SAN DIEGO COASTAL LAGOONS
TMDL MONITORING WORKPLAN

FINAL

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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

I. INTRODUCTION

A. BACKGROUND AND OBJECTIVES

The coastal lagoons of San Diego County represent approximately one-third of the remaining estuarine acreage in Southern California and provide critical natural habitat for terrestrial and aquatic species. They serve as refuge, foraging areas, and breeding grounds for a number of threatened and endangered species as well as significant spawning and nursery habitats for commercial and non-commercial fish species. However, these lagoons are heavily influenced by their urbanized watersheds. Watershed runoff, coupled with reduced tidal influence from restricted inlets, has resulted in beneficial use impairments in many systems, including low dissolved oxygen, excessive algal growth, eutrophication, presence of pathogens, excessive sedimentation and suspended sediment. Santa Margarita Lagoon, Loma Alta Slough, Agua Hedionda Lagoon, Buena Vista Lagoon, San Elijo Lagoon, Los Peñasquitos Lagoon, and Famosa Slough have been added to the State's list of impaired waterbodies (303d list) for at least one of the following constituents: sediments, total dissolved solids, enteric bacteria, and/or nutrients. Table 1 summarizes the 303 (d) listings by lagoon. As a consequence of this listing, total maximum daily loads (TMDLs) must be developed for the critical constituents in each of the lagoons.

Setting the appropriate TMDLs must be based on an understanding the hydrodynamics, sources, loading, transport and cycling of constituents of interest. Dynamic simulation models are the best tools for determining load allocations. These models must simulate loads from the watersheds as well as fate and transport in the estuary or lagoon. Complete data required to develop these models are not currently available for Southern California coastal lagoons. Partial data exist for some lagoons and will be included where applicable. Thus, the purpose of the monitoring program is to address the principal data needs required to develop watershed loading and lagoon water quality models for the targeted contaminants of interest in the lagoons. These models will then be used for TMDL development and implementation in each of the lagoons.

The objective of this monitoring program is to support the development of watershed loading and lagoon water quality models by:

1. Quantifying the loading of contaminants to the lagoons (e.g. watershed sources, storm drains, atmospheric deposition, and others) during wet and dry weather
2. Collecting data to calibrate and validate lagoon hydrodynamic and water quality models for each of the targeted contaminants (sediment, total dissolved solids, enteric bacteria, and nutrients).

Table 1. Summary of 303(d) listings by lagoon

Lagoon	Tidal Regime	Sediments	Total Dissolved Solids	Bacteria	Nutrients/ Eutrophication
Santa Margarita Estuary	Tidal[1]				X
Loma Alta Slough	Tidal[1]			X	X
Agua Hedionda Lagoon	Tidal	X		X	
Agua Hedionda Creek	N/A		X		
Buena Vista Lagoon	Nontidal	X		X	X
San Elijo Lagoon	Tidal[1]	X		X	X
Los Peñasquitos Lagoon	Tidal[1]	X			
Famosa Slough	Tidal				X

B. ORGANIZATION OF DOCUMENT

The workplan consists of the following sections: 1) a presentation of the technical approach, including description of management questions, conceptual models driving watershed loading and lagoon water quality modeling data needs, the general approach with tables of sampling effort, and quality assurance and control measures, 2) a description of monitoring plan work products, and 3) and timeline of workplan activities.

II. TECHNICAL APPROACH AND WORKPLAN ELEMENTS

The general approach and specific design elements of the monitoring program are driven by a series of management questions. These questions were drafted by the San Diego Regional Water Quality Control Board and revised by the group of watershed stakeholders for the seven lagoons. This section provides an overview of these management questions, conceptual models, general approach, and specific work elements required in order to address the study objective.

A. MANAGEMENT QUESTIONS

The management questions can be organized by three general categories:

1. Questions that characterize sources of targeted contaminants to the lagoons or to Agua Hedionda Creek
2. Questions that characterize within-lagoon hydrodynamics and water quality
3. Questions that relate to the implementation of models to set load allocations

Table 2 presents these management questions by major category.

[1] Subject to periodic closure due to build up of sand at the mouth of the lagoon.

Table 2. List of major management questions that frame approach and design elements of the monitoring plan

Type	Question
Sources	What are the relative contributions for targeted contaminants from each land use type or from regulated facilities?
	What are the concentrations of targeted contaminants at the base of each watershed before it enters an impaired lagoon?
	What is the daily rainfall in the watershed?
	What is the total annual (and daily) flow and mass loads of targeted contaminants from each watershed to each impaired lagoon?
	What is the total annual (and daily) flow and mass load of total dissolved solids to Agua Hedionda Creek?
	What are the concentrations of targeted contaminants at the ocean inlet before it enters an impaired lagoon?
	What is the net annual flux of the targeted contaminants from the impaired lagoon to the coastal ocean?
Within Lagoon or Creek Hydrodynamics or Water Quality	What is the concentration of total dissolved solids in Agua Hedionda Creek? Do they exceed Water Quality Objectives?
	What are the concentrations of targeted contaminants within each impaired lagoon? Do they exceed Water Quality Objectives?
	What are the dissolved oxygen concentrations in lagoons impaired for nutrients or eutrophication?
	What are the physical factors that control lagoon hydrodynamics and sediment transport?
	What are the sediment flux rates for nutrients in these waterbodies?
	What is the sediment oxygen demand in these waterbodies?
	What are the standing crop totals and primary productivity rates for plant/macroalgae biomass in these waterbodies?
Implementation Questions	What is the total annual load reduction of nutrients needed so that beneficial uses and water quality objectives are met?
	What is the total annual load reduction of bacteria needed so that recreational beneficial uses and water quality objectives are met?
	What is the total annual load reduction of sediment needed so that sedimentation is reduced to meet water quality, physical and biological habitat objectives?
	What is the total annual load reduction of total dissolved solids needed in Agua Hedionda Creek so that water quality objectives that support the MUN beneficial uses are met?

B. CONCEPTUAL MODELS

A basic conceptual model has been developed to describe the sources and losses of targeted constituents to each lagoon (Figure 1). Sources of constituents into the lagoons are from the watershed, within the lagoon itself, and from the ocean. Watershed loads are unidirectional into the lagoon and will vary seasonally. Watershed loads can be estimated at the mass emission site, which is located in the main tributary just before it discharges into the lagoon. The mass

emission site is located above the region of tidal influence from each lagoon. This upstream limit of tidal influence is not well established for each lagoon, but will be formalized during the process of setting up the hydrodynamic model. Lagoon sources are point or non-point discharges of constituents directly into the lagoon or released via estuarine physical or biological processes and transformations. These include: storm drains, animal sources, atmospheric deposition, and nitrogen fixation. Oceanic sources enter the lagoon either through exchange at the ocean inlet or through tidal exchange through the berm. Constituents are lost from the lagoon either through physical processes and/or biological transformations within the lagoon and via outflow or tidal scouring to the ocean. Examples of within lagoon processes that lead to loss of constituents are burial in sediments and denitrification. The watershed loading, hydrodynamic and water quality models that will be developed for each lagoon are founded upon these basic conceptual models. The lagoon models can be broken into specific components: hydrodynamics, sediment transport, enteric bacteria, and eutrophication. Each of these components will be discussed briefly below.

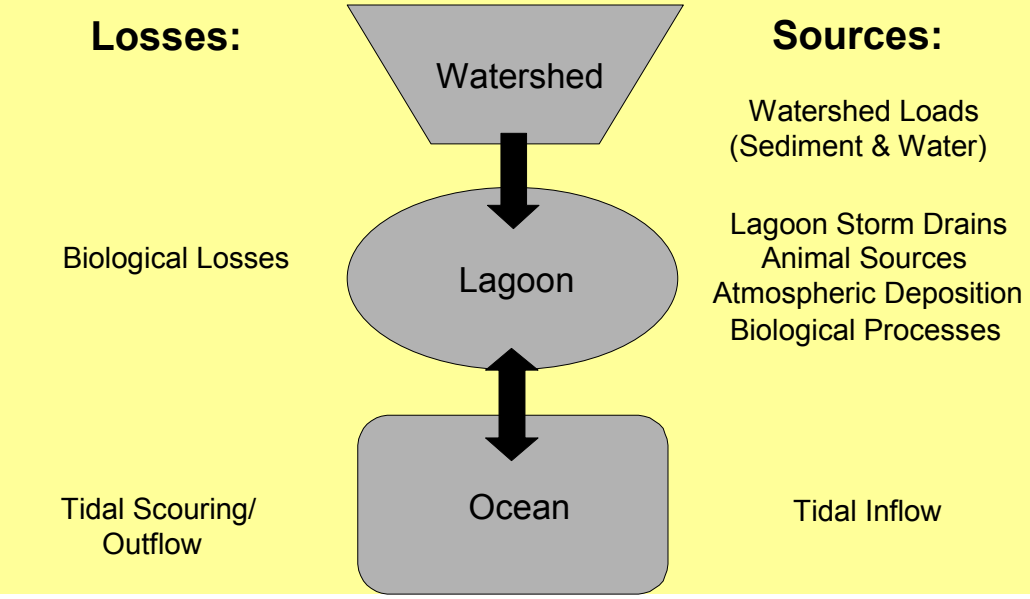

Figure 1. Basic conceptual model outlining sources and losses of constituents within the watershed/lagoon/ocean system.

1. *Hydrodynamic Model*

The hydrodynamic model describes the inputs and outputs of water within a watershed/lagoon/ocean system (Figure 2). Inputs include flow from the watershed, precipitation, groundwater inflow, storm drains, and tidal inflow from the ocean. Outputs include evaporation/transpiration, groundwater outflow, and outflow to the ocean.
The hydrodynamic model can use the following data:

- Surface water level, salinity and temperature measured within the lagoon and at the ocean inlet;
- Flow, salinity, and temperature data measured at the mass emission site;

- Lagoon bathymetry;
- Evaporation/transpiration and precipitation;
- Net groundwater inputs.

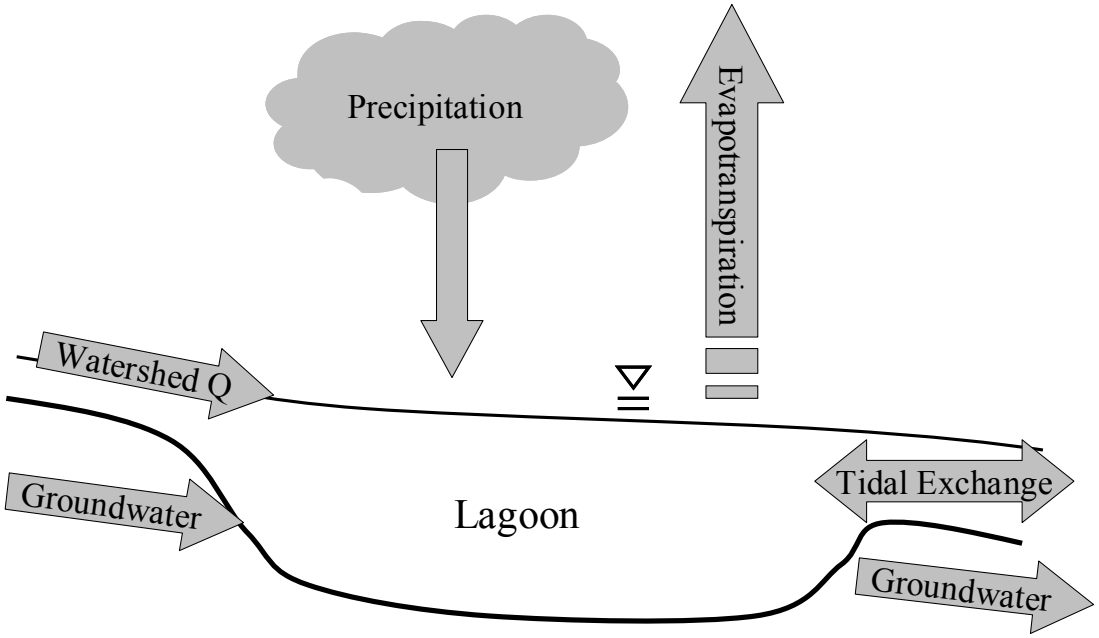

Figure 2. Conceptual model for hydrodynamic element.

2. <u>Sediment Transport</u>

Sediment transport, which is a component of the hydrodynamic model, is described by the inputs and outputs of sediment to each lagoon, as well as processes within the lagoon such as sediment resuspension, flocculation, and scouring (Figure 3). Sediment inputs into each lagoon are from the watershed and the ocean inlet. Sediment outputs are to the ocean or by dredging.

The sediment transport component of the hydrodynamic models requires, at minimum, the following data:

- Turbidity and/or total suspended sediments at the ocean inlet, mass emission site and within the lagoon during wet and dry weather periods;
- Particles size distribution in watershed loads and within the lagoon during storm events;

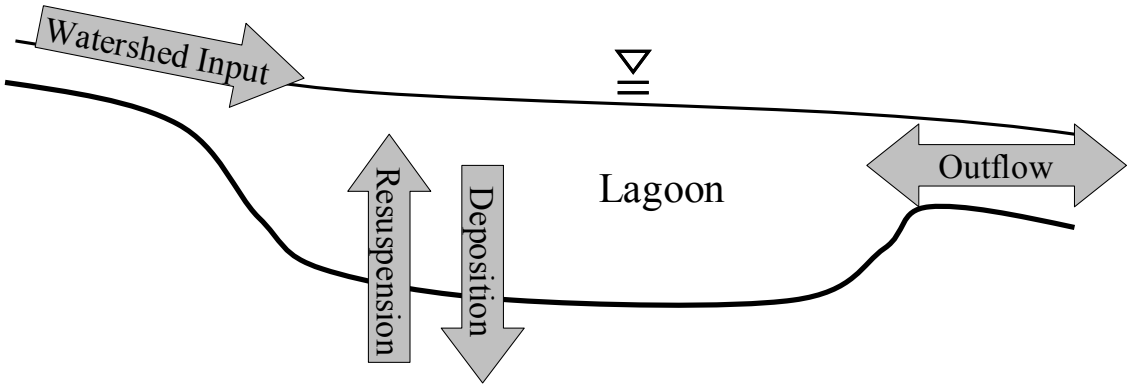

Figure 3. Conceptual model for sediment transport element.

