SOCWA
South Orange County Wastewater Authority

October 06, 2008

Mr. John Robertus, Executive Officer
Regional Water Quality Control Board
San Diego Region
9174 Sky Park Court, Suite 100
San Diego, CA. 92123-4340

Re: Settlement offer for Administrative Civil Liability Complaints

Dear Mr. Robertus:

Enclosed you will find South Orange County Wastewater Authority's (SOCWA) signed Waivers to the Right of a Public Hearing for complaint numbers: R9-2008-0090, R9-2008-0091, R9-2008-0092 and R9-2008-0094. The total amount of assessed fines associated with these complaints is $60,000, as seen in the table below.

Complaint Number	Discharger	MMP Fine
R9-2008-0090	City of San Clemente	$ 21,000
R9-2008-0091	Santa Margarita Water District	$ 27,000
R9-2008-0092	City of San Juan Capistrano	$ 6,000
R9-2008-0094	SOCWA	$ 6,000
Total Fines		**$ 60,000**

SOCWA agrees to pay $22,500 to the State Water Resources Control Board pursuant to the civil liabilities set forth in the above mentioned complaints based on the issuance of individual Administrative Civil Liability Complaints. SOCWA further agrees to pay a Trustee $37,500 towards the completion of a Regional Board approved Supplemental Environmental Project (SEP).

SOCWA requests the opportunity to fund additional monitoring within the Southern California Coastal Water Research Project's (SCCWRP's) Bight-08 intensive monitoring project. Specifically, SOCWA's funds would pay to expand the investigation of environmental triggers of Harmful Algal Blooms (HAB). Enclosed are, a completed SEP application and a copy of the Offshore Water Quality work plan which describes SCCWRP's proposed HAB investigation.

The SOCWA San Juan Creek Ocean Outfall discharges treated wastewater to coastal ocean waters approximates two miles offshore, near Dana Point Harbor. The Bight 08 water quality survey will assess the impacts of manmade nutrient sources from sewage outfalls, stormwater outfalls, as well as natural nutrient sources such as deep ocean upwelling and atmospheric disposition. The results of this project will contribute to evaluating regulatory decisions related to nutrient discharge to the coastal ocean and public health during bloom events. SOCWA believes this HAB project has a clear nexus to the water quality violations contained in the complaints and we hope that the Regional Board staff is supportive of this proposed project.

34156 Del Obispo Street • Dana Point, CA 92629 • Phone: (949) 234-5400 • Fax: (949) 489-0130 • Website: www.socwa.com

Matters related to Compliant R9-2008-0093, issued for effluent discharge violations from the South Coast Water District's Ground Water Recovery Facility, are still under review and will be handled separately. However, SOCWA requests the ability to add the SEP eligible portion of fines paid to resolve complaint R9-2008-0093 to our proposed HAB project when an agreement is reached.

If you have any questions, I can be contacted at (949) 234-5421.

Very truly yours,

SOUTH ORANGE COUNTY WASTEWATER AUTHORITY

Thomas R. Rosales
General Manager

TR/bf

Enclosures: Signed Waivers, SEP Application, HAB Work Plan

cc: Bill Cameron, CSC
John O'Donnell, CSJC
John J. Schatz, SMWD
Michael P. Dunbar, SCWD
Pat Giannone, BAWG
File

Attachment # 1

Singed Waivers for Administrative Civil Liability Complaints:	R9-2008-0090 R9-2008-0091 R9-2008-0092 R9-2008-0094

WAIVER
OF RIGHT TO A PUBLIC HEARING

Complaint No. R9-2008-0090
For
Administrative Civil Liability

$21,000

Mr. Tom Rosales
General Manager
South Orange County Wastewater Authority
34156 Del Obispo Street
Dana Point, California 92629

By signing below, I agree to waive South Orange County Wastewater Authority's right to a public hearing before the California Regional Water Quality Control Board, San Diego Region with regards to the violations alleged in the above referenced Complaint and to remit payment for the civil liability imposed. I understand that I am authorized to give up South Orange County Wastewater Authority's right to be heard, and to argue against the allegations made by the Assistant Executive Officer in the Complaint, and against the imposition of, or the amount of, civil liability proposed. I have enclosed a cashier's check or money order made payable to the State Water Resources Control Board for the civil liability imposed.

Tom Rosales
Signature

General Manager
Title

9/11/08
Date

Tom Rosales
Print your name

Send this signed form to:
California Regional Water Quality Control Board – San Diego Region
ATTN: Ms. Joann Cofrancesco, Compliance Assurance Unit
9174 Sky Park Court, Suite 100
San Diego, CA 92123

California Regional Water Quality Control Board
San Diego Region
Over 50 Years Serving San Diego, Orange, and Riverside Counties
Recipient of the 2004 Environmental Award for Outstanding Achievement from USEPA

Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

9174 Sky Park Court, Suite 100, San Diego, California 92123-4340
(858) 467-2952 • Fax (858) 571-6972
http:// www.waterboards.ca.gov/sandiego

WAIVER
OF RIGHT TO A PUBLIC HEARING

Complaint No. R9-2008-0091
For
Administrative Civil Liability

$27,000

Mr. Tom Rosales
General Manager
South Orange County Wastewater Authority
34156 Del Obispo Street
Dana Point, California 92629

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[signature] Signature — General Manager Title — 9/11/08 Date

Tom Rosales
Print your name

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WAIVER
OF RIGHT TO A PUBLIC HEARING

Complaint No. R9-2008-0092
For
Administrative Civil Liability

$6,000

Mr. Tom Rosales
General Manager
South Orange County Wastewater Authority
34156 Del Obispo Street
Dana Point, California 92629

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[signature] General Manager 9/11/08
Signature Title Date

Tom Rosales
Print your name

Send this signed form to:
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ATTN: Ms. Joann Cofrancesco, Compliance Assurance Unit
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WAIVER
OF RIGHT TO A PUBLIC HEARING

Complaint No. R9-2008-0094
For
Administrative Civil Liability

$6,000

Mr. Tom Rosales
General Manager
South Orange County Wastewater Authority
34156 Del Obispo Street
Dana Point, California 92629

By signing below, I agree to waive South Orange County Wastewater Authority's right to a public hearing before the California Regional Water Quality Control Board, San Diego Region with regards to the violations alleged in the above referenced Complaint and to remit payment for the civil liability imposed. I understand that I am authorized to give up South Orange County Wastewater Authority's right to be heard, and to argue against the allegations made by the Assistant Executive Officer in the Complaint, and against the imposition of, or the amount of, civil liability proposed. I have enclosed a cashier's check or money order made payable to the State Water Resources Control Board for the civil liability imposed.

Tom Rosales
Signature

General Manager
Title

9/11/08
Date

Tom Rosales
Print your name

Send this signed form to:
California Regional Water Quality Control Board – San Diego Region
ATTN: Ms. Joann Cofrancesco, Compliance Assurance Unit
9174 Sky Park Court, Suite 100
San Diego, CA 92123

Attachment # 2

Supplemental Environmental Project Application for funding Southern California Coastal Water Research Project's – Harmful Algal Bloom Investigation

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION
(SDRWQCB)

SUPPLEMENTAL ENVIRONMENTAL PROJECT APPLICATION FORM

Project Requested by South Orange County Wastewater Authority

Name of Project Bight'08 Offshore Water Quality Study

Date of Request October 07, 2008

Point of Contact Brennon Flahive

Phone (949)- 234-5419 E-mail bflahive@socwa.com

Project Summary: This project would characterize the extent magnitude and ecological significance of harmful algal blooms to identify the major nutrient sources to the Southern California Bight (SCB) region that may fuel those blooms.

Total Life Cycle Cost for the Project:

Project Overhead/Management	$ 0
Design/Consultation	$ 0
Construction/Implementation	$ 37,500
Long Term Maintenance/Oversight	$ 0
Total Project Cost	$ 37,500

Watershed/Water Body/Location for Project (attach maps) Pacific Ocean in the Southern California Bight.

Project Proposed Start Date and Time Line:
The intensive monitoring is current under way and is scheduled to end in October 2009. The data analysis and final report should be completed by July 1, 2010.

Organization Sponsoring Project (tax I.D. #) 95-264605

Name of Project Manager: Mr. Ken Schiff Phone (714)- 755-3202

Designated Project Trustee: Southern California Coastal Water Research Project SCCWRP

Description of Project Trustee capability or commitments to ensure that the project will be completed: SCCWRP has been conducting ocean monitoring studies for 35 years. The San Diego RWQCB executive officers serve on the SCCWRP Board of Commissioners ensuring timely completion of the study.

Statement of Project Trustee ability/authority to receive and disburse funds: SCCWRP has the ability to receive and disburse funds. SCCWRP currently holds several contracts with the RWQCB.

DETAILED PROJECT INFORMATION

1. PROPOSAL DESCRIPTION: Perform offshore water quality monitoring in the SCB to establish the relative nutrient contributions of four major sources: upwelling, POTW discharge, atmospheric deposition, terrestrial coastal runoff. Characterize the spatial and temporal patterns of algal blooms, the effects of the blooms with an emphasis on *Pseudo-nitzschia* and domoic acid. The monitoring will further characterize the specific water quality conditions associated with the blooms. This project would include additional water quality monitoring for nutrients that may contribute to harmful algal blooms.

2. PROBLEM STATEMENT: *Pseudo-nitzschia* is a marine algae capable of producing the toxin domoic acid which can cause marine mammal, bird, and fish mortality. Due to the public health implications release of domoic acid and other algal produced toxins the California Department of Public Health monitors toxins levels in shellfish and closes both commercial and recreational harvesting when specific toxin levels are exceeded. Bioaccumulation of algal toxins through the food chain has been linked the marine mammal, bird, and marine animal mortality.

3. HOW WILL THE PROJECT BENFEFIT WATER QUALITY AND BENEFICIAL USES? The results of this project will contribute to evaluating regulatory decisions regarding nutrient discharge to coastal oceans and public health decisions during bloom events.

4. HOW WILL THE SUCCESS OF THIS PROJECT BE MEASURED? Ultimately water quality managers would like to understand and reduce the manmade conditions which cause or contribute to harmful algal blooms.

5. DETAILED WORK PLAN

Please include a detailed supplemental report of the proposal/project that includes the following: *** SEE ATTACHED WORKPLAN

a. Scope of work (work to be performed)
b. Budget
c. Task descriptions
d. Methods and materials
e. Resource needs
f. Regulatory issues (environmental reviews, permits, etc.)
g. Schedule
h. Work products and documents to be retained for records
i. Other information about the proposed project that may be of interest to the SDRWQCB.

I certify that the information provided in this application is an accurate and complete report of the costs, scope of work and expectations of this proposed project I am submitting to the SDRWQCB.

SIGNATURE Thomas R Rodd ***Date*** 10/6/08

Attachment # 3

Southern California Coastal Water Research Project's Harmful Algal Bloom Investigation Workplan

Southern California Bight
2008 Regional Marine Monitoring Survey
(Bight'08)

Offshore Water Quality Workplan

Prepared by:
Bight'08 Water Quality Committee

Prepared for:
Commission of Southern California Coastal Water Research Project
3535 Harbor Blvd, Suite 110
Costa Mesa, CA 92626

August 2008

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BIGHT'08 OFFSHORE WATER QUALITY COMMITTEE

Chair:

George Robertson	Orange County Sanitation District

Co-chair:

Steve Weisberg	Southern California Coastal Water Research Project

Water Quality Committee:

Bob Brantley	City of Los Angeles
David Caron	University of Southern California
Chris Crompton	Orange County Resources and Development Management Dept.
Wanda Cross	Santa Ana Regional Water Quality Control Board
Dario Diehl	Southern California Coastal Water Research Project
Paul DiGiacomo	National Oceanic and Atmospheric Administration
Dominic Gregorio	State Water Resources Control Board
Meredith Howard	Southern California Coastal Water Research Project and University of Southern California
Scott Johnson	City of Oxnard/Aquatic Bioassay and Consulting Laboratories, Inc.
Burt Jones	University of Southern California
Mike Kelly	City of San Diego
Michael Lyons	Los Angeles Regional Water Quality Control Board
Karen McLaughlin	Southern California Coastal Water Research Project
Mike Mengel	Orange County Sanitation District
Nick Nezlin	Southern California Coastal Water Research Project
Jim Rounds	City of Los Angeles
Lisa Sabin	Southern California Coastal Water Research Project
Alex Steele	Los Angeles County Sanitation District
Fred Stern	Los Angeles County Sanitation District
Astrid Schnetzer	University of Southern California
Keith Stolzenbach	University of California, Los Angeles
Martha Sutula	Southern California Coastal Water Research Project
Ted von Bitner	Orange County Resources and Development Management Dept.

