The La Jolla Shores Coastal Watershed Management Plan

Draft Report

Submitted For:

Proposition 50,
Chapter 8 IRWM Planning Grant
Integrated Coastal
Watershed Management Plan

July 2007

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PUBLIC REVIEW DRAFT

Submitted by

Scripps Institution of Oceanography
◆
University of California, San Diego
◆
City of San Diego
◆
San Diego Coastkeeper

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Proposition 50, Chapter 8 IRWM Planning Grant
Integrated Coastal Watershed Management Plan

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LIST OF ACRONYMS & ABBREVIATIONS

ADCP	Acoustic Doppler Current Profilers
ASBS	Area(s) of Special Biological Significance
Basin Plan	Water Quality Control Plan for the San Diego Basin
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CBMS	Community-Based Social Marketing
CASQA	California Stormwater Quality Association
CCA	Critical Coastal Areas
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CIWQS	California Integrated Water Quality System
COC	Constituent(s) of Concern
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEH	Department of Environmental Health
EMC	Event Mean Concentration
GIS	Geographical Information Systems
HA	Hydrologic Area
HU	Hydrologic Unit
ICWM	Integrated Coastal Watershed Management
IRWM	Integrated Regional Water Management
JURMP	Jurisdictional Urban Runoff Management Programs
MEP	Maximum Extent Practicable
MLPA	Marine Life Protection Act
MLS	Mass Loading Station
MPA	Marine Protected Areas
MS4	Municipal separate storm sewer system
MSL	Mean sea level
MWD	Metropolitan Water District of Southern California
NGO	Non-Government Organizations
NIS	Non-indigenous Species
NPS	Non-point Source
NPDES	National Pollutant Discharge Elimination System
Ocean Plan	California Ocean Plan
OPC	California Ocean Protection Council
RWQCB	California Regional Water Quality Control Board
SANDAG	San Diego Association of Governments
SCCWRP	Southern California Coastal Waters Research Project
SIO	Scripps Institution of Oceanography
SUSMP	Standard Urban Storm Water Mitigation Plan
SWAMP	Surface Water Ambient Monitoring Program
SWMP	Storm Water Management Plan
SWRCB	California State Water Resources Control Board
TAC	Technical Advisory Committees
TMDL	Total Maximum Daily Loads
UCSD	University of California at San Diego
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WMG	Watershed Management Group

WURMP	Watershed Urban Runoff Management Program
WQO	Water Quality Objective

EXECUTIVE SUMMARY

Introduction and Overview

The La Jolla Shores Integrated Coastal Watershed Management Plan (Plan) is intended to be the blueprint for a management model that will be implemented to protect and improve water quality in two Areas of Special Biological Significance (ASBS) offshore of La Jolla Shores Beach in San Diego California; the San Diego - the La Jolla State Marine Conservation Area (ASBS No. 29), and the San Diego-Scripps State Marine Conservation Area (ASBS No. 31). ASBS are areas designated by the State of California as needing special protection because of their unique and diverse habitats that support a variety of marine species. A collaborative watershed approach is used to outline effective and efficient strategies that will address threats to the ASBS within the watershed. The watershed addressed by this Plan represents all of the land area that drains to the two ASBS covering an urbanized area of approximately 1,600 acres in the San Diego community of La Jolla, the Scripps Institution of Oceanography (SIO) and the University of California, San Diego (UCSD).

Development of this Plan was partially funded by the State Water Resources Control Board (SWRCB) through Proposition 50 Integrated Regional Water Management (IRWM) program under the Integrated Coastal Watershed Management (ICWM) program. The Plan is consistent with the IRWM Plan Standards as published in the November 7, 2004 Integrated Regional Water Management Grant Program Guidelines. The Plan was developed by the La Jolla Shores Watershed Management Group (WMG) consisting of SIO, UCSD, the City of San Diego (City), and San Diego Coastkeeper (Coastkeeper).

This Plan incorporates water quality data that was collected to characterize inputs to the ASBS: bioaccumulation and circulation data from an assessment within the ASBS to identify impacts within the marine ecosystem; an information management system that was developed to store, integrate and display watershed and ASBS water quality data; and an outreach program that was implemented to reach watershed stakeholders and the general public. Using a collaborative approach between traditional water quality managers and marine scientists, the project team developed an *ASBS Protection Model* that recognizes water quality improvements in the watershed should result in reducing ecosystem impacts. This model integrates water quality data from the watershed with other ecosystem assessment findings to identify the watershed pollutants, or constituents of concern (COCs), most likely to negatively impact the ASBS. A tiered approach was then used to develop potential best management practices (BMPs) to address these COCs. The potential BMPs were then prioritized using a phased management approach designed to address the COCs in an effective and efficient manner. The Plan not only guides local watershed activities, but also serves as a model for other efforts statewide to comply with the ASBS waste discharge prohibition in the California Ocean Plan (Ocean Plan).

Background

The 34 ASBS throughout the State of California have special protection under the 2005 Ocean Plan, which as of 2001 prohibits waste discharges into ASBS. In accordance with this prohibition, the SWRCB notified all dischargers to ASBS that they must either cease discharges of waste into ASBS, or obtain an exception to the waste discharge prohibition in the Ocean Plan. In response to the discharge prohibition, SIO worked closely with the SWRCB and RWQCB to obtain an exception to the Ocean Plan. In 2004, the SWRCB granted SIO an exception to the Ocean Plan that includes 19 “special conditions” that serve as a road map to

Ocean Plan compliance. In 2005, these conditions were added to the SIO National Pollutant Discharge Elimination System (NPDES) Permit for sea water discharges associated with their research aquaria and storm water discharges. The City of San Diego has embarked on a similar process to obtain an exception. The exceptions will allow SIO and the City to continue to work towards compliance with the Ocean Plan.

Plan Participants and Methodology

The La Jolla Shores Watershed Management Group (WMG) was established in 2005 to collaboratively address ASBS protection issues in the San Diego County Region. The WMG conducted technical analyses and implemented programs in four key areas to support development of the Plan; (1) urban runoff characterization, (2) ASBS ecosystem assessment, (3) information management, and (4) public participation/outreach. These areas were selected by the project team and stakeholders as the primary elements necessary to characterize ASBS inputs, identify potential biological or ecosystem impacts to the ASBS, establish an information management system to house, integrate and disseminate data collected for the Plan, and to begin a ocean stewardship program within the watershed. Based on the findings from these programs, management measures and assessments needs were identified and prioritized by the WMG through monthly Technical Advisory Committee (TAC) meetings of the interdisciplinary project team.

Technical Analysis

The key findings of the technical analysis performed by the project team for the Plan Development include:

Urban Runoff Management (Water Quality);

- Pollutants in urban runoff can potentially impact ecosystem health and beneficial uses and need to be identified using a triad approach considering water and sediment chemistry, physical conditions within the ASBS, and biological impacts to organisms in the ASBS. For the La Jolla ASBS, high priority pollutants of concern were identified as metals (copper, chromium, nickel and arsenic), bacteria indicators, and turbidity (sediment)
- Management measures should be focused on reducing pollutants that impact the ecosystem health and beneficial uses of the ASBS
- BMPs should be prioritized using a tiered approach that utilizes lower tier pollution prevention and source control options in early phases in order to help design and potentially implement effective treatment systems in later phases to meet overall pollutant reduction goals
- Effectiveness monitoring/assessment must be integrated into the implementation process as an adaptive management tool

ASBS Ecosystem Assessment;

- Urban runoff can potentially impact ecosystem health, but there is a large knowledge gap about the relationship between urban runoff and ecosystem health
- Existing regulatory requirements do not adequately characterize ecosystem impacts
- Physical conditions have a significant influence on the degree of impact
- Biomarkers must be assessed to evaluate the condition of the ASBS
- An ecosystem index, based on ecosystem health, is needed to prioritize ASBS protection both locally and statewide

Information Management;

- ASBS monitoring data is complex and includes a broad variety of data so that one system is not adequate for all data
- The statewide information system for regulatory data should leverage from existing Surface Waters Ambient Monitoring Program (SWAMP) design and protocols
- Study of physical and biological data is necessary for full ecosystem analysis and should be correlated over space and time
- Data dissemination and display should be easily understood and publicly accessible
- Development of a statewide system should involve multiple stakeholders
- The ASBS management process should be iterative (build, test, build) for continued improvement and regional integration

Public Participation

- ASBS stewardship is essential to changing pollutant generating habits throughout the watershed
- The connection between personal habits and ASBS protection is not widely understood
- Public involvement requires reaching out to existing groups
- Stimulation of behavioral and long-lasting social change for stormwater pollution prevention requires innovative and effective Community Based Social Marketing (CBSM) techniques.

Plan Goals and Objectives

The overarching goal of the La Jolla Shores Coastal Watershed Management Plan is to:

> ***Protect the ASBS and the many designated beneficial uses in the La Jolla Shores marine areas*.**

To achieve this goal, four objectives were developed for the Plan:

Objective 1: Develop a science-based ecosystem approach to ASBS/ocean protection.

Objective 2: Protect and improve water quality and reduce ASBS ecosystem impacts

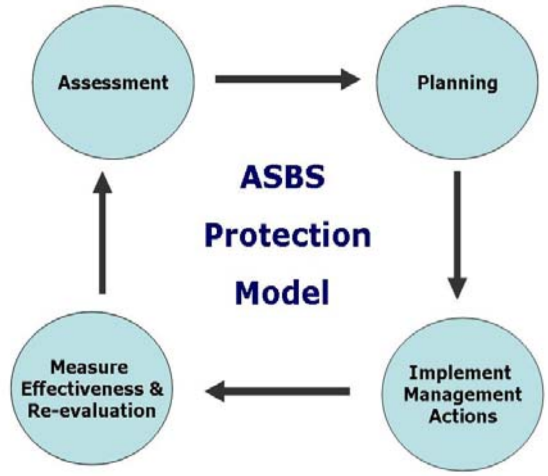
Objective 3: Facilitate watershed/ocean resource information management and knowledge transfer.

Objective 4: Encourage community involvement and ocean stewardship

In developing these goal and objectives the WPG considered a wide variety of plans and programs with objectives related to ASBS/ocean protection on a state, regional and local level. These issues helped to define the objectives of the project and focus project efforts. Some of the most important of these include the San Diego Region Basin Plan, California Ocean Plan, the Ocean Protection Council's Five Year Strategic Plan, Marine Life Protection Act (MLPA) Initiative, the County of San Diego IRWM Plan, City of San Diego's Mission Bay Watershed Urban Runoff Management Plan, and SIO and UCSD's Stormwater Management Plan.

ASBS Protection Model

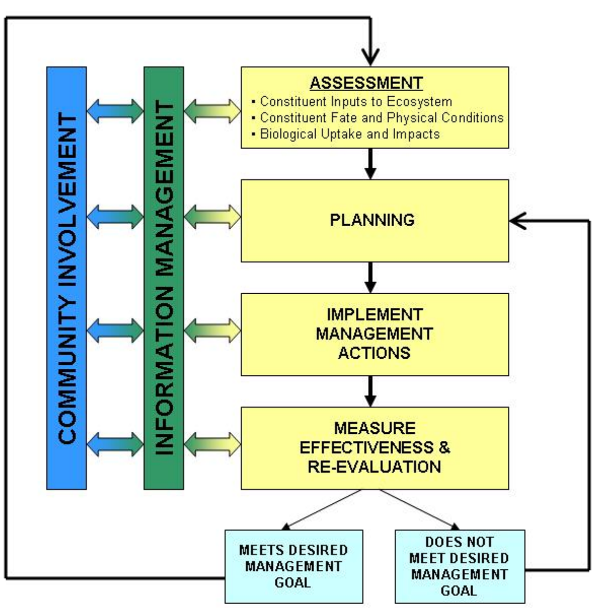
Management measure recommendations for the protection of the La Jolla Shores ASBS were developed using the *ASBS Protection Model* that was developed by the WPG. The *ASBS Protection Model* is an adaptive management strategy that consists of four key elements; assessment, planning, implementation, and effectiveness assessment.



Assessment – Assessment is the collection and assessment of watershed and marine data to determine biological and beneficial use impacts to the ASBS. A Triad Assessment Approach is recommended, which utilizes a scientific based process to identify constituents of concern and their potential impacts on the ASBS by examining chemical, physical and biological processes in the watershed and adjacent marine environment.

Planning – Planning is the identification of effective and cost efficient management strategies to reduce COCs and ASBS impacts using a tiered approach: Tier I – includes source control and pollution prevention activities; Tier II – includes source reduction through runoff reduction, non-structural, and structural BMPs; and Tier III – includes treatment controls. A phasing approach is then used to prioritize management measures.

Implementation of Management Measures – Implementation of Management Measures is the Implementation of effective and cost-efficient management measures using an integrated and phased approach that addresses current and potential COCs. The short-term implementation plan consist of Phase I projects with a 3-5 year horizon. Phase II and III represent long-term implementation beyond 5 years.



Effectiveness Assessment/Measurement and Re-evaluation – Effectiveness Assessment/Measurement and Re-evaluation is the assessment of the effectiveness of management measures to determine if ASBS impacts are lessened, expected outcomes are achieved and where management measure refinements are required. Effectiveness assessments utilize the overarching information management element of this Plan to coordinate assessments of the coastal ecosystem, prioritize management measures, determine effects of adaptive watershed management, involve community stakeholders and link pollutant stressors with biological effects.

This adaptive management process includes reassessment of marine impacts using appropriate sections of the ASBS Triad Assessment Approach. As phased implementation of management measures proceeds, data gathered from Phase I activities and ecosystem assessment studies will be integrated into the ASBS information management system and used to evaluate the prioritization and implementation schedule for Phase II and III. Inherent in this strategy, therefore, is the need to assess and manage each phase of the project implementation to ensure that management goals are being met. This is particularly important for ASBS protection because the specific impacts of urban runoff on ASBS are not well understood.

La Jolla Shores Plan Recommendations

Through the application of the *ASBS Protection Model* on the La Jolla Shores ASBS priority COCs are; metals (copper, chromium, nickel, and arsenic), bacteria indictors, and turbidity (sediment). Based on the sources of these COCs, the following Phase I management measures are recommended in this Plan:

<u>Best Management Practice Projects</u>

- Tier I (source control and pollution prevention activities)
  - Restoration and erosion control projects
  - Residential surveys
  - Increased commercial inspections & enforcement
- Tier II (source reduction through structural BMPs)
  - Runoff reduction (green parking lots/streets)
  - Bioretention basins for runoff
  - Dry weather flow diversion
  - Trash segregation (inlet filters)
  - Street sweeping (vacuum-assisted truck)
- Tier III (treatment controls)
  - Pilot Stormwater treatment system

<u>ASBS Ecosystem Assessment Projects</u>

- Water Circulation Assessment
- Dispersion Assessment
- Prioritized Biological Community Assessments
- Physical Processes Assessments
- Sediment Transport/ Benthic Habitat Study
- Analysis of Water Circulation, Dispersion and Sediment Transport Studies

<u>Ocean Stewardship, Outreach and Education Programs</u>

- Speakers Bureau & Public Workshops
- Information Dissemination (brochures, email alerts, information on key websites, etc.)
- Pollution Prevention Curriculum
- Outreach & Education (specific to BMPs being implemented in Phase I)

<u>Information Management</u>

- Document, assess, and investigate interrelated biological-physical-chemical processes present in the watershed and marine environment through information integration and public data dissemination; implement scalable data management system of regulatory and environmental data sets

The WMG has already been successful in funding some of the activities identified in the Plan, including implementation of some Tier I, II and III BMPs, watershed monitoring, information management and the initiation of a long-term ocean stewardship program. The WMG will continue to fund individual projects to the extent that their budgets can support them. Each party has secured some level of funding over the next few fiscal years; however, the WMG will depend largely on grant funding for implementation of larger projects and the *ASBS Protection Model* studies.

As California's marine environment and ASBS issues come to the forefront, there is a need to develop the science of ocean protection processes and to expand marine conservation stewardship programs. The La Jolla Shores Integrated Coastal Watershed Management Plan outlines and implements an ASBS-specific protocol for ocean protection that focuses management measures on reducing the impacts of urban runoff. The Plan also includes an ASBS information management program that will allow long-term assessment of ASBS performance and the related management decisions employed to protect the ASBS. Finally the Plan includes a comprehensive ocean stewardship program, recognizing that ultimately, it is the community that must embrace the La Jolla Shores ASBS protection since often it is their actions that have a significant impact on the quality of the runoff within the watershed and the activities within the ASBS.

1.0 INTRODUCTION

1.1 Purpose of Plan

The La Jolla Shores Coastal Watershed Management Plan (Plan) is intended to be the blueprint for actions that will be taken to protect and improve water quality in two Areas of Special Biological Significance (ASBS) offshore of La Jolla Shores; the San Diego - La Jolla Ecological Reserve, and the San Diego-Scripps State Marine Conservation Area. A collaborative watershed approach has been used to outline effective and efficient strategies to address threats to the ASBS and water quality within this urban coastal watershed that covers areas of the San Diego community of La Jolla, Scripps Institution of Oceanography and University of California, San Diego. The Plan covers a watershed located in La Jolla California approximately 15 miles north of downtown San Diego (see Figure 1).