3. *Bacteria Model*

The bacterial water quality model describes the inputs, outputs, and processes that affect bacteria levels within a lagoon. This model will be coupled to both the hydrodynamic and sediment transport models. Bacteria sources are from the watershed and storm drains, as well as direct contribution to the lagoons via wildlife. The ocean outlet can serve as either a source or loss of bacteria from the lagoon. Within lagoon cycling of bacteria includes regrowth within the sediments and water column, die-off within sediments and water column, and settling and burial within the sediments.

The enteric bacteria water quality model requires, at minimum, the following data:

- Total coliform, fecal coliform, and enterococci bacteria measured during wet and dry weather periods at the ocean inlet, mass emission sites and within the lagoon;
- Settling and die-off rates.

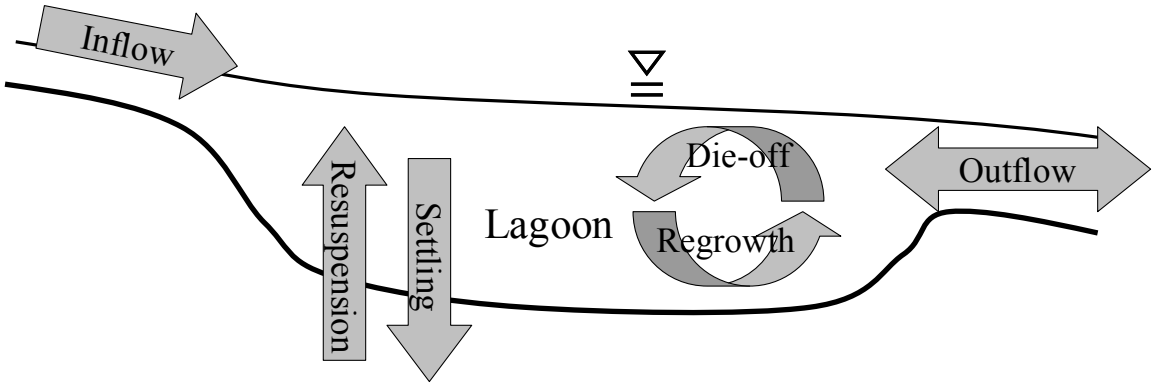

Figure 4. Conceptual model for the bacteria element.

4. Nutrient/Eutrophication Model

The eutrophication model describes the inputs, outputs, and processes that affect nutrient concentrations and primary productivity within the lagoon. This model will be coupled to both the hydrodynamic and sediment transport models; sediments are an important source of nutrients and will be tracked in the water quality model. Nutrient inputs into the lagoon are surface waters coming from the watershed, ocean, and storm drain inflow, flux from the sediments, leakage from plant or animal tissues, and decomposition of organic matter within the water column. Nutrient outputs from the lagoon are to the ocean, to growth and storage of biomass within the lagoon, burial and flux into the sediments, and storage in the water column.

The eutrophication model requires the following data:

- Surface water nutrient concentrations during wet and dry weather periods at the ocean inlet, mass emission site and within the lagoon;
- Bulk sediment characteristics and sediment pore water nutrient concentrations during dry weather periods;
- Primary producer community (emergent and submerged vascular plants, algae, and phytoplankton) percent cover, biomass, and tissue nutrients;
- Annual particulate nitrogen and phosphorus loading into lagoons;
- Rates of exchange of nutrients between lagoon sediments and surface waters (hereto referred to as benthic flux of nutrients);
- Rates of transformation of nutrients within and between sediments, surface waters and primary producer communities (e.g. denitrification, nitrogen fixation, atmospheric deposition, algal and submerged aquatic vegetation uptake and release of nutrients)

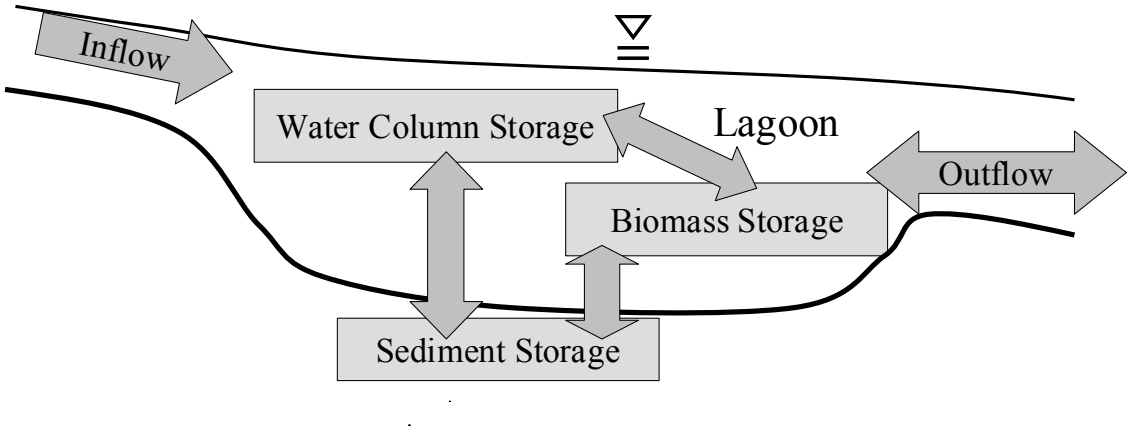

Figure 5. Conceptual model for nutrient/eutrophication element.

C. GENERAL APPROACH

The general approach is to calibrate and validate the watershed loading and water quality models with a targeted set of monitoring data. Model parameters can either be developed from measured

data or estimated from literature values. Where necessary, site-specific sources, losses, and key rates of transformation within the lagoons will be measured to assure that models for each specific lagoon reflect its unique hydrology and water quality. The monitoring program adopted will characterize the site-to-site variations within each lagoon as well as seasonal variability in loads and fluxes.

The three principal types of monitoring included are as follows:

1. Continuous monitoring of hydrodynamic and primary water quality parameters (salinity, temperature, etc.);
2. Wet weather monitoring, which will be conducted during and immediately following a specified number of storm events at a mass emission (ME) site in the main tributary, targeted locations in the lagoon, and at the ocean inlet; and
3. Dry weather monitoring, which will be conducted during "index" periods that are meant to capture representative seasonal cycles of physical forcing and biological activity in the lagoon. During each index period, sampling will be conducted at the ME and ocean inlet sites, as well as key locations within the lagoon.

The actual sampling effort within each lagoon is a function of the number of segments agreed upon between the San Diego Regional Board and the stakeholders. The number of segments depended upon the number of unique environments within a specific lagoon and does not include the ocean inlet site and the mass emission site. Table 3 gives the number of segments by lagoon. Table 4 shows proposed GPS coordinates for sampling sites within each segment. Appendix 1 shows locations of segment sampling sites in each lagoon. The actual location may change if necessary due to logistics, accessibility, etc.

Table 3. Number of segments by lagoon.

Lagoon Description	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Number of Segments*	2	1	1	2	2	2	1

Table 4. Table of GPS coordinates for each site. Actual locations may vary based on stakeholders needs and logistical issues.

Type	GPS Points	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Segment 1	Latitude	33.23732	33.17770	33.14153	33.17631	33.01077	33.93009	32.75087
	Longitude	-117.39821	-117.36831	-117.32488	-117.34649	-117.26164	-117.24748	-117.22799
Segment 2	Latitude	33.23508	NA	NA	33.16891	33.00902	33.93246	NA
	Longitude	-117.40809	NA	NA	-117.35892	-117.26851	-117.25328	NA

A "primary" set of analytes will be monitored in each lagoon to establish the lagoon hydrodynamic model. Other analytes will depend on specific lagoons' listing (bacteria, total dissolved solids, sediment, eutrophication). Table 5 provides a list of analytes by TMDL type,

the analytical method for analysis, and the target reporting limits for each analyte. Each analytical method and target reporting limit are compatible with the Surface Water Ambient Monitoring Program (SWAMP).

The San Diego Regional Water Quality Control Board has determined that the Stakeholders are not required to use laboratories with state certification for this workplan, as long as it meets the SWAMP-comparable Measurement Quality Objectives (MQOs) for the target analytes. Stakeholders and SCCWRP are allowed to filter and freeze nutrient samples to increase the holding times to 28 days. (not applicable to SWAMP holding times for other constituents). Samples collected must be immediately put on ice until processed. The filtering must be done within 6 hours of sample collection and prior to freezing. Appendix 2 contains recommended university research institute laboratories, price per analyte, and laboratory contact information.

Table 5. List of analytes by TMDL, analytical methods, and target reporting limits. Under "type", "Primary" refers to parameters that apply across the board to all TMDLs of interest.

Type	Analyte	Analytical Method	Target Reporting Limit
Primary	Temperature	Data Sonde	0.1 °C
	Conductivity	Data Sonde	2.5 µS/cm
	Turbidity	Data Sonde	0.5 NTU
	Total Suspended Solids (TSS)	SM 2540-D	0.5 mg/L
Total Dissolved Solids	Total Dissolved Solids (TDS)	SM2450C	0.2 mg/L
Bacteria	Total Coliform*	SM 2222B	2 MPN/ 100 mL
	Fecal Coliform*	SM 9222D	2 MPN/ 100 mL
	Enterococcus	SM 9230C	1 colonies/ 100 mL
Eutrophication	pH	Data Sonde	0.2
	Dissolved Oxygen (DO)	Data Sonde	1.00 mg/L
	Total Nitrogen (TN)	USGS I-4650-03	0.1 mg/L
	Total Phosphorus (TP)	USGS I-4650-03	0.05 mg/L
	Total Dissolved Nitrogen (TDN)	USGS I-2650-03	0.1 mg/L
	Total Dissolved Phosphorus (TDP)	USGS I-2650-03	0.05 mg/L
	Nitrate+Nitrite-N	SM 4500-NO3+NO2 F	0.05 mg/L
	Ammonium-N	SM 4500-NH3 G SM 4500-NH3 F	0.05 mg/L 0.05 mg/L
	Soluble Reactive Phosphorus (SRP)	SM4500P C	0.05 mg/L
	Chlorophyll a	EPA 445.0 SM 10200H	2 µg/L 0.01 mg/m^3
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	EPA 405.1 SM 5210B	2 mg/L
Suspended Sediment or Sediment	% Fines or % Sand/Silt/Clay	ASTM D-422 (1963)[1] EPA (1995)[2] Plumb (1981)[3]	1 %
	% Organic Carbon (%OC)	EPA 9060	0.01 %
	% Organic Nitrogen (%ON)	EPA 9060	0.01 %

Type	Analyte	Analytical Method	Target Reporting Limit
	% Total Phosphorus (%TP)	Nelson (1987)[4]	0.01 %

*Suggested analytical methods from SWAMP, using membrane filtration technique.

[1.] ASTM D-2216, 1980. Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures. American Society for Testing and Materials.

[2.] U.S. EPA, 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual – Estuaries, Volume 1: Biological and Physical Analyses. United States Environmental Protection Agency, Office of Research and Development, Narragansett, RI. EPA/620/R-95/008.

3. Plumb, R. H., 1981. Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE 81-1, prepared for Great Lakes Laboratory, State University College at Buffalo, NY, for the U.S. EPA/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. U.S. Army Engineers Waterways Experiment Station, CE, Vicksburg, MS.

4. Nelson, N. S. 1987. An acid-persulfate digestion procedure for determination of phosphorus in sediments. Commun. in Soil Sci. Plant Anal. v.18 no.4 p.359-69.

D. SPECIFIC WORK ELEMENTS

This section provides details on each of the monitoring program elements, including the general technical approach for each type of work element, summary tables of sampling effort by lagoon and targeted contaminant, and assumptions made to calculate the specified number of samples. These assumptions are based on consensus reached at a series of San Diego Lagoon TMDL stakeholder meetings conducted in Spring 2007. Sample numbers will vary by lagoon and reflect the basic number of samples required for each element to satisfy data needs of the models. In order to make the stakeholder monitoring efforts compatible with the Surface Water Ambient Monitoring Program (SWAMP) QA standards, an additional percentage should be added on to the number of samples given for duplicates, field blanks, laboratory blanks, and equipment blanks (see QA/QC section below). Specific analytical methods and target reporting limits for all analytes are listed in Table 5.

The organization of the discussion of the specific work elements is as follows: 1) continuous monitoring of hydrodynamic and primary chemical parameters, 2) wet weather sources and within-lagoon sampling, 3) dry weather sources and within-lagoon sampling, and 4) special studies. Unless otherwise noted, stakeholders from each lagoon will be responsible for all monitoring except the special studies, which will be conducted by the Southern California Coastal Water Research Project (SCCWRP) and its collaborating institutions (University of California, Los Angeles and Louisiana State University).

1. Continuous Monitoring for Hydrology and Chemical Parameters

In order to calibrate and validate the watershed hydrology and lagoon hydrodynamic models, monitoring of hydrology and primary chemical parameters (salinity, temperature, turbidity, and water-level and flow) will be measured via *in-situ* probes installed at the mass emission site, within each segment, and at the ocean outlet at discrete depths. Water level will be measured at the segment and ocean inlet sites, and flow will be measured at the mass emission site. For the lagoons listed for eutrophication (San Elijo Lagoon, Santa Margarita Estuary, Loma Alta Slough, Buena Vista Lagoon, and Famosa Slough), pH and dissolved oxygen will also be measured.