I. INTRODUCTION

A. History of Bight Regional Monitoring Surveys

There have been three previous regional monitoring efforts to begin assessing environmental status of the Southern California Bight (SCB) at larger spatial scales. The first regional monitoring survey in 1994, the Southern California Bight Pilot Project (SCBPP), was a compilation of 12 agencies that sampled 261 sites along the continental shelf between Point Conception and the United States/Mexico border. The second regional monitoring survey, the Southern California Bight 1998 Regional Monitoring Project (Bight'98), was comprised of 64 agencies that sampled 416 sites between Point Conception and Punta Banda, Mexico and included new habitats such as ports, bays, and marinas. The third regional monitoring survey, the Southern California Bight 2003 Regional Monitoring Project (Bight'03), was comprised of 65 agencies that sampled 391 sites between Point Conception and the United States/Mexico border, and expanded the number of habitats from Bight'03 to include estuaries and deep ocean basins. The increase in the number of sites and sampled habitats is a reflection of the value of this type of monitoring approach and positive interactions among organizations. Benefits derived from the previous surveys included the development of new useful technical tools and increased comparability in field, taxonomic, and laboratory methods that could only be developed with regional data sets and participation by multiple organizations.

B. Context for Bight'08 Offshore Water Quality Study

The Bight'03 Water Quality survey focused on characterizing stormwater plumes produced by major rivers in southern California. One of the major findings from this survey was the high numbers of *Pseudo-nitzschia* measured in the Los Angeles Harbor and San Pedro Shelf. *Pseudo-nitzschia* is a marine alga capable of producing a toxin called domoic acid that has the potential to impact ecological resources in the near-shore coastal waters of the southern California Bight by causing marine mammal, bird and fish mortality. The occurrence of *Pseudo-nitzschia* in other parts of the SCB is not well documented.

Pseudo-nitzschia abundances and toxin concentrations were associated with decreases in macronutrient concentrations (phosphate and silicate) as well as with changes in nutrient ratios but the exact relationships require further study. As a result, the main recommendations of the Bight'03 water quality report was for future research to quantify nutrient loadings to the SCB and characterize the attendant ecosystem impacts with respect to phytoplankton and harmful algal bloom ecology in the coastal waters of the SCB.

Algal blooms occur frequently along the southern California coastline in response to inputs of nutrients from both natural and anthropogenic sources. There are many environmental conditions, particularly nutrient sources, that have been identified which lead to the development and/or maintenance of algal blooms. California has a number of phytoplankton species capable of releasing toxins during periods of rapid growth. From a management perspective, *Pseudo-nitzschia* and *Alexandrium* raise the most concern. These algae can produce the potent neurotoxins domoic acid and saxitoxin, respectively. Domoic acid poisoning can cause memory loss, brain damage and fatalities; saxitoxin poisoning can lead to numbness, respiratory failure and fatalities. Due to the public health implications of these toxins, the California Department of Public Health (CDPH) monitors toxin levels in shellfish and closes both commercial and recreational harvesting when specific alert levels are exceeded. Bioaccumulation of algal toxins through the food web (via contaminated shellfish or filter feeding fish, such as anchovies and sardines) has been linked to erratic behavior in birds and marine mammals, as well as marine animal mortality events.

The geographic distribution and the frequency of domoic acid and paralytic shellfish toxin (PSP; saxitoxin being one of the PSP toxins) alert levels between 1981 through 2007 are summarized in Figure 1 below. The top panel shows the number of samples that exceeded the regulatory alert levels of domoic acid of 20 µg/g (20 ppm) by county and the bottom panel shows the same information for the regulatory limit of 80 µg/100 g tissue (0.4 ppm) for saxitoxin by county. These figures show that southern California has a larger number of domoic acid toxic events compared to saxitoxin. Domoic acid is considered to be the toxin of highest frequency in recent years in southern California and therefore of the most concern for research, monitoring and management.

C. Bight 2008 Offshore Water Quality Survey

The 2008 Regional Marine Monitoring Survey (Bight'08) Offshore Water Quality component will assess the magnitude of anthropogenic nutrient sources (such as continuous inputs from sewage outfalls and anthropogenically-fed river flows) as well as natural nutrient sources (such as coastal runoff, aeolian dust transport and upwelling) to the coastal ocean. The influence of these sources on algal bloom events will be evaluated, with particular emphasis on *Pseudo-nitzschia* blooms that negatively impact the environment, human health, marine wildlife and/or coastal economies. The results of this project will contribute to evaluating regulatory decisions regarding nutrient discharge to the coastal oceans and public health decisions during bloom events.

There have been a large number of local and small scale studies in limited geographic regions conducted to determine the environmental factors and specific nutrient sources and dynamics that contribute to the development and maintenance of harmful algal blooms (HABs). There are numerous research programs throughout California that collect data on HABs, most of which are not coordinated within the research community. The Bight'08 program provides an opportunity to coordinate and unify the monitoring and research efforts in the southern California bight. The Bight survey will cover the largest geographical scale to date in California, thereby providing a regional picture of the factors and conditions that are driving algal blooms, particularly HABs in southern California.

The Bight'08 water quality project will:

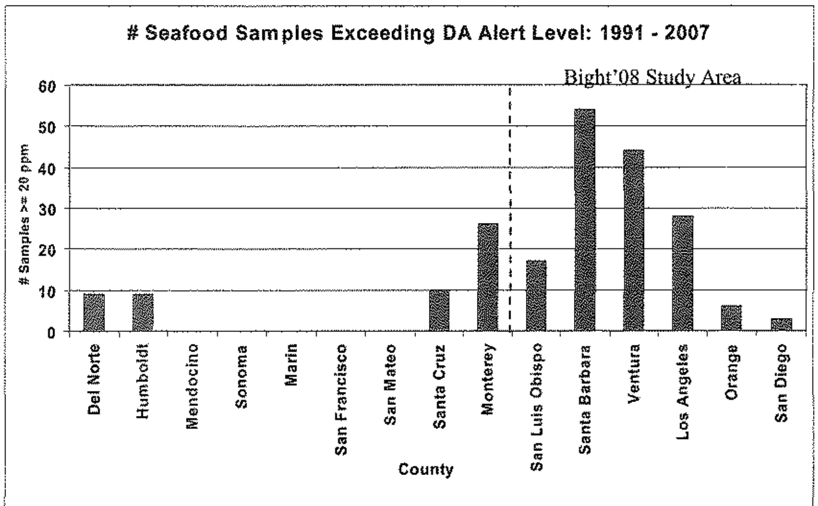
- Establish the relative nutrient contributions of four major sources to the SCB: (1) upwelling; (2) Publically-Owned Treatment Works (POTW) discharges; (3) atmospheric deposition; and (4) terrestrial runoff.

- Characterize the spatial and temporal patterns of algal blooms, as well as the effects of these blooms, with an emphasis on *Pseudo-nitzschia* and domoic acid.

- Identify the specific water quality conditions associated with algal bloom events.

Table 1 provides a list of the participating organizations in the Bight'08 Offshore Water Quality Study.

Figure 1. The geographic distribution and frequency of domoic acid (top panel) and saxitoxin (bottom panel) levels in mussel samples above the regulatory limits of 20 µg/g (20ppm) and 80 µg/100g tissue (0.4ppm) respectively. The counties to the right of the red dashed lines represent the Bight'08 study area. (Gregg Langlois, California Department of Public Health, www.cdph.ca.gov)



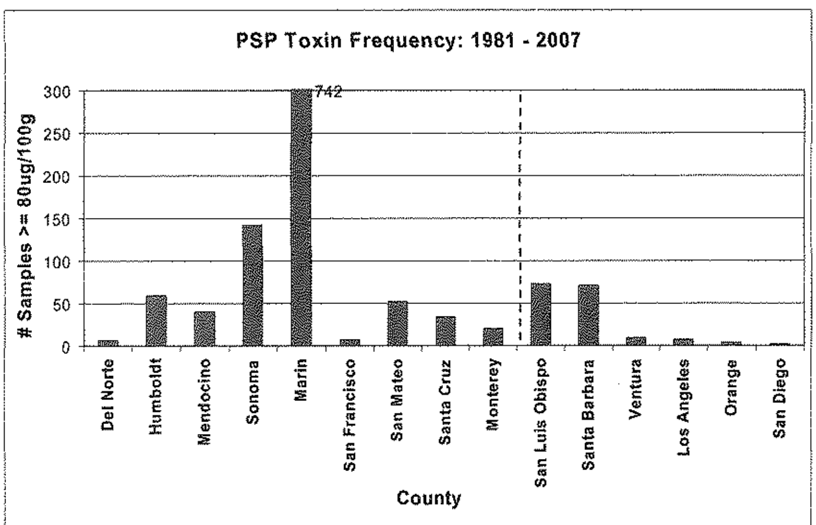


Table 1. Participating organizations in the Bight'08 Offshore Water Quality Regional Monitoring Program.

Aquatic Bioassay and Consulting Laboratories, Inc.
California Department of Public Health
California State Polytechnic University
City of Los Angeles
City of Oxnard
City of San Diego
Jet Propulsion Laboratory
Los Angeles County Sanitation Districts (LACSD)
Los Angeles Regional Water Quality Control Board
National Oceanic and Atmospheric Administration (NOAA)
Orange County Sanitation District (OCSD)
Orange County Resources and Development Management Department
San Diego Regional Water Quality Control Board
Santa Ana Regional Water Quality Control Board
Scripps Institution of Oceanography
State Water Resources Control Board
Southern California Coastal Water Research Project
University of Southern California
University of California at Santa Barbara
University of California at Los Angeles

II. STUDY DESIGN

A. Study Objectives

The overall goal of the offshore water quality study of Bight'08 is to characterize the extent, magnitude, and ecology of harmful algal blooms and to identify the major nutrient sources to the SCB that may fuel those blooms. To accomplish this goal, Bight'08 will focus on three primary objectives:

1) Establish the relative nutrient contributions of four major sources to the SCB (upwelling, POTW discharge, atmospheric deposition, terrestrial coastal runoff)
2) Characterize the spatial and temporal patterns of algal blooms, as well as the effects of these blooms, with an emphasis on *Pseudo-nitzschia* and domoic acid.
3) Identify the specific water quality conditions associated with bloom events.

The first objective will establish the relative nutrient (nitrogen, phosphorus, silica) contributions of four major sources to the SCB (upwelling, POTW discharge, atmospheric deposition, and terrestrial runoff). This data will be used to identify the major sources and investigate the timing and magnitude of nutrient delivery to the coastal ocean relative to remotely-sensed and field observations of algal blooms in the SCB.

