

**Characterizing the Spatial and Temporal Variation of
Key Physical Water Quality Parameters in
San Diego Bay:
The Importance of Continuous Baseline Data when
Evaluating Physical, Biological, and Chemical
Processes.**

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A Project Proposal for:

Environmental Projects Benefiting San Diego Bay
San Diego Unified Port District
Environmental Services Department

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I Introduction

This project proposes to characterize the spatial and temporal variation of key physical water quality parameters in San Diego Bay over the course of two years, in order to determine dominant components and characteristics of turbidity and provide consistent long-term data as a baseline for future physical, biological, and chemical scientific investigations. Tierra Data Inc (TDI) will collect continuous physical water quality measurements at three fixed locations within San Diego Bay and correlate the results with rainfall events, suspended particulate matter, and primary production to aid in understanding changes in turbidity as it pertains to water quality, hydrology, surface water runoff, and non point source pollution. The results will provide important baseline information that will help managers and scientists understand natural spatial and temporal trends in turbidity from those caused by project specific impacts or long-term effects attributed to factors outside of San Diego Bay. Focusing on understanding the components of turbidity by measuring and reporting continuous water quality parameters within San Diego Bay, this study provides managers and policy makers information beneficial to natural resource management, habitat restoration, and environmental education. This project is beyond compliance and mitigation and is intended to form a baseline for complementary ecological and community investigations.

II Project Narrative

Physical water quality parameters: turbidity, chlorophyll *a*, temperature, salinity, pH, and conductivity will be recorded by moored instrumentation placed near the surface (2-3 meters) within three separate ecogregions of San Diego Bay. This effort will be coordinated with the ongoing Regional Harbor Monitoring Plan and supplement similar data acquired intermittently by the Port of San Diego since 2000. In addition to continuous physical water quality data collection Photosynthetically Active Radiation (PAR) measurements will be collected bimonthly to investigate the dominant components regulating turbidity and the role primary production (Chlorophyll *a*) contributes to visually perceived water clarity and light penetration.

Phytoplankton are the direct or indirect sources of food for most marine animals. The concentration of the photosynthetic green pigment chlorophyll *a* in estuarine, coastal, and marine waters is a proven indicator of the abundance and biomass of microscopic plants (phytoplankton) such as unicellular algae (ANZECC/ARMCANZ 2000). Chlorophyll *a* is also a commonly used measure of water quality, as a surrogate of nutrient availability. Enclosed and semi-enclosed bays need the correct amount of algae to maintain a balanced food web. Too much algae can cause large-scale algae blooms that reduce light availability for submerged aquatic vegetation (eelgrass), create harmful algal blooms, and eventually die and sink to the bottom depleting oxygen levels at depth. Turbidity is a measure of the amount of light intercepted by a given volume of water due to the presence of suspended and dissolved matter and microscopic biota. Increasing the turbidity of water decreases the amount of light that penetrates the water column. Measuring turbidity and the amount of chlorophyll *a* in tandem within three ecoregions of San Diego Bay (north, north-central, and south-central) in conjunction with bimonthly PAR measurements provides valuable information regarding the various sources of turbidity, its composition, and its natural spatial and temporal variability.

