler looked at the creek downstream from the bridge and saw a good place to estimate flow. The stream width was around 15 ft. It appeared the average depth on this reach was about 0.75 ft. The sampler timed a piece of floating debris as it moved a distance of 10 ft in 25 s downstream over the reach. An estimated flow with a smooth bottom was calculated using the following formula.

Width x Depth x Velocity x A (correction factor) = estimated flow
15 ft (width) x 0.75 ft (depth) x 2.5 ft/s (velocity) x A =25 ft3/s (cfs)

"A" is a correction constant: 0.8 for rough bottom and 0.9 for smooth bottom
Estimated flow should be reported to one or two significant figures.

Experienced field personnel are able to estimate flow to within 20% of actual flow for total flows less than 50 ft^3/s. The best way to develop this skill is to practice estimating flow before making measurements at all monitoring visits to non-tidally influenced flowing streams and then compare estimated flows with those obtained from USGS gages or from instantaneous flow measurements

Appendix B. Monitoring Program Field Data Sheet

San Diego Stormwater Copermittees
City of Santee
Dry Weather Monitoring Field Datasheet

☐ **Field Screening** ☐ **Confirmation For** ________________ ☐ **IC/ID Follow-Up For** ________________

GENERAL SITE DESCRIPTION (NAD 83 decimal degrees to 5th place) ☐ **MS4** ☐ **Receiving Water**

Site ID		**Latitude**		**Watershed**	**Hydrologic Unit**		
Location		**Longitude**			**Hydrologic Area**		
		TB Page			**Hydrologic Subarea** (Optional)		
Date		**Time**		**Observer**		**Discharge Area** (Optional)	

Land Use (Primary) (Check one only) ☐ Residential ☐ Commercial ☐ Industrial ☐ Agricultural ☐ Parks ☐ Open

Land Use (Secondary) (Optional, greater than 10%) ☐ Residential ☐ Commercial ☐ Industrial ☐ Agricultural ☐ Parks ☐ Open ☐ None

Conveyance (Check one only) ☐ Manhole ☐ Catch Basin ☐ Outlet ☐ Concrete Channel ☐ Natural Creek ☐ Earthen Channel ☐ Curb/Gutter

ATMOSPHERIC CONDITIONS

Weather ☐ Sunny ☐ Partly Cloudy ☐ Overcast ☐ Fog

Tide ☐ N/A ☐ Low ☐ Incoming ☐ High ☐ Outgoing **Tide Height:**______ft.

Last Rain ☐ > 72 hours ☐ < 72 hours

Rainfall ☐ None ☐ < 0.1” ☐ > 0.1”

RUNOFF CHARACTERISTICS

Odor ☐ None ☐ Musty ☐ Rotten Eggs ☐ Chemical ☐ Sewage ☐ Other

Color ☐ None ☐ Yellow ☐ Brown ☐ White ☐ Gray ☐ Other

Clarity ☐ Clear ☐ Slightly Cloudy ☐ Opaque ☐ Other

Floatables ☐ None ☐ Trash ☐ Bubbles/Foam ☐ Sheen ☐ Fecal Matter ☐ Other

Deposits ☐ None ☐ Sediment/Gravel ☐ Fine Particulates ☐ Stains ☐ Oily Deposits ☐ Other

Vegetation ☐ None ☐ Limited ☐ Normal ☐ Excessive ☐ Other

Biology ☐ None ☐ Insects ☐ Algae ☐ Fish ☐ Snails ☐ Mussels/ Barnacles ☐ Insect/ Algae ☐ Insect/ Snail ☐ Other

Water Flow ☐ Flowing ☐ Ponded ☐ Dry ☐ Tidal

Does the storm drain flow reach the Receiving Water? ☐ Yes ☐ No ☐ N/A

Evidence of Overland Flow? ☐ Yes ☐ No ☐ Irrigation Runoff ☐ Other: ________________