Development of this plan was funded by the State Water Resources Control Board (SCWRB) through Proposition 50, Integrated Regional Water Management (IRWM) program under the Integrated Coastal Watershed Management (ICWM) program. This plan is consistent with the IRWM Plan Standards as published in the November 7, 2004 Integrated Regional Water Management Grant Program Guidelines. The Plan was developed by the La Jolla Shores Watershed Management Group (WMG) consisting of Scripps Institution of Oceanography (SIO), University of California, San Diego (UCSD), the City of San Diego (City), and San Diego Coastkeeper (Coastkeeper) which is the functional equivalent of a Regional Water Management Group for the ICWM programs.

The purpose for preparing this Plan was to characterize the issues related to ASBS protection and develop an implementation plan to manage and protect the ASBS. Five primary planning objectives were established for development of the Plan:

1. Identify water quality pollutants of concern, their potential sources specific to the coastal watershed, and how they may impact the ASBS;
2. Identify, evaluate, and prioritize urban runoff management activities, both structural and non-structural in nature, to address the pollutants of concern;
3. Develop a model for science-oriented, ecosystem-based ASBS assessment and protection that is transferable to other ASBS statewide;
4. Create a user-driven data management system at the core of the watershed plan that serves data providers, analysts, partner agencies and the community, and is transferable statewide; and
5. Encourage stewardship of the ASBS through a pioneering public involvement and outreach strategy that utilizes University tools and science.

To meet these objectives, the planning process included a collection of watershed and ecosystem data to characterize the watershed and the water quality of storm water run-off and to develop the following:

1. an urban runoff management strategy;
2. a marine ecosystem assessment and monitoring pilot program;
3. an adaptive watershed monitoring plan;
4. an information management system template that integrates land and ocean data; and
5. an outreach program.

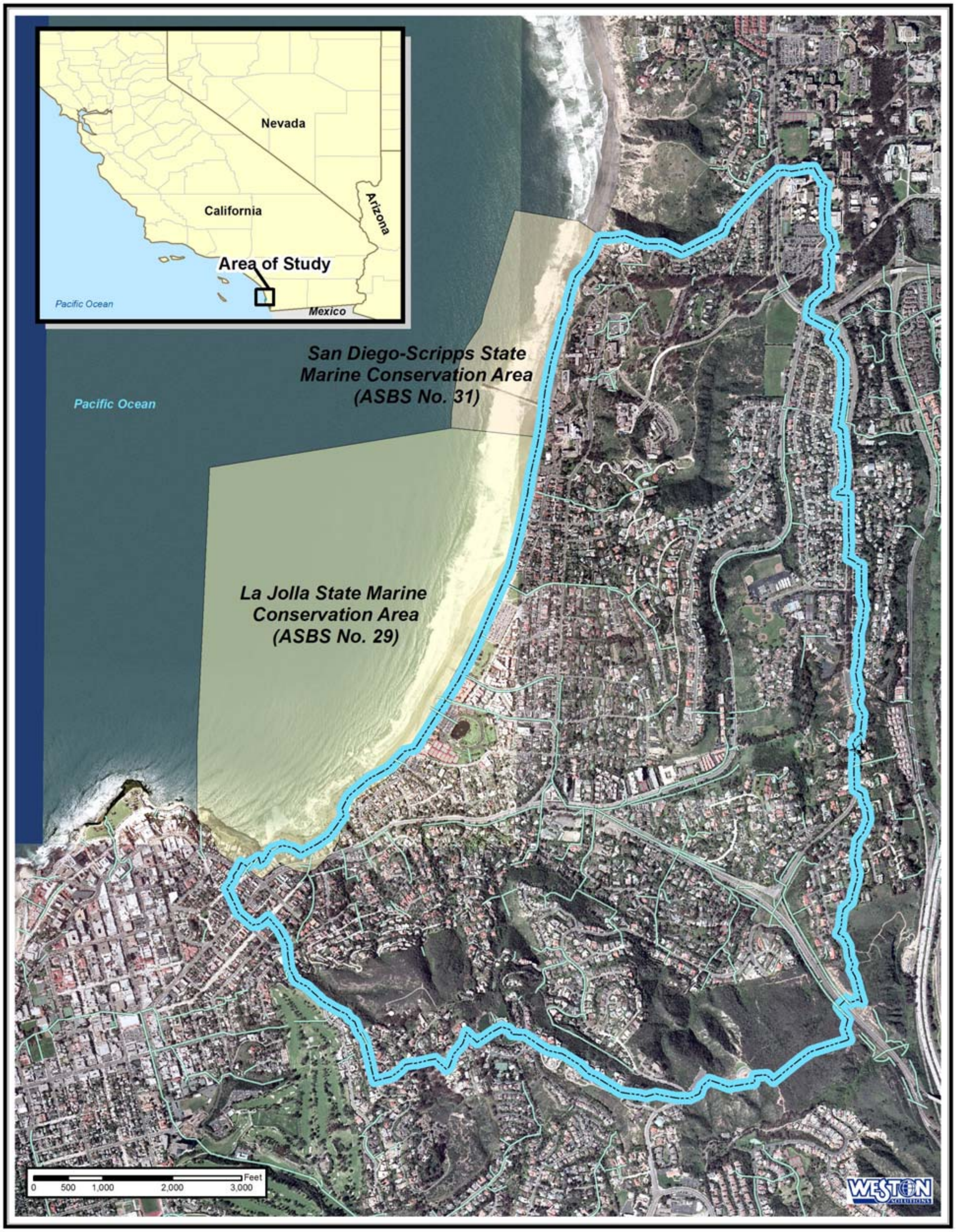


Figure 1. Overview Map of La Jolla Shores Coastal Watershed

The Plan also serves as a model for other efforts statewide to comply with the waste discharge prohibition into ASBS in the California Ocean Plan.

1.2 Background

The 34 ASBS throughout the state have special protection under the California Ocean Plan, which in 2001 was revised to prohibit waste discharges into ASBS (Figure 2). This prohibition and recent increased enforcement efforts represent a renewed interest and commitment to our oceans and coastal environments that is further supported by the latest report from the U.S Commission on Ocean Policy, the PEW Commission report - *America's Living Oceans*, California's Ocean Action Strategy - *Protecting our Ocean* and the recent formation of the California Ocean Protection Council.

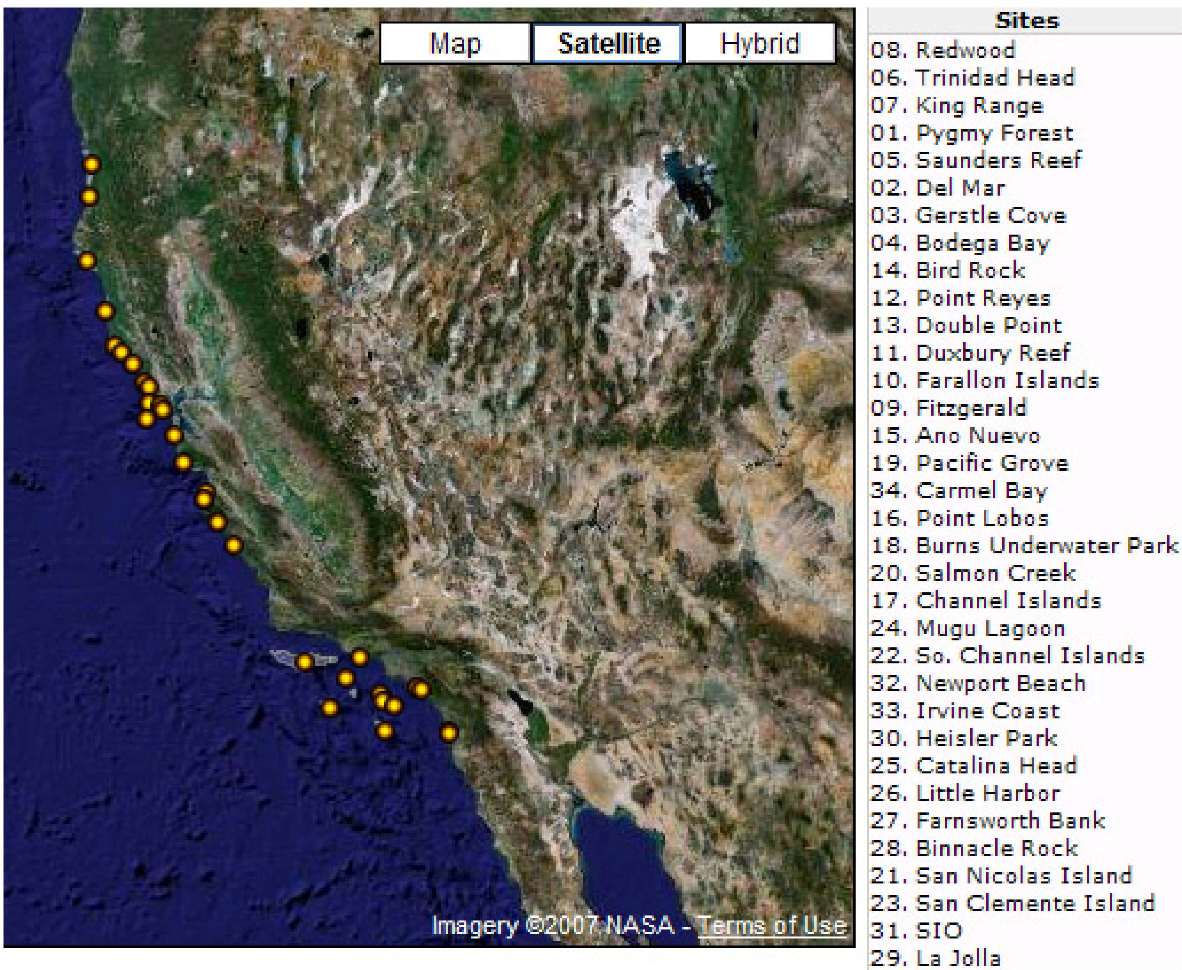


Figure 2. ASBS Sites Statewide

The seawater discharges at SIO has been regulated under a National Pollutant Discharge Elimination Program (NPDES) Industrial Discharge Permit since 1984. In the Fall of 2002, SIO was the first ASBS discharger to be directed to either cease its discharges in the adjacent ASBS, or obtain an exception to the California Ocean Plan. SIO worked collaboratively with the

SWRCB and the San Diego Regional Water Quality Control Board (RWQCB) over the next two years to obtain the exception to the Ocean Plan which was granted on July 19, 2004 by the SWRCB. The purpose of these conditions is to protect the natural water quality of the ASBS. These 19 conditions were incorporated by the RWQCB into SIO's NPDES permit along with other additional conditions in February 2005 (NPDES Permit No. CA0107239 adopted on February 19, 2005). A copy of that Order can be found on the SWRCB website at: http://www.waterboards.ca.gov/sandiego/orders/order_files/R9-2005-0008%20Order.pdf. The required monitoring, studies and planning associated with the NPDES Permit is currently being performed at SIO. In addition, UCSD has implemented a Storm Water Management Program to comply with the SWRCB Phase II MS4 Permit requirements.

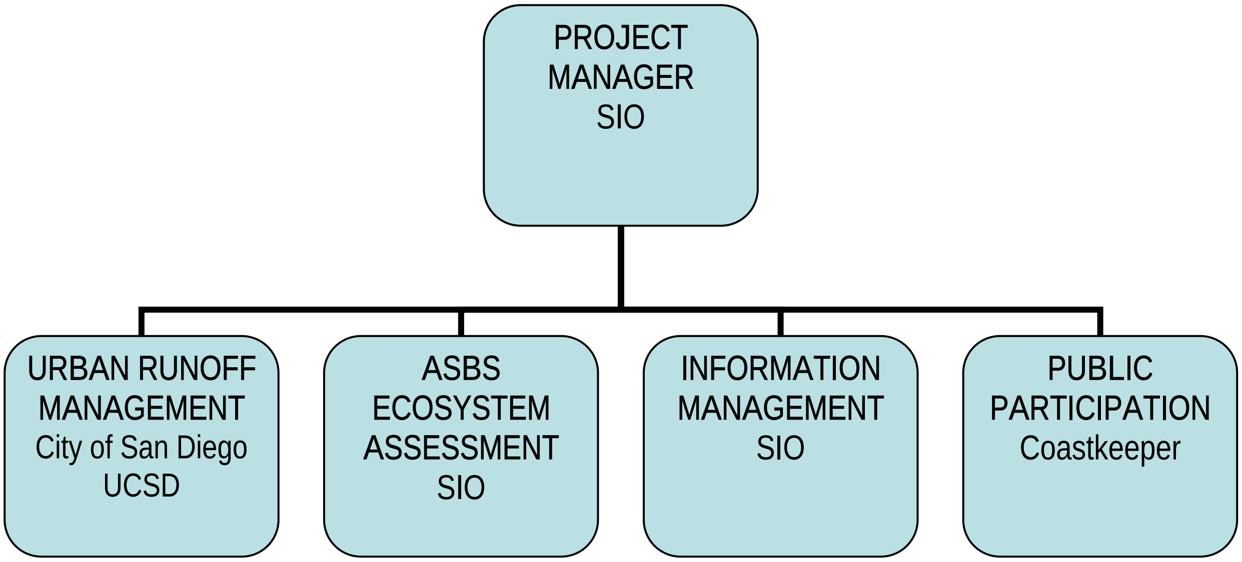
The City has been performing urban runoff management activities since the early 1990s when they were permitted by the RWQCB under Order 2001-01, NPDES No. CAS0108758, Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems (MS4) Draining the Watersheds of the County of San Diego. The MS4 permit has recently been reissued and replaced with Order No. 2007-001. The new permit will result in increased monitoring and use of low impact development techniques throughout the San Diego region.

In 2006, the City submitted an application package to the SWRCB for an exception from the California Ocean Plan prohibition of discharges into the ASBS. In support of this application, the City has begun work to meet some of the draft "special conditions" set forth by the SWRCB to address storm water and nonpoint source discharges to the ASBS as well as plan and institute best management practices (BMPs) to eliminate dry weather flows and reduce pollutants in storm water runoff. The City's participation in the La Jolla Shores Coastal Watershed Management Plan development process is part of those efforts.

1.3 Project Methodology and Participants

The La Jolla Shores Watershed Management Group (WMG) was established in 2005 to work collaboratively to address ASBS protection issues in the San Diego Region. The WMG consists of SIO, the City and San Diego Coastkeeper. This partnership was a natural fit since SIO and the City are adjacent and their urban runoff commingles as it drains into the ASBS, and San Diego Coastkeeper's primary mission is to preserve the integrity of San Diego's coastal waters and inland waterways. The WMG signed a Letter of Agreement March of 2006 and was amended in 2007 to add UCSD. The Letter of Agreement outlines WMG's commitment to a watershed approach to ASBS protection.

The La Jolla Shores WMG is jointly responsible for development and implementation of this Plan, however, responsibilities were divided to best utilize the unique skills of the partners. These responsibilities include:



Through this partnership, a fundamental commitment has been made to work together and engage stakeholders in a process to protect and become stewards of California's marine environment and ASBS. The project partners recognize the public's growing appreciation for these fragile environments and the need to protect them.

1.3.1 Scripps Institution of Oceanography

SIO is one of the oldest, largest, and most important centers for marine science research, graduate training, and public service in the world. SIO was founded in 1903 as an independent biological research laboratory. SIO occupies 170 acres and currently has a staff of approximately 1,000, including more that 200 graduate students. Research at SIO encompasses physical, chemical, biological, geological, and geophysical studies of the oceans. Among the hundreds of research programs that may be under way at any one time are studies of air-sea interaction, climate prediction, earthquakes, the physiology of marine animals, marine chemistry, beach erosion, the marine food chain, the ecology of marine organisms, the geological history of the ocean basins, and the multidisciplinary aspects of global change and the environment. (UCSD 2006 General Catalog, http://www.ucsd.edu/catalog/front/SIO.html).

1.3.2 University of California, San Diego

Founded in the 1960s as a research institution, UCSD (one of the ten campuses in the world-renowned University of California system) has rapidly achieved the status as one of the top institutions in the nation for higher education. Today UCSD is recognized throughout the academic world for its faculty and for its graduate and undergraduate programs. In 2006 UCSD's total enrollment was just over 26,000 students and projections are for significant growth. UCSD's interdisciplinary tradition of innovation underlies its research strength and ability to recruit top scholars and students. The 1,200 acre campus is also important to regional economic health; UCSD is San Diego County's third largest employer with over 26,000 employees.

UCSD is an autonomous entity responsible for operations within the campus including land use planning, operations and utilities. Water for the campus is purchased directly from the City of San Diego and distributed throughout the campus by the UCSD Facilities Management Department.