Buena Vista Lagoon is never open to tidal exchange and, consequently, no ocean inlet site will be monitored. In each of the watersheds, data from a minimum of one rainfall station must be acquired.

Continuous monitoring will occur during two periods in all lagoons, except Los Peñasquitos Lagoon. The first period will be wet weather monitoring (3 months), the second will be dry weather monitoring (4 months from mid-June to mid-October). Wet weather continuous monitoring should coincide with storm sampling in each of the lagoons. Because Los Peñasquitos Lagoon is only listed for sediment impairment, wet weather monitoring is most crucial. Thus, Los Peñasquitos Lagoon will have one continuous monitoring period for 6 months from October 1st through March 31st.

The mass emission site will be placed at a location above the upstream boundary of the estuary. The location of segment sites is driven by the number of distinct regions of the lagoon (Table 3). Proposed locations for segment sites have been defined in Table 4, though these coordinates are subject to change given logistical considerations.

The ocean inlet is generally defined as the lagoon mouth. For all lagoons except Buena Vista, ocean inlet continuous monitoring will occur when the lagoon mouth is open. During this time period, the monitoring station should be located within the lagoon mouth, except for Santa Margarita, in which an alternative design was developed (see below). The stakeholders in the Agua Hedionda watershed concur to have an additional "boundary" condition station at the I-5 bridge for all sampling in order to enhance data collection. This site will serve as a second ocean inlet site.

For Buena Vista, which has no surface water tidal influence, no ocean inlet monitoring is required. For Santa Margarita Estuary, which is a seasonally tidal estuary, no continuous monitoring of the ocean inlet will be conducted. Instead, the cross section and elevational gradient from channel bottom to the oceanic water level at the mouth of Santa Margarita Estuary at the specific time of surveying will be measured monthly. During index period monitoring when Santa Margarita Estuary is open to tidal exchange, discrete water samples will be measured twice daily in the coastal ocean for salinity, temperature, total suspended solids, and the suite of nutrient parameters at a location just upstream of the prevailing longshore current near the mouth of the lagoon.

Table 6 is a list of the number of stations for moored continuous monitoring of hydrodynamics and water quality for each lagoon. Tables in subsequent sections indicate specifically which chemical parameters will be measured continuously and the minimum frequency and/or duration during index periods and outside of index periods.

The contribution from ground water will not be assessed, due to the difficulty in accurately measuring groundwater transport. However, it is possible that in some lagoons, particularly those with extensive agriculture in close proximity, groundwater may play an important role. A portion of the subsurface flows will be collected during storm drain sampling (*c.f.* Section 3.1) and during benthic flux measurements (*c.f.* Section 4.3), but specific measurements of groundwater flow and its constituent contribution has not been incorporated into this workplan.

Further discussion on the contribution of groundwater and modification of the workplan to incorporate groundwater contribution will be conducted for each specific lagoon at a later date.

Table 6. Number of monitoring stations for continuous monitoring of hydrodynamics and water quality

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Lagoon Bathymetry	Bathymetry	Assumed all lagoons have bathymetry data						
Weather Station	Rainfall, wind speed and direction, air temperature, % humidity	Minimum of one site per watershed measured daily over one year						
Mass Emission Site	Temperature	1 site/ lagoon	1 site/ lagoon	1 site/ lagoon	1 site/ lagoon	1 site/ lagoon	3 site/ lagoon	1 site/ lagoon
	Conductivity							
	Turbidity[2]							
	Flow							
	Dissolved Oxygen[3]			N/A			N/A	
	pH[4]							
Lagoon Segment	Temperature	2 sites	1 site	1 site	2 sites	2 sites	2 sites	1 site
	Conductivity							
	Turbidity							
	Water Level							
	Dissolved Oxygen[3]			N/A			N/A	
	pH[4]							
Ocean Inlet[5]	Temperature	discrete sampling only – no continuous monitoring of ocean inlet	1 site/ lagoon	2 sites (1 at tidal inlet and at I-5 bridge)	No ocean inlet	1 site/ lagoon	1 site/ lagoon	1 site/ lagoon
	Conductivity							
	Turbidity							
	Water Level							
	Dissolved Oxygen[3]			N/A			N/A	
	pH[4]							

N/A: Not applicable

The following assumptions govern level of sampling effort per lagoon:

- Rainfall will be monitored continuously for one year (October 1, 2007- September 30, 2008).
- Mass emission site monitoring is continuous for one year (October 2007- September 2008). Primary hydrodynamic parameters are required continuously throughout the year, which includes flow, conductivity, and temperature. Dissolved oxygen and pH only required in eutrophic lagoons during index period sampling.

[2] To be measured during index periods only
[3] To be measured during index periods only
[4] To be measured during index periods only
[5] To be measured only when lagoon mouth is open.

- Length of continuous monitoring and target parameters for segments and ocean inlet depend on the lagoon
    - Eutrophication-listed lagoons: 3 months wet season (January – March) and 4 months dry season (beginning of June through end of September)
    - Santa Margarita only has discrete sampling and measurement of dimensions of ocean inlet; no continuous monitoring is required
    - Agua Hedionda Lagoon has 3 months wet season (January – March) and 3 months dry season (July through August)
    - Los Peñasquitos Lagoon has no dry season continuous monitoring; wet season continuous monitoring will be conducted from October 2007 through end of March 2008.
- Sample numbers for *in-situ* monitoring of hydrology, primary chemical parameters, and discrete water quality samples for all analytes are given assuming a 2-meter depth at each site. The actual number of vertical depths at which probes and samplers will be deployed will be based on the total depth at a given site, based on the following rule set:
    - One depth (mid-depth) will be monitored for sites less than 2 meters deep
    - 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
    - 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep

2. Wet Weather Sources and Within Lagoon Sampling

Wet weather sources consist of three major types: 1) watershed loading, 2) direct runoff to the lagoon from storm drains within the lagoon's local catchment, and 3) atmospheric deposition. Groundwater contribution is presently ignored for reasons discussed in the previous section. Watershed loading of the targeted contaminants will be estimated through a wet weather watershed model (see Conceptual Model section above). Data collection will include pollutagraph sampling (flow and concentration) at a mass emission site in the main tributary, sampling within the lagoons and at the ocean inlet to capture impacts of the storms on lagoon water quality. Post-storm sediment sampling will be conducted to assess how the storm impacts sediment bulk characteristics after one storm. Atmospheric deposition will be estimated from existing data in the literature.

Wet weather sampling is sub-divided into 4 sections each of which is detailed on the following pages:

2.1. Collection of pollutagraph data during storm events
2.2. Storm event sampling within the lagoons
2.3. Storm event sampling at the ocean inlet
2.4. Sediment sampling within the lagoons after a storm event

2.1. Watershed Hydrology and Pollutagraph Sampling

Watershed loading during wet weather will be estimated from pollutagraphs generated during storm events. Storm events should span a range of sizes. Though prediction of the amount of

rainfall in each storm prior to the event is not possible, a best effort should be made using pre-storm weather forecasts to sample storms with rainfall spanning a range from 0.2 inch to 1 inch or greater. Pollutagraphs estimate the contaminant discharge as a function of time. They can be used to determine the loading of contaminants from the watershed to the lagoons over the course of a storm event.

Pollutagraph sampling at mass emission sites will occur during three storm events in Los Peñasquitos Lagoon, Famosa Slough, and Santa Margarita Lagoon, with 10 samples taken throughout the pollutagraph per storm. Los Peñasquitos will measure 3 events at each of 3 mass emission sites, for a total of 9 pollutagraphs generated over the wet season.

In Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, and Agua Hedionda Lagoon, additional storm water sampling is being conducted and will provide event mean concentrations for 2 storms. For this reason, the number of required storms for these four lagoons was reduced from three to two. For these four lagoons, pollutagraph sampling will consist of 8 samples per storm.

For those lagoons listed for bacterial impairment (Agua Hedionda, San Elijo Lagoon, and Buena Vista Lagoon, and Loma Alta), only five of the pollutagraph samples collected need to be analyzed for bacteria per storm.

In addition to the chemical constituents required for a given impairment, all lagoons will monitor particle size distribution at the mass emission site during a minimum of one storm event. The sample to be analyzed will consist of one composite of the 8-10 pollutagraph samples taken over the course of the storm. The sample will be analyzed, at minimum, for %sand/silt/clay.

Additional monitoring of large tributaries that drain into lagoons downstream of the mass emission site is not required during wet weather. Wet weather contribution of these tributaries will be modeled. This applies specifically to San Elijo Lagoon and Santa Margarita Estuary, but may apply to others.

Table 7 lists the total number of samples required for pollutagraph sampling for each lagoon.

Table 7. Minimum number of samples for pollutagraph sampling by lagoon and targeted analytes. Fixed site refers to instrumentation continuously measuring water quality parameters at the ME site.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Fixed site at ME						
	Conductivity	Fixed site at ME						
	Turbidity	Fixed site at ME						
	Total Suspended Solids (TSS)	30	16	16	16	16	90	30
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	16	--	--	--	--
Bacteria	Total Coliform	--	10	10	10	10	--	--
	Fecal Coliform	--	10	10	10	10	--	--
	Enterococcus	--	10	10	10	10	--	--
Eutrophication	pH	**--**						

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
	Dissolved Oxygen (DO)	--						
	Total Nitrogen (TN)	30	16	--	16	16	--	30
	Total Phosphorus (TP)	30	16	--	16	16	--	30
	Total Dissolved Nitrogen (TDN)	30	16	--	16	16	--	30
	Total Dissolved Phosphorus (TDP)	30	16	--	16	16	--	30
	Nitrate+Nitrite-N	30	16	--	16	16	--	30
	Ammonium	30	16	--	16	16	--	30
	Soluble Reactive Phosphorus (SRP)	30	16	--	16	16	--	30
	Chlorophyll a	--	--	--	--	--	--	--
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	30	16	--	16	16	--	30
Particle size of Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	3	1	1	1	1	9	1
	% Organic Carbon (%OC)	--	--	--	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--	--	--	--

2.2. Lagoon Storm Sampling

The purpose of storm event sampling within the lagoons is to calibrate the lagoon water quality model with respect to its response over the course of a storm event. Storm event sampling within the lagoon will be conducted simultaneously with pollutagraph sampling and ocean inlet sampling during storm events. Because Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon and Agua Hedionda Lagoon are only required to sample two pollutagraphs, the third within lagoon storm event sampling should correspond to one of the two EMC storms monitored. The influence of a storm on the lagoon may lag the onset of the storm and that lag period will vary with each lagoon; therefore, timing of lagoon storm sampling and how it is done is not specified in order to leave stakeholders maximum flexibility. One option is that samples could be taken with an autosampler. If this is done, then many samples will be collected over the storm, and a subset of samples could be selected based on the salinity of the sample, the turbidity of the sample, and the targeted period (slack high and low tide). Such a sampling protocol would allow Stakeholders to select those samples that best represent the freshwater plume as it moves through the lagoon. Suggested locations of autosamplers within lagoon segments are listed

below. Final locations are at discretion of stakeholders and will depend on logistics and safety of staff and/or consultants:

- Agua Hedionda Lagoon: segment sampler at I-5 bridge
- Santa Margarita Estuary: segment samplers at Stuart Mesa Bridge and I-5 bridge
- Loma Alta Slough: segment sampler at railroad trestle
- Buena Vista Lagoon: segment samplers at I-5 and Carlsbad Boulevard bridges
- San Elijo Lagoon: segment samplers at I-5 bridge and at Segment 1 site
- Los Peñasquitos Lagoon: segment samplers at railroad trestle and Via Cortina .
- Famosa Slough: segment sampler at West Point Loma Boulevard.

Table 8 gives the number of samples associated with this effort. The following assumptions were used to calculate these numbers:

- Because of safety issues, continuous monitoring of the lagoons during storm events will be conducted via automated sampling set up at key access points (railroad trestles, bridges, etc.) that mark the boundaries between segments (boundaries between segments being the narrowest section)
- In all lagoons except Los Peñasquitos Lagoon, storm samples will consist of 2 samples per event taken during slack high and slack low tide during the storm and each sample will be a 3-hour composite of sub-samples taken at 15-minute intervals.
- Sampling in Los Peñasquitos Lagoon will consist of periodic interval samples taken per storm at each ME, segment and ocean inlet location and from these 12 will be selected for analysis per station.
- Sample numbers for *in-situ* monitoring of hydrology, primary chemical parameters, and discrete water quality samples for all analytes are given assuming a 2-meter depth at all sites. The actual number of vertical depths at which samples will be taken will be based on the total depth at a given site, based on the following rule set:
    - One depth (mid-depth) will be sampled for sites less than 2 meters deep
    - 2 vertical depths (surface and bottom) will be sampled for sites between 2 and 4 meters deep
    - 3 vertical depths (surface, mid-depth, and bottom) will be sampled for sites greater than 4 meters deep.