The second objective will characterize the spatial and temporal patterns of algal blooms, as well as the effects of these blooms, with an emphasis on the occurrence of *Pseudo-nitzschia* and the toxin domoic acid. Historic patterns in algal bloom frequency and biomass will be assessed using remote sensing, CTD data and modeled estimates of historic nutrient loads from the four sources to understand trends over time. The temporal and spatial occurrence of *Pseudo-nitzchia* and associated concentrations of domoic acid, nutrient and other physiochemical parameters will be characterized with a combination of remote sensing, gliders, pier-based and ship-based sampling during January – June 2009. Additional questions to be addressed include where algal blooms originate, how frequently they occur and if this frequency has increased over the last 10 years. Are blooms originating nearshore where terrestrial runoff and POTW discharges are present or are they originating offshore where the main nutrient source is upwelling?

The third objective will identify the specific water quality conditions and nutrient sources associated with bloom events. Data collected synoptically on ambient nutrient concentrations and loads from the various sources, upwelling patterns, and other remote sensing data will be used to investigate factors associated with bloom events. A special study using natural isotope ratios found in the four major sources of nutrients will be used as tracers to identify relative contributions in ambient surface waters associated with bloom events.

B. Sampling Design

The water quality sampling design for Bight'08 will be divided into three components. These include: 1) nutrient sources; 2) spatial and temporal patterns of algal blooms and 3) nutrient source tracking.

Nutrient Sources

Estimation the four principal nutrient sources to the Bight (atmospheric deposition, terrestrial runoff, upwelling, and POTW discharge) will involve a combination of field measurements and modeling targeted over a one-year period from November 2008 – October 2009. Where possible, the same suite of constituents will be measured in each of the sources to provide maximum comparability among sources (Table 2). Methods of estimation of loads from each of the sources are summarized below.

Atmospheric Deposition

Atmospheric deposition of nutrients will be measured during three climatic conditions intended to capture the range of expected variability in rates: 1) wet deposition during rain events, 2) quarterly sampling of dry deposition, and 3) dry deposition during a Santa Ana wind event. Rates of wet deposition and dry deposition will be measured at three coastal stations and one station based on Catalina Island. Measurement of dry deposition during a Santa Ana wind event will be made at one of the coastal stations. Wet deposition will be measured with rain water collectors. Dry deposition will be measured with a static water bath surrogate surface sampler.

Upwelling

To estimate the upwelling contributions of nitrate to the nutrient budget, the Regional Oceanic Modeling System (ROMS), a three-dimensional ocean circulation model, will be used to generate a reanalysis of the ocean environment from November 2008-October 2009. This model integration will result in highly time-resolved output of the three dimensional physical and biogeochemical parameters, one of which is nitrate. From this detailed output, periods of upwelling will be determined using vertical velocity and temperature fields, and then the mass of nitrate upwelled to the euphotic zone will be calculated. Comparison of this quantity of upwelled nitrate will be made to the amount of nitrate from the other studied sources (POTWs, atmospheric deposition, and terrestrial runoff) over a range of spatial scales, from the entire Bight to smaller volumes, such as just Santa Monica Bay. In addition to vertical velocity, horizontal velocities will be examined to determine if lateral advection plays a large role in the transport of upwelled nitrate. Other expected end products include the time-varying concentration of surface nitrate within, for example, 20 km of the coastline. From this distribution, locations that contain elevated levels of nitrate will be identified and their correlation to phytoplankton blooms, as detected from either satellite or ship-board measurements, will be calculated and analyzed. The annual mean distribution of surface nitrate will also be computed, which would then enable quantification of the potential impact or other nitrate sources on the local ocean environment, for instance, near a river mouth.

Large POTW Effluent

Nutrient concentrations in the effluent will be measured monthly at each of the following large POTWs:

(1) Hyperion Treatment Plant (HTP) operated by City of Los Angeles
(2) Joint Water Pollution Control Plant (JWPCP) operated by Los Angeles County Sanitation District
(3) Treatment Plant No. 2 operated by Orange County Sanitation District
(4) Point Loma Wastewater Treatment Plant (PLWTP) operated by City of San Diego

Table 2 provides a complete list of constituents being measured for this nutrient source from November 2008 through October 2009. These concentrations will be multiplied by measured effluent discharge rates to produce monthly loads to the SCB.

Terrestrial Sources

Watershed-based sources of nutrients will be estimated from a combination of measured and modeled wet weather and dry weather loads from all coastal watersheds that drain to the SCB. Watershed loading models will use a Rational Method approach to quantify wet weather loads. Dry weather loads will use measured flows where possible and where not, relationships will be developed between watershed size, land use, and measured flows for the non-gaged watersheds. Watershed wet and dry weather models will be calibrated using data on nutrient concentrations and loads measured at 38 mass emission stations collected by Storm Water Monitoring Coalition (SMC) agencies during the period of November 2008- October 2009 (Table 3). Existing data on wet weather runoff from various land uses and wet and dry weather loads from mass emission stations will be compiled from SMC agencies to provide supporting data for model development. Table 2 provides a list of the analytes that will be measured in wet and dry weather runoff from the mass emission stations.

Spatial and Temporal Patterns of Algal Blooms

Remote Sensing

Satellite remote sensing will be used to illustrate the spatial and temporal patterns of surface algal blooms as well as the physical factors working as "triggers" of blooms with special focus on coastal upwelling and advection into the Bight. Spatial and temporal patterns of algal blooms can be assessed based on satellite imagery (SeaWiFS since 1997; MODIS-Aqua since 2002; and, probably, MODIS-Terra since 2000). The relationship between the chance of a bloom and environmental factors (e.g., season, upwelling, wind, stormwater discharge, aeolian (dust) fertilization, etc.) will be explored. The criterion that will characterize a "bloom" will be high phytoplankton biomass determined by chlorophyll values exceeding a certain threshold as well as an abrupt increase in chlorophyll (using the method suggested by Stumpf @ NOAA).
Physical factors stimulating phytoplankton blooms will be assessed based on data measured by satellites and contact methods (e.g., NDBC buoys). These factors include:

- SST measured by National Data Buoy Center (NDBC) buoys;
- SST measured by satellites (AVHRR and MODIS);
- Stormwater discharge (USGS data and/or model estimations);

- Photosynthetically available radiation (SeaWiFS and MODIS);
- Atmospheric deposition (estimated from aerosol characteristics measured by SeaWiFS and MODIS);

Upwelling in SCB can also be assessed from the maps of SST. We can use modified methodology of Stumpf, estimating the anomalies (i.e., the differences between daily SST and SST averaged over preceding 2-month period) indicating dramatic SST decreases.

Real-time chlorophyll and sea surface imagery available from SCCOOS and Coast Watch will be analyzed before ship-based sampling resulting in optimal coverage of the bloom area.
The Jet Propulsion Laboratory (JPL) has incorporated real-time data (e.g., high-frequency surface currents) to its version to create daily "nowcast" data products as part of the ROMS model. Daily model predictions of temperature, salinity, and currents will be evaluated in conjunction with satellites for additional evidence of Bight-wide upwelling, transport and advection of phytoplankton from offshore to the coast.

Modeling
ROMS is an ocean circulation model capable of computing three-dimensional variability in physical and biogeochemical parameters with fine spatial resolution with the North American and South American West Coast regions as primary testbeds (Marchesiello et al. 2003, Shchepetkin and McWilliams 2003, Shchepetkin and McWilliams 2005). The ROMS model will be used in this study to estimate the magnitude of upwelling to the SCB. The ROMS configuration for the Southern California Bight has the following elements: a uniform grid scale of 1 km over the entire Bight, surface forcing from regional meteorological simulations based on National Centers for Environmental Prediction (NCEP) operational analyses, lateral boundary conditions from a U.S. West Coast ROMS simulation with 6 km horizontal grid resolution and a global tidal analysis, surface gravity wave fields from regional wave models, empirically specified river inflow of water and material concentrations, circulation dynamics, material concentration dynamics, plankton ecosystem dynamics, and sediment resuspension and transport dynamics. Simulations of physical variables have been performed for a multi-year period from 1996-2003. The ROMS model is currently being used by the Southern California Coastal Ocean Observing System (SCCOOS) at a horizontal grid scale of 1 km to assimilate available observations, especially HF radar measurements of surface currents, as well as satellite sea surface temperature (SST) and sea surface height (SSH) measurements.

The dynamics of the coastal N cycle are described using a state-of-the-art ecosystem model (the Biogeochemical Elemental Cycling, or BEC, model) that includes both phytoplankton and zooplankton, and dissolved, suspended, and sinking particulates (Moore et al., 2002). The model includes four phytoplankton "functional groups" (picoplankton, diatoms, coccolithophores, diazotrophs) characterized by distinct biogeochemical functions (nutrient recycling, silicification, calcification, and N_2 fixation, respectively) and limited by four different nutrients (nitrogen, silicic acid, phosphate, and iron). The ecosystem is linked to an ocean biogeochemistry module based on an expanded version of the Ocean-Carbon Cycle Model Intercomparison Project (OCMIP) biotic model (Doney et al., 2004). Prognostic variables are added for carbon, alkalinity, iron, and dissolved O_2. The model has been augmented with atmospheric iron deposition, iron scavenging, and continental margin iron sources (Jin et al., 2008). A mineral ballast/organic matter parameterization is used to predict the fate of particulate matter. At UCLA, the BEC model has been fully implemented within ROMS and used to study the Pacific basin carbon cycle (at coarser resolution) and the consequences of iron open-ocean fertilization (Jin et al., 2008).

Field Measurements

Pier-based Sampling

The Southern California Coastal Ocean Observing System (SCCOOS) has implemented a new HAB pier-based sampling program that started in July 2008. This program will be part of the Bight'08 Water Quality study design through the collaboration of Burt Jones (USC), David Caron (USC) and Meredith Howard (USC and SCCWRP). Sampling will occur at five piers located in San Luis Obispo, Santa Barbara, Santa Monica Bay, Newport Beach and La Jolla (Table 4, Figure 2). The piers will have mounted sensors for continuous time-series data of temperature, salinity and chlorophyll fluorescence. These samples will be used as a trigger to evaluate if an algal bloom is developing in the Southern California Bight. Discrete water samples will be collected weekly and analyzed for the constituents listed in Table 5.

Offshore vessel surveys

There will be three event surveys following the onset of a "bloom" event from February to May 2009 (Figure 3). The onset (trigger) of an event will be determined by sampling at five piers located along the coast (Figure 2) and the data from the SCCOOS gliders (see section below). Two additional surveys will be conducted by the Central Bight Water Quality (CBWQ) group and City of San Diego (SD) as part of their permit monitoring programs (Figure 4). These offshore field surveys will consist of CTD (conductivity, temperature, depth) and bio-optical (transmissivity; chlorophyll, and CDOM flourometry) vertical profiles and discrete water samples collected at the surface and at the subsurface chlorophyll *a* maximum for measurements of domoic acid, chlorophyll *a*, nutrients, and phytoplankton toxins. The ship-based indicators to be sampled are listed in Table 6.

Regions and Station Selection

Sampling will take place along a series of preselected transects located at input sources to the SCB. Along each transect, 5-6 CTD profiles will be collected with three of those stations including the collection of discrete samples. The timing of the discrete sampling during the CBWQ/SD group cruises will adjust to sample algal bloom events while still meeting the permit requirements (e.g., winter and spring sampling) of the agencies involved. Station locations are listed in Tables 7 and 8 and shown in Figures 3 and 4.

Event and temporal selection

The three bloom events will be sampled coincidently throughout the SCB (±2 days). If the primary triggers are weak (e.g., little upwelling) or if there are low concentrations of algal biomass, then the CBWQ/SD sampling will occur no later than the second week of March (to insure meeting permit requirements). Subsequent sampling will be conducted either by the onset of a trigger or algal bloom or on a set temporal pattern (e.g., every two weeks) determined by consultation between the Bight'08 water quality committee or its designees.