1.3.3 City of San Diego

The City of San Diego is California's third largest city with a growing population of more than 1.2 million residents and approximately 237 square miles of urbanized development. The City is in the municipal water supply business with more than 250,000 metered service connections within the jurisdictional boundaries. The City's Water Department efforts include water conservation, water recycling, and planning for an adequate and reliable future water supply. The Water Department has an approved urban water management plan (The 2005 Urban Water Management Plan). The City also collects and discharges storm water and urban runoff containing pollutants through their storm water conveyance systems.

1.3.4 San Diego Coastkeeper

San Diego Coastkeeper is a non-profit 501(c) organization that with the goal to preserve the integrity of our regional water bodies. In pursuit of this goal, SD Coastkeeper balances outreach, education, advocacy and litigation to increase awareness of issues and reduce pollution of our waters.

1.4 Other Relevant Studies/Projects

Several ongoing studies and projects were drawn upon in the development of this Plan. These include:

- SIO NPDES Permit monitoring and special studies, including ongoing discharge monitoring (storm water and seawater return flows), weekly surfzone bacteria monitoring, a nearshore dilution study, and an intensive nearshore bacteria study
- Seawater Separation Project, an infrastructure project at SIO to separate the seawater effluent conveyance system from the storm water conveyance system. The separation of these commingled systems will enable SIO to implement more effective storm water pollution controls.
- Mission Bay Watershed Urban Runoff Management Plan (Mission Bay Watershed Urban Runoff Management Plan (WURMP)) prepared by the City's Storm Water Pollution Prevention Program (current Project partner) to address the quality of urban runoff. Mission Bay WURMP annually assesses conditions of concern and associated potential activities to address likely sources.
- NCEX: Nearshore Canyon Experiment (National Science Foundation), a large-scale field program to study on the complex effects of the deep marine canyons found in the ASBS on nearshore circulation and transport of water offshore.
- SDCOOS (San Diego Coastal Ocean Observing System, California Clean Beaches Initiative) includes observations near SIO pier which include continuous temperature, daily chlorophyll, currents, and other measurements useful in determining environmental changes and assessing water quality.
- The Southern California Coastal Ocean Observing System (www.sccoos.org) has established and is maintaining a broad suite of environmental measurements on the entire coast of Southern California. Integration of the ASBS monitoring programs with SCCOOS data sources (planned and existing) will ensure efficiency for implementing model monitoring programs at other ASBS.
- CalCOFI - The California Cooperative Oceanic Fisheries Investigations (CalCOFI) are a unique partnership of the California Department of Fish and Game, the NOAA Fisheries Service and the Scripps Institution of Oceanography. The organization was formed in

1949 to study the ecological aspects of the collapse of the sardine populations off California. Today its focus has shifted to the study of the marine environment off the coast of California and the management of its living resources.

- California State Mussel Watch - The State Mussel Watch Program began in 1977 and is a joint program of the California State Water Resources Control Board and the California Department of Fish and Game. The main objective of the program is to quantify contaminant concentrations in the tissue of bivalve mollusks along California's coast, and in some inland waters of California (SWRCB, 1988).

2.0 WATERSHED DESCRIPTION

2.1 Watershed Overview

The La Jolla Shores Coastal Watershed includes all land area that drains to the two adjacent ASBS and is located in the community of La Jolla and the SIO campus of the University of California San Diego (Figure 3). The watershed is located approximately 15 miles north of downtown San Diego, California and is approximately 1,600 acres in size. It extends from the shoreline to an elevation of approximately 800 feet at Mount Soledad. The Rose Canyon Fault transects the southern portion of the watershed. The watershed drains westerly into two ASBS: the San Diego-Scripps State Marine Conservation Area and the La Jolla State Marine Conservation Area.

Figure 3. La Jolla Shores Beach – North end of Kellogg Park

The watershed consists primarily of residential and institutional land uses. The City of San Diego has primary jurisdictional control over the watershed; however, the SIO campus operates autonomously. The majority of the watershed drains overland within streets, is then captured by curb inlets and is conveyed to the beach through storm drain systems (some drains do not go to the beach but off the bluff) at multiple locations. The central and largest portion of the watershed generally drains to a single storm drain system that discharges to the beach at Avenida de la Playa.

2.2 History of the Watershed

Development in the La Jolla area began in 1886, when the land in the community was first subdivided. This is considered the beginning of urban La Jolla. The first industry began at the turn of the century, capitalizing on tourism. Much of La Jolla's development through the years is attributed to the influence of tourism (*La Jolla Community Plan and Local Coastal Program Land Use Plan*, February 2004). Scripps Institution was founded in 1903 and became part of the University of California in 1912. University of California Professor William E. Ritter and a group of San Diegans established Scripps Institution of Oceanography as a seaside research laboratory for the University of California's Department of Zoology. It was first known as the San Diego Marine Biological Station.

The receiving waters in the area of SIO Pier were designated the San Diego Marine Life Refuge in 1929 by the California Department of Fish and Game (CDFG). CDFG altered the designation to a Marine Protected Area (MPA) in 1957, and renamed the area the San Diego – Scripps State Marine Conservation Area. In 1974 the Scripps State Marine Conservation Area was split into two areas and renamed the San Diego Marine Life Refuge and La Jolla Ecological Preserve. About that same time, the SWRCB designated them Areas of Special Biological Significance (ASBS) because of their unique marine diversity and opportunity for public use and research. Thirty-four (34) total ASBS were designated in the state; the two areas off La Jolla Shores are the southern-most ASBS and are the only ASBS in the San Diego Region.

2.3 Cultural Resources

2.3.1 Social and Cultural Makeup of the Regional Community

The Watershed is in the La Jolla, which in Spanish means "The Jewel", area of San Diego. It is firmly established as a residential community and can be for the most part considered built-out. The area exemplifies the picture of Southern California culture; it is a primary tourist destination, known for famous beaches, beautiful natural scenery, and cultural activities. It is home to renowned institutions, such as SIO, the Birch Aquarium and Museum at Scripps, and many Bio-Tech and software companies. (Courtesy of www.lajolla.com) The San Diego-Scripps State Marine Conservation Area and the adjoining La Jolla State Marine Conservation Area, attract San Diegans and tourists from around the world interested in enjoying native marine plants and animals - including lobsters, abalone, crabs, trigger fish, giant kelp fish, schools of leopard sharks and sea turtles – all in their natural state.

2.3.2 Cultural and Social Values

The culture and social values of the La Jolla area can best be described in the following excerpts from the La Jolla Community Plan and Local Coastal Program Land Use Plan (February 2004):

"Over the next 10 to 20 years, the focus of development in La Jolla will be to highlight those elements and features of the community that contribute to its overall sense of charm, character and village atmosphere. Many of these elements are in place in La Jolla such as: its coastline parks of Ellen B. Scripps and Kellogg Park; its historic structures including the La Jolla Recreation Center, the Athenaeum and the La Jolla Woman's Club; the delicate relationship that exists between the community and its coastline, bluffs, hillsides, and canyons;…"

"The relationship between La Jolla and the ocean must always be protected. La Jolla's oceanfront setting is and will continue to be the focus of the community, forming the scenic framework to many of its recreational, residential and retail areas. The key natural resources of the community, including Mount Soledad with its magnificent panoramic views of San Diego, the shoreline parks, and the sensitive coastline bluffs, will be protected. La Jolla's landscaped and natural parks, nature trails, bikeways and promenades along the public beaches will be preserved for future generations to enjoy.

La Jolla will continue to be in touch with its past, recognizing that the preservation of its designated historic sites and the adaptive reuse of its structures of historic significance reflect an earlier era in the development of the community which will be permanently lost if left to deteriorate."

The community within the watershed area has a keen awareness and interest in environmental issues, many of which are focused primarily on the ocean. Institutional areas include portions of the University of California, San Diego and SIO. SIO has been located in its current site for over 100 years. The student population and facilities have grown over the years and are very actively connected to the ocean; for example surfing is a popular activity with much of the student body. The residential and commercial areas of the watershed support a large number of service jobs filled from outside of the watershed. Community members are active in local issues and interested in pursuing environmental protection.

2.3.3 Economic Conditions and Trends

The area serves as an important regional resource that supports a large outdoor recreational base focused around the beach and ocean (walking, sunbathing, surfing, scuba diving, snorkeling and swimming). The La Jolla Shores beach is a fee-free beach that draws visitors from diverse communities around San Diego County and beyond. The San Diego-La Jolla Underwater Park is one of the key attractions in San Diego drawing divers, snorkelers, swimmers and kayakers both locally and nationally to see abundant flora and fauna. The University of California, San Diego also contributes significantly to the local economy, not only in terms of economics, but the way it influences the San Diego region's development by contributing to the diversification of the economy into high-tech industries.

2.3.4 Population Growth Trends

Although the City of San Diego as a whole expects a population growth of nearly 25% by 2030 (City of San Diego Urban Water Management Plan, 2005), the community of La Jolla is estimated to be 99% developed and only infill and redevelopment can be expected. UCSD is planning approximately 20% increase in growth of the campus, primarily through densification (UC San Diego 2004 Long Range Planning Plan).

Regionally, San Diego County is expected to grow by more than 1 million people over the next 30 years (Regional Comprehensive Plan Performance Monitoring Report 2006, SANDAG). Although this growth may not necessarily be within the watershed, it will bring increase environmental pressure on the La Jolla Shores beaches and marine areas as more visitors come to enjoy the area.

2.4 Physical Resources

2.4.1 Ecological Processes and Environmental Resources

The watershed consists of a variety of land forms including gently sloping terrain, sandy beaches, coastal bluffs, and deep canyons. The area has several potentially active faults, some unstable soil conditions, and some steep slopes (25+% grade). The submarine topography consists of a narrow continental shelf with a deep submarine canyon just north of the ASBS. The Rose Canyon Fault that transects the watershed in a northwesterly angle and dips into the ASBS forming the La Jolla Canyon. The La Jolla Canyon extends through the middle of the ASBS contributing to the wide variety of habitats.

The ASBS consists of a highly variable physical environment including a submerged sandy plain, sandy beach, rocky intertidal zone, submarine canyon head and associated ledges, and the pier pilings. This broad sandy shelf giving way to the submarine canyon allows for important ecological processes, such as the life cycle of the giant bladder kelp and breeding cycle of the squid and grunion, as well as sand migration. The California Current and Southern California Counter Current influence the ocean waters in the ASBS bringing in transient species. The area is also influenced by periods of upwelling, during which cold, nutrient-rich deep water flows into the ASBS.

As a result of the varying topography of this area, the coastland curvature, and a headland, there is a great deal of variability in the current patterns through the water column in the two ASBS. In general, surface currents tend to flow northward in the alongshore direction and subsurface currents often flow in the opposite direction.

2.4.2 Major Land Use Divisions

Land use within the watershed can be broken down into five categories: single family residential, multi family residential, commercial, roads and paved parking areas, and open space, with nearly 60% of the watershed comprised of residential use. A graphical distribution of each land use within the watershed is presented in Figure 4.

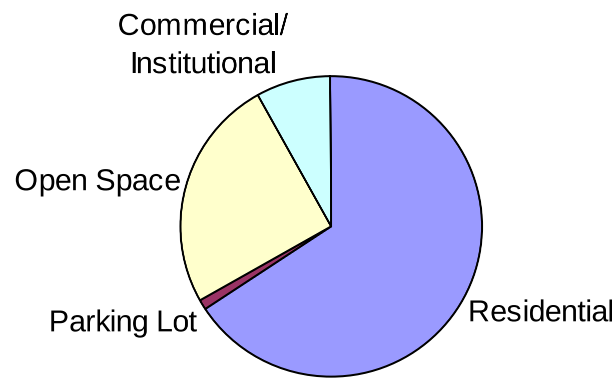


Figure 4. Land Use Distribution Within La Jolla Shores Watershed

2.4.3 Major Water Related Infrastructure

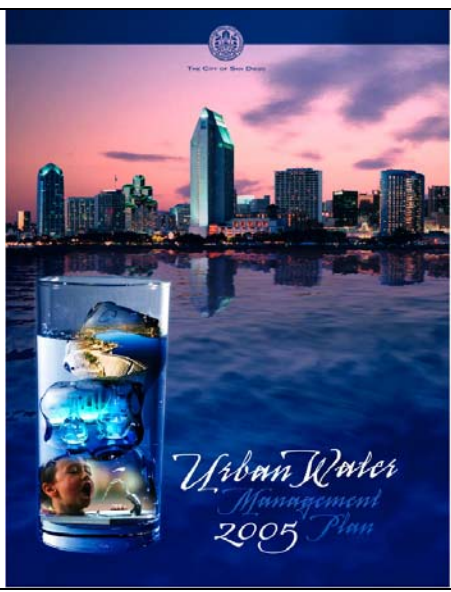


Figure 5. San Diego County Urban Water Plan 2005

Potable Water System - The City of San Diego Water Department provides municipal water supply to customers in the watershed through metered service connections within (including providing service to SIO). The City's Water Department efforts include water conservation, water recycling, and planning for an adequate and reliable future water supply. The Water Department maintains an approved urban water management plan. UCSD independently manages the water infrastructure within its boundaries.

The area relies mostly on imported water from Northern California and the Colorado River. During a normal year about 10-20 percent of the City's water supply is made up of local rainfall and is captured in one of the reservoirs in San Diego County. The remaining 80-90 percent is imported via the Metropolitan Water District of Southern California (MWD) and the San Diego County Water Authority (CWA) from two separate sources. A 242 mile-long aqueduct brings Colorado River water from Lake Havasu to the southland. This water may have originated as snow melt on the mountain slopes of Utah, Wyoming or Colorado and traveled more than 1,000 miles before being diverted to Southern California. The second source is Northern California water from the State Water Project. This water is captured in reservoirs north of Sacramento and released through natural rivers and streams into the Sacramento-San Joaquin Delta. The 444 mile-long California

Aqueduct then carries the water from south of the Delta to State Water Project contractors throughout the state such as MWD.

Providing reliable and sufficient water supplies upon demand has been a constant challenge for San Diego County Water Authority and the challenge is addressed by planners using variety of strategies including:

- Conservation and Peak Management Programs
- Storage
- Water Transfers
- Local Supplies

Conservation efforts are related to storm water pollution prevention as noted by the following excerpt from the 2005 Urban Water Plan.

> ***"2.5.4 More than "Just Saving Water"***
> *Storm Water Pollution Prevention - Water conservation contributes more than just local water savings. Proper water conservation techniques assist the City's Storm Water Pollution Prevention Program. When excess irrigation water flows out of yards, it flows directly into storm drains. Everything that flows down into a storm drain goes untreated directly into canyons, creeks, bays, lagoons and ultimately the ocean. Irrigation runoff water carries pesticides, fertilizers, motor oil, pet waste and silt. The Clean Water Act prohibits disposal of wastes and pollutants into creeks, bays, lakes and oceans. Such pollutants have harmful effects on recreational areas, waterways and wildlife. Proper irrigation scheduling either through the Section's various survey programs or the Department's website landscape watering calculator prevents storm water pollution."*

Watershed Storm Drain System - In most cases, runoff within the watershed flows overland within streets, is intercepted by catch basins, and is conveyed westerly within storm drain systems to outfall points along the coast. Drainage facilities within the watershed primarily fall within public right-of-way, mainly consisting of storm drain systems within roads and public right-of-way, and generally consist of concrete and metal pipes and concrete box culverts. The City of San Diego has constructed dry weather diversion facilities for the majority of the watershed. These facilities divert dry weather flows from the storm drain system to the sanitary sewer system. The portion of the storm drain system within SIO is maintained separately by UCSD, with the remainder of the systems within the watershed maintained by the City. The storm drain systems within the watershed are generally old, consisting of reinforced concrete pipelines.

Wastewater System - A third water-related infrastructure within the watershed is the sanitary sewer system. This system is important, not only to provide disposal for human sewage, but to provide a means for diverting and treating dry weather flows. At SIO, the sanitary sewer system traverses under campus and drains into the City of San Diego system at various points. The City of San Diego sanitary sewer system is primarily located within the public street right of way and generally drains by gravity from the east to the west. Upon reaching the coast, the sanitary sewer system drains southerly by a series of sewer pump stations. The sewage ultimately reaches the Point Loma Treatment Plant, located approximately thirteen miles to the south, for treatment prior to disposal to the Pacific Ocean. The sanitary sewer system within SIO is maintained separately by UCSD, with the remainder of the systems within the watershed maintained by the City.

2.5 Hydrologic Resources

The watershed is located in a semi-arid coastal desert environment. The climate is Mediterranean with an average annual rainfall of approximately 9.3 inches. Most of this rain falls from November through March. There are no permanent streams or natural lakes in the watershed and there are no groundwater resources utilized for municipal water supply.

The San Diego coast experiences mixed semidiurnal tides. Generally there are two tide cycles each day with different amounts of fluctuation from each high to low tide varying typically from about 4 to 6 feet. The "mixed" tide type indicates that the diurnal and the semidiurnal cycles are on the same order of magnitude. The interaction of these two tides gives San Diego its extreme tide ranges.