Table 8. Wet weather lagoon storm sampling. Moored site refers to instrumentation to continuously measure water quality parameters within each segment.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Moored Site						
	Conductivity	Moored Site						
	Turbidity	Moored Site						
	Total Suspended Solids (TSS)	12	6	6	12	12	72	6
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	6	6	12	12	--	--
	Fecal Coliform	--	6	6	12	12	--	--

	Enterococcus	--	6	6	12	12	--	--
Eutrophication	pH	--	--	--	--	--	--	--
	Dissolved Oxygen (DO)	--	--	--	--	--	--	--
	Total Nitrogen (TN)	12	6	--	12	12	--	6
	Total Phosphorus (TP)	12	6	--	12	12	--	6
	Total Dissolved Nitrogen (TDN)	12	6	--	12	12	--	6
	Total Dissolved Phosphorus (TDP)	12	6	--	12	12	--	6
	Nitrate+Nitrite-N	12	6	--	12	12	--	6
	Ammonium	12	6	--	12	12	--	6
	Soluble Reactive Phosphorus (SRP)	12	6	--	12	12	--	6
	Chlorophyll a	12	6	--	12	12	--	6
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	12	6	--	12	12	--	6
Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	--						
	% Organic Carbon (%OC)	--	--	--	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--	--	--	--

2.3. Ocean Inlet Sampling

The purpose of the ocean inlet sampling is to calibrate the lagoon water quality model with respect to the net transport of the targeted contaminants to the ocean from the lagoons during a storm event. Sampling at the ocean inlet will be conducted simultaneously with pollutagraph and within lagoon sampling during each of the 3 storm events. As with lagoon segment sampling, ocean inlet sampling during storm events can be conducted using an autosampler deployed at a fixed location in each lagoon and the storm lag should be considered. Potential locations for ocean inlet autosampler locations are:

- Agua Hedionda Lagoon: Pacific Coast Highway bridge
- Santa Margarita Estuary: Discreet samples measured daily in coastal ocean
- Loma Alta Slough: Pacific Street bridge
- Buena Vista Lagoon: no ocean inlet sampling optional during storm event
- San Elijo Lagoon: Pacific Coast Highway bridge
- Los Peñasquitos Lagoon: North Torrey Pines Road bridge
- Famosa Slough: culvert to San Diego River

Table 9 gives the number of samples associated with this effort. The following assumptions were used to calculate these sample numbers:

- In all lagoons except Los Peñasquitos Lagoon, storm samples will consist of 2 samples per event taken during slack high and slack low tide during the storm and each sample will be a 3-hour composite of sub-samples taken at 15-minute intervals.
- Sampling in Los Peñasquitos Lagoon will consist of periodic interval samples taken per storm at each location and from these 12 will be selected for analysis.
- Sample numbers for *in-situ* monitoring of hydrology, primary chemical parameters, and discrete water quality samples for all analytes are given assuming a 2-meter depth at all sites. The actual number of vertical depths at which samples will be taken will be based on the total depth at a given site, based on the following rule set:
    - One depth (mid-depth) will be sampled for sites less than 2 meters deep
    - 2 vertical depths (surface and bottom) will be sampled for sites between 2 and 4 meters deep
    - 3 vertical depths (surface, mid-depth, and bottom) will be sampled for sites greater than 4 meters deep.

Table 9. Wet weather ocean inlet sampling. Moored site refers to instrumentation to continuously measure water quality parameters within each segment.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Moored Site						
	Conductivity	Moored Site						
	Turbidity	Moored Site						
	Total Suspended Solids (TSS)	6	6	6		6	36	6
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	6	6	--	6	--	--
	Fecal Coliform	--	6	6	--	6	--	--
	Enterococcus	--	6	6	--	6	--	--
Eutrophication	pH	--	--	--	--	--	--	--
	Dissolved Oxygen (DO)	--	--	--	--	--	--	--
	Total Nitrogen (TN)	6	6	--	--	6	--	6
	Total Phosphorus (TP)	6	6	--	--	6	--	6
	Total Dissolved Nitrogen (TDN)	6	6	--	--	6	--	6
	Total Dissolved Phosphorus (TDP)	6	6	--	--	6	--	6
	Nitrate+Nitrite-N	6	6	--	--	6	--	6
	Ammonium	6	6	--	--	6	--	6
	Soluble Reactive Phosphorus (SRP)	6	6	--	--	6	--	6
	Chlorophyll a	6	6	--	--	6	--	6

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	6	6	--	--	6	--	6
Particle Size in Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	Optional						
	% Organic Carbon (%OC)	--	--	--	--	--	--	--
	% Organic Nitrogen (%ON)	--	--	--	--	--	--	--
	% Total Phosphorus (%TP)	--	--	--	--	--	--	--

2.4. Post-storm Event Sediment Sampling

The purpose of this sampling element is to calibrate the lagoon sediment transport and water quality models with respect to the impact of a storm event on the spatial characteristics of sediment within the lagoon. These data will be used to determine where sediments settle in the lagoon. Post-storm event sediment sampling should occur within 2 weeks after one of the three storm events. In order to trigger this sampling, the storm should be generally ±50 % of the median storm. Sediment samples should be surface grab samples, no more than 2 cm deep.

Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, Famosa Slough, Agua Hedionda Lagoon, and Santa Margarita Estuary will collect sediment samples and SCCWRP will cover the cost of the analysis (% fines, % organic carbon, % organic nitrogen, and % total phosphorus).

Los Peñasquitos Lagoon sediments will be analyzed for % sand, silt and clay and the stakeholders will pay for the grain size analysis.

Table 10 gives the number of sediment samples and their approximate distribution. Table 11 gives the number of samples associated with this effort. Sample sites should be distributed throughout the lagoon with a greater density in areas of greatest deposition or scouring.

Table 10. Number and distribution of post storm event sediment sampling locations

Lagoon	**Number of Sediment Samples and Approximate Location**
Santa Margarita	15 (8 west of I- 5, 7 east of I-5). Samples west of I-5 should include southern most tidal channel.
Loma Alta	5 (3 west of PCH bridge, 2 east of PCH bridge)
Agua Hedionda	10 (assuming just in the easternmost basin)
Buena Vista	10 in eastern most basin, 10 in central basin
San Elijo	5 in eastern most basin, 30 in western-most basin
Los Peñasquitos	20 (focusing on habitats not previously sampled in recent studies)
Famosa Slough	15 (5 in channel, 10 in central basin)

Table 11. Post-storm event sediment sampling.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	15	5	30	20	35	27	15
	% Organic Carbon (%OC)	15	5	--	20	35	--	15
	% Organic Nitrogen (%ON)	15	5	--	20	35	--	15
	% Total Phosphorus (%TP)	15	5	--	20	35	--	15

3. *Monitoring of Dry Weather Sources and Within Lagoon Hydrodynamics and Water Quality*

As with the wet weather monitoring, data collected for the dry weather program is designed to support the watershed model development through the estimation of loading and fluxes of target constituents into and out of each lagoon. Dry weather monitoring consists of storm drains, each mass emission site, ocean inlet, and within lagoon sampling sites during key "index" periods. These index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

Dry weather sampling is sub-divided into 2 sections, each of which is detailed below:

3.1. Storm drain and other point source sampling
3.2. Index period monitoring of lagoon segments, the ocean inlet, mass emission site and lagoon longitudinal transects

3.1. Storm Drain and Other Point Source Sampling

Storm drains are not expected to be a significant source of constituents to each lagoon during dry weather due to low flows. Thus, flow rates and analyte concentration will be measured once per index period at those drains that represent 80% of the target constituent loading into each lagoon. Table 12 lists the estimated number of samples that will be collected for the storm drain study for each lagoon. Point sources specific to individual lagoons (e.g. a large tributary that flows into the lagoon downstream of the mass emission site) should also be sampled once per index period in addition to the storm drain sampling. Once identified, these point sources will be added to Table 12. The following assumptions governed the estimates of the number of storm drain samples:

- We assume that all lagoons have historical data documenting which drains are responsible for 80% of loading of the contaminant of concern. For these lagoons, only those drains that represent 80% of the load will be sampled for flow and the target analytes one day during each index period.

- Stakeholders that have historical data of this nature for the lagoon will provide a copy of these data to the SD Regional Water Quality Control Board.
- We assume that 3 drains per lagoon constitute 80% of the load and that these 3 drains will be sampled once per index period.
- We assume that San Elijo Lagoon and Santa Margarita Estuary each have one large tributary that drain into the lagoons downstream of the mass emission site, though other point sources may be identified within these lagoons and others.
- Los Peñasquitos Lagoon is not subject to dry weather monitoring, therefore no storm drains will be sampled.
- For lagoons in which no historical data exists, all drains must be sampled for the full suite of analytes for one day during the first index period to screen for the 80%.

Table 12. Storm drain sampling. Hand held refers to parameters measured over specified period with hand held device

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Hand held						
	Conductivity	Hand held						
	Turbidity	Hand held						
	Total Suspended Solids (TSS)	64	64	64	64	64	--	64
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	64	64	64	64	--	--
	Fecal Coliform	--	64	64	64	64	--	--
	Enterococcus	--	64	64	64	64	--	--
Eutrophication	pH	Hand held	Hand held	--	Hand held	Hand held	--	Hand held
	Dissolved Oxygen (DO)	Hand held	Hand held	--	Hand held	Hand held	--	Hand held
	Total Nitrogen (TN)	64	64	--	64	64	--	64
	Total Phosphorus (TP)	64	64	--	64	64	--	64
	Total Dissolved Nitrogen (TDN)	64	64	--	64	64	--	64
	Total Dissolved Phosphorus (TDP)	64	64	--	64	64	--	64
	Nitrate+Nitrite-N	64	64	--	64	64	--	64
	Ammonium	64	64	--	64	64	--	64
	Soluble Reactive Phosphorus (SRP)	64	64	--	64	64	--	64
	Chlorophyll a	64	64	--	64	64	--	64
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	64	64	--	64	64	--	64

3.2. Index Period Monitoring

Sampling during index periods is intended to calibrate and validate the hydrodynamic and water quality models with data capturing seasonal cycles of physical forcing and biological activity within the lagoons. Spacing of index periods is particularly important for lagoons with eutrophication and bacteria impairments due to seasonality in algae blooms and associated variations in nutrient cycling.

The following section covers sampling of all constituents during the index periods in the following locations:

3.2.1. Within lagoon segments,
3.2.2. At ocean inlet,
3.2.3. At mass emission site,
3.2.4. Along longitudinal transects.

These index periods are intended to capture representative seasonal cycles of physical forcing and biological activity in the lagoon.

Index periods for each lagoon are as follows:

- Agua Hedionda Lagoon: Four index periods, 7 days in length split over 2 weeks
- Santa Margarita Estuary: Four index periods, 7 days in length split over 2 weeks
- Loma Alta Slough: Four index periods, 7 days in length split over 2 weeks
- Buena Vista Lagoon: Four index periods, 7 days in length split over 2 weeks
- San Elijo Lagoon: Four index periods, 7 days in length split over 2 weeks
- Los Peñasquitos Lagoon: No dry weather index period sampling
- Famosa Slough: Four index periods, 7 days in length split over 2 weeks

Table 13 provides an example of a sampling schedule for a typical 7-day index period. Within lagoon segment sampling is spread over 6 days during 2 weeks. Transect sampling is conducted on the 4th day of the first week (Table 13). For the six lagoons with four, 7-day index periods, the last two index periods will be sampled in the next fiscal year of the local agencies (i.e. sampling for 3rd and 4th index period will occur in July and September respectively). This applies to mass emission site sampling, lagoon segments, ocean inlet sampling, storm drain sampling, and lagoon transects.

Table 13. Mock up of sampling schedule for a typical index period for all lagoons except Los Peñasquitos (4 index periods with sampling activities occurring on a total of 7 days). Ocean inlet, within-lagoon segment, and ME sampling is spread over 6 days during 2 weeks. Transect sampling is conducted on the 4th day of the first week.

Day	Santa Margarita, Loma Alta, Buena Vista, San Elijo, Agua Hedionda and Famosa Slough	
	Week 1	Week 2
Mon	ME Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for BVL)	ME Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for BVL)

Day	Santa Margarita, Loma Alta, Buena Vista, San Elijo, Agua Hedionda and Famosa Slough	
	Week 1	Week 2
Tues	ME Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for BVL)	ME Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for BVL)
Wed	ME Site – 1 x per day Segments & ocean inlet – 2 X per day (1/day for BVL)	ME Site – 1 X per day Segments & ocean inlet – 2 X/day (1/day for BVL)
Thurs	Transect sampling (ebb and flood tide or AM & PM for BVL)	No sampling
Fri	No sampling	
Sat	No sampling	
Sun	No sampling	

3.2.1. Lagoon Segment Sampling:

Sampling at each segment site constrains intra-lagoon variability in target constituents, as well as daily variations at each individual segment. Table 3 gives the number of segments per lagoon. Table 14 indicates the lagoon segment sampling effort by targeted analyte during all index periods. The following assumptions govern the estimate of sampling effort by lagoon for this component:

- Sampling within each segment will be conducted during each index period
- One 30-minute composite of samples (3 samples taken every 15 minutes and composited) will be collected at each segment site per two meters of depth once per day at non-tidal lagoons and twice per day (ebb and flood tides) for tidal lagoons.
- For the all lagoons except Los Peñasquitos, this sampling will occur on the first 3 days of the two weeks for each index period (6 days per index period)
- Sample numbers for *in-situ* monitoring of hydrology, primary chemical parameters, and discrete water quality samples for all analytes are given assuming a 2-meter depth at each site. The actual number of vertical depths at which probes and samples will be deployed will be based on the total depth at a given site, based on the following rule set:
    - One depth (mid-depth) will be monitored for sites less than 2 meters deep
    - 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
    - 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep.