CTD profiles and discrete water sampling

At each station (as defined above), CTD profiles will include the measurement of the distribution of temperature, salinity, dissolved oxygen, turbidity, chlorophyll fluorescence and CDOM fluorescence in the water column. Profiles will extend from the surface ($\leq$ 1 m) to within 2-3 meters of the bottom, except in water depths greater than 75 meters, where only the upper 75 meters of the water column will be sampled. Discrete samples will be obtained at two depths to assess the relationship between HAB species, nutrients, chlorophyll concentration, and domoic acid. Discrete chlorophyll *a* measurements will be used to calibrate CTD-based fluorescence measurements to chlorophyll *a*. Ocean water samples will be taken at three of the CTD sites along each transect at the surface ($\leq$ 1 m) and at the depth of maximum chlorophyll-fluorescence. Table 6 summarizes the indicators that will be sampled through ship-based sampling

Gliders

The USC Webb Research gliders are equipped to measure temperature, salinity, chlorophyll fluorescence, CDOM fluorescence, phycoerythrin fluorescence and optical backscatter at three minimally absorbing wavelengths (550, 650 and 880 nm). The slope of the multi-wavelength optical backscatter spectrum provides an index of particle size. By using two gliders, exchanged about every three weeks, it will be possible to maintain a nearly continuous presence for this period. Near real-time telemetering of the glider data will provide information about the timing and location of blooms. This data will be used for initiating additional pier and boat sampling should a bloom event occur. The glider data also feeds directly into data assimilating numerical models (i.e., ROMS) that can be used for nowcasting and forecasting of coastal conditions. If run with a biogeochemical model, the model can predict formation, location, and transport of blooms.

Glider mapping along several sentinel lines will be used to monitor for the development of blooms and/or precursor events such upwelling or stormwater runoff events. The region of observation will be San Pedro Bay between Los Angeles Harbor and the Newport Pier. This is an area where additional fixed site monitoring is occurring through a project funded through NOAA's Monitoring and Event Response for Harmful Algal Blooms (MERHAB) program. The glider mapping will occur during a five-month period that spans the primary period of concern for domoic acid toxicity from *Pseudo-nitzschia* spp. This period is typically between February and June of each year. Figure 5 shows a map of the SCCOOS glider coverage on the San Pedro Shelf.

High-Frequency Radar

High frequency (HF) radar is used to measure surface current velocity fields near the coast. Depending on the number and frequency of HF radar used, these systems can detect up to 70 km offshore. The resulting surface plots provide a high-resolution representation (e.g., vector plots) of currents. These vector plots allow mesoscale features, like coastal eddies, to be resolved with

a great degree of accuracy. Daily (25-hour averaged) vector plots will be evaluated in conjunction with satellite and ROMS model output.
Figure 6 shows the HF installations for the SCB.

Special Study on Nutrient Source Tracking

Isotopes offer a direct means of source identification because different sources of nitrogen (*e.g.* soil nitrogen, atmospheric nitrogen, chemical fertilizers, manure, and sewage) often have distinct isotopic compositions. In addition, biological cycling of nitrogen often changes isotopic ratios in predictable and recognizable directions that can be reconstructed from the isotopic compositions. Thus utilizing the isotopic composition of nitrate in the SCB could potentially be used to identify point and non-point sources of nitrate to the bight and/or the biological transformation of nitrate. In addition, estimates the amount of primary productivity due to biological recycling and nitrification in surface waters, and loss of nitrogen from the surface waters due to denitrification is critical information to interpret data from the nutrient sources to the SCB.

This component will serve as a pilot for the utilization of nitrate nitrogen and oxygen isotope ratios as indicators of sources and cycling of nitrate in the SCB. The study involves two parts: 1) determination of nitrate nitrogen and oxygen isotope ratios in specific sources (POTW effluent, river discharge, and upwelled water); and 2) field measurements to determine if source signatures are maintained in the SCB or if they are over-written by biological transformations. For the source signature identification part, water will be collected from LACSD and OCSD during three consecutive months, from the mouths and upstream (freshwater) areas of the Los Angeles River, the San Gabriel River, the Santa Ana River, and the San Diego Creek, and mid-depth and deep water from the SCB representing the upwelling end-member. Samples of wet and dry atmospheric deposition will be analyzed to obtain their isotopic source value. The utility of nitrate isotopic measurements depends on each of these sources having a unique, and identifiable paired oxygen and nitrogen isotopic composition.

The second part of the study will determine if isotopic source tracking is possible in the SCB or if the isotopic composition points to the extent of biological cycling. Water will be collected from the SCB on LACSD and OCSD cruises along both a vertical and horizontal profile from the POTW effluent pipes off shore and along transects from the San Gabriel and Santa Ana Rivers (Table 9). Salinity measurements from CTD casts are used to direct sampling into these freshwater plumes. These measurements will be used to assess whether the river source and POTW source signatures are altered as organisms utilize and recycle nitrate in surface waters. If so, nitrate isotope measurements can still be used to identify key biological source and loss terms for the SCB, but cannot be used for source tracking.

C. Methods

The Bight'08 Water Quality study will measure a suite of indicators in order to relate nutrient sources and oceanic hydrodynamic and physiochemical conditions to algal blooms, especially the growth of *Pseudo-nitzschia* and the production of domoic acid. Carefully designed collection of these indicators will allow investigators to identify and statistically model associations between nutrient loads, associated environmental factors and biological response in the SCB.

A design principle of Bight'08 is that these indicators will be measured using uniform sampling methods throughout the Bight; the validity of such an assessment depends on ensuring that all the data that contribute to it are comparable. Below, we present a short description of the methods used to measure the Bight'08 indicators; more detailed descriptions of the methods can be found in the accompanying Field Methods and Quality Assurance Manuals for the project.

Nutrients

Water samples from wet weather and dry weather runoff, atmospheric deposition, POTW effluent, and offshore sampling will be analyzed for a suite of total, total dissolved, and dissolved inorganic nitrogen and phosphorus. Silicate, dissolved organic carbon, and urea will also be measured on all samples. Nutrient and silicate samples will be analyzed by autoanalyzer. Urea will be measured by wet chemical methods. Dissolved organic carbon will be measured by high temperature combustion.

Biological Response

Domoic Acid: Particulate domoic acid samples will be collected in the field and frozen until analysis. Rapid analysis of domoic acid concentrations will be made using a new Enzyme Linked Immunosorbent Assay (ELISA) method. The analysis (developed and now offered commercially by Mercury Science, Inc.) is based on a competitive binding assay and is highly specific for domoic acid.

HAB Species Counts: Approximately 100 mL of water will be preserved in lugol's fixative and stored in the lab for future analysis and counts of *Pseudo-nitzschia.*

CTD Profiles: CTD surveys will be conducted using SeaBird CTDs equipped with auxiliary sensors to measure dissolved oxygen, pH, beam transmission (turbidity), chlorophyll fluorescence, and CDOM fluorescence and follow established regional pre- and post-cruise calibrations and deployment procedures.

SCCOOS gliders: The gliders will be deployed on the San Pedro Shelf and will collect measurements of temperature, salinity, chlorophyll fluorescence, CDOM fluorescence and optical backscatter.

Special Studies: Stable Nutrient Isotopes

Nitrogen and oxygen isotope ratios of dissolved nitrate will be measured to identify the sources and cycling of nitrate in the SCB. In addition, the oxygen isotopic composition of water will be analyzed as a tracer for water sources (freshwater sources have lower water oxygen isotope ratios compared to seawater); water oxygen can also be used to extrapolate expected nitrate oxygen isotope values if denitrification is present. Nitrate will be isolated from water samples via reduction of nitrate to nitrous oxide, which will be analyzed on a continuous flow isotope ratio mass spectrometer (CF-IRMS). The oxygen isotopic composition of water will be measured on whole water samples by laser-absorption spectroscopy.

D. References

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Figure 2. Map of the study area. The HAB surveillance piers are represented by the blue balloons and the white box shows the San Pedro Shelf, the location of intensive studies using SCCOOS gliders.

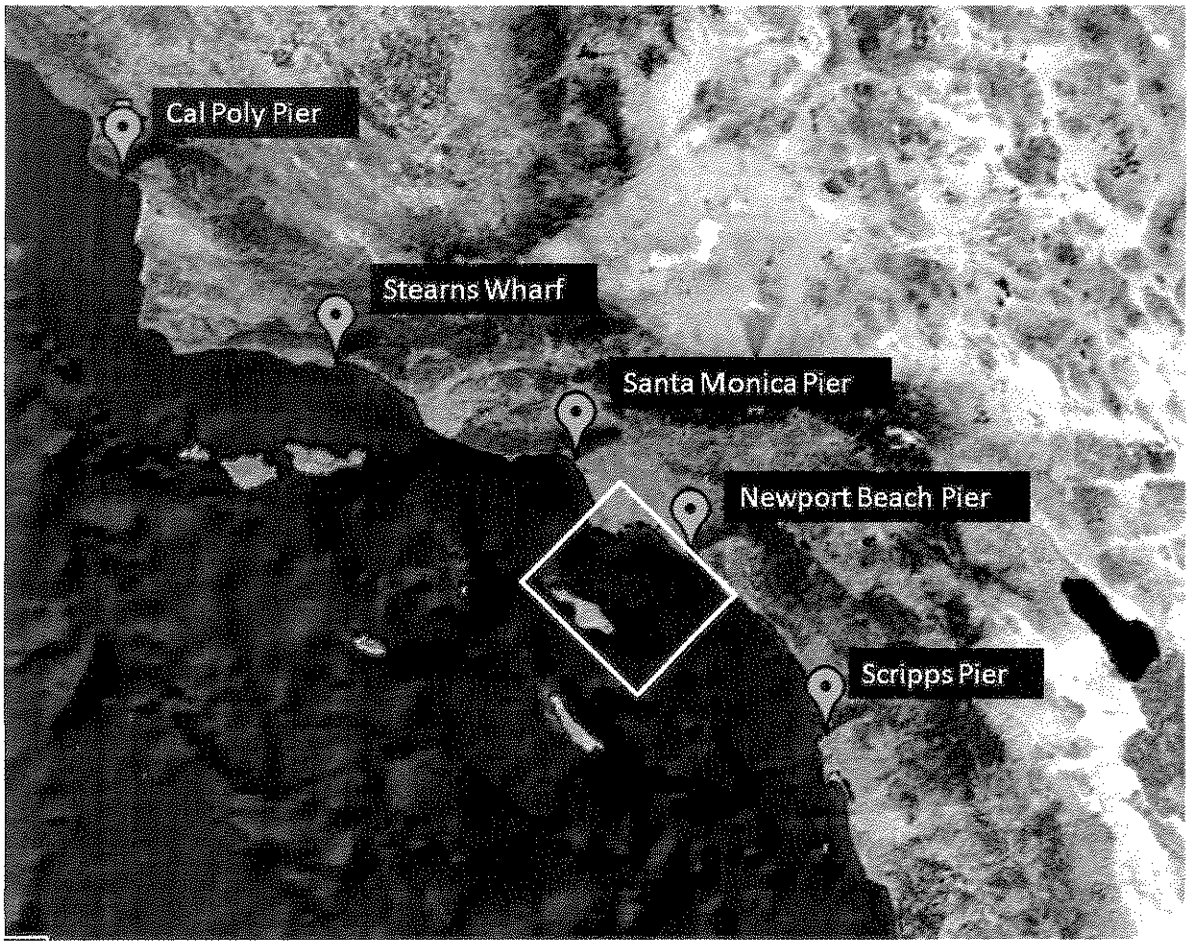

Figure 3. Map of the Bight'08 offshore water quality stations for the three event surveys.