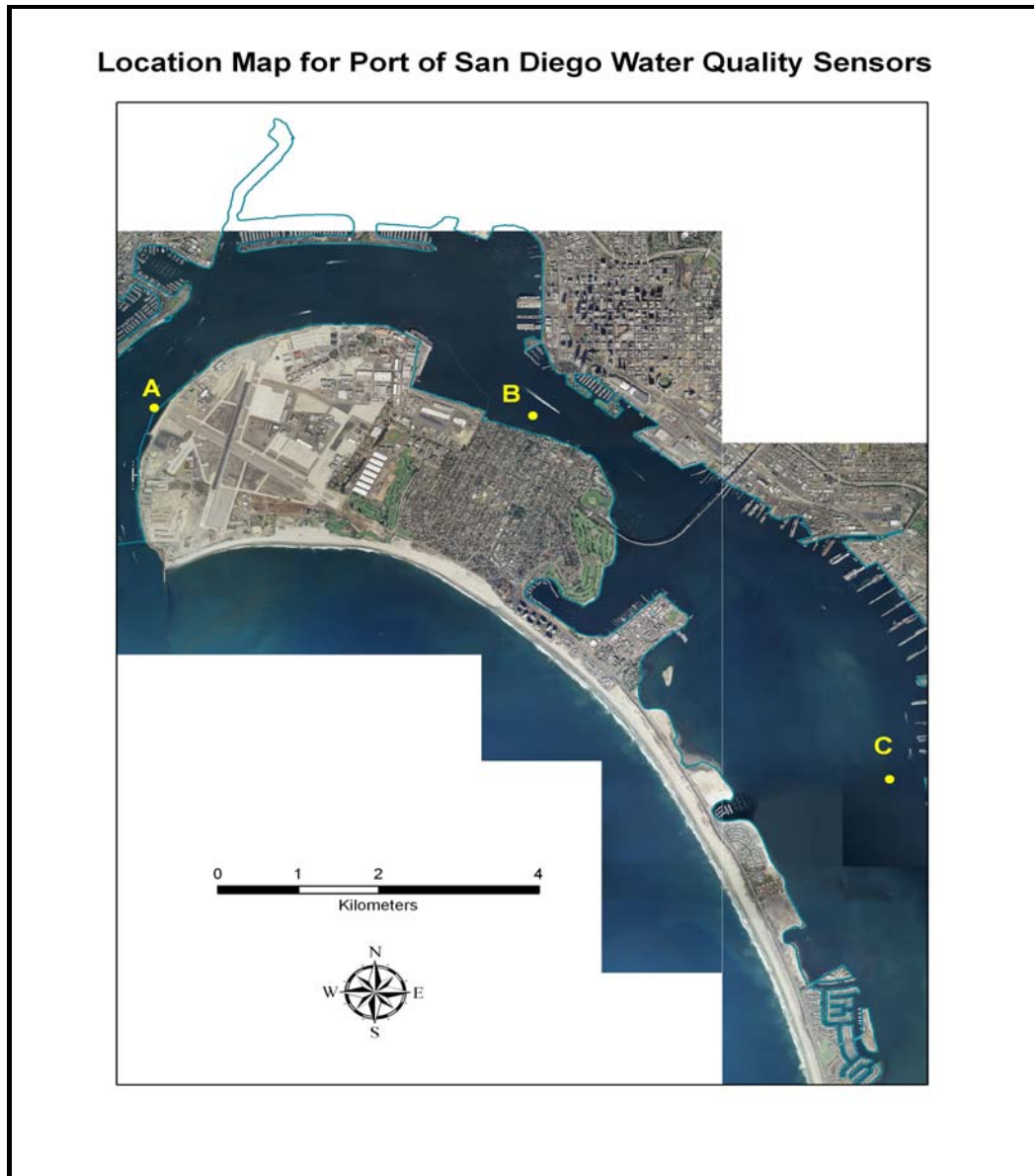
San Diego Bay is a productive, natural, deepwater harbor on the southwestern coast of California, containing important ecosystem values as well as a diversity of commercial, national defense, and industrial interests. The high potential for conflict between natural resources and human interests in the Bay establishes an important need to separate background from human-induced changes. The delicate balance between primary production from photosynthesis and light availability to submerged aquatic vegetation within the Bay, is vital to maintaining ecosystem health on multiple trophic levels. A baseline characterization of the spatial and temporal variation of physical water properties, (turbidity, temperature, salinity, etc.) and chlorophyll *a*, provides early detection of potential harmful algal blooms while maintaining a baseline of valuable water quality data initiated in the year 2000. Dissolved oxygen (DO) measurements have been previously collected in conjunction with the Regional Harbor Monitoring Plan and results have shown that DO fluctuates primarily between 6 to 8 mg/l approximately 1-2 meters off the bay bottom at two locations (Port of San Diego, In Prep). The waters of San Diego Bay are typically considered saturated at approximately 8.0 mg/l and because of the proposed surface locations of the instruments (sondes) and substantial mixing from tidal change and wind DO concentrations are not considered to inhibit bay water quality. Thus DO measurements were determined to be expendable in return for chlorophyll *a* measurements. In situ sondes proposed for this project only accommodate two optical ports that will be utilized to collect turbidity and chlorophyll *a*.

In order for natural resources managers and researchers to evaluate the health and dynamic changes in San Diego Bay it is imperative that we collect and understand information about the drivers of Bay ecosystem health. Senate Bill 68, signed into law in 2003, supported 1) an independent assessment of condition and trends in the Bay's health for the purpose of making comprehensive decisions about future proposals to improve habitat and species diversity, and 2) water quality standards and objectives in a fair and equitable manner to ensure full protection of all beneficial uses of the bay (SDBAC 2005). This proposal provides an independent assessment of water quality and provides baseline information about primary production and turbidity in support of present and future studies evaluating habitat health and water quality. Without baseline information on the dominant components shaping Bay health (water quality), future studies will struggle to understand the Bay's important productive communities and their associated natural variability versus human caused perturbations.