2.6 Biological Resources

Vegetation in the open space areas of the watershed includes coastal sage scrub and chaparral communities. There are some sensitive habitats including the Nuttall's scrub oak (*Quercus dumosa*) that have been observed in small numbers in the southern maritime chaparral habitat near SIO. The open space areas also support several species of sensitive animals, including the orange-throated whiptail lizard (*Cnemidophorus hyperythrus beldingi*), Cooper's hawk (*Accipiter cooperii*), Southern California rufous-crowned sparro (*Aimophila ruficeps canesceas*), Coastal California gnatcatcher (*Poliopalta California californica*), and San Diego black-tailed jackrabbit (*Lepus califonicau bennetitii*). The developed areas of the watershed have well established landscaping and grown trees.

The marine environment in the ASBS supports a large variety of plants and animals including uncommon or transient species. The diversity of the ecological resources is more extensive and varied than may be expected due to the variety of distinct biotic habitats within relatively close confines. Examples of the variety include:

- The submerged sandy plain supports many invertebrates, resident and transient fish, as well as plankton including the larvae of coastal animals.
- The sandy beach supports a rich invertebrate fauna of mollusks, crustaceans, and worms.
- The rocky intertidal habitat supports sea grass, algae, mollusks, echinoderms, sponges, and arthropods as well as a diverse invertebrate population that is significantly different than nearby rocky intertidal sites.
- The submarine canyon head and associated ledges support varied habitat, including hard substrate that supports sessile invertebrates and red and brown algae, as well as areas of detritus accumulation that support mats of cyanobacteria.
- The pier pilings also provide hard substrate, as well as shelter for schools of small fish such as anchovy and grunion.

Some of the unique environmental resources within the ASBS include the giant bladder kelp, (*Macrocystis pyrifera)*, Pacific Coast squid, (*Loligo opalescens)*, grunion, (*Leuresthes tenuis)*, and garibaldi, (*Hypsypops rubicundus)*.

3.0 AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE DESCRIPTION

3.1 Description of ASBS

The ASBS were established under provisions of a 1970 SWRCB plan to protect fragile or valuable biological communities. The two ASBS in the San Diego Region are the La Jolla State Marine Conservation Area and the adjoining San Diego-Scripps State Marine Conservation Area. Together these areas are part of the larger San Diego-La Jolla Underwater Park. The underwater park was established by the City of San Diego in 1971 and is approximately 6,000 acres in size, stretching for 10 miles from La Jolla Cove to the northerly end of Torrey Pines State Reserve. The park is a boat-free zone, with undersea flora and fauna that draw scuba divers and snorkelers, many of them hoping for a glimpse of the state fish, the brilliant orange garibaldi. The purpose of these areas is to:

- Ensure protection of vital aquatic ecosystems and thriving marine life;
- Allow San Diego residents and tourists to enjoy nature in its natural state; and
- Further scientific understanding of these unique and special marine habitats.

The reserve and refuge house several distinct habitats, including kelp beds, rocky reefs, sandy flats and canyon areas. They represent ‘the place’ in San Diego where divers, snorkelers, swimmers and kayakers go to enjoy abundant flora and fauna, including lobsters, abalone, crabs, trigger fish, giant kelp fish, schools of leopard sharks, seals that have established a rookery near the Reserve, sea turtles and hosts of other species of fish and aquatic life. Because of its high level of use and proximity to a heavily urbanized area, this marine environment is vulnerable to impacts from human activities and it is critical that those using this area and living within the watershed understand their role in protecting it.

3.1.1 San Diego-Scripps State Marine Conservation Area (ASBS No. 31)

The San Diego-Scripps State Marine Conservation Area (also known as the San Diego Marine Life Refuge and the San Diego-Scripps ASBS) The was established in 1929 by the California Fish and Game Commission to allow licensees of the Regents of the University of California to take, for scientific purposes, any invertebrate (invertebrates include abalone, lobster, starfish, sea anemones, mussels, etc.) or specimen of marine plant life without a permit from the Department of Fish and Game (SWRCB September 1980). The refuge has a surface area of 92 acres, includes 0.6 miles of shoreline and extends 1,000 feet westward from the mean high tide line; just beyond the end of the Scripps Pier. This ASBS includes three distinct habitats: a broad sloping sandy shelf concrete pier pilings that support the SIO pier; and a small intertidal and shallow subtidal mudstone reef complex of dikes, boulders and ledges. Both the sandy shelf and reef complexes are entirely within the surf zone during periods of typical winter swell and storms. The ASBS contains organisms representative of sandy substrate and a rocky reef, and the pier supports only a limited hardbottom biota. The submarine topography consists of a narrow continental shelf with a deep submarine canyon immediately north of the ASBS.

3.1.2 La Jolla State Marine Conservation Area (ASBS No. 29)

The La Jolla State Marine Conservation Area (also known as the San Diego-La Jolla Ecological Reserve and the La Jolla ASBS) was set aside by the City of San Diego in 1971, in conjunction with the California Department of Fish and Game. It extends from Goldfish Point northerly to the southerly end of the Scripps Institution of Oceanography and encompasses a surface area of 518 acres (SWRCB February 1979). This ASBS is also fully contained within the San Diego-La Jolla Underwater Park. It is somewhat pie-shaped, extending outward from the shore to a maximum distance of approximately one mile. The ASBS consists of a wide variety of habitats including: a broad sloping sandy shelf, a submarine canyon, a small giant kelp (*Macrocystis pyrifera*) forest, small submerged cobble patches, reefs composed of flat sandstone/shale ledges interspersed with patches of sand, and a boulder-strewn mudstone reef complex. The submarine topography is similar to that of the San Diego Marine Refuge, consisting of a narrow continental shelf and submarine canyon. The La Jolla Canyon extends through the middle of the ASBS contributing to the wide variety of habitats. The La Jolla Canyon is a seaward extension of the Rose Canyon Fault that transects the watershed in a northwesterly angle.

3.2 Beneficial Uses

The watershed and ASBS support the many beneficial uses as outlined in the SDRWRCB Basin Plan and California Ocean Plan (see following list). Of these long lists the most relevant beneficial uses relate to the recreational uses of the beach and support of the special habitat within the marine reserves.

SDRWQCB Basin Plan:

- Industrial Service Supply (IND)
- Navigation (NAV),
- Contact Recreation (REC-1),
- Non-contact Recreation (REC-2),
- Commercial /Sport Fishing (COMM),
- Preservation of Biological Habitats of Special Significance (BIOL),
- Wildlife Habitat (WILD),
- Rare, Threatened, or Endangered Species (RARE),
- Marine Habitat (MAR),
- Aquaculture (AQUA),
- Migration of Aquatic Organisms (MIGR),
- Shellfish Harvesting (SHELL).

California Ocean Plan:

- Industrial Water Supply,
- Water Contact & Non-Contact Recreation, Including Aesthetic Enjoyment,
- Navigation,
- Commercial & Sport Fishing,
- Mariculture,
- Preservation & Enhancement of Designated Areas of Special Biological Significance,
- Rare and Endangered Species,
- Marine Habitat,
- Fish Migration,
- Shellfish Harvesting.

3.3 Critical Coastal Areas

The Critical Coastal Areas (CCA) Program is an innovative program to foster collaboration among local stakeholders and government agencies, to better coordinate resources and focus efforts on coastal watersheds in critical need of protection from polluted runoff. A multi-agency statewide CCA Committee has identified an initial list of 101 CCAs along the coast and in San Francisco Bay. The CCA Program, part of the state's Non-Point Source (NPS) Plan, is a non-regulatory planning tool to coordinate the efforts of multiple agencies and stakeholders, and direct resources to CCAs. The program's goal is to ensure that effective NPS management measures are implemented to protect or restore coastal water quality in CCAs.

The watershed includes two Critical Coastal Areas; the San Diego-Scripps State Marine Conservation Area (CCA# 79) and the San Diego-La Jolla State Marine Conservation Area (CCA #78). These areas are designated CCAs because they flow into the San Diego-Scripps State Marine Conservation Area ASBS and the La Jolla State Marine Conservation Area ASBS. The development of this watershed management plan followed the Critical Coastal Area planning process. The process consists of performing a watershed assessment that identifies and evaluates existing and potential non-point source (NPS) pollution impacts to coastal and marine resources, by compiling and analyzing available data. This assessment is then used to develop an Action Plan that identifies all the steps required to address NPS impacts and improve water quality conditions in the CCA's watershed, including application of appropriate Management Measures or Best Management Practices (BMPs). This process is presented in detail in Section 4.1, Urban Runoff Characterization and Section 6, Management Program Recommendations. The CCA process also includes a strong stakeholder participation component, which was followed through the establishment of the project goals and development of the Plan as discussed in Section 4.4, Public Participation.

4.0 TECHNICAL ANALYSIS

This section discusses data, technical methods, and analyses used to develop the Plan. The technical analysis consisted of carrying out four key components:

1. Urban runoff characterization
2. ASBS ecosystem assessment
3. Information management
4. Public participation

These areas were selected by the project team as the primary components necessary to characterize ASBS inputs, identify potential biological or ecosystem impacts to the ASBS, establish an information management system to house, integrate and disseminate data collected for the Plan, and to begin an ocean stewardship program within the watershed. Following is a description of the work performed in the four components and the findings based on the data collected, analyses performed, and tasks implemented.

4.1 Urban Runoff Characterization

This section presents the water quality constituents of concern (COCs) based on the results of the storm water sampling and analysis performed in the watershed. The water quality COCs represent one component of the Plan that provides a holistic approach to identifying the potential impacts to the ASBS in order to develop management actions that will preserve the biological resources of these areas. The *ASBS Protection Model* was developed for this project, but is applicable to other ASBS. The model components include the identification of water quality COCs, potential COC sources, migration pathways, bioavailability, and the impact of COCs on the beneficial uses of the ASBS. Impacts may also be the result of physical processes in the environment, such as cross contamination from tidal flows, ocean currents, air deposition, and other human activities. As part of the *ASBS Protection Model* these components are assessed along with the potential impacts from constituent loading from wet weather flows on the biological community of the ASBS. Management actions that include Best Management Practices (BMPs) are developed and evaluated in the Watershed Management Plan to address these potential impacts. The implementation of BMPs is prioritized based on the results of the *ASBS Protection Model* presented in Section 6.1.

The preliminary COCs presented in this section therefore represent an initial listing of potential pollutants that may result in possible impacts, however, the actual fate and effect of these COCs, based on additional testing and modeling, will determine the need and scope of any management actions. The additional testing results that will be part of this analysis include toxicity testing, bioaccumulation studies, tide/current studies, biological surveys and a dilution and dispersion study.

4.1.1 Water Quality Monitoring

This baseline storm water runoff characterization includes a review of historical water quality and toxicity data collected by the City and SIO. In addition to conducting the data review; storm water, ocean mixing zone or surf zone (nearshore zone between the outermost breakers and the area of the wave uprush) and outer ocean (beyond the surf zone) sampling and analysis were conducted as part of this grant project to obtain additional baseline water quality, flow, and toxicity data. Storm water samples were collected at two locations within the municipal storm drain system upstream of outfalls to the ASBS. The storm water samples were collected during rain events, and were analyzed for the constituents listed in the California Ocean Plan listed in the next section. Pollutograph sampling (multiple discrete samples throughout the course of a storm) at a single municipal storm drain system location was also conducted during a rain event in order to obtain loading information on COCs. Sampling and analysis results from monitoring performed by SIO for their discharge permit is also presented in this section. Dry weather flow samples were not analyzed as part of this project because they are to be prohibited from entering the ASBS and therefore are planned for elimination. Additionally, acute and chronic bioassays to evaluate toxicity were preformed on water samples and are discussed in Section 4.4.

4.1.1.1 Grant-funded Water Quality Monitoring

The sampling program that was funded by this grant project consisted of installing mass loading stations in the storm drain system within two of the largest sub-drainage areas as shown on Figure 6. Storm water samples were collected from the two MS4 sampling stations using automated flow and sampling equipment installed within the manholes at locations S1 (near the intersection of El Paseo Grande and La Jolla Shores Drive) and S2 (near the intersection of Paseo Dorado and La Jolla Shores Drive). Flow-weighted composite runoff samples were collected during a storm event from the two automated sampling stations. Samples were collected at frequencies that were adjusted depending on measured flow over the course of the storm and combined into a 20 liter container. Grab samples were collected for those constituents that are not conducive to composite sampling (pH, temperature, conductivity, oil and grease, and bacteriological indicators). Flow within the MS4 was also monitored and recorded at the sampling stations to provide accurate flow data for the purpose of calculating load estimations.

Ocean outfall/mixing zone (within the surf zone) and outer ocean (beyond the surf zone) samples were collected to compare COCs with the storm water samples and with applicable water quality criteria. Mixing zone grab composite samples were collected within the immediate mixing zone (surf zone) at the storm drain outfalls downstream of the MS4 sample station. Composite grab samples from the two ocean mixing zone sites (D1 and D2) were collected on a time-weighted basis at the outfalls of the sub-drainage areas. The time-weighted samples were collected over the portion of the storm during which storm water samples were collected, but at set and equal intervals. The outer ocean mixing zone grab samples were collected outside the surf zone from a depth of 40-60 feet and were taken within 24 hours of the storm event from a boat.

Pollutograph sampling was performed at the S2 MS4 location during a single storm event. To accomplish this, discrete grab samples were taken at short intervals over the duration of the storm event. Each grab sample was then analyzed separately to evaluate constituent loading over the course of the rain event.

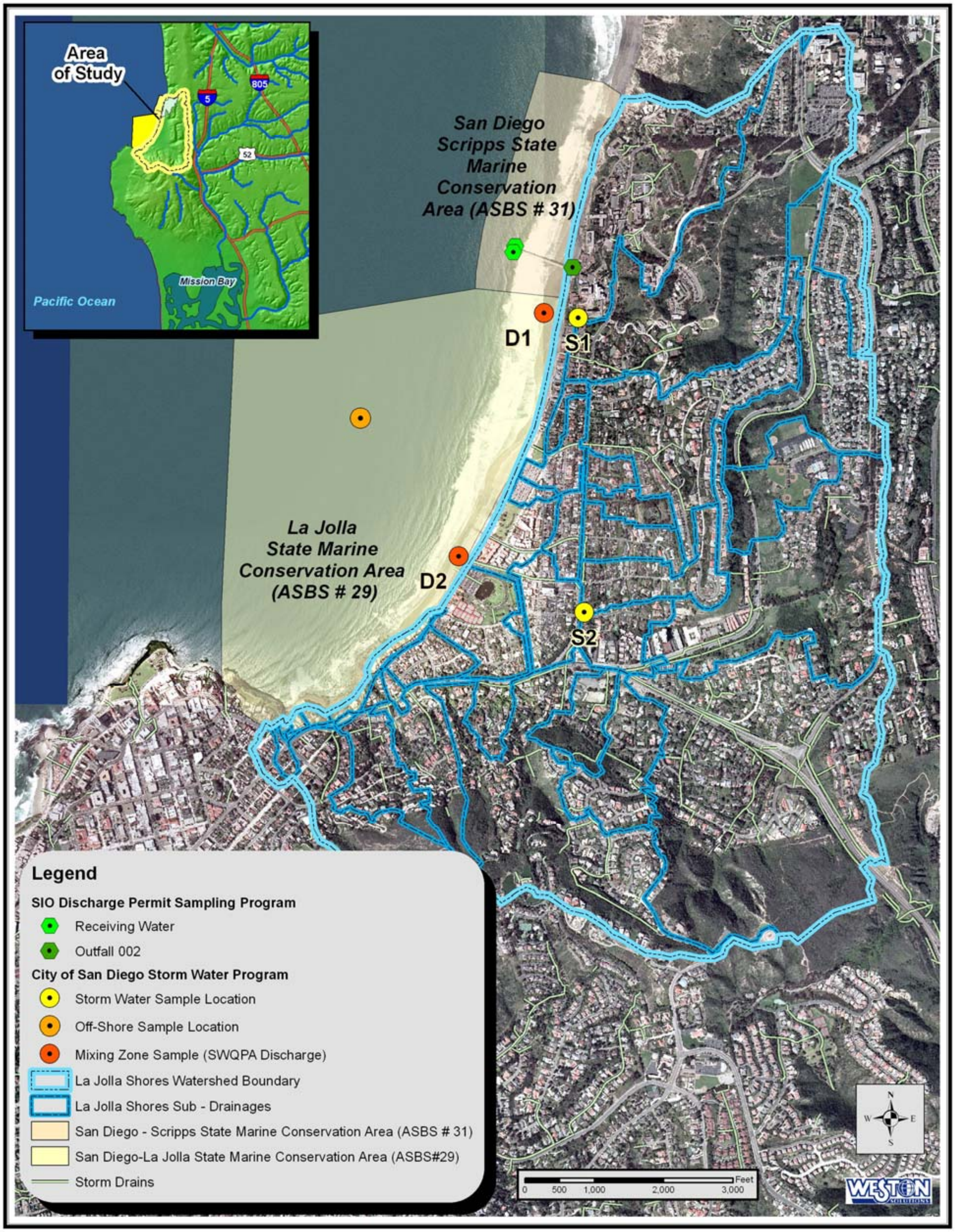


Figure 6. La Jolla Shores Coastal Watershed and Monitoring Locations

Water quality samples were analyzed for the constituents listed below in Table 1.