Photo Taken ☐ Yes ☐ No **Photo #** __________

Field Screening Samples Collected? ☐ Yes ☐ No

Water Temp (°C)		NH_3-N (mg/L)		NO_3 (mg/L)		Ortho-PO_4 (mg/L)	
pH (pH units)		TURB (NTU)		NO_3-N (mg/L)		Ortho-PO_4 -P (mg/L)	
COND (mS/cm)		MBAS (mg/L)		DO (mg/L)			

Analytical Lab Samples Collected? ☐ **Yes** ☐ **No**

FLOW ESTIMATION WORKSHEETS

Flowing Creek or Box Culvert

Width		in
Depth		in
Velocity		ft/sec
Flow		gpm

Filling a Bottle or Known Volume

Volume		mL
Time to Fill		sec
Flow		gpm

Flowing Pipe

Diameter		ft
Depth		ft
Velocity		ft/sec
Flow		gpm

COMMENTS: ____

Appendix C. Chain of Custody Form

CHAIN-OF-CUSTODY RECORD

EnviroMatrix Analytical, Inc.

4340 Viewridge Ave., Ste. A - San Diego, CA 92123 - Phone (858) 560-7717 - Fax (858) 560-7763

EMA LOG #:

EMA DATE/TIME STAMP

Client:

Address:

Attn: Phone:

Sampled by: Fax:

Billing Address:

Project: PO #:

REQUESTED ANALYSIS

EMA ID #	Client Sample ID	Sample Date	Sample Time	Sample Matrix	Container(s) #	Type*	418.1 (TRPH)	Oil & Grease 413.1__ 413.2__ 1664__	TPH (8015B) Gas__ Diesel__	TPH-Extended 8015B__ ASTM D2887__	602 / 8021 B BTXE__ MTBE__	601 / 8021 B (Volatile Organics)	EPA 8021 B Aromatics__ Halogenated__	608 / 8081 (Pesticides)	608 / 8082 (PCB's)	624 / 8260 (Volatile Organics)	625 / 8270 (Semi Volatile Organics)	TTLC Metals (CAC Title 22)	STLC Metals (CAC Title 22)	TCLP (RCRA) Metals__ Organics__	Cd Cr Cu Pb Ni Ag Zn	pH EC TSS							
1																													
2																													
3																													
4																													
5																													
6																													
7																													
8																													
9																													
10																													

*Container Types: B=Brass Tube; V=VOA; G=Glass; P=Plastic; O=Other (list)

Tamper-Proof Seals Intact: Yes No N/A | Correct Containers: Yes No

Sample(s): Cold Ambient Warm | VOAs w/ZHS: Yes No N/A

All Samples Properly Preserved: Yes No N/A

Disposal: N/C (aqueous) *EMA (@$5.00/sample) Return Hold

Turnaround Time: 24 hr 48 hr 3 day 4 day 5 day Normal

Comments:

RELINQUISHED BY	DATE/TIME	RECEIVED BY
Signature		Signature
Print		Print
Company:		Company:
Signature		Signature
Print		Print
Company:		Company:
Signature		Signature
Print		Print
Company:		Company:

* EMA reserves the right to return samples that do not match our waste profile.

White - EMA Canary - Accounting Pink - Client (w/Report) Goldenrod - Client (Relinquish Sample:

Appendix D. Calibration Log Sheet

D-MAX Quality Assurance/Quality Control (QA/QC) Plan

Daily Calibration Log Sheet

Project Name: ________________________ Project Number: ________________________

Pre-Field Calibration											Post-Field Check			
Constituent		**pH meter 1**			**pH meter 2**			**Cond. (mS/cm)**	**Turbidity (NTU)**	**DO (mg/L)**	**pH meter 1**		**pH meter 2**	
Standard value		4.0	7.0	10.0	4.0	7.0	10.0	12.88	0	8.39 @ 23°C	7.0	10.0	7.0	10.0
Acceptable range		± 0.5	± 0.5	± 0.5	± 0.5	± 0.5	± 0.5	± 5%	± 0.5	± 5%	± 0.5	± 0.5	± 0.5	± 0.5
Date	Staff													

Additional notes: ____

____

____