This study proposes a partnership with Merkel and Associates Inc. (San Diego) for the lease of four YSI 6600 V2-2 in situ multi parameter meters (or sondes) to collect physical water quality measurements on a continuous basis over a two year period. The grant will fund the leasing of the instruments and all calibration standards, the purchase of the chlorophyll *a* probes for the leased units, and the labor and professional services provided by Tierra Data Inc. to access, download data, service data sondes, and install chlorophyll *a* probes in place of the current dissolved oxygen (DO) probes. Instruments will be downloaded bimonthly at which time instruments (sondes) will be cleaned, calibrated, and redeployed. Three stations will be located in separate ecoregions throughout the bay and will be distributed to coincide with the locations previously monitored by the Port's Bay-Wide Water Quality Monitoring Program (SDUPD 2000; Figure 1). Additionally, the project will partner with the US Navy in obtaining and utilizing a Photosynthetically Active Radiation (PAR) sensor to collect bimonthly particle size readings at all the selected stations. Correlation with rainfall events, PAR measurements, and in situ

measurements obtained at all three Bay monitoring stations will be evaluated and presented quarterly in quarterly reports.

The proposed study fills a data gap created by two concurrent complementary studies: (1) Data collected by Southern California Coastal Water Resources Project (SCCWRP) in partnership with Tijuana National Wildlife Refuge (TNWR) in the south bay and (2) coastal data currently collected by Scripps Institute of Oceanography (SIO). Integrating all the data provides a complete San Diego Bay regional water quality data set. This study would provide future researchers easy access to information valuable for studies on endangered or indicator species as well as trends in populations.



The proposed study will accomplish one of the many monitoring needs identified in the 2000 San Diego Bay INRMP and will provide an easily maintainable long term data acquisition program that could be carried into the future, possibly administered by the San Diego Unified Port District. The most effective and complete approach to understanding the Bay is to combine long-term monitoring with experimental research

and development of conceptual models about how the ecosystem works with disturbance. This is the only way to determine the cause and effect of changes in the Bay ecosystem (DoN and SDUPD 2000).

It is expected that with a more complete understanding of the dominant components and characteristics of turbidity in conjunction with the expansion of the existing long term water quality dataset, entities that utilize the Bay will be better able to understand their relative impact to the Bay's turbidity and water quality parameters. Separating natural variability from anthropogenic disturbance and understanding ecosystem change over the long term are problems that plague researchers worldwide, because of the relative lack of long term, baseline data sets about basic ecological parameters (Landres et al. 1999). This proposed study will provide an effective method for evaluating turbidity and productivity on a continuous two year term and investigate the effects of rainfall and storm water runoff with respect to suspended particulate matter.

Tierra Data Incorporated (TDI) is a natural resources consulting firm that has been providing environmental planning documents, reports, and natural resources surveys in San Diego County for over twenty years. Typically focusing on natural resource compliance and mitigation consulting for various federal, state, and public entities, TDI has been intimately involved in a host of San Diego bay projects, relevant ones are discussed in section.

III Qualifying Experience

Tierra Data Inc. and its personnel have completed a diversity of natural resource assessments integrating field data collections with remote sensing information. TDI is considered a GIS expert and provides reports with mapping, modeling, and imagery for terrestrial and aquatic based studies.

Selected Completed Projects (past five years only):

- | | |
|--|------|
| Senate Bill 68 Report | 2005 |
| Synthesized issues and reporting on San Diego Bay natural resources planning for Report to Legislature. | |
| Reference: David Merk, San Diego Unified Port District (619) 686-6254 | |
| San Clemente Island Wildland Fire Management Plan | 2008 |
| This is an interagency, consensus-based fire plan for the federal lands on Point Loma. | |
| Reference: Kim O'Connor, Navy Region Southwest (619)524-6334 | |
| Remote Training Site Warner Spring Biological Surveys | 2006 |
| Wide-ranging biological surveys for all species groups, wetland delineation, and focused rare species surveys. | |
| Reference: Tammy Conkle, Navy Region Southwest, (619) 545-3703 | |

Selected On Going Projects:

Update to the San Diego Bay INRMP

2006 – Present

This is an update to the award winning San Diego Bay INRMP that was written by Tierra Data in 2000. This effort requires synthesis of a wide array of information from survey results, academic and popular journals, and personal interviews with Bay managers and stakeholders. This information will be distilled to a manageable form and recommendations made for future management and research efforts.

References: Mitch Perdue, Navy, (619) 556-7594
Eileen Maher, Port, (619) 686-6254

San Diego Bay Avian Species Survey

March 2006 - Present

This is a year-long Bay-wide survey effort of shore- and waterbirds of San Diego Bay. It has required consensus forming and coordination with established stakeholders and professional ornithologists in and around San Diego Bay. The report will require analysis of the data on multiple spatial and temporal levels, correlating results with tides and season as well as substrate and fish abundances.