Table 1. Chemical Constituents for Which Laboratory Analyses Were Performed

- Total Hardness as $CaCO_3$
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Settleable Solids (SS)
- Total Organic Carbon (TOC)
- Turbidity
- Ammonia
- Total Kjeldahl Nitrogen (TKN)
- Nitrate as N
- Nitrite
- Total residual chlorine
- Total Phosphorus
- Orthophosphate (as P)
- Total Cyanide
- Total and Dissolved Metals
- Synthetic Pyrethroids (Pesticides)
- Organophosphorus Pesticides
- Organochlorine Pesticides/PCBs
- Semi-Volatile Organic Compounds (VOCs) including Polynuclear Aromatic Hydrocarbons (PAHs)
- Dioxins/furans (expressed as TCDD equivalents

Composite samples were taken in the MS4 for most constituents and grab samples were collected for those constituents that are not conducive to composite sampling (pH, temperature, conductivity, oil and grease, and bacteriological indicators). The bacteriological indicators for which analyses were performed included total coliforms, fecal coliforms, and enterococci. All samples were collected and analyzed in the manner described in the approved QAPP, dated January 2006. In addition to conducting analyses for those constituents listed above and presented in Table 1, acute and chronic toxicity testing was also conducted on urban runoff samples in order to assess possible toxic impacts to mysid shrimp, giant kelp, and sea urchins.

4.1.1.2 Historic Water Quality Monitoring

Historic data included samples from the City and SIO as part of the City's application for an exception to the California Ocean Plan and SIO's discharge permit monitoring (Monitoring and Reporting Program No. R9-2005-0008 NPDES Permit No. CA0107239). The City collected samples at S-1 and S-2 in 2005 during two storm events. SIO collected storm water samples from Outfall 002, located approximately 20 feet north of Scripps Pier and receiving water samples just beyond the surf zone next to Scripps Pier in 2005 and 2006.

Storm water and receiving water samples were collected as shown in Figure 6. Flow-weighted composite storm water samples were collected during four wet weather sampling events from Outfall 002 at SIO, which discharges storm water runoff from the MS4 in and around SIO. The receiving water samples collected during each of these four storm events were collected four times during a 24-hour period and equally combined by the lab into a single sample (with the exception of analyses requiring a single grab such as VOCs).

Historic monitoring included the constituents listed in Table 1.

Table 2. Rainfall and Runoff Volume Calculations for La Jolla ASBS.

Constituent	Percentage Impervious Land	Acres	Units	La Jolla ASBS				
				Monitored events			Average (05-06 Season)	Annual Average*
				03/23/05	04/28/05	02/19/06		
Rainfall (San Diego Airport)	-	-	inches	0.53	0.51	0.19	4.6	10.5
Estimated S1 Runoff Volume	0.45	215	Acre feet	2.91	4.07	1.92	37.2	93.1
Estimated S2 Runoff Volume	0.36	853	Acre feet	9.21	12.9	6.06	117	294
Estimated Total Preserve Runoff Volume	0.37	1452	Acre feet	15.9	22.3	10.5	204	509

* Based upon San Diego Airport rainfall data from 1914-2006.

4.1.1.3 Water Quality Testing Results

Results of chemical analyses, bacterial analyses, and toxicity bioassays from wet weather sampling events occurring from March 2005 through April 2007 in the La Jolla Shores watershed are presented in Appendix A Water Quality Characterization Report and are discussed briefly in this section. Appendix A also contains chemical analysis of water collected by the City from the MS4, mixing zone, and offshore sample locations as part of their storm water characterization study, as well as results of testing performed on water samples collected by SIO. Bioassay results for each of these two separate sampling programs are presented within this same appendix following water chemistry results.

Pollutograph Sampling

Repeated sampling of the MS4 was conducted throughout the storm event of April 20, 2007 at the S2 sampling location in order to create a pollutograph. Ten grab samples, collected at regular intervals throughout the storm, were selected to undergo chemical analyses. In addition to chemical analyses of the water samples, loading estimates for selected constituents were calculated for the MS4 based upon measured flow rates throughout the storm. In general, metal concentrations in the storm water runoff were highest during the initial stages of the storm while total suspended solids concentrations were closely correlated to the rate of flow through the MS4 (Figure 7 and Figure 8). TSS concentrations were highest immediately following the period of peak flow and as flow declined, TSS concentrations also declined. The majority of total PAHs were transported during the peak storm flow (Figure 9).

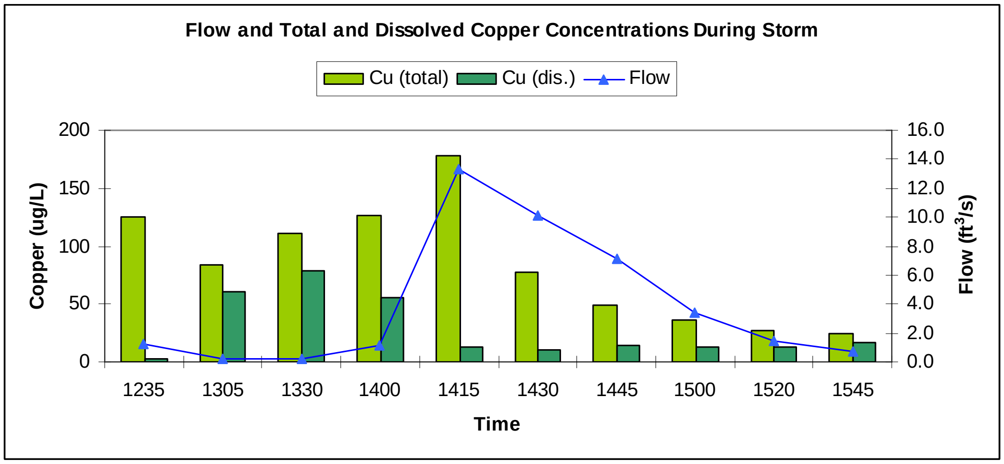


Figure 7. Comparison of total and dissolved copper versus flow during storm event

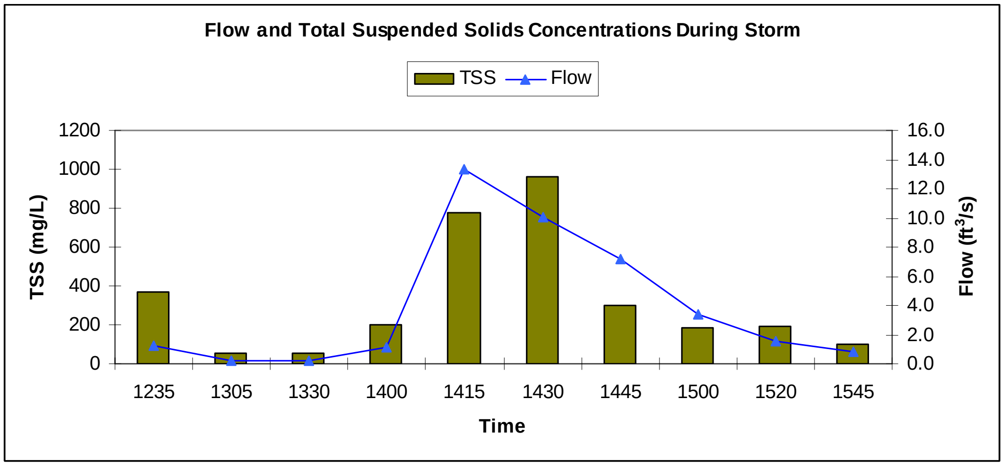


Figure 8. TSS versus flow during storm event

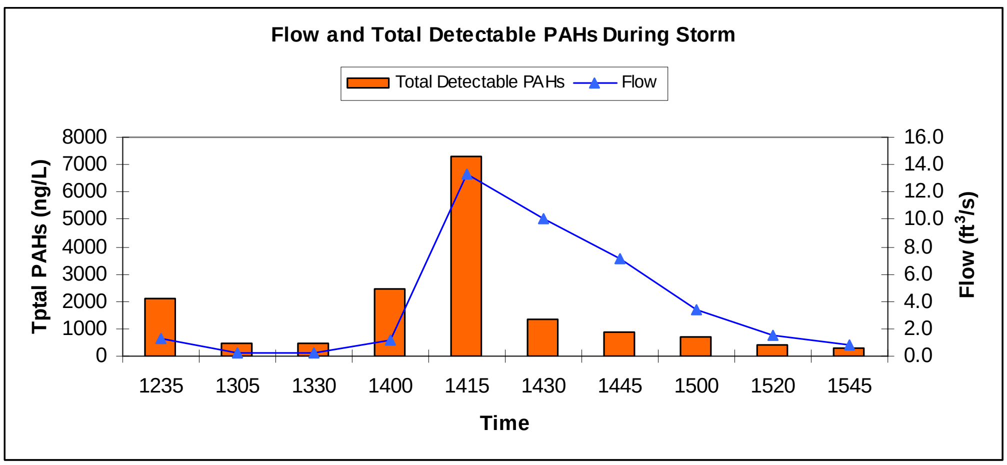


Figure 9. Comparison of total detectable PAHs versus flow during storm event

Over the course of the entire 3-hour storm event, 108.9 grams of total copper (which included 15.3 grams of dissolved copper), were calculated to have washed through the storm drain (Table 3). Additionally, 46.5 grams of total lead, 583.5 grams of total zinc, 3.31 grams of total PAHs, and 630.7 kg of total suspended solids were calculated to have passed through the storm drain via storm water runoff. At the time of the peak flow of the storm (14:30), 68 percent of the total copper and 49.5 percent of the dissolved copper load had passed through the storm drain system (Figure 10). Other constituent loads which had flowed through the storm drain system by this time included 51 percent of the total lead load, 74 percent of the total zinc load, 81 percent of total detectable PAHs load, and 46.9 percent of the TSS load.

Table 3. Calculated Load Concentrations Over the Course of the Storm for COCs

Time span	Total Copper (g)	Dissolved Copper (g)	Total Lead (g)	Total Zinc (g)	TSS (g)	Total Detectable PAHs (g)
1235-1305	8.03	0.13	2.00	34.22	23,881	0.13
1305-1330	0.88	0.63	0.06	2.27	601	0.01
1330-1400	1.39	0.99	0.09	3.79	654	0.01
1400-1415	3.57	1.59	0.53	13.94	5,627	0.07
1415-1430	60.35	4.22	21.13	377.35	265,189	2.48
1430-1445	19.99	2.75	15.78	90.00	247,691	0.35
1445-1500	8.87	2.68	4.27	39.07	54,077	0.16
1500-1520	4.10	1.44	1.81	16.89	20,956	0.08
1520-1545	1.74	0.86	0.81	5.99	12,062	0.03
Total load from MS4 in grams for 3-hour storm	**108.9**	**15.3**	**46.5**	**583.5**	**630,738**	**3.31**

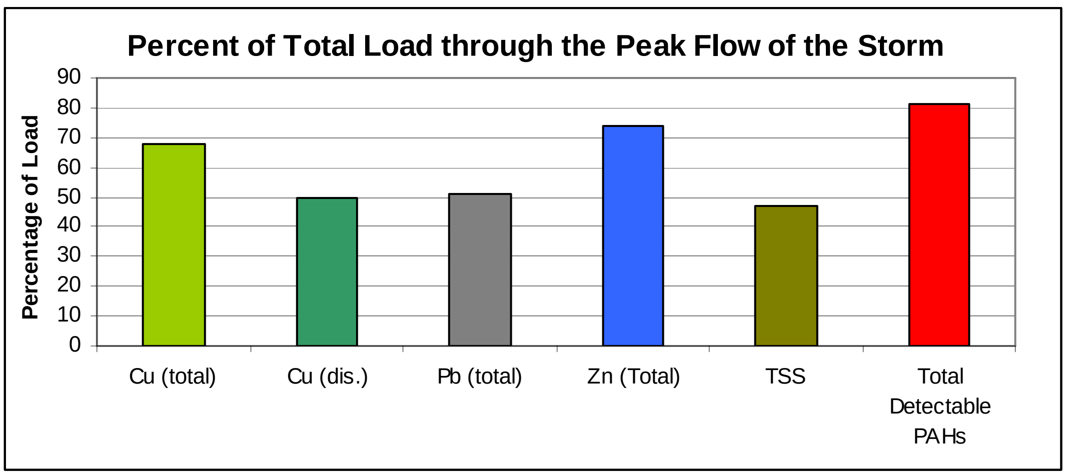


Figure 10. Comparison of the percentage of total loads through the peak flow of the storm event

4.1.2 Preliminary Constituents of Concern

In wet weather sampling events conducted over a two-year time period, copper, fecal indicator bacteria and turbidity were the only constituents detected persistently above Basin Plan water quality guidance criteria over multiple storm events and throughout the watershed. Enterococci bacteria was the only constituent persistently detected above California Ocean Plan guidance criteria in water collected from mixing zone and offshore sampling locations over multiple storm events and locations. These preliminary COCs were used to identify the parameters for the bioaccumulation study and will be evaluated further in the *ASBS Protection Model* using the results of the other studies as discussed above. Based on the sampling results, copper, fecal and enterococci indicator bacteria, and turbidity have been identified as the primary COCs for the La Jolla Shores watershed

The constituents discussed above are consistent with the project team's experience with urban runoff. Also based on the project team's experience, turbidity, metals, and possibly PAHs are anticipated to have the most potential impact on marine life. Turbidity levels detected can impact marine life by reducing light penetration necessary for phytoplankton and macroalgal growth. Total and dissolved metals can potentially affect marine life through direct toxic impacts to fish and algae. PAHs can also affect marine life. These constituents were targeted for further study as part of the ASBS Protection Model through the toxicity tests and bioaccumulation studies.

The actual impact of urban runoff on marine life within the ASBS, however, must be based on considering the results of various studies in a holistic approach as described in the *ASBS Protection Model* in Section 6.1. Water quality is one of several potential components of this model that assesses the potential impact to the ASBS in order to define the possible management actions and their priorities. Other potential impacts include cross contamination from tidal flows, public use, air deposition, and physical environmental changes. COCs with potentially higher relative impacts should receive greater attention and resources to cost effectively preserve the beneficial uses of the ASBS. Potential impacts from storm water to the ASBS should be evaluated by water quality monitoring, toxicity testing, bioaccumulation studies, biological surveys and physical environment data. This holistic approach is the basis for the design and impact reduction goals of the proposed BMPs.

4.1.3 Watershed-Specific Pollutants of Concern

Based on the results of the water quality monitoring, the watershed-specific COCs for the La Jolla Shores Coastal Watershed are listed below. Following the list is a discussion of each COC, the basis for consideration. The potential sources of these COCs are discussed in Section 4.1.7 and the potential impacts to the ASBS are discussed in Section 4.1.8.

- Turbidity (sediment)
- Copper
- Fecal and enterococci indicator bacteria

4.1.3.1 Turbidity (Sediment)

Turbidity was measured in the storm water samples from the City of San Diego's sampling locations (S1 and S2) and from SIO Outfall 002 in levels above the water quality criteria. Although samples collected from the MS4 and from Scripps Outfall 002 exceeded the Basin Plan's guidance criteria for turbidity during each of the monitored storm events, turbidity did not exceed Ocean Plan criteria on the same dates within the mixing zone or at the offshore sampling location. Therefore, although concentrations in storm water within the City's MS4 and SIO's MS4 are above Basin Plan water quality criteria, the dilution of these discharges within the mixing zone may result in lower concentrations in the ocean waters within the ASBS as described in Section 4.2.3.

4.1.3.2 Copper

Total and dissolved copper levels in City storm water samples and total copper levels in SIO Outfall 002 samples were detected at concentrations above the 30.5 mg/L total copper and 29.3

mg/L dissolved copper guidance criteria listed in the Basin Plan. However, the City's mixing zone and offshore copper concentrations, as well as SIO's receiving water copper concentrations, were all below California Ocean Plan guidance criteria. Therefore, although concentrations in storm water within the City's MS4 and SIO's MS4 are above Basin Plan water quality criteria, the dilution of these discharges within the mixing zone may result in lower concentrations in the ocean waters within the ASBS.