Table 14. Lagoon water quality sampling within segments during index periods. Moored site refers to instrumentation to continuously measure water quality parameters within each segment.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Moored Site						
	Conductivity	Moored Site						
	Turbidity	Moored Site						

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
	Total Suspended Solids (TSS)	96	48	48	48	96	--	48
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	48	48	48	96	--	--
	Fecal Coliform	--	48	48	48	96	--	--
	Enterococcus	--	48	48	48	96	--	--
Eutrophication	pH	Moored	Moored	--	Moored	Moored	--	Moored
	Dissolved Oxygen (DO)	Moored	Moored	--	Moored	Moored	--	Moored
	Total Nitrogen (TN)	96	48	--	48	96	--	48
	Total Phosphorus (TP)	96	48	--	48	96	--	48
	Total Dissolved Nitrogen (TDN)	96	48	--	48	96	--	48
	Total Dissolved Phosphorus (TDP)	96	48	--	48	96	--	48
	Nitrate+Nitrite-N	96	48	--	48	96	--	48
	Ammonium	96	48	--	48	96	--	48
	Soluble Reactive Phosphorus (SRP)	96	48	--	48	96	--	48
	Chlorophyll a	96	48	--	48	96	--	48
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	96	48	--	48	96	--	48

3.2.2. Ocean Inlet Sampling

The ocean inlet will be monitored over each index period in order to constrain the tidal exchange across the inlet over each of the index periods. This sampling will be conducted at all lagoons except Buena Vista, which has no tidal exchange. For all other lagoons, if the mouth of the lagoon is closed during the index period, then ocean inlet sampling is not required. Ocean inlet sampling should correspond with index period sampling of lagoon segments and mass emission sites. Table 15 indicates the sampling effort at the ocean inlet during all index periods. The following assumptions govern the estimate of sampling effort by lagoon for this component:

- At the ocean inlet sampling will be conducted daily during each of the index periods, assuming the mouth of the lagoon is open during each index period.
- One 30-minute composite sample of sub-samples taken every 15 minutes will be collected at the ocean inlet site per two meters of depth twice per day (ebb and flood tides and low tides; *c.f.* Section 1).
- This sampling will occur on the first 3 days of each week for all lagoons (except Los Peñasquitos with the 4 index periods (6 days per index period).
- Sample numbers for *in-situ* monitoring of hydrology, primary chemical parameters, and discrete water quality samples for all analytes are given assuming a 2-meter depth at each

site. The actual number of vertical depths at which probes and samples will be deployed will be based on the total depth at a given site, based on the following rule set:

- One depth (mid-depth) will be monitored for sites less than 2 meters deep
- 2 vertical depths (surface and bottom) will be monitored for sites between 2 and 4 meters deep
- 3 vertical depths (surface, mid-depth, and bottom) will be monitored for sites greater than 4 meters deep.

Table 15. Ocean inlet sampling during index periods. Moored site refers to instrumentation to continuously measure water quality parameters within each segment.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hediond a	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Moored Site						
	Conductivity	Moored Site						
	Turbidity	Moored Site						
	Total Suspended Solids (TSS)	48	48	48	--	48	--	48
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	48	48	--	48	--	--
	Fecal Coliform	--	48	48	--	48	--	--
	Enterococcus	--	48	48	--	48	--	--
Eutrophication	pH	Moored	Moored	--	--	Moored	--	Moored
	Dissolved Oxygen (DO)	Moored	Moored	--	--	Moored	--	Moored
	Total Nitrogen (TN)	48	48	--	--	48	--	48
	Total Phosphorus (TP)	--	48	--	--	48	--	48
	Total Dissolved Nitrogen (TDN)	48	48	--	--	48	--	48
	Total Dissolved Phosphorus (TDP)	48	48	--	--	48	--	48
	Nitrate+Nitrite-N	48	48	--	--	48	--	48
	Ammonium	--	48	--	--	48	--	48
	Soluble Reactive Phosphorus (SRP)	48	48	--	--	48	--	48
	Chlorophyll a	48	48	--	--	48	--	48
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	48	48	--	--	48	--	48

Moored site = continuous monitoring with moored instrument

3.2.3. Mass Emission Site Sampling:

Loading from the watershed will be estimated by monitoring the mass emission site over each of the index periods, conducted simultaneously with sampling of the lagoon segments and ocean

inlet sites. Table 16 indicates the sampling effort at the mass emission site during all index periods. The following assumptions govern the estimate of sampling effort by lagoon for this component:

- Mass emission site sampling will be conducted daily during the same index periods as the within segment sampling and ocean inlet sampling, occurring on the first 3 days of each week for the six lagoons with the 4 index periods (6 days per index period).
- Water samples will be 30-minute composite samples (samples collected at 0, 15 and 30 minutes) collected once per day.

Table 16. Mass emission site sampling during index periods. Fixed site refers to instrumentation to continuously measure water quality parameters at the ME site.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Fixed Site						
	Conductivity	Fixed Site						
	Turbidity	Fixed Site						
	Total Suspended Solids (TSS)	24	24	24	24	24	--	24
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	24	--	--	--	--
Bacteria	Total Coliform	--	24	24	24	24	--	--
	Fecal Coliform	--	24	24	24	24	--	--
	Enterococcus	--	24	24	24	24	--	--
Eutrophication	pH	Fixed	Fixed	--	Fixed	Fixed	--	Fixed
	Dissolved Oxygen (DO)	Fixed	Fixed	--	Fixed	Fixed	--	Fixed
	Total Nitrogen (TN)	24	24	--	24	24	--	24
	Total Phosphorus (TP)	24	24	--	24	24	--	24
	Total Dissolved Nitrogen (TDN)	24	24	--	24	24	--	24
	Total Dissolved Phosphorus (TDP)	24	24	--	24	24	--	24
	Nitrate+Nitrite-N	24	24	--	24	24	--	24
	Ammonium	24	24	--	24	24	--	24
	Soluble Reactive Phosphorus (SRP)	24	24	--	24	24	--	24
	Chlorophyll a	24	24	--	24	24	--	24
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	24	24	--	24	24	--	24

3.2.4. Transect Sampling

The purpose of measuring a longitudinal transect is to provide spatial data by which the water quality will be calibrated and then validated within the lagoon. Sampling conducted at moored

sites within segments provides data on only one site within each segment, albeit for 6 days. Data from a longitudinal transect will show the mean and range of values for targeted contaminants for each segment. Measuring values over the transect twice provides data for both calibration and validation of the models.

Transect samples will be collected during flood and ebb tide (morning and evening for Buena Vista) on the fourth day of week 1 of each index period (Table 13).

The number of samples per lagoon for the first and second transects as well as the locations for transect sampling are given in Table 17. For Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, Santa Margarita Estuary, and Famosa Slough, stakeholders will collect these samples, but SCCWRP will pay for the analysis of nutrients, TSS, and chlorophyll a. For all other constituents required (e.g. BOD, bacteria, etc.), stakeholders may choose to only analyze the minimum number per segment (3). For these lagoons, transect samples should include samples from the either the ME site (or other location just upstream of tidal influence) and ocean inlet endmembers. The number of transect locations in each eutrophication-listed lagoon is scaled to its size. Transect samples should be collected at 0.5 m below the surface as grab samples and should be spaced throughout the lagoon.

Table 17. Number of transect samples by lagoon

Lagoon	Transect 1 (1st of index period)	Transect 2 (2nd of index period)	Location
Santa Margarita	12	12	Along salinity gradient, with a few samples taken in southern most tidal channel
Loma Alta	8	8	Along salinity gradient)
Agua Hedionda	3	3	In western most basin only
Buena Vista	10	10	5 in eastern most basin, 5 in central basin
San Elijo	18	18	3 in eastern most basin and 15 in western-most basin (along salinity gradient and with spatial coverage of whole basin)
Los Peñasquitos	None	None	Not applicable
Famosa Slough	15	15	5 in channel, 10 in central basin

Table 18 shows the transect sampling level of effort for each lagoon.

The following assumptions govern the estimate of sampling effort by lagoon for this component:

- Two longitudinal transects will be conducted in each lagoon during the same index period as the within segment sampling, ocean inlet and mass emission site sampling
- Number of transect sites varies by lagoon (Table 17).

- At each transect site, discrete water samples will be collected just below the water surface, salinity, temperature, turbidity, dissolved oxygen, and pH will be measured with a hand-held probe, and the GPS location will be recorded.

Table 18. Transect sampling during index periods. Hand held refers to water quality parameters measured over vertical profile in the water column with hand held device.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	Hand held						
	Conductivity	Hand held						
	Turbidity	Hand held						
	Total Suspended Solids (TSS)	96	64	24[6]	80	144	--	104
Total Dissolved Solids	Total Dissolved Solids (TDS)	--	--	--	--	--	--	--
Bacteria	Total Coliform	--	24	24	24	24	--	--
	Fecal Coliform	--	24	24	24	24	--	--
	Enterococcus	--	24	24	24	24	--	--
Eutrophication	pH	Hand held	Hand held	--	Hand held	Hand held	--	Hand held
	Dissolved Oxygen (DO)	Hand held	Hand held	--	Hand held	Hand held	--	Hand held
	Total Nitrogen (TN)	96	64	--	80	144	--	104
	Total Phosphorus (TP)	96	64	--	80	144	--	104
	Total Dissolved Nitrogen (TDN)	96	64	--	80	144	--	104
	Total Dissolved Phosphorus (TDP)	96	64	--	80	144	--	104
	Nitrate+Nitrite-N	96	64	--	80	144	--	104
	Ammonium	96	64	--	80	144	--	104
	Soluble Reactive Phosphorus (SRP)	96	64	--	80	144	--	104
	Chlorophyll a	96	64	--	80	144	--	104
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	24	24	--	24	24	--	24

4. <u>Special Studies</u>

There are 4 types of special studies that will be conducted by SCCWRP in lagoons listed for eutrophication or nutrient enrichment (Santa Margarita Lagoon, Loma Alta Slough, Buena Vista Lagoon, San Elijo Lagoon, and Famosa Slough). The purpose of these studies is to provide data on the inventories of nutrients in key components that store nutrients within the system (i.e. sediments, primary producer biomass) and to measure the rates of exchange of nutrients between

[6] Transect samples will only be collected in western most basin

compartments, if existing literature is not sufficient to characterize these exchanges. These studies include:

4.1. Characterization of sediment bulk characteristics and sediment total and pore water sediment nitrogen (N) and phosphorus (P) content;
4.2. Measurement of wet season and annual sediment deposition and particulate N and P loading;
4.3. Measurement of sediment and oxygen demand and benthic N and P flux to the surface waters;
4.4. Measurement of aquatic primary producer biomass and/or percent cover and tissue nutrient content; and
4.5. Measurement of denitrification rates within sediment.

Special studies will be conducted at the same sites as stakeholder sampling (Tables 3 and 4). Additional special studies may be included by stakeholders in individual lagoons to characterize a particular source to the system. A summary of the SCCWRP special studies and tables of effort are given below. Sample numbers do not include replicate analysis and blanks.

4.1. Characterization of Sediment Bulk and Pore Water N and P Content

The purpose of this study element is to inventory the content of nutrients and related parameters in lagoon sediments. Sediment pore water nutrients, sediment bulk characteristics (grain size, porosity, percent organic carbon, and total sediment N and P) will be measured during each index period along a vertical profile within a site in each segment of the five lagoons. Pore water equilibrators (a.k.a. peepers) will be used to sample sediment pore water. Each peeper consists of a 50x18 cm solid, plexiglass frame into which cells are milled at a spacing of either 1.0 or 2.0 cm. The cells are filled with water and a filter is laid over the surface of the frame. The filter is held in place by an outer plexiglass frame secured with teflon screws. Peepers are pushed by hand into the sediment and a two-week period is allowed for equilibration. Immediately following retrieval, pore water samples are extracted and preserved for subsequent analysis.

Bulk sediment characteristics and bulk sediment and pore water nutrient concentrations will be measured during the four index periods within each of the segments in the five lagoons. One sediment core will be taken per segment per site (the same core is used for measurement of radioisotopes, discussed below) and vertically sectioned down to 12 cm. Within each 2 cm section, percent solids, porosity, percent organic carbon, percent organic nitrogen, percent total phosphorus, and grain size (percent sand) will be measured. Pore waters will be analyzed for dissolved TN, dissolved TP, ammonia, SRP, nitrate, dissolved organic carbon, dissolved iron, and sulfide. Table 19 shows the level of effort for the characterization of sediment bulk and pore water nutrient content for each lagoon.

The following assumptions govern the estimate of sampling effort by lagoon for this component:

- One 12 cm core will be taken at each segment site during each of the 4 index periods. This core will be subdivided into six, 2 cm sections each of which will be analyzed for sediment constituents

- One pore water peeper will be installed at each segment site during each of the 4 index periods. Peepers will collect pore waters from 2 cm depth intervals down to 12 cm for a total of 6 pore water samples.

Table 19. Sediment bulk and pore water (PW) nutrient content

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Probe in Surface Water	Temperature	Hand Held				
	Conductivity					
	pH					
	Dissolved Oxygen					
Sediment	% Fines or %Sand/Silt/Clay	48	24	48	48	24
	% Organic Carbon	48	24	48	48	24
	% Organic Nitrogen	48	24	48	48	24
	% Total Phosphorus	48	24	48	48	24
	Porosity	48	24	48	48	24
	PW Total Dissolved Nitrogen	48	24	48	48	24
	PW Total Dissolved Phosphorus	48	24	48	48	24
	PW Nitrate- N	48	24	48	48	24
	PW Ammonia- N	48	24	48	48	24
	PW Soluble Reactive Phosphorus	48	24	48	48	24
	PW Dissolved Iron	48	24	48	48	24
	PW Dissolved Manganese	48	24	48	48	24
	PW Dissolved Organic Carbon	48	24	48	48	24
	PW Sulfide	48	24	48	48	24

4.2. Wet Season and Annual Sediment Deposition and Particulate N and P Loading

The purpose of this study element is to measure the rate of wet season and annual sediment deposition and particulate N and P loading within the lagoons. A common problem in estimating nutrient sources to estuaries and coastal lagoons is the lack of consideration of particulate load from the watershed. This load can be underestimated if loading from freshwater sources is calculated from surface water nutrient concentrations and flow alone. Watershed-derived sediments deposited in estuaries during the wet season carry an associated particulate nutrient load. When deposited in the estuary, these particulate nutrients break down to biologically available forms and may build up in high concentrations in sediment pore waters. Therefore, wet season and net annual sediment and particulate nutrient deposition will be measured in the five lagoons listed for eutrophication. The measurement of wet season sediment deposition and associated particulate nutrient load into lagoon will be done, where possible, with naturally occurring radioisotope tracer beryllium-7 (Be-7). The natural radionuclide Be-7 (53-day half-life) is produced in the atmosphere and has a constant rate of supply, via wet (rainfall) or dry deposition, to the Earth where they adhere to suspended particles in surface waters. These radioisotope tracers are deposited with sediments and can be used to track sedimentation and resuspension in aquatic environments such as lakes, lagoons and estuaries. Use of this technique

requires that the sediments are of sufficiently fine grain size that they adsorb these particles; thus in sediments with a high percentage of sand, it may not be possible to use these methods. These techniques allow the project team to track the fate of particulate nitrogen and phosphorus from the rainy season to the dry season.