References: Mitch Perdue, Navy, (619) 556-7594
Eileen Maher, Port, (619) 686-6254

San Clemente Island Soil Erosion and ASBS Impact Assessment Feb 2007-June 2008

This project required soil erosion and sedimentation modeling for issues related to sensitive receiving waters designated an Area of Special Biological Significance.

Reference: Mitch Perdue, Navy, (619) 556-7594

IV Objectives of Grant Proposal

The objective of the grant proposal is to provide the Port of San Diego with a understanding of the dominant components and characteristics of turbidity and a comprehensive baseline data set of the described parameters to complement the existing data collected during the initial phases of Port's Bay-Wide Water Quality Monitoring Program initiated in 2000. Monthly data will be checked for errors, smoothed, and converted into a Excel spreadsheet format for web based publishing quarterly in conjunction with graphic representations of correlations with PAR measurements and monthly rainfall totals obtained from National Oceanographic Atmospheric Association (NOAA) weather service for Lindberg Field, San Diego. Success will be measured based on the consistency of the data set, regular instrument servicing, and the timely submittal of quarterly and monthly reports. At the culmination of the grant the Port of San Diego will have a solid understanding of the main sources of turbidity and be able to confidently present a continuous and comprehensive water quality data set to interested researches as a baseline for related investigations.

V Cost Proposal

The cost proposal includes initial design, equipment acquisition, implementation, data collection, analysis, and report generation for a term of two years. Equipment purchased remains property of the San Diego Unified Port District at project completion.

Item	unit	cost per (\$)	total (\$)
<i>Equipment</i>			
YSI 6600 fixed multi-parameter meters w/ probes and accessories	4 meters	\$300/month	28,800
YSI Data Logger	1 meter	Included	0
YSI Chlorophyll <i>a</i> probes	4 units	\$500	2,000
YSI Calibration Standards	4 units	\$500	2,000
YSI Mooring Hardware (Stainless steel hose clamps, shackles, etc)	4 setups	\$200	800
YSI Chlorophyll <i>a</i> probes	4	\$2,761 – 10%	9,939
<i>Labor</i>			
Marine Biologist (30 days x 2 years x 8 hours)	480 hours	62.56	30,028.80
Biologist 1 (24 days x 2 years x 8 hours)	288 hours	48.13	13,861.44
Senior Modeling Analyst (12 days x 2 years x 8 hours)	192 hours	78.75	15,120
Boat, vehicle and equipment use (24 days x 2 years)	flat rate	10,000.00	10,000
Report Generation (8 days x 2 years x 8 hours)	128 hours	62.56	8007.68
Overhead (administration costs)	No charge	0	0
Total Requested			\$119,758
Matching funds available			\$38,000

VI Personnel

Project Manager (Primary Contact): Elizabeth Kellogg, President Tierra Data
Liz is one of the principles of Tierra Data Inc., and has 25 years experience producing environmental documents for both terrestrial and aquatic ecosystems.

B.S. Agricultural Science and Management, UC Davis (1978)

M.S. International Agricultural Development, UC Davis (1981)

Senior Modeling Analyst: James Kellogg, Vice President Tierra Data Inc.
Jim is one of the principles of Tierra Data Inc. and has 25 years of experience programming and modeling on various GIS platforms integrating field data collections with remote sensing imagery.

B.S. Plant Science, UC Davis (1977)

M.S. Plant Pathology, UC Davis (1985)

Marine Biologist: Derek Lerma, Senior Marine Biologist/Safety Officer, Tierra Data Inc. Derek has 16 years experience working for various state and federal government agencies performing biological and oceanographic monitoring with expertise in California ecosystems.

B.S. Biological Oceanography, Humboldt State University (1993)

Marine Biologist: Erica Cunningham, Marine Biology Analyst, Tierra Data Inc. Erica has 3 years experience performing marine and terrestrial biological studies and impact assessments.

B.S. Marine Biology College of Charleston, South Carolina (2001)

M.S. Environmental Studies, College of Charleston, South Carolina (2003)

Graduate Studies, Ecology, Miami University, Oxford, OH

Biologist 1: Harry Smead, Associate Biologist, Tierra Data Inc.

Harry has over 20 years of experience in the biological field working on a host of projects from the water quality to rare plants. Harry has outstanding engineering and trouble shooting skills to compliment his biological background.