4.1.3.3 Fecal and Enterococci Indicator Bacteria

Fecal indicator bacteria are used to identify waters that may be at risk for containing disease causing pathogens. Thus, if relatively high numbers of fecal indicator bacteria are measured in an environment, it is assumed that there is an increased likelihood of pathogens being present as well. Fecal coliform levels within the City's MS4s were elevated above Basin Plan guidance criteria at sampling locations S1 and S2, and at SIO's Outfall 002. Enterococci bacterial concentrations within the mixing zone at sites D1 and D2 were elevated above California Ocean Plan guidance criteria while analysis of SIO receiving water samples did not detect enterococci. Prevailing longshore currents, dilution, and toxicity from seawater may prevent bacteria in storm drain effluent from reaching beyond the mixing zone.

4.1.3.4 Lower Priority COCs

The following are lower priority preliminary COC which are discussed below:

- octa chlorinated dibenzo-p-dioxins (expressed as TCDD equivalents),
- oil and grease
- PAHs
- synthetic pyrethroids (pesticides)

Dioxins/furans (expressed as TCDD equivalents) - Dioxins/furans (expressed as TCDD equivalents) were detected in storm water samples at SIO Outfall 002, as well as in the ocean mixing zone near this outfall. Dioxins/furans were also detected in storm drain, mixing zone, and offshore samples in 2007. In previous testing by the City, TCDD equivalents were not detected in storm water or outer ocean samples. Likely, this was because the analytical method (SW-846 8280A) used for the samples in which dioxins and furans were not detected had a higher method detection limit than the method used by SIO and for the City's 2007 sampling (EPA Method 1613). The majority of the dioxins/furans that were detected were octa chlorinated dibenzo-p-dioxins. Octa-dioxins are ubiquitous in the environment and are primarily formed through combustion of fossil fuels. Likely sources of octa-dioxins are aerial deposition from wild fires, recreational bonfires, air emissions, and diesel exhaust. TCDDs are considered a lower priority preliminary COC due to the prevalence of the octa-isomer group in the environment from natural sources.

Oil and grease- Oil and grease were detected in the SIO Outfall 002 during one storm event at quantifiable concentrations. The water quality objective is no visible sheen. This result appears to be an isolated source, and was not detected at quantifiable levels in the other storm water samples reported. Oil and grease are therefore also identified as lower priority preliminary COCs. The management action for these constituents may therefore be source control and pollution prevention measures where oil spills may likely occur (e.g. fueling and maintenance areas, etc.).

PAHs- PAHs were analyzed in all eight sampling events; however, the detection limits were ultra-low in only five of the samples. Of these five samples PAHs were detected in four. Low levels of PAHs were detected in the ocean mixing zone during one storm event but were not detected in outer ocean sites, even using ultra-low detection limits. As a result, PAHs are considered a lower priority COC. PAHs are characterized as a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. Sources include automobile exhaust, used engine oil, asphalt roads, cigarette smoke, and fossil-fuel combustion, as well as recreational bonfires.

Synthetic pyrethroids- No synthetic pyrethroids were detected in any of the samples collected from the storm drains or ocean samples, except in the 2007 storm drain and mixing zone samples when ultra-low detection limits were used. In the 2007 storm event, bifenthrin was detected in S2 storm drain and mixing zone samples while prallethrin was detected in the mixing zone. No synthetic pyrethroids were detected from samples collected at the offshore site. Synthetic pyrethroids are currently considered to be emerging contaminants that have the potential to be a long-term issue within the City of San Diego. Based on predominant residential land use (with extensive landscaping) in the watershed, these pesticides are considered a possible low priority COC in the watershed in the future.

4.1.4 Toxicity Testing

As part of the urban runoff characterization study, toxicity testing was performed using four approved ocean species (mysid shrimp, fish, giant kelp, and purple sea urchins) to help determine biological impacts from storm water runoff to animal and algae phyla living within the ASBS marine ecosystem. The toxicity testing included both acute and chronic bioassays. Acute exposure testing was performed on mysid shrimp while chronic exposure testing was performed on giant kelp, mysid shrimp, and purple sea urchins (Table 4). The rationale for performing both acute and chronic tests was that the acute test would represent short-term conditions (such as storm water entering the ASBS) and would examine impacts (such as mortality) from short-term exposures to storm water effluent and its receiving water. The chronic test, on the other hand, would focus on long-term exposures to examine both lethal (mortality) and sub-lethal endpoints (growth and reproduction) in test organism exposures to MS4 discharge, mixing zone, and receiving water samples.

Table 4. Bioassay testing performed on MS4, mixing zone, and offshore (receiving water) samples

Test Organism	Acute Testing	Test End Point	Samples Tested	Chronic Testing	Test End Points	Samples Tested
Mysid Shrimp (*Mysidopsis bahia*)	X	Survival	**The City**: MS4, Mixing Zone, and Offshore samples **SIO**: None	X	Survival, Biomass	**The City**: MS4, Mixing Zone, and Offshore samples **SIO**: Outfall 002, Receiving Water
Fish (*Menidia beryllina*)	X	Survival	**The City**: None **SIO**: Outfall 002, Receiving Water	X	Survival, Growth	**The City**: None **SIO**: Outfall 002, Receiving Water
Giant Kelp (*Macrocystis pyrifera*)				X	Germination, Growth	**The City**: MS4, Mixing Zone, and Offshore samples **SIO**: Outfall 002, Receiving Water
Purple Sea Urchin (*Strongylocentrotus purpuratus*)				X	Fertilization	**The City**: MS4, Mixing Zone, and Offshore samples **SIO**: Outfall 002, Receiving Water

No acute toxicity was observed in bioassay testing using mysid shrimp in exposures to City of San Diego storm drain, mixing zone, and offshore samples. Similarly, no acute toxicity was observed in bioassay testing using fish in exposures to samples collected from SIO Outfall 002 and SIO receiving waters. In chronic testing, no chronic toxicity was observed in bioassays using mysid shrimp and purple sea urchins in exposures to City of San Diego storm water, mixing zone, and offshore samples. In the giant kelp bioassays, using germination and growth as endpoints, decreased growth was observed in exposures to storm drain and mixing zone samples, while decreased germination was observed in exposure to the mixing zone sample.

In order to help verify the results of the giant kelp test, a second bioassay test was performed with giant kelp using water collected during the fourth monitored storm event (April 2007). In this test, no toxicity to kelp germination was observed in exposures to storm drain, mixing zone, or offshore sample water but reductions in kelp embryo growth were observed.

No chronic toxicity was observed in bioassay testing of SIO Outfall 002 and receiving water samples. In exposures to SIO Outfall 002 discharge and SIO receiving water, fish, mysid shrimp, and giant kelp had No Observable Effect Concentrations (NOECs) equal to the highest test concentration. Bioassay results will be used in *ASBS Protection Model* approach to identify constituents of concern within the watershed.

4.1.5 Watershed Characterization (Pollutant Sources)

4.1.5.1 Watershed Boundaries

The La Jolla Shores Coastal Watershed is located in La Jolla, California, within the limits of the City of San Diego. The watershed is 1,639 acres and is roughly bounded by the Pacific Ocean shoreline to the west, La Jolla Scenic Drive to the east, the intersection of La Jolla Shores Drive and Torrey Pines Road to the north, and South Via Casa Alta Road to the south. The land rises from sea level along the coast to an elevation of approximately 800 feet at Mt. Soledad. Within the watershed boundaries there are 32 distinct sub-drainage areas (Figure 11).

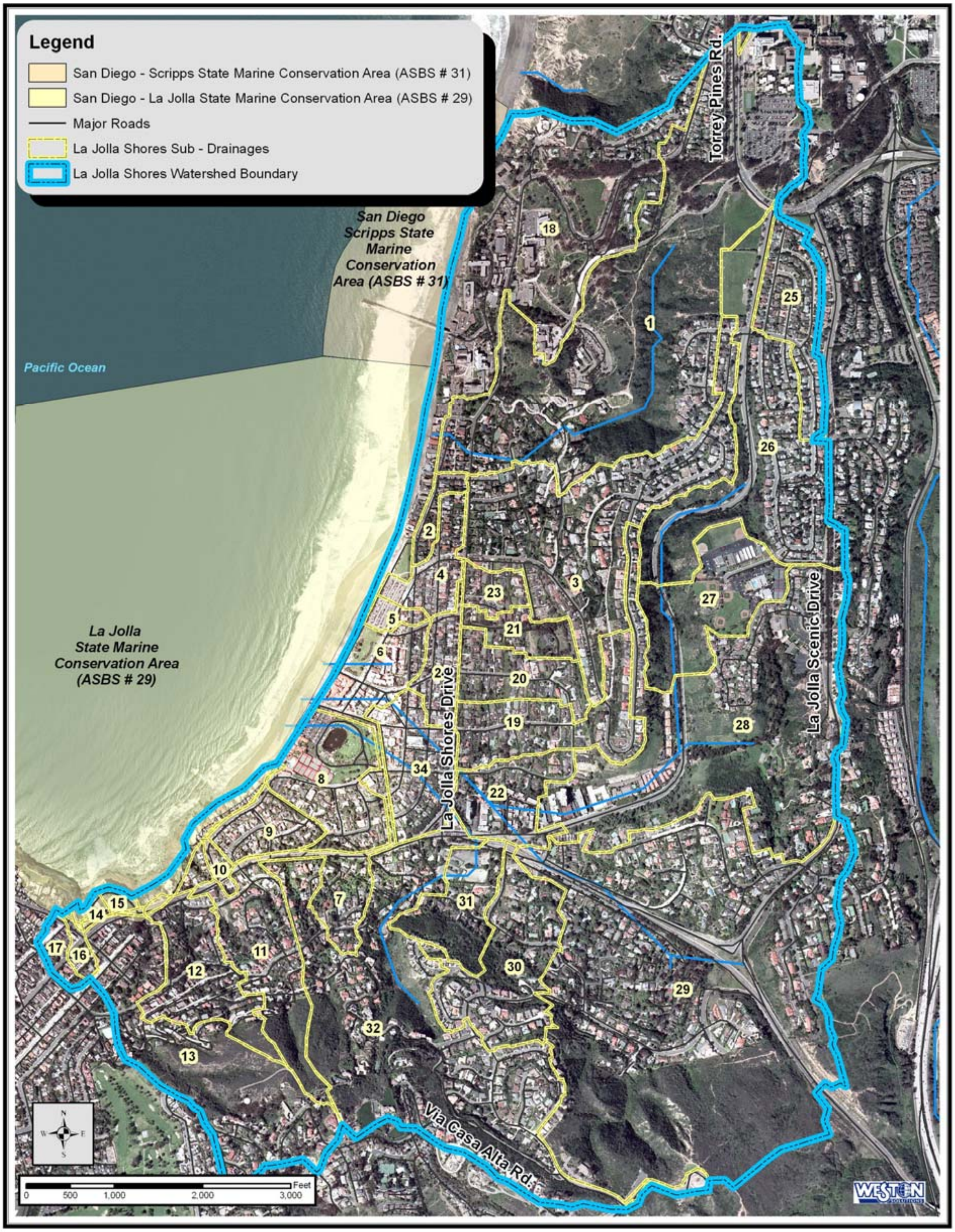


Figure 11. Sub-drainage areas within the La Jolla Shores Coastal Watershed

4.1.5.2 Key Drainage Infrastructure

The La Jolla Shores Coastal Watershed discharges into the two ASBS areas in several ways: the municipal separate storm sewer system (MS4), direct discharges from overland sheet flow, and natural drainage features. For the majority of the watershed, runoff generally enters the MS4 through curb inlets located within public streets or through catch basins located at the lower, or westerly, ends of open space and undeveloped areas. The majority of wet weather flows within the watershed are conveyed through the MS4 and subsequently discharge into the ASBS via 17 main outfalls located along the shoreline. The largest of these is the Avenida de la Playa and El Paseo Grande storm drains that drain up to 50% of the watershed. In many locations, rather than discharge from the MS4 to the ASBS, dry weather flows are diverted from the MS4 to the sanitary sewer system (Figure 12). However, wet weather flows exceed the capacity of the sanitary sewer system and are therefore not diverted. It should be noted that there are no natural streams that flow directly into the ASBS due to the urbanization of the lower watershed.

In total, the annual average volume of runoff entering the La Jolla Shores Coastal Watershed was calculated to be slightly greater than 22 million cubic feet of water, based on average annual rainfall at the San Diego Airport (1914-2006). Greater than 75 percent of that runoff (16.8 million cubic feet) was discharged by two storm drain outfalls (D1 and D2, see Figure 6) within the watershed. The approximate annual volume of runoff entering the La Jolla ASBS through the D1 storm drain outfall was calculated to be 12.8 million cubic feet of water, while runoff entering the ASBS through the D2 storm drain outfall was approximated to be 4 million cubic feet of water. Each of these outfalls (D1 and D2) was sampled during the 2005-2006 wet weather monitoring season. Discharge volumes were calculated using ArcGIS based upon the percentage of impervious surface area within the watershed according to SANDAG land use data (SANDAG, 2003).

Currently, there are 287 discharge points into the ASBS (Figure 13). Most of these originate from privately owned homes which discharge irrigation via pipes, outfalls, and weep holes embedded in the sea walls. SIO also discharges waste seawater, pursuant to their NPDES permit (No. CA0107239), onto the beach at four outfalls along the sea wall. The water discharging from the SIO outfalls is seawater that has been pumped directly from the Pacific Ocean at Scripps Pier, filtered, and then circulated through the laboratories and aquaria of SIO, the Birch Aquarium at Scripps, and National Marine Fisheries Service aquaria. After circulation, the seawater is then discharged across the beach and directly into the San Diego-Scripps State Marine Conservation Area ASBS.

Although the vast majority of the urban runoff at La Jolla Shores reaches the ASBS via outfalls from pipes and weep holes, several natural drainage features may also discharge urban runoff within the watershed directly onto beaches and off of cliffs. These natural systems, however, are ephemeral in nature and transport urban runoff only during storm events.

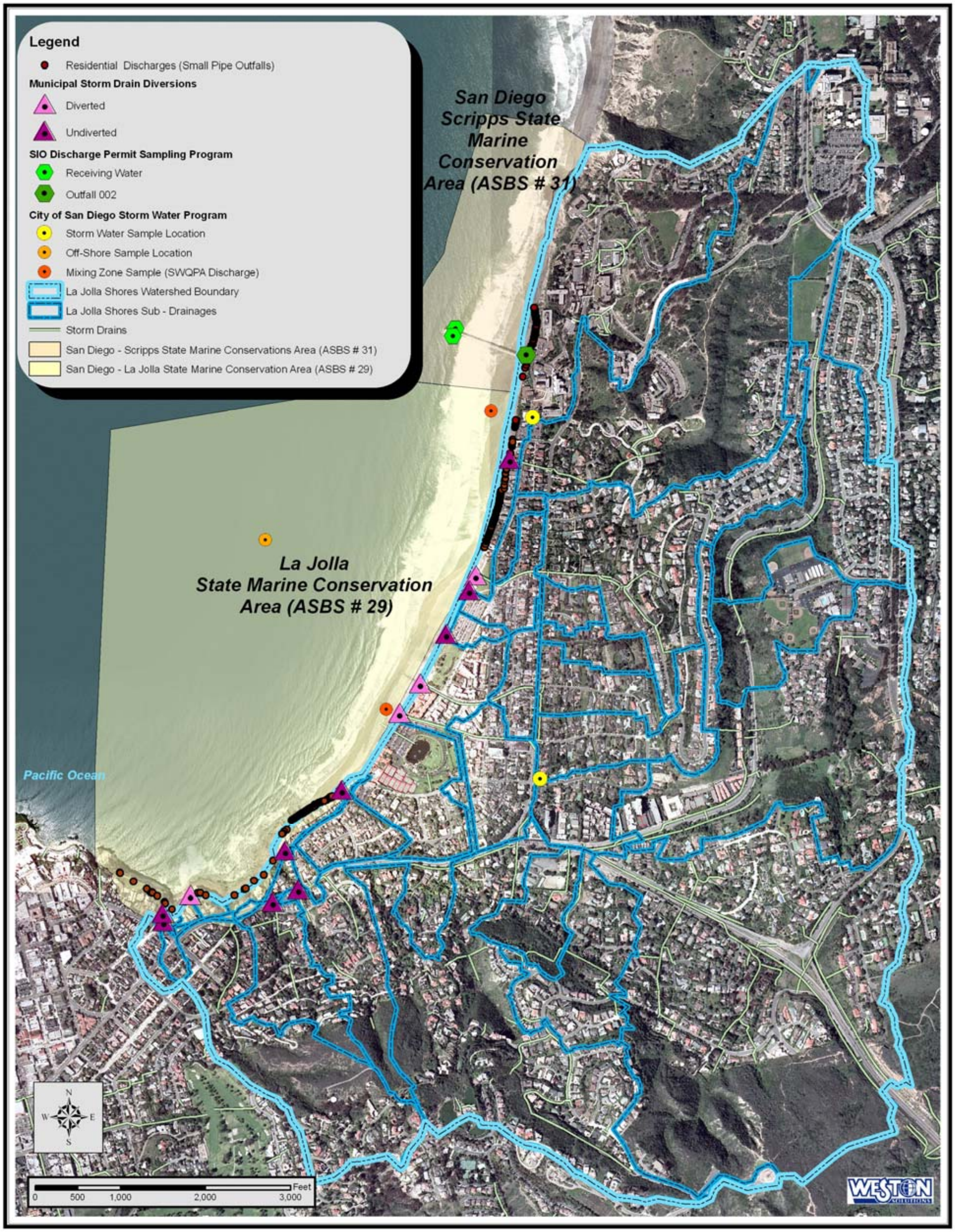


Figure 12. Dry Weather Diversions in La Jolla Shores Coastal Watershed

Figure 13. Example of Direct Discharge Point to the ASBS

4.1.6 Land Use

Within the La Jolla Shores Coastal Watershed drainage area, land is used primarily for residential housing and associated roads, followed by parks and open space, commercial and associated roads, and to a small degree parking facilities (Table 5). Approximately sixty-six percent of the land is dedicated to residential housing and associated roads; parks and open space comprise approximately twenty-five percent of the land; approximately eight percent of the land is used commercially by restaurants, retail stores, and adjacent streets; and areas used primarily for vehicle parking comprise approximately one percent of the land. Due to the built-out condition of the watershed, it is estimated that typically at any given time less than one percent of the land is undergoing construction activity. Each of the above land uses is listed numerically in Table 5 and depicted graphically in Figure 14.