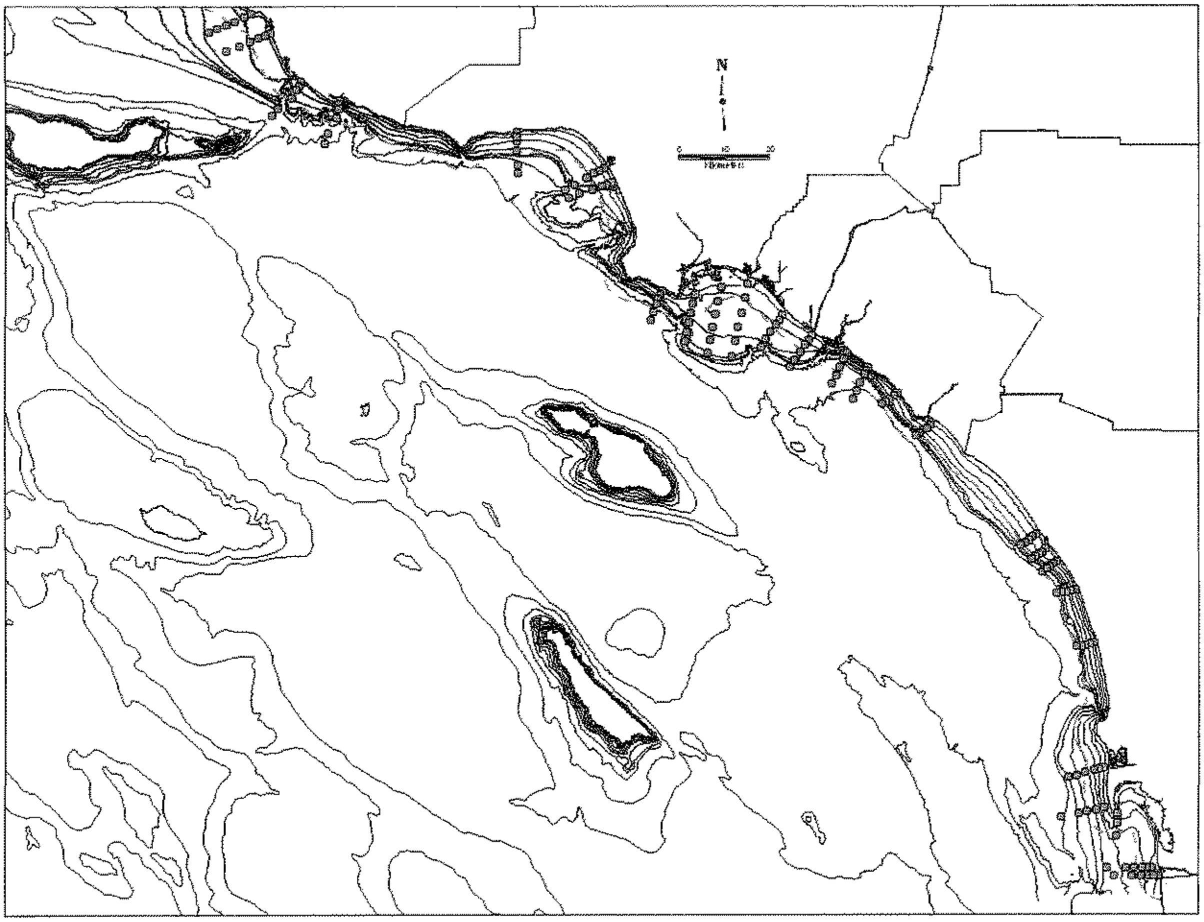

Figure 4. Map of the Bight'08 offshore sampling stations for the two Central Bight Water Quality surveys conducted as part of their permit monitoring programs.

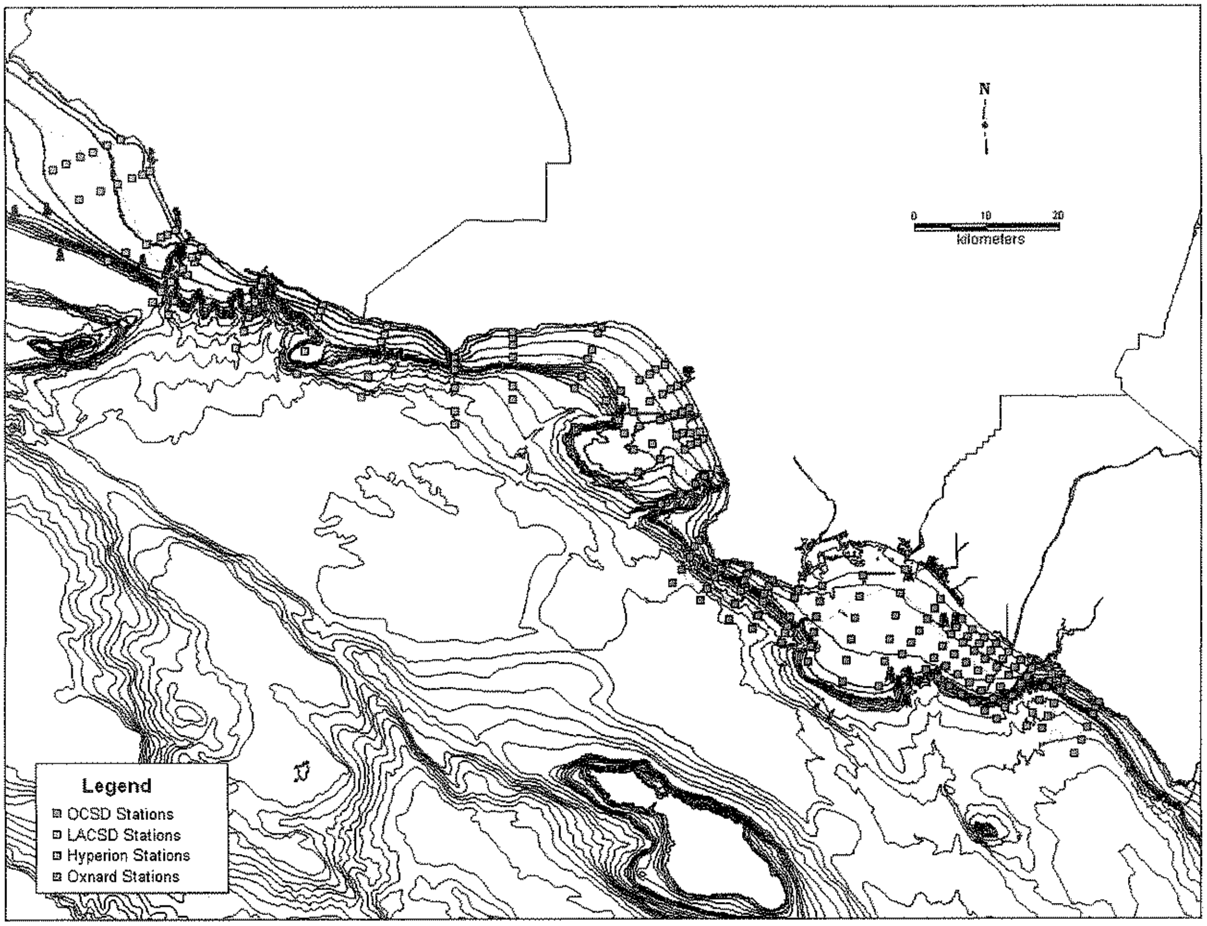

Figure 5. Map of the Bight'08 glider sampling area off the San Pedro Shelf. Black box outlines the intensive region. Red lines are the Spray glider lines and the yellow box is the Webb glider operational area. Hydrographic profiles will be taken along the two Spray lines.

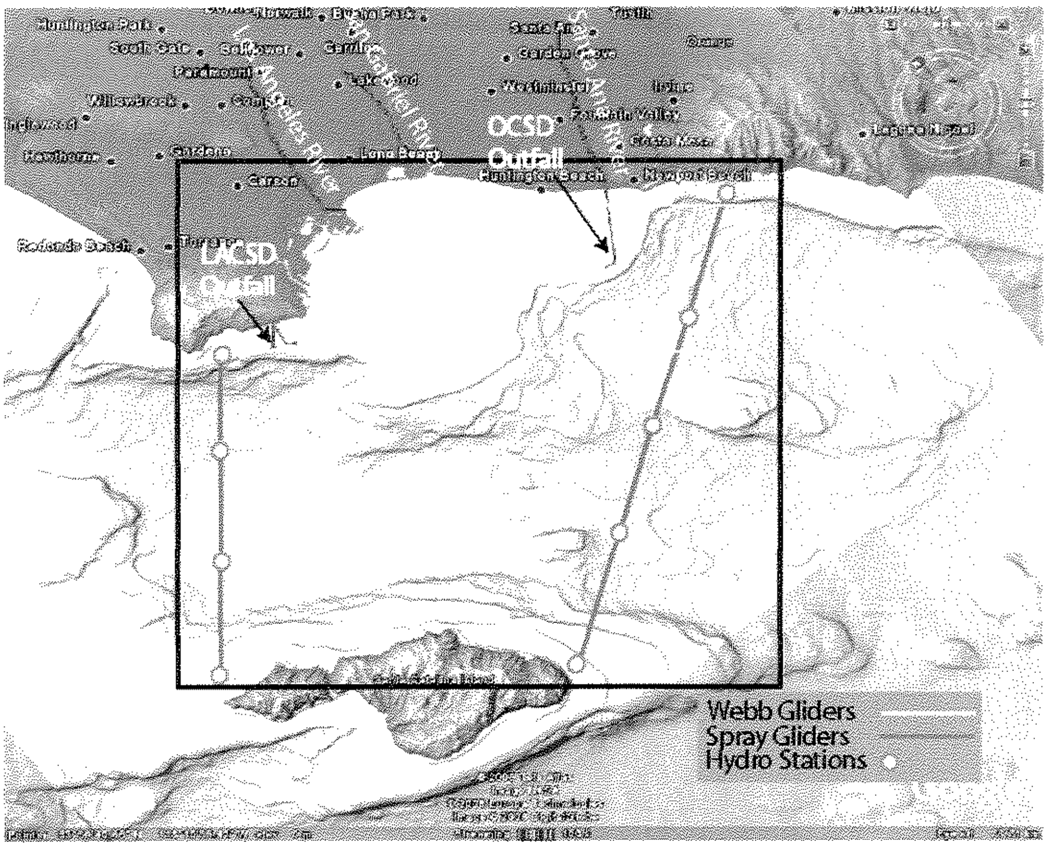

Figure 6. Map of the Bight'08 water quality study area with high-frequency (HF) radar sites.