Be-7 activity in sediments will be measured, at minimum, during the four index periods within each of the segments in the five lagoons. One sediment core will be taken per segment per site and vertically sectioned down to 12 cm (this is the same core that is used for bulk sediment characteristics – see section above). Radioisotope levels will be measured in the core, starting from the top of the core and proceeding downcore until no radioisotopes are detected. Table 20 shows the level of effort for the characterization of wet season and annual sediment deposition and particulate N and P Loading.

The following assumptions govern the estimate of sampling effort by lagoon for this component:

- One 12 cm core will be taken at each segment site during each of the 4 index periods. This core will be subdivided into six, 2 cm sections for analysis
- Assumes sediment grain size is sufficiently fine grained such that analysis can be conducted at each segment site.

Table 20. Number of samples for measurement of wet season and annual sediment deposition and particulate N and P Loading.

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Deposition	Beryllium- 7	48	24	48	48	24

4.3. Benthic N and P Flux

A combination of techniques will be used to estimate sediment flux of nutrients and oxygen demand. These include: 1) calculation of diffusive fluxes based on concentration gradient between surface waters and pore waters and 2) direct *in situ* measurements of nutrient flux and sediment oxygen demand using benthic flux chambers. We will use a combination of these techniques to estimate nutrient flux and sediment oxygen demand in all five lagoons targeted for nutrient TMDLs. A benthic chamber consists of cylindrical unit of approximately 30 cm in diameter and a clear acrylic lid. This chamber is mounted in an aluminum frame and is 'plumbed' with tubing leading to sample containers with a sample draw mechanism. The chambers are continuously stirred with a rotating paddle to mimic natural conditions. Each chamber is equipped with an oxygen electrode and temperature probe that monitors these parameters within the chamber and outside of the chamber every 15 minutes for the duration of the deployment. Once the lid closes, a spike of cesium bromide is injected into the chamber to estimate actual chamber volume. Water samples are then periodically drawn from the chamber water. These samples, when analyzed, yield the change in concentration of the targeted analyte over time. As the chamber is of known surface area and the volume of water contained with the chamber can be calculated, a flux rate can be derived.

Benthic flux will be measured during the four index periods within each of the segments in the five lagoons. A minimum of two replicate chamber deployments will be conducted per segment per index period. Chamber water samples will be analyzed for dissolved TN, dissolved TP, ammonia, SRP, nitrate, nitrate, total carbon dioxide, and bromide. Sediment oxygen and total carbon dioxide (TCO_2) flux will be determined from the change in oxygen and TCO_2 over time. After the deployment is completed, surface sediment samples will be collected and analyzed for grain size, organic carbon, organic nitrogen, and TP content, and sediment chlorophyll a. Table 21 shows the level of effort for the characterization of benthic N and P flux.

The following assumptions govern the estimate of sampling effort by lagoon for this component:

- Two benthic flux chambers will be installed at each segment site during each index period.
- One ambient water measurement and 5 time-series chamber measurements will be collected during each chamber incubation (6 total per chamber); only ambient waters will be analyzed for total nitrogen, total phosphorus, and Chlorophyll a.
- One bulk sediment analysis will be conducted per chamber per index period.

Table 21. Number of benthic flux samples from deployment of chambers.

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Probe	Temperature	96	48	96	96	48
	Conductivity	96	48	96	96	48
	pH	96	48	96	96	48
	Dissolved Oxygen	96	48	96	96	48
Sediment	% Fines or %Sand/Silt/Clay	96	48	96	96	48
	% Organic Carbon	96	48	96	96	48
	% Organic Nitrogen	96	48	96	96	48
	% Total Phosphorus	96	48	96	96	48
	Aluminum & Iron Content	96	48	96	96	48
	Porosity	96	48	96	96	48
	Sediment Chlorophyll a	96	48	96	96	48
Water	Total Nitrogen	96	48	96	96	48
	Total Dissolved Nitrogen	96	48	96	96	48
	Total Phosphorus	96	48	96	96	48
	Total Dissolved Phosphorus	96	48	96	96	48
	Nitrate+ Nitrite- N	96	48	96	96	48
	Ammonia- N	96	48	96	96	48
	Soluble Reactive Phosphorus	96	48	96	96	48
	Silicate	96	48	96	96	48

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
	Dissolved Iron	96	48	96	96	48
	Dissolved Manganese	96	48	96	96	48
	Chlorophyll a	96	48	96	96	48
	Dissolved Organic Carbon	96	48	96	96	48
	Total Carbon Dioxide	96	48	96	96	48
	Bromide	96	48	96	96	48

4.4. Inventory of Aquatic Primary Producer Cover and Tissue Content

Aquatic primary producer communities include macroalgae, benthic algal mats, and submerged aquatic vegetation. The purpose of this study element is to characterize seasonal variation in the standing biomass and cover of these primary producer communities and the tissue nutrient content of these communities. This information will be used to calibrate the component of the eutrophication water quality model that accounts for the storage and transformation of nutrients in primary producer community biomass.

Aquatic primary producer biomass will be measured during the four index periods within each of the segments in the five lagoons. For each site, a transect will be established and samples will be collected at randomly selected locations along each transect. Samples will be cleaned and weighed to determine wet and dry weights before and after drying. Dried samples will be analyzed for percent organic carbon, percent organic nitrogen and percent phosphorus. Table 22 shows the level of effort for the inventory of primary producer cover and tissue content.

The following assumptions govern the estimate of sampling effort by lagoon for this component:

- Five transect sites per segment site per index period.
- Assumes all sites have sufficient biomass.

Table 22. Algal biomass and tissue nutrient content.

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Algal Monitoring	Biomass	40	20	40	40	20
	% Organic Carbon	40	20	40	40	20
	% Organic Nitrogen	40	20	40	40	20
	% Total Phosphorus	40	20	40	40	20

4.5. Characterizing Benthic N Fixation and Denitrification Rates within Sediments

Denitrification and nitrogen fixation can alter the concentrations of dissolved inorganic nitrogen species within waterbodies. Nitrogen fixation transforms elemental nitrogen (N_2) into ammonium ions (NH_4^+) that can be used by primary producers, and therefore is considered a

"new" source of nitrogen. Denitrification transforms nitrate (NO_3^-) into atmospheric nitrous oxide (N_2O) or nitrogen (N_2), and is therefore a loss of nitrogen from aquatic ecosystems. The purpose of this study element is to develop a predictive statistical model of N-fixation by investigating factors controlling their response to increased N loads from the watershed. Field surveys will be conducted in selected locations within the 5 lagoons to test the predictive capability of this model.

Nitrification and denitrification rates will be determined within selected lagoon segments by either the acetylene inhibition technique or the ^{15}N isotope pairing technique. In both cases, a tracer (either acetylene or $^{15}NO_3$) is injected into a sediment core, which is subsequently incubated for several hours. The production of N_2O or N_2 gas is measured at regular intervals to generate a flux rate. One core will be collected at each of the segment sites coincidently with the other special study elements, frozen and returned to UCLA for incubation. Table 23 shows the level of effort for the characterization of nitrification and denitrification project element. Note that because this will be an element of a graduate student's thesis, the level of effort as well as the distribution of effort across lagoons may change from that represented in Table 23.

The following assumptions govern the estimate of sampling effort by lagoon for this component.

- One core will be collected from each segment site during two of the index periods (dry and wet season). Core will be analyzed for bulk characteristics.
- Assumes 6 sampling events during laboratory batch incubation of cores.

Table 23. Characterizing benthic N fixation and denitrification rates.

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Nitrification and Denitrification Rates	N_2O/N_2 gas production	24	12	24	24	12

5. Additional Special Considerations for Individual Lagoons

Both Buena Vista and San Elijo Lagoon deserve special attention for the lagoon restorations that are being planned for these two systems.

For San Elijo Lagoon, the SD RWQCB, SCCWRP, and TetraTech are committed to working with the stakeholders to assure that the existing data are used to the greatest extent possible in the analysis of existing conditions and modeling of lagoon hydrodynamics and water quality.

For Buena Vista, tighter coordination among interested parties is required in order to optimize the utility of data collected and modeling work for both the TMDL and restoration planning process. In this system, the Lagoon is undergoing restoration planning, with lagoon restoration to be completed in approx. 7-10 yrs. The Coastal Conservancy is preparing to develop the environmental impact reports and select the final alternative for the lagoon configuration. This is done by modeling lagoon hydrodynamics and water quality with respect to the restoration scenarios. With respect to this work, there is obvious overlap with the TMDL effort in the data

needed to develop and run these models and modeling work itself. Given this, the stakeholders and SD RWQCB came to the following resolutions regarding the coordination with this effort:

- Hydrodynamic model will be the same, so coordinate with Everest International (Coastal Conservancy consultants) on modeling effort and, in particular, effort should be made to suggest that they use EDFC to model restoration analysis.
- Water quality impacts of restoration scenarios should be considered as part of final selection of restoration plan
- Stakeholders, Regional Board and Coastal Conservancy (as lead on the effort) should determine how to cost-share, since data produced for the TMDL is same data needed for restoration effort
- Regional Board agreed to increase level of coordination within agency on project and will reach out to the Coastal Conservancy as well.
- Post-restoration lagoon monitoring should be aligned so that data can be collected to recalibrate model for new lagoon configuration.
- TMDL modeling should analyze the lagoon restoration scenarios under consideration

E. SUMMARY OF STAKEHOLDER SAMPLING EFFORT FOR DRY AND WET WEATHER

Tables 24 and 25 provide a summary of sampling effort by the stakeholders and SCCWRP respectively required to fulfill the data needs of the modeling effort. It should be noted that these numbers do no reflect the total number of samples required. An additional 10-15% should be included to meet SWAMP quality assurance requirements.

Table 24. Summary of stakeholder sampling effort by lagoon.

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
Primary	Temperature	In situ						
	Conductivity	In situ						
	Turbidity	In situ						
	Total Suspended Solids (TSS)	382	276	236	256	416	198	330
Total Dissolved Solids	Total Dissolved Solids (TDS)	0	0	40	0	0	0	0
Bacteria	Total Coliform	0	230	230	194	290	0	0
	Fecal Coliform	0	230	230	194	290	0	0
	Enterococcus	0	230	230	194	290	0	0
Eutrophication	pH	In situ	In situ	--	In situ	In situ	--	In situ
	Dissolved Oxygen (DO)	In situ	In situ	--	In situ	In situ	--	In situ
	Total Nitrogen (TN)	382	276	0	256	416	0	330
	Total Phosphorus (TP)	334	276	0	256	416	0	330

Type	Analyte	Santa Margarita	Loma Alta	Agua Hedionda	Buena Vista	San Elijo	Los Peñasquitos	Famosa Slough
	Total Dissolved Nitrogen (TDN)	382	276	0	256	416	0	330
	Total Dissolved Phosphorus (TDP)	382	276	0	256	416	0	330
	Nitrate+ Nitrite- N	382	276	0	256	416	0	330
	Ammonium	334	276	0	256	416	0	330
	Soluble Reactive Phosphorus (SRP)	382	276	0	256	416	0	330
	Chlorophyll a	352	260	0	240	400	0	300
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)	334	236	0	224	320	0	274
Suspended Sediment or Sediment	% Fines or %Sand/Silt/Clay	18	6	31	21	36	36	16
	% Organic Carbon (%OC)	15	5	0	20	35	0	15
	% Organic Nitrogen (%ON)	15	5	0	20	35	0	15
	% Total Phosphorus (%TP)	15	5	-	20	35	--	15

Table 25. Summary of SCCWRP sampling effort by lagoon.

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
Deposition	Beryllium- 7	48	24	48	48	24
Benthic N Fixation and Denitrification Rates	N2O/N2 gas production	24	12	24	24	12
Algal Monitoring	Biomass	40	20	40	40	20
	Tissue % Organic Carbon	4	4	4	4	4
	Tissue % Organic Nitrogen	4	4	4	4	4
	Tissue % Total Phosphorus	4	4	4	4	4
Water Column Monitoring	Temperature	Hand Held				
	Conductivity					
	pH					
	Dissolved Oxygen					
Chamber and Pore Water	Total Nitrogen	64	32	64	64	32
	Total Dissolved Nitrogen	144	72	144	144	72
	Total Phosphorus	16	8	16	16	8
	Total Dissolved Phosphorus	96	48	96	96	48
	Nitrate + Nitrite- N	144	72	144	144	72

Type	Analyte	Santa Margarita	Loma Alta	Buena Vista	San Elijo	Famosa Slough
	Ammonia- N	144	72	144	144	72
	Soluble Reactive Phosphorus	144	72	144	144	72
	Dissolved Iron	144	72	144	144	72
	Dissolved Manganese	144	72	144	144	72
	Chlorophyll a	16	8	16	16	8
	Dissolved Organic Carbon	144	72	144	144	72
	Total Carbon Dioxide	96	48	96	96	48
	Sulfide	48	24	48	48	24
	Bromide	96	48	96	96	48
Sediment	% Fines or %Sand/Silt/Clay	64	32	64	64	32
	% Organic Carbon	64	32	64	64	32
	% Organic Nitrogen	64	32	64	64	32
	% Total Phosphorus	64	32	64	64	32
	Manganese & Iron Content	16	8	16	16	8
	Porosity	64	32	64	64	32
	Sediment Chlorophyll a	16	8	16	16	8

F. TIMING OF FIELD SAMPLING

Table 26 presents the targeted time periods of the wet and dry weather sampling with respect to the major study elements of the workplan. These time periods are meant to give a general idea of when sampling should occur. The final targeted periods should be established by the stakeholders for each lagoon in consultation with SCCWRP and Tetra Tech.