Table 5. Land use within La Jolla Shores Coastal Watershed.

Category	Total Acres	% Total Area
Residential	1,074	66%
➢ Single Family Residence	986	60%
➢ Multi-Family Residence	89	6%
Parking Lot	18	1%
Open Space	413	25%
Commercial	132	8%
Grand Total	**1,638**	**100%**

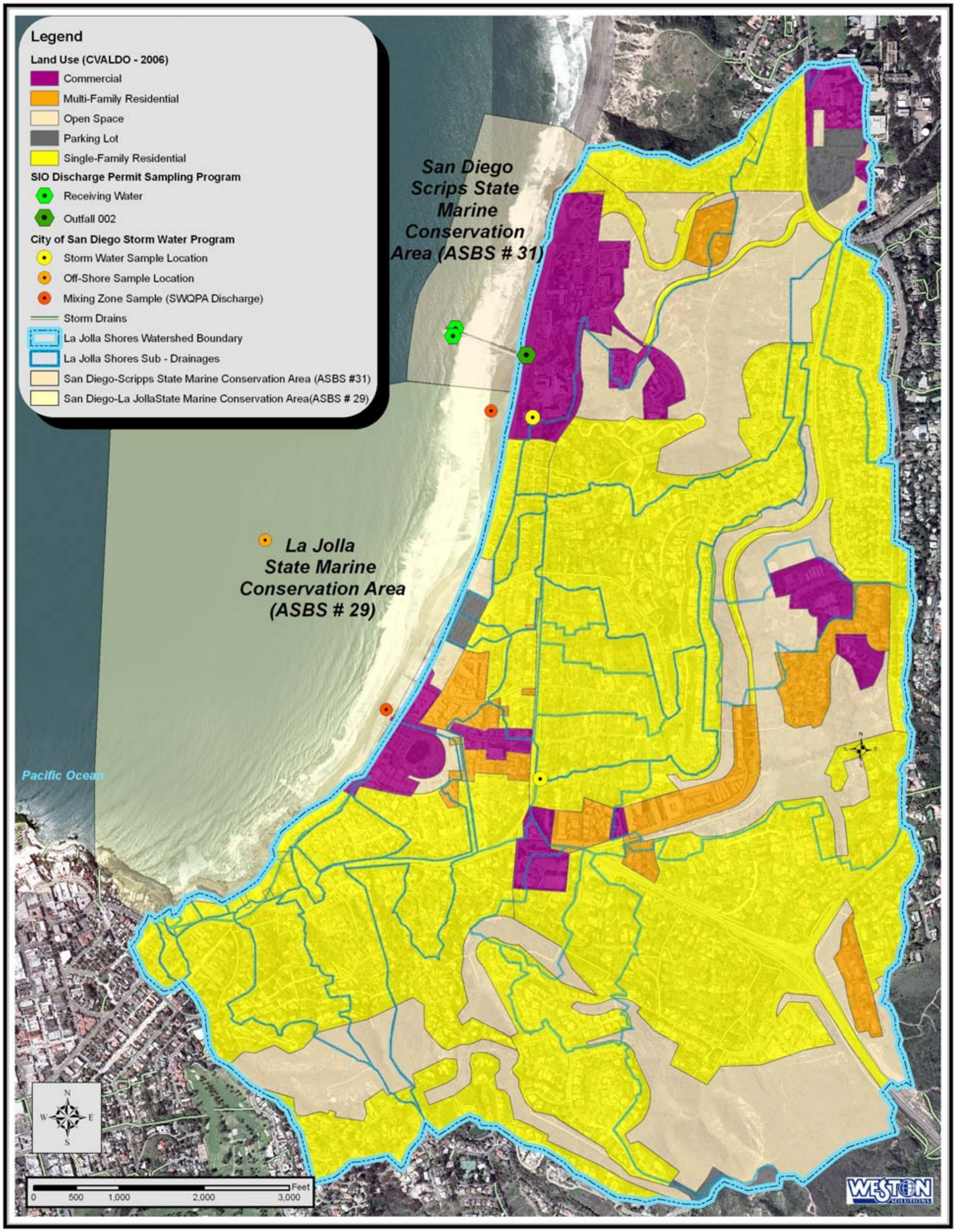


Figure 14. Land use within the La Jolla Shores Coastal Watershed.

4.1.7 Potential COC Sources

Each of the 32 sub-drainage areas is numbered and its boundaries outlined in Figure 15. Within this figure, potential sources for each of the COCs for the La Jolla Shores Coastal Watershed (copper, turbidity, bacteria, and synthetic pyrethroids) are also depicted. The most likely source of sediment is erosion of canyon and open space areas within the watershed. Areas of increased storm water flows and velocities have resulted from development around open space areas and lead to higher rates of erosion. Sediment loading to storm water may result from land disturbance activities at residences that include landscaping, construction activities, and exposed unvegetated soils. Other potential sources of turbidity within the La Jolla Shores Coastal Watershed include urban and residential land uses as well as transportation uses such as roads, highways, and parking facilities. Of these potential sources, construction activities would likely generate the largest sediment load and are regulated under the Standard Urban Stormwater Mitigation Plan (SUSMP). Road grit and finer particles not collected through street sweeping can also be a source of sediment loading in storm water. Each of these land uses is common throughout the watershed. The plant nursery in sub-drainage 18 and the golf course in sub-drainage areas 8 and 9 could also potentially be contributing suspended sediment to the ASBS during rain events. The introduction of invasive plant species and disturbances from public access can also lead to increased erosion and sediment loading.

Transportation within the watershed is a potential source of total and dissolved copper within both the northern and southern sub-drainage areas. Brake pad discharge, in particular, has been estimated to be responsible for 80 percent of copper in urban storm water runoff (Woodward-Clyde Consultants, 1994). Aerial deposition of copper has been shown to be a source of copper in other watershed in the San Diego region (Weston, 2006). The nursery in sub-drainage 18 may also potentially be a source for total and dissolved copper. The slightly higher levels of both total and dissolved copper detected in the samples from the southern drainage may be related to the higher traffic density in these sub-drainage areas. The fueling station located at the junction of sub-drainage areas 22, 32, and 34 may also be a potential source of metals.

Potential sources of indicator bacteria within the watershed's urban runoff include residential activities (dog waste, over-irrigation, waste management). Slightly higher levels of bacteria were detected in the northern sub-drainage, where a nursery is located, than in the southern sub-drainage. Other potential sources of fecal coliforms and enterococci include the cluster of restaurants around sub-drainage 34.

The potential sources for synthetic pyrethroids throughout the watershed include residences, nurseries, and golf courses.

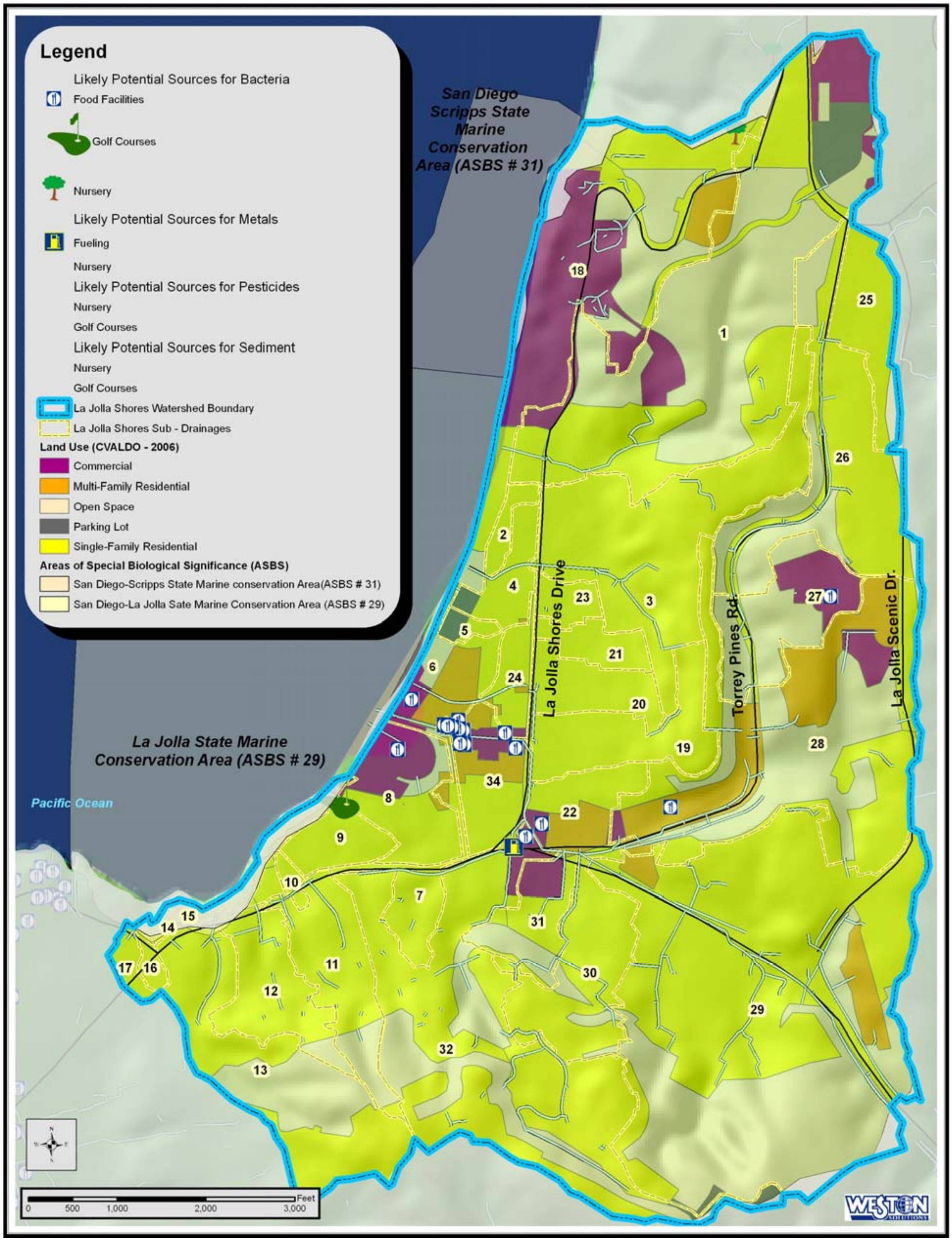


Figure 15. Potential Sources of COCs within La Jolla Shores Coastal Watershed.

4.1.8 Potential COC Impacts to the ASBS

Turbidity, total and dissolved copper, indicator bacteria, and synthetic pyrethroids have been identified as COCs based on the storm water quality study. These constituents will be further assessed using a holistic approach to determine potential impacts to the ASBS. This assessment will evaluate the results of the water quality, toxicity, bioaccumulation, dilution, tidal, and mass balance studies in determining the potential impacts. The relative impact of storm water compared to cross contamination from tidal currents, air deposition, and public use will also be evaluated. For the discussion presented below, the potential impact of specific constituents of issue will be addressed. Assessment of any single impact to the ASBS will be based upon its relative influence upon the overall health of the ecosystem.

Turbidity levels detected in each of the major sub-drainage areas may impact the ASBS by reducing light penetration necessary for phytoplankton and macroalgal growth. Sediment transport through the storm drain system occurred during each rain event, as evidenced by repeated burial of sampling equipment mounted in the storm drains at both the northern and southern sub-drainage sample locations.

Total and dissolved copper concentrations detected in urban runoff from each of the major sub-drainage areas within the watershed could potentially affect the ASBS through direct toxic impacts to fish and algae. Copper is both a micronutrient and toxin that is known to strongly adsorb to organic matter as well as to carbonates and clay. Although its adsorption to particulates significantly reduces its bioavailability, copper is considered toxic in aquatic environments and has the capacity to bioconcentrate in the organs of both fish and mollusks (Owen, 1981). The results of the bioaccumulation studies are discussed in Section 4.2.1. These studies will help to identify if copper is bio-available and accumulating in sand crabs and mussels. Copper also effectively acts as an algaecide when combined with sulfate, chloride or other compounds. Single-cell and filamentous algae and cyanobacteria are particularly susceptible to acute effects of copper, resulting in reductions in photosynthesis and growth, loss of photosynthetic pigments, disruption of potassium regulation, and mortality (USEPA, 2006). Further toxicity testing of storm water and mixing zone samples should be performed to assess if copper concentrations are resulting in toxic effects.

The presence of sufficient numbers of these bacteria may indicate an increased health risk to recreational users of the ASBS during wet weather events. Fecal indicator bacteria are used to identify waters that may be at risk for disease-causing pathogens. If relatively high numbers of fecal indicator bacteria are measured in an environment, an increased likelihood of pathogens being present is assumed. It should be mentioned that the Pacific Ocean shoreline in the Scripps Hydrologic Sub Unit is on the 2002 SWRCB 303(d) list for impaired water quality due to the presence of bacterial indicators. However, it has been deleted from the draft version of the 2006 303(d) list.

Synthetic pyrethroids have the ability to bioconcentrate within the food web; therefore, they will remain a COC for the La Jolla Shores ASBS into the foreseeable future. Pesticide runoff into the ASBS has the potential to affect algal growth as well as to compromise the health of vertebrate and invertebrate populations.

These potential impacts represent possible effects from the constituents of concern. The actual impact assessment, however, is based on considering the results of various studies in a holistic approach. Water quality is one of several potential impacts to the ASBS. The impact assessment for the La Jolla Shores ASBS is presented in the Watershed Management Plan following the presentation of the ecological assessment and the tidal and dilution studies. The results of these studies will then be assessed with the water quality, watershed characterization, and potential source evaluation presented above.

4.2 ASBS Ecosystem Assessment

The preliminary ecosystem assessment conducted during the planning phase of this project consisted primarily of studies of bioaccumulation and circulation in La Jolla Bay. Bioaccumulation is a useful indicator of pollution and provides a relative measure of biologically available pollutants in time and space. Bioaccumulation was studied in two species that feed on suspended particles, the California mussel, *Mytilus californianus*, and the sand crab, *Emerita analoga*. Suspension feeders are useful for bioaccumulation studies because they feed on all forms of suspended particulate organic matter and absorb dissolved organic matter. Mussels and sand crabs can therefore integrate contamination over time within their tissues. Circulation within La Jolla Bay was studied to determine likely fates of contaminants loaded within the ASBS and to give a first-order approximation of circulation patterns and transport rates within the Bay. Circulation was measured using four Acoustic Doppler Current Profilers (ADCP) at two shallow and two deep sites (Figure 16). These sensors were deployed for four months, including the period the bioaccumulation study was conducted.

Figure 16. ADCP Deployment Locations

The results of each study are summarized below and provided in detail in Appendix B Ecosystem Assessment Report.

4.2.1 Bioaccumulation Study

The bioaccumulation of metals, pesticides, PAHs, and PCBs by mussels was studied along approximately 7.5 miles (12 kilometers (km)) of coastline from La Jolla to Del Mar, extending well north and south of the two ASBS located within La Jolla Bay using caged mussels that were deployed for three months. Mussels were also outplanted near the mouth of San Diego Bay in Point Loma, outside of the study area, for comparison. The bioaccumulation of metals and PAHs by sand crabs was studied by sampling crabs at sandy beaches over nearly the same spatial scale. The mussel and sand crab sampling stations are depicted on Figure 17.