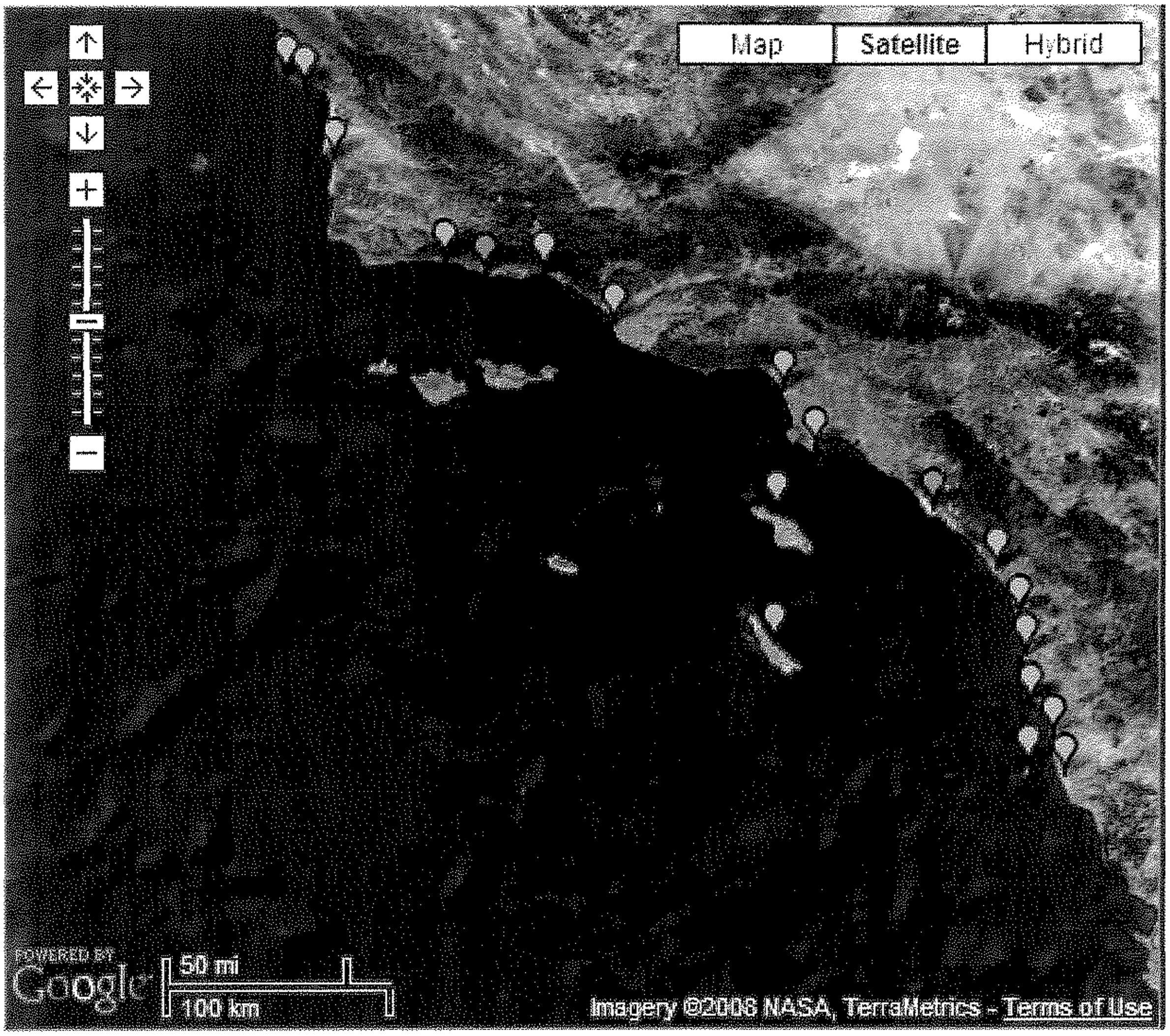

Table 2. List of constituents to be sampled and analyzed for each nutrient source.

Constituent	Watershed Loading	Atmospheric Deposition		POTW Effluent	Upwelling
		Wet	Dry		
Nitrate+Nitrate	X			X	
Nitrate		X	X		X
Ammonia	X	X	X	X	
Phosphate	X			X	X
Silicate	X			X	X
Urea	X			X	
Total Dissolved Nitrogen	X			X	
Total Nitrogen	X	X	X	X	
Total Dissolved Phosphorus	X			X	
Total Phosphorus	X	X	X	X	

Table 3. List of mass emission stations where nutrient concentrations and loads will be measured under Bight'08 water quality study.

County	Location	Number of Wet and Dry Weather Events
Los Angeles	Ballona Creek at Sawtelle	3 storms + 2 dry
Los Angeles	Coyote Creek at Spring Street	3 storms + 2 dry
Los Angeles	Dominguez Channel at Artesia Blvd	3 storms + 2 dry
Los Angeles	Los Angeles River at Wardlow	3 storms + 2 dry
Los Angeles	Malibu Creek at Piuma Road	3 storms + 2 dry
Los Angeles	San Gabriel River at SGR Parkway	3 storms + 2 dry
Los Angeles	Santa Clara River at The Old Road	3 storms + 2 dry
Orange	San Diego Creek at Campus	3 storms + ≥ 3 dry
Orange	Bolsa Chica at Westminster	3 storms + 2 dry
Orange	Bonita Cyn Wash u/s University	3 storms + ≥ 3 dry
Orange	Costa Mesa Channel at Highland	3 storms + ≥ 3 dry
Orange	Garden Grove Wintersburg at Gothard	3 storms + 2 dry
Orange	Santa Ana Delhi at Irvine Ave	3 storms + ≥ 3 dry
Orange	Aliso Creek at Aliso/Woods Cyn Park	3 storms + 2 dry
Orange	Laguna Canyon at Woodland	3 storms + 2 dry
Orange	Prima Deschecha at Calla Grande Vista	3 storms + 2 dry
Orange	Segunda Deschecha at El Camino Real	3 storms + 2 dry
Orange	San Juan Creek at La Novia	3 storms + 2 dry
Orange	Trabuco Creek at Del Obispo Road	3 storms + 2 dry
San Diego	Santa Margarita River	1 storm
San Diego	San Luis Rey River	1 storm
San Diego	Agua Hedionda Creek	1 storm
San Diego	Escondido Creek	1 storm
San Diego	San Dieguito River	1 storm
San Diego	Penasquitos	1 storm
San Diego	Tecolote Creek	1 storm
San Diego	San Diego River	1 storm
San Diego	Chollas Creek	1 storm
San Diego	Sweetwater River	1 storm
San Diego	Tijuana River	1 storm
Ventura	Calleguas Creek at CSUCI Bridge	4 storms + 2 dry
Ventura	Freeman Diversion, Saticoy	4 storms + 2 dry
Ventura	Ojai Valley Sanitation District	4 storms + 2 dry

Ventura	La Vista Drain	1st storm
Ventura	Revolon Slough	1st storm

Table 4. The SCCOOS HAB pier sampling locations and research groups.

Pier	City	Laboratory	Researcher/PI	Institution
California State Polytechnic Pier	San Luis Obispo	Moline Laboratory	Mark Moline	California State Polytechnic University
Stearn's Wharf	Santa Barbara	Brzezinski laboratory	Mark Brzezinski	University of California Santa Barbara
Santa Monica Pier	Santa Monica	Shipe Laboratory	Rebecca Shipe	University of California, Los Angeles
Newport Pier	Newport Beach	Jones and Caron Laboratories	Burt Jones and David Caron	University of Southern California
Scripps Pier	La Jolla	McGowan laboratory	John A. McGowan	University of California, San Diego - Scripps Institution of Oceanography

Table 5. List of pier-based indicators to be sampled in the Bight'08 study.

Component	Indicator/Analyte
Continuous sensor	temperature salinity fluorescence
Discrete water samples	chlorophyll *a* nitrate ammonia phosphate silicate domoic acid temperature HAB species counts *Pseudo-nitzschia* *Alexandrium* *Lingulodinium polyedrum* *Prorocentrum* *Dinophysis* *Akashiwo sanguineum* *Cochlodinium* *Phaeocystis*

Table 6. List of ship-based indicators to be sampled in the Bight'08 study.

Component	Indicator/Analyte
CTD profile	Temperature Salinity dissolved oxygen turbidity fluorescence (for chlorophyll a and CDOM)
Discrete water samples	chlorophyll *a* nitrate nitrite phosphate silicate urea total dissolved nitrogen total dissolved phosphorus total nitrogen total phosphorus *Pseudo-nitzschia* cell counts

Table 7. Bight'08 offshore water quality stations for the three event surveys.

Area	Station Name	Latitude	Longitude	Depth	Location	Responsible Agency
North	New	34.40860	- 119.82540	10	Goleta Outfall	Contractor
North	New	34.39640	- 119.82690	45	Goleta Outfall	Contractor
North	New	34.38500	- 119.82820	60	Goleta Outfall	Contractor
North	New	34.37230	- 119.82980	70	Goleta Outfall	Contractor
North	New	34.35700	- 119.83200	100	Goleta Outfall	Contractor
North	New	34.41050	- 119.67090	10	Santa Barbara Outfall	Contractor
North	New	34.39390	- 119.67250	20	Santa Barbara Outfall	Contractor
North	New	34.37460	- 119.67430	50	Santa Barbara Outfall	Contractor
North	New	34.33140	- 119.67800	70	Santa Barbara Outfall	Contractor
North	New	34.30560	- 119.68040	100	Santa Barbara Outfall	Contractor
Central	4701	34.27123	- 119.31041	10	Ventura River	Oxnard (ABC Labs)
Central	4702	34.26350	- 119.32909	20	Ventura River	Oxnard (ABC Labs)
Central	4703	34.25557	- 119.35091	20	Ventura River	Oxnard (ABC Labs)
Central	4704	34.24853	- 119.37058	20	Ventura River	Oxnard (ABC Labs)
Central	4705	34.24054	- 119.39239	30	Ventura River	Oxnard (ABC Labs)
Central	4706	34.23303	- 119.41258	30	Ventura River	Oxnard (ABC Labs)
Central	4601	34.23065	- 119.26730	10	Santa Clara River	Oxnard (ABC Labs)
Central	4602	34.22732	- 119.27850	20	Santa Clara River	Oxnard (ABC Labs)
Central	4603	34.22166	- 119.29413	30	Santa Clara River	Oxnard (ABC Labs)
Central	4604	34.21452	- 119.31484	30	Santa Clara River	Oxnard (ABC Labs)
Central	4605	34.20637	- 119.33997	30	Santa Clara River	Oxnard (ABC Labs)
Central	4606	34.19531	- 119.37207	35	Santa Clara River	Oxnard (ABC Labs)
Central	4401	34.13350	- 119.19300	15	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4402	34.12550	- 119.19900	20	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4403	34.11770	- 119.20500	25	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4404	34.10180	- 119.21600	40	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4405	34.07941	- 119.25044	100	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4406	34.06687	- 119.26411	100	Port Hueneme/Oxnard Outfall	Oxnard (ABC Labs)
Central	4301	34.09760	- 119.10000	15	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)
Central	4302	34.08870	- 119.10200	20	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)
Central	4303	34.07960	- 119.10300	65	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)

Area	Station Name	Latitude	Longitude	Depth	Location	Responsible Agency
Central	4304	34.06160	-119.10700	100	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)
Central	4305	34.03021	-119.12659	100	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)
Central	4306	34.00905	-119.13779	100	Mugu Lagoon/Calleguas Creek	Oxnard (ABC Labs)
Central	138501	34.03190	-118.67600	10	Malibu Creek	Hyperion
Central	138502	34.02280	-118.67500	20	Malibu Creek	Hyperion
Central	138503	34.01360	-118.67500	30	Malibu Creek	Hyperion
Central	138504	33.99570	-118.67500	60	Malibu Creek	Hyperion
Central	138505	33.96624	-118.67400	100	Malibu Creek	Hyperion
Central	138506	33.94944	-118.67300	100	Malibu Creek	Hyperion
Central	3601	33.95973	-118.46625	10	Ballona Creek	Hyperion
Central	3602	33.95555	-118.47777	20	Ballona Creek	Hyperion
Central	3603	33.94943	-118.49027	30	Ballona Creek	Hyperion
Central	3604	33.94027	-118.50977	45	Ballona Creek	Hyperion
Central	3605	33.92777	-118.53555	60	Ballona Creek	Hyperion
Central	3606	33.91667	-118.55833	100	Ballona Creek	Hyperion
Central	3501	33.93138	-118.44805	10	Hyperion Outfall	Hyperion
Central	3502	33.92777	-118.46027	20	Hyperion Outfall	Hyperion
Central	3503	33.92388	-118.47250	30	Hyperion Outfall	Hyperion
Central	3504	33.91667	-118.49417	45	Hyperion Outfall	Hyperion
Central	3505	33.90917	-118.52527	60	Hyperion Outfall	Hyperion
Central	3506	33.90000	-118.54972	80	Hyperion Outfall	Hyperion
Central	2901	33.71430	-118.32345	10	LACSD Outfall	LACSD
Central	2902	33.70693	-118.32983	30	LACSD Outfall	LACSD
Central	2903	33.69847	-118.33568	60	LACSD Outfall	LACSD
Central	2904	33.68783	-118.33900	300	LACSD Outfall	LACSD
Central	2905	33.67094	-118.34618	555	LACSD Outfall	LACSD
Central	2906	33.65409	-118.35430	775	LACSD Outfall	LACSD
Central	2701	33.70775	-118.24666	26	Los Angeles Harbor/Dominguez Channel	LACSD
Central	2702	33.68864	-118.25112	26	Los Angeles Harbor/Dominguez Channel	LACSD
Central	2703	33.66953	-118.25559	28	Los Angeles Harbor/Dominguez Channel	LACSD
Central	2704	33.65042	-118.26005	50	Los Angeles Harbor/Dominguez Channel	LACSD
Central	2705	33.63131	-118.26452	220	Los Angeles Harbor/Dominguez Channel	LACSD
Central	2706	33.61220	-118.26898	80	Los Angeles Harbor/Dominguez Channel	LACSD