M.S. Biology/Ecology, San Diego State University (1994)

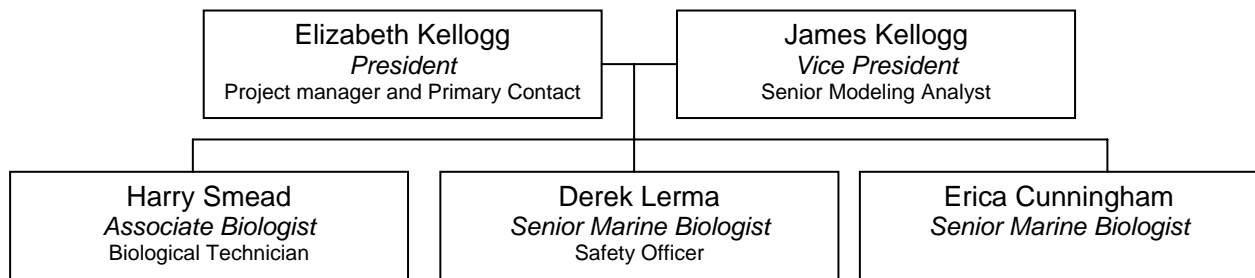


Figure 1: Tierra Data Incorporated key project personnel organizational flow chart

VII Sub consultants

Ken Richter, Scientist, US Navy. Ken will donate time and equipment as well as provide consulting services for hydrodynamic modeling previously performed within San Diego Bay. Ken is a well-known and published researcher within the San Diego Bay research community. Estimated time and equipment cost is \$20,000.

B.A. Biology, Lawrence University (1974)

Ph.D. Oceanography, Scripps Institute of Oceanography, UC San Diego (1982)

Merkel and Associates Inc., 5434 Ruffin Road, San Diego, CA 92123 will donate the use of a YSI Data Logger to download, calibrate, and troubleshoot the YSI 6600 multi parameter sondes. Additionally, Merkel and Associates Inc will provide initial calibration standards, expertise and training on the sondes and data logger administered by Lawrence Honma, Senior Marine Scientist for Merkel and Associates. Estimated time and equipment costs are \$8000

B.A. University of California Santa Cruz, (1990)

M.S. Marine Biology, Moss Marine Lab, Moss Landing (1993)

Navy Facilities Engineering Command South West (NAVFAC SW)

Has agreed to cooperate and support this effort with in kind services or monetarily in the amount of \$10,000 if funding is authorized by Congress. Funding would be provided in conjunction with a project studying pile driving and implications to Bay turbidity.

VIII Non-Profit Status

Not applicable.

IX Applicant Disclosure

Tierra Data Inc. and associated sub consultants have been issued no citations for environmental violations from any regulatory agency with the last five years.

X Agreement

Tierra Data Inc. accepts the terms of this agreement including the acceptance of the insurance and indemnification clauses.

XI Conflict of Interest

None

XII Additional Information

Tierra Data Inc. is currently contracted to provide continuous GIS support for the US Navy in the form of integrating aerial and satellite imagery with field data collections. Jim Kellogg, vice president, has performed numerous in depth modeling studies on watersheds, soils, bathymetry, and plant populations. Derek Lerma, senior marine biologist, is a United States Coast Guard Masters Licensed Captain and Dive Master and has performed installations and servicing of underwater hydrographic equipment utilizing a variety of vessels and SCUBA equipment. The equipment that will be procured through this study is considered on the leading edge of technology and is from a well-known, long-standing company, which provides outstanding customer service. At the conclusion of the project the equipment shall become the property of the San Diego Unified Port District and all warranties transferred. The Hydrolab multi parameter meters are equipped with a wiper mechanism for antifouling and are capable of housing an array of probes that allow for flexibility to measure additional parameters.

XIII References

Australian and New Zealand Environment Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ). 2000. Australian Guidelines for Water Quality Monitoring and Reporting, ANZECC/ARMCANZ, Canberra.

Department of the Navy Southwest Division (DoN SWDIV) and San Diego Unified Port District (SDUPD). 2000. San Diego Bay Integrated Natural Resources Management Plan, September 2000. San Diego, CA. Prepared by Tierra Data Incorporated, Escondido, CA.

Landres, P.B., P. Morgan, and F.J. Swanson. 1999. Overview of the Use of Natural Variability Concepts in Managing Ecological Systems. *Ecological Applications*, 9 (4): 1179-1188.

San Diego Bay Advisory Committee for Ecological Assessment (SDBAC). 2005. Senate Bill 68 Report, December 2005. Prepared by Tierra Data Incorporated, Escondido, CA

San Diego Unified Port District (SDUPD). 2000. Bay-Wide Water Quality Monitoring Program, Field Sampling and Data Management Plan, December 2000.