Table 26. Timing of major elements of field studies. Note that continuous monitoring in eutrophic lagoons is 4 months in length during the summer, from mid-June through mid-October.

Month	SCCWRP Sediment Deposition	Stakeholder Stormwater Sampling	Stakeholder and SCCWRP Index Period Sampling	Lagoon Hydrodynamic and Water Quality Monitoring
October 2007	X	X		
November		X		
December	X	X		
January 2008		X		X
February	X	X	X	X
March		X		X
April	X		X	

Month	SCCWRP Sediment Deposition	Stakeholder Stormwater Sampling	Stakeholder and SCCWRP Index Period Sampling	Lagoon Hydrodynamic and Water Quality Monitoring
May				
June	X			X
July			X	X
August	X			X
September			X	X
October				

G. QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

All data collected as a part of this monitoring program must be compatible with the Surface Water Ambient Monitoring Program (SWAMP) quality assurance standards. Thus, an additional 10-15% should be added to the total number of samples estimated in Tables 24 and 25. This 10-15% should cover analysis of field, laboratory, and equipment blanks, as well as blind field duplicates and laboratory duplicates. Table 27 lists the data quality objectives for each constituent.

Table 27. Constituents and data quality objectives.

Group	***Parameter***	***Accuracy***	***Precision***	***Recovery***	***Completeness***
Conventional Constituents in stormwater and Estuary waters	TSS TN TDN TP TDP SRP Nitrate Nitrite Ammonium Chlorophyll a $CBOD_5$ TDS	Standard Reference Materials (SRM, CRM) within 95% CI 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 $\pm$ 3 standard deviations based on actual lab data.	90%
In situ sampling	Temperature Conductivity Turbidity pH DO	Calibration Standards (3-5 standards over the expected range of sample target analyte conc., with the lowest conc. Std at or near the MDL).	Field duplicate	N/A	90%

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Completeness*
Bacteria	Total Coliform Fecal Coliform Enterococcus	Field and Laboratory blanks >TRL	Laboratory duplicate, Blind Field duplicate, $R_{log} \leq 3.27 \bullet$mean R_{log} (*)	N/A	90%
Sediment and suspended solids	% Fines or %Sand/Silt/Clay % OC % ON	Standard Reference Materials (SRM, CRM) within 95% CI stated by provider of material.	Laboratory duplicate, blind field duplicate, <20% relative standard deviation	N/A	90%

Notes: TRL = Target Reporting Limit, MDL = Maximum Detection Limit
(*) R_{log} is the absolute difference between logarithms of coliform counts for duplicate analyses. The mean R_{log} is determined by performing duplicate analyses on the first 15 positive samples analyzed for each matrix type.

III. WORKPLAN PRODUCTS

The purpose of this section is to specify the products of the workplan with respect to stakeholder monitoring and SCCWRP special studies.

Data Deliverables:

Stakeholders should provide data to the regional board in Excel spreadsheet format or ACCESS database. All data should be in a SWAMP compatible format. SCCWRP will work with contractors to develop standard data transfer formats and data dictionaries for the minimal set of data required for each monitoring component. This data standardization will happen over three meetings, which will occur during mid-June through mid-July. Data should be submitted via email to the Regional Board on a quarterly basis. SCCWRP and TetraTech should be carbon-copied (cc:) on each of these emails. For the stakeholders, a final data report is required that details whether data collected met quality assurance and quality control objectives.

IV. TIME LINE

The stakeholder monitoring and special studies will take approximately 2.5 yrs to complete (Table 28). Monitoring will be conducted during the first year (October 2007- September 2008). Final laboratory analysis, data quality assurance, and data analysis will occur during the subsequent 6 months (through April 2009). Although SCCWRP and stakeholder monitoring data will be provided to Tetra Tech to initiate modeling work as soon as it becomes available, the final stakeholder monitoring data sets and quality assurance reports will be submitted by June 2009. Draft versions of the SCCWRP special studies chapters and data integration chapters will be made available by July 2009. The SCCWRP final report will be submitted in January 2010.

Table 28. Project Timeline

Task	Quarter and Year											
	Apr – Jun 07	Jul – Sept 07	Oct-Dec 07	Jan-Mar 08	Apr – Jun 08	Jul – Sept 08	Oct-Dec 08	Jan-Mar 09	Apr – Jun 09	Jul – Sept 09	Oct-Dec 09	Jan-Mar 10
Project Planning and QAPP												
Stakeholder Data Collection												
Stakeholder Data Analysis												
Stakeholder Final Data QA Project Report												
SCCWRP Data Analysis												
Preliminary drafts of special study chapters and data integration chapter												
SCCWRP Final Report												
Stakeholder Presentation to Regional Board for Action												

Appendix 1. Locations of Segment Sampling Sites

Figures 1-7 show locations of segment sampling sites in lagoon. Actual location may change if necessary due to logistics, etc. If stakeholders agree with these locations, then a final table of GPS coordinates will be generated.

Figure 1. Locations of Santa Margarita Estuary sites for each segment

Figure 2. Loma Alta Slough site.

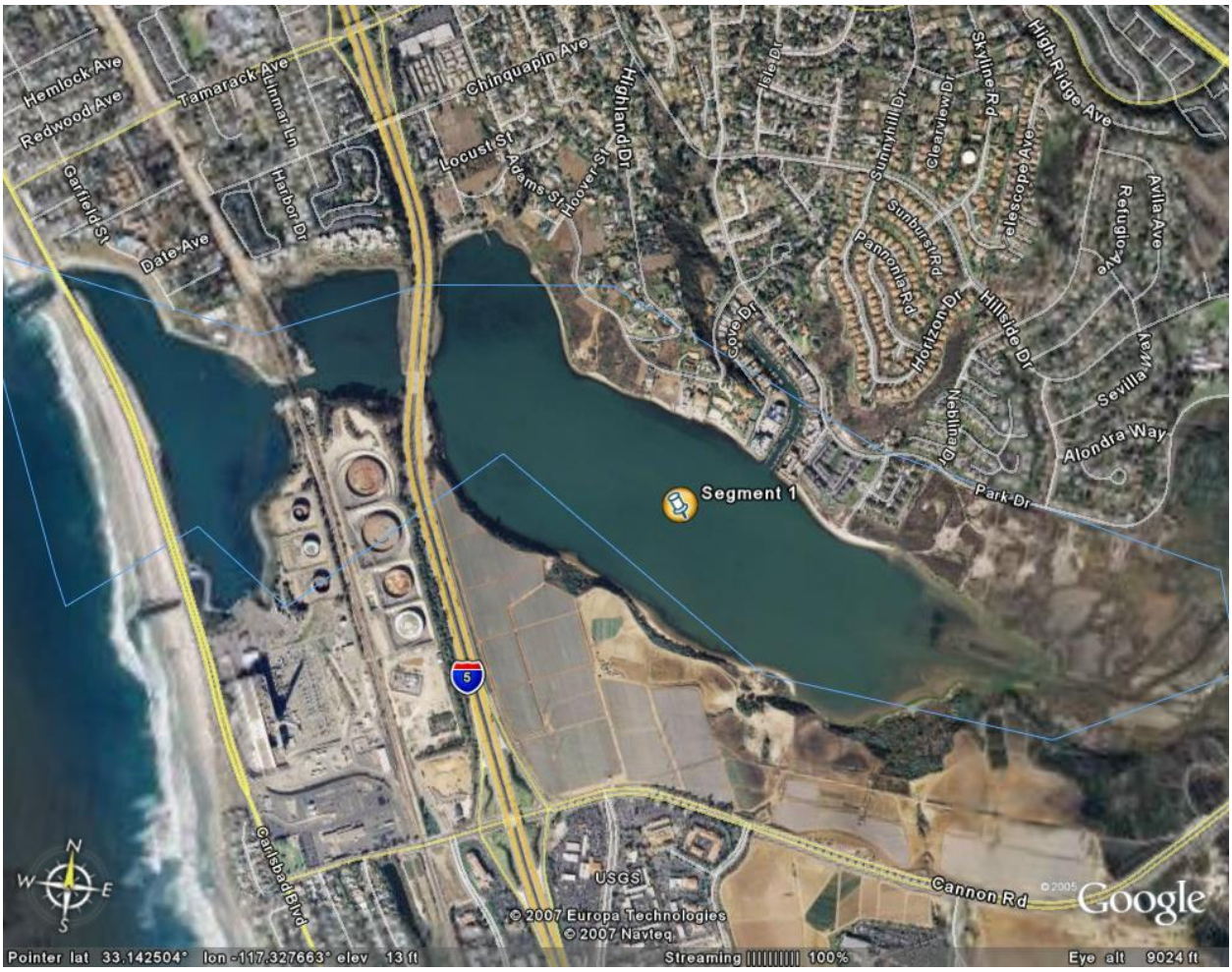

Figure 3. Agua Hedionda site.

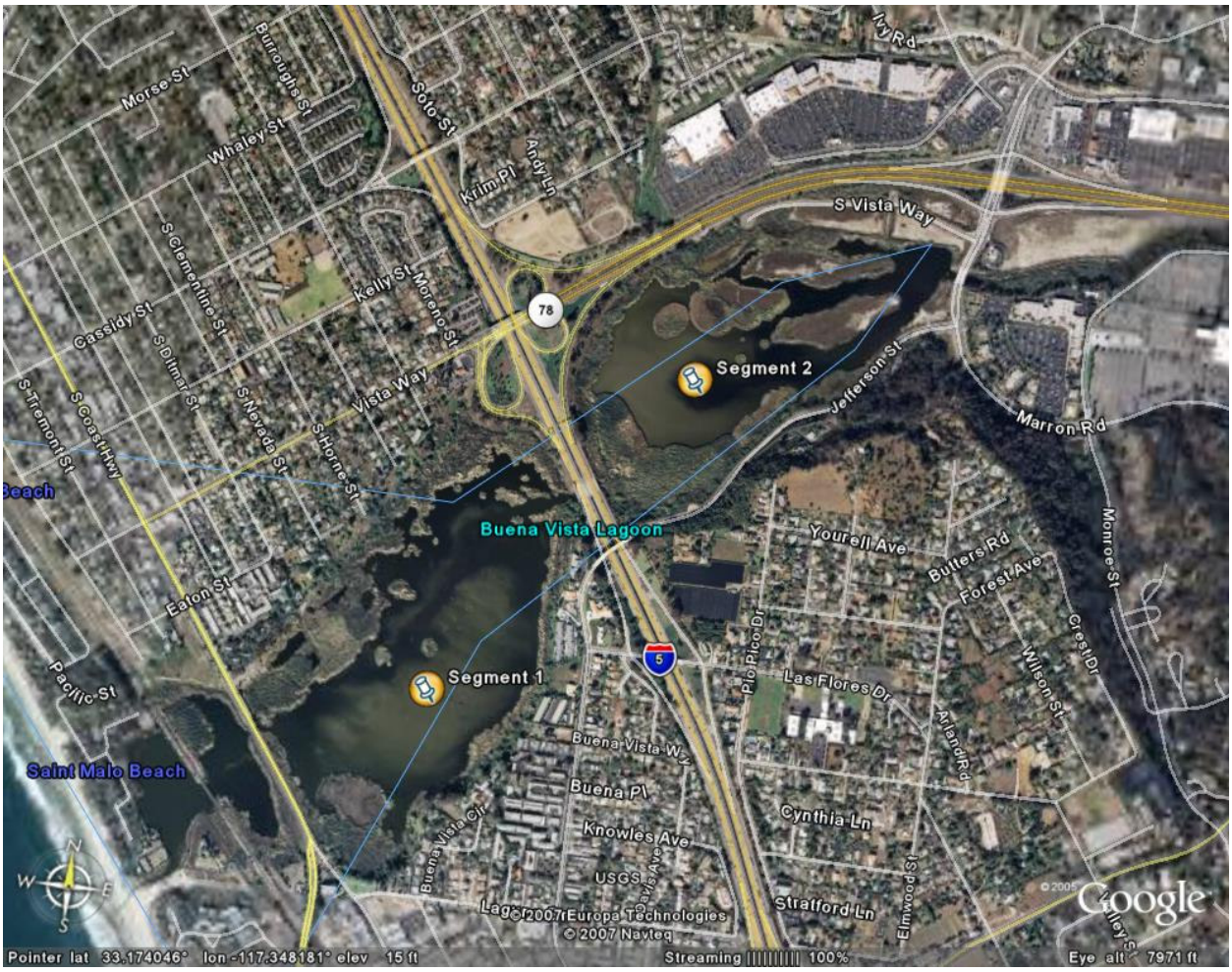

Figure 4. Buena Vista sites.