Area	Station Name	Latitude	Longitude	Depth	Location	Responsible Agency
Central	2601	33.72043	-118.18426	19	Long Beach Harbor/Los Angeles River	LACSD
Central	2602	33.69398	-118.19050	23	Long Beach Harbor/Los Angeles River	LACSD
Central	2603	33.66752	-118.19674	23	Long Beach Harbor/Los Angeles River	LACSD
Central	2604	33.64107	-118.20299	32	Long Beach Harbor/Los Angeles River	LACSD
Central	2605	33.61461	-118.20923	47	Long Beach Harbor/Los Angeles River	LACSD
Central	2606	33.58816	-118.21547	62	Long Beach Harbor/Los Angeles River	LACSD
Central	2501	33.72787	-118.12025	10	San Gabriel River/Alamitos Bay	LACSD
Central	2502	33.69904	-118.12779	20	San Gabriel River/Alamitos Bay	LACSD
Central	2503	33.67021	-118.13533	26	San Gabriel River/Alamitos Bay	LACSD
Central	2504	33.64139	-118.14287	33	San Gabriel River/Alamitos Bay	LACSD
Central	2505	33.61256	-118.15041	44	San Gabriel River/Alamitos Bay	LACSD
Central	2506	33.58102	-118.15908	60	San Gabriel River/Alamitos Bay	LACSD
Central	2401	33.66533	-118.03505	10	Bolsa Chica Inlet	OCSD
Central	2402	33.65570	-118.04322	16	Bolsa Chica Inlet	OCSD
Central	2403	33.64608	-118.05120	21	Bolsa Chica Inlet	OCSD
Central	2404	33.63125	-118.06347	29	Bolsa Chica Inlet	OCSD
Central	2405	33.61643	-118.07573	37	Bolsa Chica Inlet	OCSD
Central	2406	33.60160	-118.08800	60	Bolsa Chica Inlet	OCSD
Central	2201	33.62488	-117.96385	10	Santa Ana River	OCSD
Central	2202	33.61502	-117.97190	16	Santa Ana River	OCSD
Central	2203	33.60522	-117.98017	25	Santa Ana River	OCSD
Central	2204	33.59038	-117.99243	39	Santa Ana River	OCSD
Central	2205	33.57557	-118.00470	57	Santa Ana River	OCSD
Central	2206	33.56073	-118.01697	185	Santa Ana River	OCSD
Central	2001	33.58892	-117.87820	10	Newport Harbor/San Diego Creek	OCSD
Central	2002	33.57925	-117.88380	60	Newport Harbor/San Diego Creek	OCSD
Central	2003	33.57608	-117.88573	100	Newport Harbor/San Diego Creek	OCSD
Central	2004	33.55982	-117.89513	345	Newport Harbor/San Diego Creek	OCSD
Central	2005	33.54355	-117.90438	410	Newport Harbor/San Diego Creek	OCSD
Central	2006	33.52745	-117.91373	470	Newport Harbor/San Diego Creek	OCSD
Central	1901	33.56137	-117.82757	10	Crystal Cove State Beach	OCSD
Central	1902	33.55275	-117.83240	60	Crystal Cove State Beach	OCSD
Central	1903	33.54603	-117.83637	100	Crystal Cove State Beach	OCSD

Area	Station Name	Latitude	Longitude	Depth	Location	Responsible Agency
Central	1904	33.52978	-117.84557	405	Crystal Cove State Beach	OCSD
Central	1905	33.51350	-117.85475	510	Crystal Cove State Beach	OCSD
Central	1906	33.49715	-117.86403	550	Crystal Cove State Beach	OCSD
Central	118001	33.50920	-117.75700	15	Aliso Outfall/Aliso Creek	Contractor
Central	118002	33.50350	-117.76600	45	Aliso Outfall/Aliso Creek	Contractor
Central	118003	33.49790	-117.77600	65	Aliso Outfall/Aliso Creek	Contractor
Central	New	33.49272	-117.78431	160	Aliso Outfall/Aliso Creek	Contractor
Central	118004	33.48740	-117.79300	175	Aliso Outfall/Aliso Creek	Contractor
Central	116001	33.44420	-117.67700	10	SERRA Outfall/San Juan Creek	Contractor
Central	116002	33.43890	-117.68500	20	SERRA Outfall/San Juan Creek	Contractor
Central	116003	33.43430	-117.69300	30	SERRA Outfall/San Juan Creek	Contractor
Central	New	33.42878	-117.70148	70	SERRA Outfall/San Juan Creek	Contractor
Central	116004	33.42280	-117.71100	155	SERRA Outfall/San Juan Creek	Contractor
South	113001	33.22530	-117.42600	15	Santa Margarita River	Contractor
South	113002	33.21990	-117.43500	20	Santa Margarita River	Contractor
South	113003	33.21450	-117.44300	25	Santa Margarita River	Contractor
South	New	33.20900	-117.45100	30	Santa Margarita River	Contractor
South	113004	33.20380	-117.46100	55	Santa Margarita River	Contractor
South	112001	33.19620	-117.40200	15	San Luis Rey River/Oceanside Harbor	Contractor
South	112002	33.19060	-117.41100	20	San Luis Rey River/Oceanside Harbor	Contractor
South	112003	33.18520	-117.42000	25	San Luis Rey River/Oceanside Harbor	Contractor
South	New	33.17960	-117.42810	45	San Luis Rey River/Oceanside Harbor	Contractor
South	112004	33.17460	-117.43700	65	San Luis Rey River/Oceanside Harbor	Contractor
South	111001	33.17190	-117.37700	15	Oceanside Outfall	Contractor
South	111002	33.16650	-117.38500	20	Oceanside Outfall	Contractor
South	111003	33.16100	-117.39400	45	Oceanside Outfall	Contractor
South	New	33.15660	-117.40120	75	Oceanside Outfall	Contractor
South	111004	33.15060	-117.41100	155	Oceanside Outfall	Contractor
South	110001	33.11410	-117.33300	15	Encina Outfall	Contractor
South	110002	33.11230	-117.34300	30	Encina Outfall	Contractor
South	110003	33.11060	-117.35400	65	Encina Outfall	Contractor
South	New	33.10890	-117.36470	100	Encina Outfall	Contractor
South	110004	33.10690	-117.37600	155	Encina Outfall	Contractor

Area	Station Name	Latitude	Longitude	Depth	Location	Responsible Agency
South	109001	33.00780	-117.28700	15	Escondido Outfall	Contractor
South	109001	33.00590	-117.29800	30	Escondido Outfall	Contractor
South	109001	33.00390	-117.30900	55	Escondido Outfall	Contractor
South	New	33.00182	-117.31913	100	Escondido Outfall	Contractor
South	109004	33.00010	-117.33000	155	Escondido Outfall	Contractor
South	108001	32.75710	-117.26505	12	Mission Bay	San Diego
South	108002	32.75502	-117.27597	22	Mission Bay	San Diego
South	108003	32.75280	-117.28703	40	Mission Bay	San Diego
South	108004	32.74875	-117.30815	65	Mission Bay	San Diego
South	F23	32.74188	-117.33042	81	Mission Bay	San Diego
South	F34	32.73890	-117.34937	99	Mission Bay	San Diego
South	107001	32.67817	-117.26035	14	Point Loma Outfall	San Diego
South	107002	32.67353	-117.28207	59	Point Loma Outfall	San Diego
South	107003	32.66960	-117.30302	79	Point Loma Outfall	San Diego
South	107004	32.66558	-117.32412	93	Point Loma Outfall	San Diego
South	107005	32.65735	-117.36497	100	Point Loma Outfall	San Diego
South	New	32.68420	117.22960	10	San Diego Harbor	San Diego
South	104001	32.66637	-117.22888	15	San Diego Harbor	San Diego
South	104002	32.65633	-117.23008	14	San Diego Harbor	San Diego
South	104003	32.64740	-117.23100	17	San Diego Harbor	San Diego
South	104004	32.62038	-117.23322	32	San Diego Harbor	San Diego
South	102001	32.55713	-117.14718	10	Tijuana River	San Diego
South	102002	32.55748	-117.15927	16	Tijuana River	San Diego
South	102003	32.55782	-117.16995	20	Tijuana River	San Diego
South	102004	32.55742	-117.19142	30	Tijuana River	San Diego
South	102005	32.55743	-117.21142	38	Tijuana River	San Diego
South	102006	32.55740	-117.25495	53	Tijuana River	San Diego
South	101001	32.54035	-117.13193	11	Tijuana Outfall	San Diego
South	101002	32.54057	-117.14177	15	Tijuana Outfall	San Diego
South	101003	32.53930	-117.15368	18	Tijuana Outfall	San Diego
South	101004	32.54000	-117.17398	24	Tijuana Outfall	San Diego
South	101005	32.54047	-117.19515	33	Tijuana Outfall	San Diego
South	101006	32.53975	-117.23932	45	Tijuana Outfall	San Diego

Table 8. Bight'08 offshore water quality stations for the two Central Bight Water Quality surveys as part of their permit monitoring programs.

Station	Latitude	Longitude	Depth	Agency
1901	33.56137	-117.82757	10	OCSD
1902	33.55275	-117.83240	60	OCSD
1903	33.54603	-117.83637	100	OCSD
1904	33.52978	-117.84557	405	OCSD
1905	33.51350	-117.85475	510	OCSD
1906	33.49715	-117.86403	550	OCSD
2001	33.58892	-117.87820	10	OCSD
2002	33.57925	-117.88380	60	OCSD
2003	33.57608	-117.88573	100	OCSD
2004	33.55982	-117.89513	345	OCSD
2005	33.54355	-117.90438	410	OCSD
2006	33.52745	-117.91373	470	OCSD
2021	33.59618	-117.89803	10	OCSD
2022	33.58805	-117.90270	53	OCSD
2023	33.57993	-117.90737	165	OCSD
2024	33.56352	-117.91718	300	OCSD
2025	33.54752	-117.92655	390	OCSD
2026	33.53167	-117.93582	432	OCSD
2101	33.60305	-117.92915	10	OCSD
2102	33.59385	-117.93677	26	OCSD
2103	33.58482	-117.94463	110	OCSD
2104	33.56998	-117.95690	143	OCSD
2105	33.55515	-117.96917	280	OCSD
2106	33.54033	-117.98142	309	OCSD
2181	33.61462	-117.94587	10	OCSD
2182	33.60453	-117.95440	15	OCSD
2183	33.59502	-117.96240	36	OCSD
2184	33.58018	-117.97467	51	OCSD
2185	33.56537	-117.98692	114	OCSD
2186	33.55053	-117.99918	247	OCSD
2201	33.62488	-117.96385	10	OCSD
2202	33.61502	-117.97190	16	OCSD
2203	33.60522	-117.98017	25	OCSD
2204	33.59038	-117.99243	39	OCSD
2205	33.57557	-118.00470	57	OCSD
2206	33.56073	-118.01697	185	OCSD
2221	33.63498	-117.98180	10	OCSD
2222	33.62537	-117.98957	15	OCSD
2223	33.61557	-117.99785	22	OCSD
2224	33.60058	-118.01013	31	OCSD
2225	33.58577	-118.02243	47	OCSD
2226	33.57095	-118.03472	135	OCSD
2301	33.64287	-118.00107	10	OCSD
2302	33.63422	-118.00825	15	OCSD
2303	33.62562	-118.01560	21	OCSD

Station	Latitude	Longitude	Depth	Agency
2304	33.61082	-118.02790	29	OCSD
2305	33.59600	-118.04020	38	OCSD
2306	33.58118	-118.05248	114	OCSD
2349	33.65317	-118.01892	10	OCSD
2350	33.64445	-118.02610	14	OCSD
2351	33.63585	-118.03335	21	OCSD
2352	33.62103	-118.04565	29	OCSD
2353	33.60622	-118.05795	37	OCSD
2354	33.59140	-118.07023	123	OCSD
2401	33.66533	-118.03505	10	OCSD
2402	33.65570	-118.04322	16	OCSD
2403	33.64608	-118.05120	21	OCSD
2404	33.63125	-118.06347	29	OCSD
2405	33.61643	-118.07573	37	OCSD
2406	33.60160	-118.08800	60	OCSD
2451	33.69125	-118.06573	10	OCSD
2452	33.67898	-118.07640	17	OCSD
2453	33.66645	-118.08673	22	OCSD
2454	33.65163	-118.09910	30	OCSD
2455	33.63683	-118.11125	36	OCSD
2456	33.62197	-118.12352	42	OCSD
2501	33.72787	-118.12025	10	LACSD
2502	33.69904	-118.12779	20	LACSD
2503	33.67021	-118.13533	26	LACSD
2504	33.64139	-118.14287	33	LACSD
2505	33.61256	-118.15041	44	LACSD
2506	33.58102	-118.15908	60	LACSD
2601	33.72043	-118.18426	19	LACSD
2602	33.69398	-118.19050	23	LACSD
2603	33.66752	-118.19674	23	LACSD
2604	33.64107	-118.20299	32	LACSD
2605	33.61461	-118.20923	47	LACSD
2606	33.58816	-118.21547	62	LACSD
2701	33.70775	-118.24666	26	LACSD
2702	33.68864	-118.25112	26	LACSD
2703	33.66953	-118.25559	28	LACSD
2704	33.65042	-118.26005	50	LACSD
2705	33.63131	-118.26452	100	LACSD
2706	33.61220	-118.26898	80	LACSD
2801	33.70288	-118.28438	10	LACSD
2802	33.69327	-118.28908	30	LACSD
2803	33.66845	-118.29680	60	LACSD
2804	33.65767	-118.30128	100	LACSD
2805	33.64854	-118.30404	100	LACSD
2806	33.63708	-118.30919	100	LACSD
2901	33.71430	-118.32345	10	LACSD
2902	33.70693	-118.32983	30	LACSD
2903	33.69847	-118.33568	60	LACSD

Station	Latitude	Longitude	Depth	Agency
2904	33.68783	-118.33900	100	LACSD
2905	33.67094	-118.34618	100	LACSD
2906	33.65409	-118.35430	100	LACSD
3001	33.73217	-118.36030	10	LACSD
3002	33.72238	-118.36315	30	LACSD
3003	33.71462	-118.36592	60	LACSD
3004	33.70098	-118.37132	100	LACSD
3005	33.68492	-118.38107	100	LACSD
3006	33.66679	-118.39075	100	LACSD
3051	33.73632	-118.39430	13	LACSD
3052	33.73315	-118.40043	30	LACSD
3053	33.72995	-118.40247	60	LACSD
3054	33.71893	-118.41098	100	LACSD
3055	33.70497	-118.42198	100	LACSD
3056	33.68966	-118.43313	100	LACSD
3101	33.77100	-118.43017	10	LACSD
3102	33.76498	-118.43538	30	LACSD
3103	33.75730	-118.44105	60	LACSD
3104	33.74527	-118.44977	100	LACSD
3105	33.72877	-118.46123	100	LACSD
3106	33.71254	-118.47551	100	LACSD
3201	33.85416	-118.40611	10	Hyperion
3202	33.84861	-118.41778	30	Hyperion
3203	33.84528	-118.42638	100	Hyperion
3204	33.83695	-118.44055	100	Hyperion
3205	33.82388	-118.46361	100	Hyperion
3206	33.81110	-118.49278	100	Hyperion
3301	33.89305	-118.42721	10	Hyperion
3302	33.88916	-118.43638	20	Hyperion
3303	33.88555	-118.44666	30	Hyperion
3304	33.87945	-118.45695	45	Hyperion
3305	33.86833	-118.49333	60	Hyperion
3306	33.85111	-118.52721	80	Hyperion
3401	33.90250	-118.43250	10	Hyperion
3402	33.90000	-118.44721	20	Hyperion
3403	33.90110	-118.46000	30	Hyperion
3404	33.89693	-118.46860	45	Hyperion
3405	33.88721	-118.50638	55	Hyperion
3406	33.87916	-118.53555	60	Hyperion
3501	33.93138	-118.44805	10	Hyperion
3502	33.92776	-118.46026	20	Hyperion
3503	33.92388	-118.47250	30	Hyperion
3504	33.91666	-118.49416	45	Hyperion
3505	33.90916	-118.52526	60	Hyperion
3506	33.90000	-118.54971	80	Hyperion
3601	33.95973	-118.46625	10	Hyperion
3602	33.95555	-118.47776	20	Hyperion
3603	33.94943	-118.49026	30	Hyperion

Station	Latitude	Longitude	Depth	Agency
3604	33.94026	-118.50976	45	Hyperion
3605	33.92776	-118.53555	60	Hyperion
3606	33.91666	-118.55833	100	Hyperion
3701	33.98610	-118.48610	10	Hyperion
3702	33.98000	-118.50000	20	Hyperion
3703	33.97416	-118.51000	30	Hyperion
3704	33.96666	-118.52555	45	Hyperion
3705	33.95360	-118.55360	60	Hyperion
3706	33.94250	-118.57500	100	Hyperion
3801	34.03333	-118.58333	10	Hyperion
3802	34.02583	-118.58750	20	Hyperion
3803	34.00583	-118.59721	45	Hyperion
3804	33.99333	-118.60416	60	Hyperion
3805	33.97221	-118.61416	100	Hyperion
3806	33.95610	-118.62360	100	Hyperion
3901	34.02750	-118.71666	10	Hyperion
3902	34.01943	-118.71666	20	Hyperion
3903	34.01110	-118.71666	30	Hyperion
3904	33.99750	-118.71666	60	Hyperion
3905	33.96026	-118.71666	100	Hyperion
3906	33.94276	-118.71666	100	Hyperion
4001	33.99527	-118.80526	20	Hyperion
4002	33.98833	-118.80526	100	Hyperion
4003	33.98055	-118.80526	100	Hyperion
4004	33.95833	-118.80526	100	Hyperion
4005	33.92805	-118.80526	100	Hyperion
4006	33.91250	-118.80526	100	Hyperion
4101	34.03544	-118.90773	10	Oxnard
4102	34.02571	-118.91235	30	Oxnard
4103	34.01688	-118.91685	55	Oxnard
4104	33.99222	-118.92713	100	Oxnard
4105	33.97154	-118.93645	100	Oxnard
4106	33.94652	-118.94706	100	Oxnard
4201	34.06184	-119.00716	12	Oxnard
4202	34.05438	-119.01035	30	Oxnard
4203	34.04703	-119.01413	58	Oxnard
4204	34.02756	-119.02273	100	Oxnard
4205	34.00423	-119.03314	85	Oxnard
4206	33.97667	-119.04532	100	Oxnard
4301	34.09358	-119.09774	11	Oxnard
4302	34.08612	-119.10060	25	Oxnard
4303	34.06628	-119.11031	70	Oxnard
4304	34.04719	-119.11955	100	Oxnard
4305	34.03021	-119.12659	100	Oxnard
4306	34.00905	-119.13779	100	Oxnard
4391	34.13118	-119.18943	10	Oxnard
4392	34.12417	-119.19680	15	Oxnard
4393	34.11637	-119.20182	25	Oxnard

Station	Latitude	Longitude	Depth	Agency
4394	34.10033	-119.21225	35	Oxnard
4395	34.06795	-119.23137	100	Oxnard
4396	34.05077	-119.24043	100	Oxnard
4401	34.13506	-119.19020	10	Oxnard
4402	34.12225	-119.20381	15	Oxnard
4403	34.10871	-119.21827	25	Oxnard
4404	34.09253	-119.23644	37	Oxnard
4405	34.07941	-119.25044	100	Oxnard
4406	34.06687	-119.26411	100	Oxnard
4501	34.15659	-119.22992	10	Oxnard
4502	34.15167	-119.24178	15	Oxnard
4503	34.14807	-119.25161	20	Oxnard
4504	34.13992	-119.27199	20	Oxnard
4505	34.12876	-119.30299	31	Oxnard
4506	34.11839	-119.32968	65	Oxnard
4601	34.23065	-119.26730	10	Oxnard
4602	34.22732	-119.27850	15	Oxnard
4603	34.22166	-119.29413	20	Oxnard
4604	34.21452	-119.31484	20	Oxnard
4605	34.20637	-119.33997	25	Oxnard
4606	34.19531	-119.37207	31	Oxnard
4701	34.27123	-119.31041	10	Oxnard
4702	34.26350	-119.32909	20	Oxnard
4703	34.25557	-119.35091	25	Oxnard
4704	34.24853	-119.37058	25	Oxnard
4705	34.24054	-119.39239	25	Oxnard
4706	34.23303	-119.41258	30	Oxnard

Table 9. Selected sites for Isotope Pilot Study

Site #	Depth	Purpose
LACSD 2903	surface	effluent plume source tracking
LACSD 2903	34 m	effluent plume source tracking
LACSD 2903	45 m	effluent plume source tracking
LACSD 2904	surface	effluent plume source tracking
LACSD 2904	45 m	effluent plume source tracking
LACSD 2904	50 m	effluent plume source tracking
OCSD 2205	surface	effluent plume source tracking
OCSD 2205	30 m	effluent plume source tracking
OCSD 2205	54 m	effluent plume source tracking
OCSD 2206	surface	effluent plume source tracking
OCSD 2206	30 m	effluent plume source tracking
OCSD 2206	45 m	effluent plume source tracking
OCSD POTW	effluent	effluent plume source tracking
LACSD POTW	effluent	effluent plume source tracking
San Gabriel River mouth at Marina Drive	surface	river source tracking
San Gabriel River at 2nd Street/Westminster Blvd (freshwater)	surface	river source tracking
LACSD 2501 - San Gabriel River	surface	river source tracking
LACSD 2502 - San Gabriel River	surface	river source tracking
LACSD 2503 - San Gabriel River	surface	river source tracking
LACSD 2504 - San Gabriel River	surface	river source tracking
PCH and Santa Ana River (river mouth)	surface	river source tracking
Hamilton Ave and Santa Ana River (freshwater)	surface	river source tracking
OCSD 2201 - Santa Ana River	surface	river source tracking
OCSD 2202 - Santa Ana River	surface	river source tracking
OCSD 2203 - Santa Ana River	surface	river source tracking
OCSD 2204 - Santa Ana River	surface	river source tracking
LA River at boat launch near Queens Way Bridge/Bay (river mouth)	surface	river source tracking
LA River at West Wardlow Rd. (freshwater)	surface	river source tracking
San Diego Creek (Upper Newport Bay) Fish and Game Dock at Shellmaker Island (freshwater/saltwater mixing)	surface	river source tracking
San Diego Creek near Campus Drive and University Drive (freshwater)	surface	river source tracking
LACSD 2505	45 m	upwelling source tracking
LACSD 3056	45 m	upwelling source tracking
OCSD 1906	75 m	upwelling source tracking

OCSD 2354	30 m	upwelling source tracking