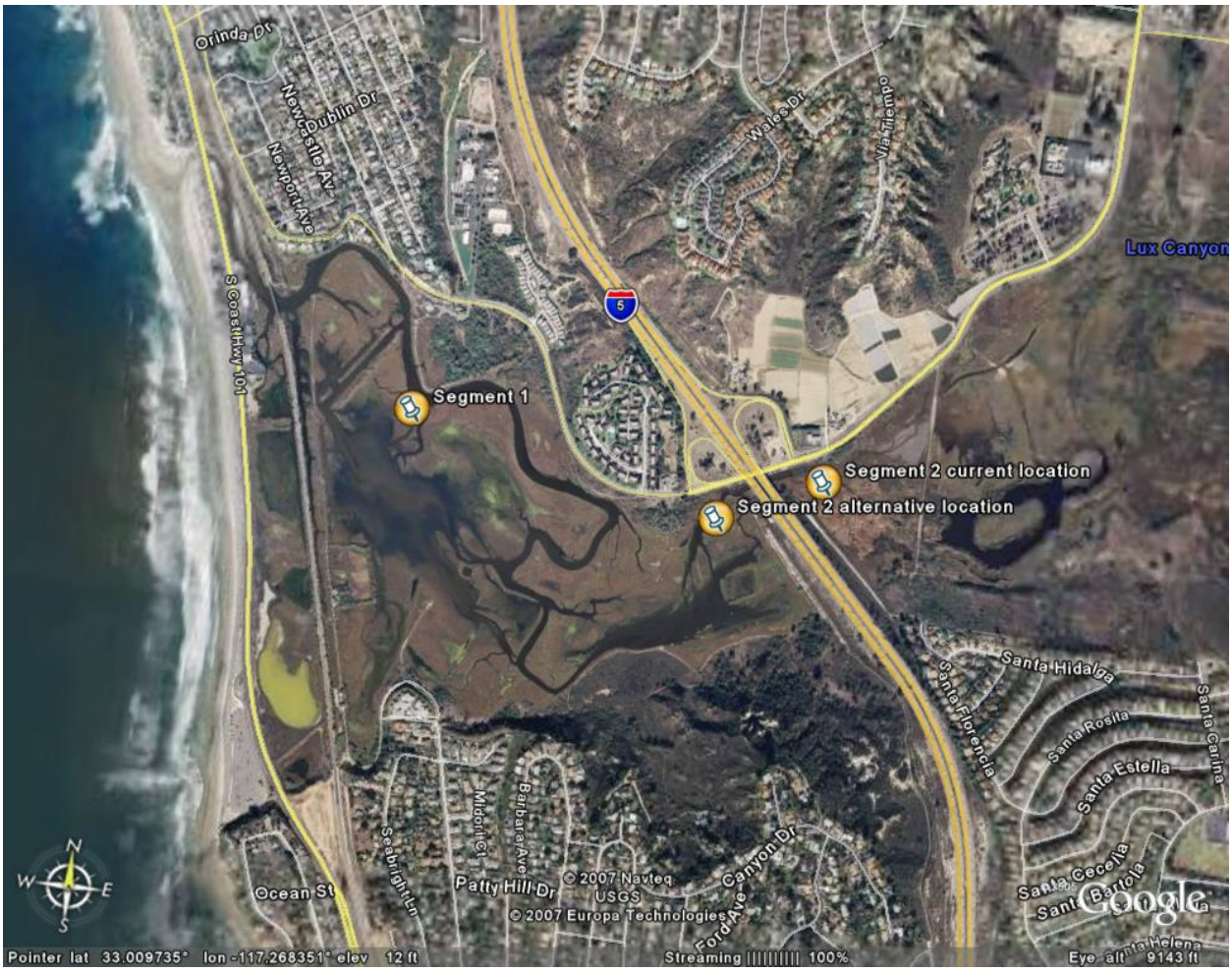

Figure 4. San Elijo sites. Note proposed site for segment 2 sampling is downstream of I-5 bridge.

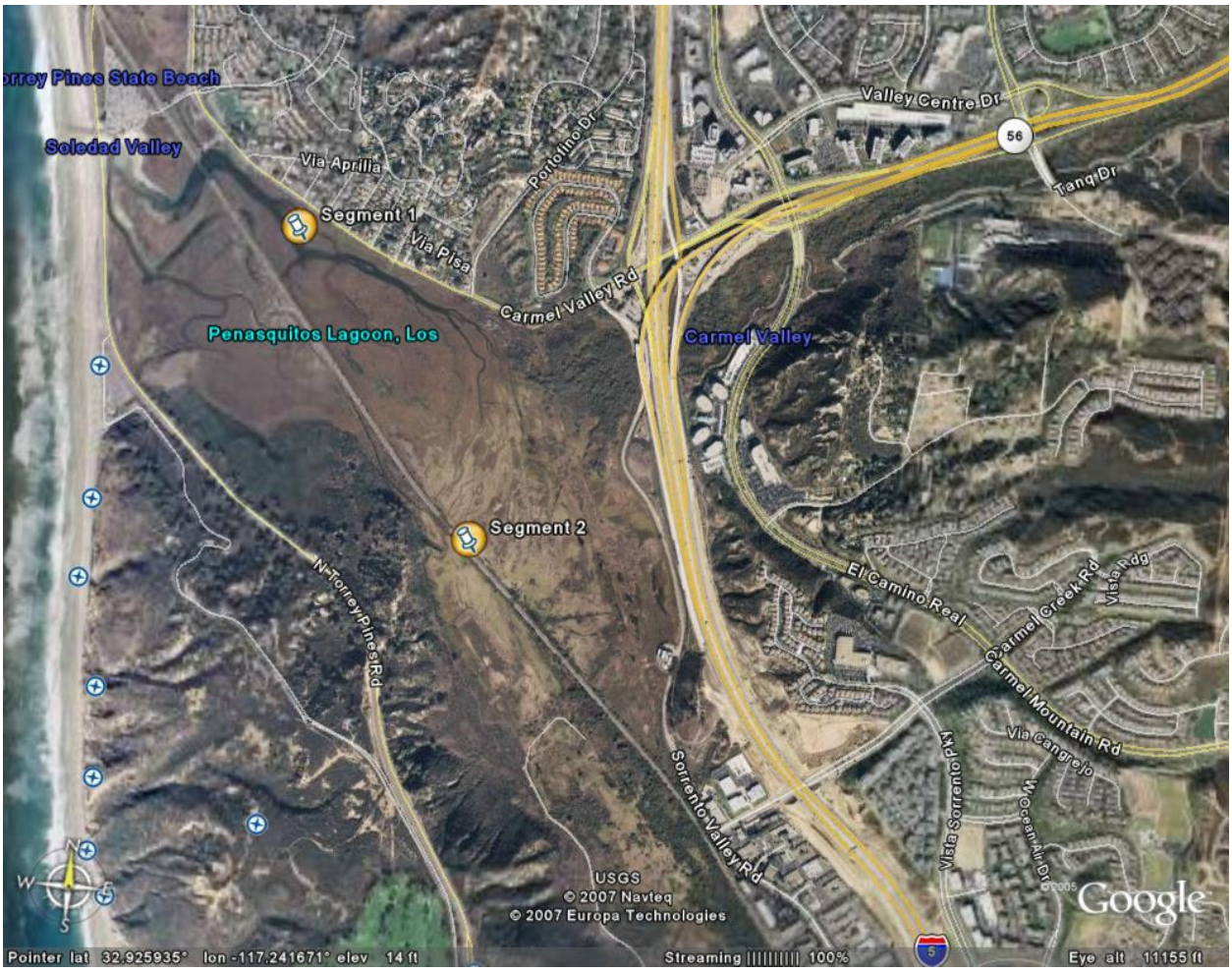

Figure 5. Los Peñasquitos Lagoon sites. The exact location of the Segment 2 sample station will be dependent on the accessibility and safety concerns.

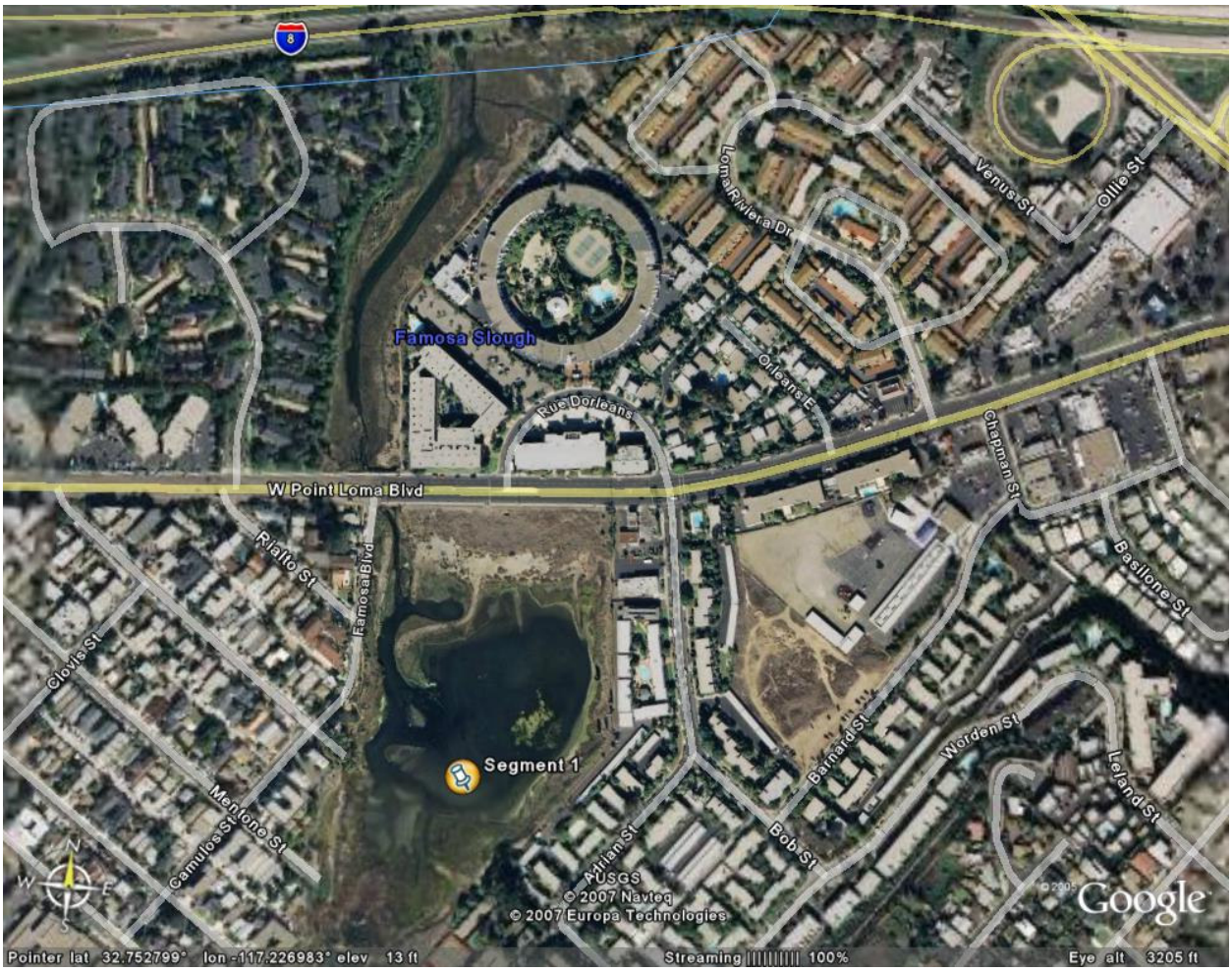

Figure 7. Famosa Slough site.

Appendix 2. Academic Labs

Type	Analyte	Laboratory	Price	Contact Person	Contact Information
Primary	Temperature	Field Measurement			
	Conductivity				
	Turbidity				
	Total Suspended Solids (TSS)	UC Davis ANR Analytical Lab	$8.80	Traci Francis	danranlab@ucdavis.edu
Total Dissolved Solids	Total Dissolved Solids (TDS)	Field Measurement			
Bacteria	Total Coliform	No known academic lab			
	Fecal Coliform				
	Enterococcus				
Eutrophication	pH	Field Measurement			
	Dissolved Oxygen (DO)				
	Total Nitrogen (TN)	University of Georgia (UGA)	$8.00	Tom Maddox	trmaddox@uga.edu
	Total Phosphorus (TP)	University of Georgia (UGA)	$8.00	Tom Maddox	trmaddox@uga.edu
	Total Dissolved Nitrogen (TDN)*	University of Georgia (UGA)	$8.00	Tom Maddox	trmaddox@uga.edu
	Total Dissolved Phosphorus (TDP)*	University of Georgia (UGA)	$8.00	Tom Maddox	trmaddox@uga.edu
	Nitrate*	Marine Science Institute Lab (MSI)	$3.02	Georges L. Paradis	paradis@msi.ucsb.edu
	Nitrite*	Marine Science Institute Lab (MSI)	$3.02	Georges L. Paradis	paradis@msi.ucsb.edu
	Ammonium*	Marine Science Institute Lab (MSI)	$3.02	Georges L. Paradis	paradis@msi.ucsb.edu
	Soluble Reactive Phosphorus (SRP)*	Marine Science Institute Lab (MSI)	$3.02	Georges L. Paradis	paradis@msi.ucsb.edu
	Chlorophyll a	No known academic lab			
	Carbonaceous Biological Oxygen Demand ($CBOD_5$)				
Particle size of Suspended Sediment or Sediment	% Sand/Silt/Clay	UC Davis ANR Analytical Lab	$20.70	Traci Francis	danranlab@ucdavis.edu
	% Organic Carbon (%OC)	Marine Science Institute Lab (MSI)	$13.00	Georges L. Paradis	paradis@msi.ucsb.edu
	% Organic Nitrogen (%ON)	Marine Science Institute Lab (MSI)	$13.00	Georges L. Paradis	paradis@msi.ucsb.edu
	% Total Phosphorus (%TP)	UC Davis ANR Analytical Lab	$13.85	Traci Francis	danranlab@ucdavis.edu

*Filtration of water samples for total dissolved nitrogen and phosphorus, and for nutrients (nitrate, nitrite, ammonium, and SRP) must be conducted in the field prior to shipping to academic labs for analysis. Samples should be filtered through a 0.45 μm filter and stored frozen until shipment.