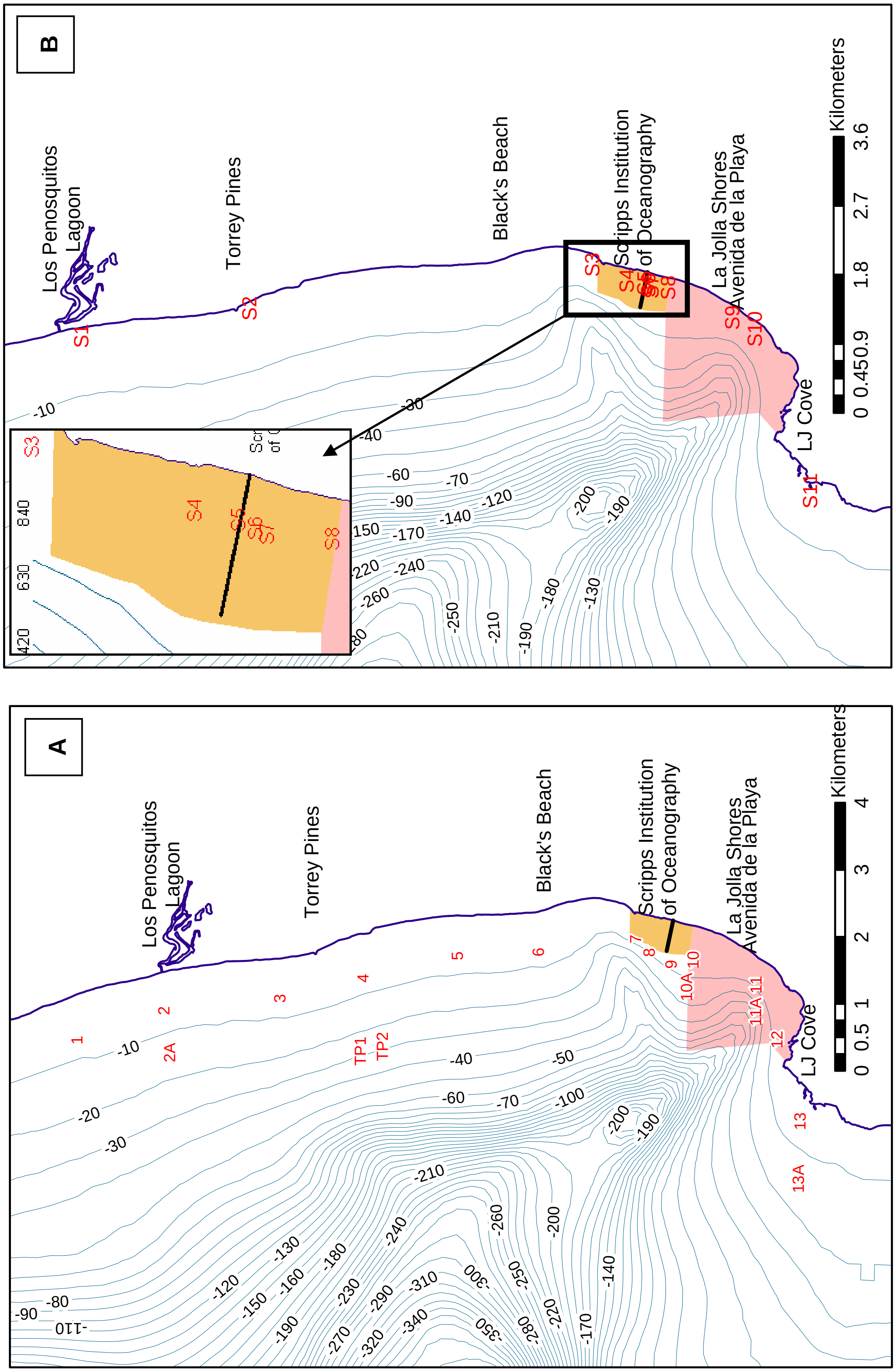


Figure 17. Mussel Outplanting (A) and San Crab Collection (B) Locations

4.2.1.1 Mussel Results

Mussel bioaccumulation results indicated no statistically significant contamination by chlorinated pesticides, organophosphorus pesticides, PAHs, or PCBs off La Jolla and Del Mar (the study area). Metal concentrations in the mussel tissue were higher at the following sites relative to other sites within the study:

1. Site 9, located immediately south of Scripps Pier within ASBS 31. The mussels from this site accumulated elevated concentrations of nickel, iron, manganese, and chromium.

2. The sample area between the Caves in southern La Jolla Bay (Site 12 located on the southern boundary of ASBS 29) extending out around Pt. La Jolla and down to the southern extent of the study off the Children's Pool (Site 13). Mussels located between the Caves and the Children's Pool had greater concentrations of arsenic, cadmium, lead, and zinc.

3. Site SIO2PL, located near the mouth of San Diego Bay in Point Loma, outside of the two ASBS. The mussels from this site accumulated elevated concentrations of aluminum, iron, lead, manganese, nickel, selenium, and zinc. In addition, mussels at this site also had high concentrations of the PAH, phenanthrene.

Mussels placed near the mouth of San Diego Bay in Point Loma and at study sites located between the Caves (southern boundary of ASBS 29) and Children's Pool (outside of ASBS) appeared stressed exhibiting lower lipid concentrations and growth. However, the mussels sited nearest the Scripps Pier exhibited no sign of stress despite having higher concentrations of chromium, nickel, iron, and manganese relative to other sites within the ASBS. Metal contamination near the Scripps Pier appeared to be highly localized. Mussels with elevated tissue concentrations of arsenic, cadmium, lead, and zinc exhibited decreased growth rates compared to the other mussels in the study, however it is not known if this is a cause and effect (Table 6). The mussels within the two ASBS did not exhibit signs of stress.

The data from this study were also compared to data from mussels sampled along the entire west coast of the United States under the Mussel Watch Program (see Figures 35-46 of Appendix B). Relative to other sites located along the entire west coast, chromium, nickel, and arsenic appear to be the metals of most concern in the present study.

Table 6. Constituents of Interest Based on Mussel Results

Station ID	Location	Constituents that are higher compared to other sites in the study	Constituents that are higher compared to West Coast Mussel Watch Program data	Decreased Growth Rates observed at this Site?
Site 12	Southern Boundary of ASBS 29	Arsenic, Cadmium, Lead, and Zinc	Arsenic	YES
Site 13	Outside of both ASBS, to the south	Arsenic, Cadmium, Lead, and Zinc	Arsenic	YES
Site 9	ASBS 31, south of Scripps Pier	Chromium, Nickel, Iron, and Manganese	Chromium and Nickel	NO
SIO2PL	Source mussels from Scripps Pier Outplanted in Point Loma	Aluminum, Iron, Lead, Manganese, Selenium, Nickel, Zinc, and Phenanthrene (PAH)	Nickel	YES

4.2.1.2 Sand Crab Results

Bioaccumulation results for sand crabs included:

1. 14 of the 15 metals analyzed for were observed at concentrations greater than the analytical method reporting limits; and

2. PAHs were not detected above the laboratory method reporting limits in any of the samples collected within the two ASBS. Of the 46 PAHs that were analyzed for, only one sample at the site located several km north of both ASBS had a concentration of a single PAH greater than its reporting limit (2,6 Dimethylnapthalene).

The sand crab metal bioaccumulation results were difficult to interpret due to the strong dependence of some metals on size and gravid condition (egg-bearing or not). It was not possible to sample sand crabs of similar sizes and gravid compositions at the sites because sand crab populations were patchy and composed of different sized animals. Significant negative relationships between metal concentrations and size/gravid condition were observed for antimony, arsenic, and lead. In other words, sites with sand crabs that had higher concentrations of antimony, arsenic, and lead compared to the other sampling stations in the study had fewer gravid females and smaller sand crabs then the other sampling stations. Sites with higher concentrations of aluminum, beryllium, nickel, and zinc compared to the other sampling stations in the study, on the other hand, had larger sand crabs and a higher abundance of gravid females compared to the other sites (positive relationship).

There were no distinct spatial patterns of metal concentrations after accounting for size/gravid dependencies. However, the station located immediately south of Scripps Pier had elevated concentrations of nickel, cadmium, and chromium. This site was located immediately onshore of the mussel site where mussels also had elevated concentrations of nickel and chromium in addition to other metals. There was an abundance of large and gravid female sand crabs at this site compared to other sites.

Comparisons with a previous sand crab study conducted over a spatial scale of approximately 400km in central California showed that metal concentrations in sand crabs from this study were distinct from sand crabs further north. Crabs in this study were characterized by higher concentrations of arsenic, zinc, and selenium, while crabs in the central California study were characterized by higher concentrations of cadmium, manganese, copper, and aluminum. The variability of sand crab metal compositions among sites within the smaller scale of this study (~7 miles or 12km) was equivalent to that for the larger scale study in central California.

Sand crabs are not recommended for future studies in the La Jolla Bay because of the dependence of metal concentrations on the size and gravid condition of the crabs which could not be controlled and varied at each sampling station.

4.2.2 Circulation Study

Four Acoustic Doppler Current Meters (ADCPs) were deployed in La Jolla Bay for approximately 17 weeks from April to July 2006 to help determine circulation patterns within the bay. The circulation observed during this limited time period was characterized by (a) moderately high velocity flow at all sites, (b) weak tidal currents relative to the mean flow, (c) frequent vertically sheared flow (different flow directions between surface and mid-bottom currents), (d) a shallow wind-driven surface layer, (e) a large degree of temporal variability in direction, and (f) fairly strong coherence between sites. The complex topography of the region is likely to be a factor in the variability of the circulation.

Tidal current magnitudes were small relative to the magnitude of subtidal (periods longer than a tidal cycle) currents. Generally, tidal currents reverse in direction over a tidal cycle such that major tidal components effectively move contaminants back and forth along the shoreline, while subtidal currents represent a larger scale mean flow and provide an indication of contaminant removal from the system. In La Jolla Bay, subtidal current magnitudes were five to ten times greater than tidal currents.

Surface and subsurface flows were markedly different at all locations. The surface layer in which currents were significantly correlated with winds comprised only the top 2-5 meters of the water column. At mid-depths and lower, subtidal currents were coherent between sites, but highly uncorrelated with wind. Lower water column current directions were often in opposition to surface currents. Tidal currents also showed a large degree of variability with depth, with direction rotating as much as 180 degrees between the surface and mid-depths. It is not known what physical processes are responsible for the vertical variability in current direction. However, the topography of La Jolla Bay is complex, with curvature of the coastline, a headland, and two large submarine canyons, and is likely to play a strong role in the current variability.

Analysis of the ADCP data time series indicated a predominant circulation pattern in the alongshore direction within the region. This pattern (referred to as Mode 1 in this report) accounts for 84% of the variability at the surface, but decreases with depth to 54% at the bottom. It is also notable that the reversal in current direction at depth appears in the Mode 1 pattern. Other patterns (referred to as Modes 2-4 in this report) account for 10-21% of the current variability at the bottom. The increasing variability in pattern deeper in the water column suggests that topographic effects unique to this area may significantly influence transport pathways within the La Jolla bay.

Transport times were estimated for storm events that occurred during the study. During the largest storm (April 5, 2006) advective transport through the ASBS would have taken approximately 1-2 hours at the surface, and up to 8 hours near the bottom. However, as frequently seen in the ADCP time series, during this period the direction of transport at the surface was opposite that near the bottom (in this case, surface velocity was northward, bottom velocity southward).

Based on the data from the circulation study, pollutants on the surface of the water in the La Jolla Bay would generally be transported northward in the alongshore direction within the region. Pollutants near the bottom, on the other hand, are frequently transported in the opposite direction (southward). There is a great deal of variability in the current patterns throughout the water column, most likely as a result of the varying topography in the La Jolla Bay (e.g., two submarine canyons, coastline curvature, and a headland).

4.2.3 Dilution and Dispersion Study

The dilution and dispersion of effluent from the five permitted outfalls at Scripps Institution of Oceanography (SIO) into Area of Special Biological Significance (ASBS) 31 was studied using the ***SEDXPORT*** hydrodynamic modeling system. This modeling system numerically simulated dry weather (non-storm water discharges) and wet weather (storm water discharges) case scenarios. This process-based model was developed at SIO for the US Navy's *Coastal Water Clarity System* and *Littoral Remote Sensing Simulator* and has a proven ability to predict dispersion patterns and dilution ratios. This model has been peer reviewed multiple times, calibrated, and validated in the Southern California Bight for four previous water quality and design projects. In addition, ***SEDXPORT*** was approved by the EPA in December 2004 for use in this study.

Based on discussions with State Water Resources Control Board staff, the dilution factor analysis was evaluated for two distinct extreme case scenarios: 1) peak seawater effluent discharges during dry weather with low mixing rates in the receiving waters due to quiescent ocean/atmosphere conditions; and 2) storm water runoff co-mingled with peak seawater effluent discharges during high energy conditions typical of a winter storm event.

To calculate the dilution and dispersion of the discharges from the five beach outfalls, the ***SEDXPORT*** model system uses a numerical tidal model to simulate tidal currents in the nearshore and shelf region offshore of Scripps Beach as well as a wave transport model to compute wave-driven currents from the shoaling wave field as detailed in the report. In addition, uninterrupted, long-term monitoring of ocean properties conducted at the Scripps Pier was used to develop the data bases for initializing the boundary conditions and forcing functions used in the model. Statistical searches of these data bases were performed to extract the dry and wet weather extreme case scenarios.

Based on a review of the monitoring data from the five outfalls for California Ocean Plan constituents from December 2004 through March 2005 (four monitoring events), detected concentrations of total suspended solids (TSS) and copper were used in the dispersion modeling.

The dilution and dispersion study generated 7,523 separate simulations of dilution fields, including the storm water and non-storm water case scenarios. Based on this data, the study concluded the following:

Dilution and Dispersion Seaward of the Surf Zone:

- Minimum dilution rates during calm dry weather conditions (non-storm water discharges) range from 100:1 to 1,000,000:1 in ASBS 31 everywhere seaward of the surf zone.
- Minimum dilution rates during storm events (storm water discharges) range from 100:1 to 10,000:1 in ASBS 31 everywhere seaward of the surf zone.

Dilution and Dispersion inside the surf zone:

- Minimum dilution inside the surf zone averages 31:1 (median value) when maximum seawater discharge rates are perpetuated over the long term. The minimum dilution rates range as high as 96:1 and as low as 7:1 (occurring only 0.13% of the time). Minimum dilutions greater than 20:1 occur 89% of the time.

4.3 Information Management

In recent years there has been an awakening to the need for integrated information management systems to provide efficiency in assessing and managing regulatory programs. The statewide network of ASBS is one example in which a robust and persistent data system is required. A large amount and wide variety of data have been, and will be, collected in the watershed and ASBS through both regulatory permitting requirements and ancillary data collection efforts required to assess ASBS performance. Currently, these datasets are relatively isolated and unavailable to a wide range of users. Information management systems are needed for integration and public data dissemination so that interrelated biological-physical-chemical processes present in the watershed and marine environment can be assessed. These data requirements span both regulatory and non-regulatory based data collection efforts.

The information management system developed for this Plan, and described below, was designed to meet the following project needs:

- Data collection and storage
- Analysis and evaluation by the professional, policy making and regulatory community to assess the performance of the ASBS
- Data availability to the general scientific community
- Dissemination to the public for outreach and stewardship

A distinction is made between *information management* and *data management*. Data management consists primarily of the "back-end" system (or network of systems) for data collection, ingestion, storage, archival, and retrieval. A robust data management system should consist of a tested and reliable method of acquiring data, a scalable and accessible method of storing and retrieving data, and a secure and replicated method of archiving data. Information management is the process by which the data becomes useful to decision makers. It includes the mechanisms for utilizing the data, optimized methods for disseminating the data, and the generation and presentation of useful products that can be used for research and decision making. Information management facilitates the transition from content (data) to knowledge.

4.3.1 Data System Development and Management

The goal of the ASBS information management system is to establish the infrastructure needs and generate a conceptual design required for long term assessment of ASBS performance and related management decisions. The infrastructure needs to meet both the needs of the regulatory data collection as well as incorporate monitoring activities, scientific studies, and observations that are required for enhanced ecosystem assessment and ASBS management, yet may be outside of the present regulatory framework. Upon analysis of needs for compatibility with both the Surface Water Ambient Monitoring Program (SWAMP) and the California Integrated Water Quality System (CIWQS) as well as room for expansion for other state mandated observations, the data management team recommends adoption and extension of the SWAMP (Surface Water Ambient Monitoring Program) backend for regulatory ASBS data, establishment of correlated ecosystem management data, and inclusion of environmental data necessary for ecosystem assessment. Although SWAMP in its current form does not fulfill the entire suite of regulations, the system can behave as a building block for a comprehensive and transferable relational data management system for regulatory data. The SWAMP data management system was chosen over other data management systems because it is more comprehensive, including lookup tables for laboratory contacts, station ID, units, analytes, methods, etc.

Due to the complexity of the SIO permit requirements, the limited scope of CIWQS, and the growing use of SWAMP throughout the state, data managers determined integration of the SWAMP structured system would be a preferred method for data storage, retrieval, and display. Recommendations for future data system development and management include adoption and implementation of the SWAMP structure with alterations, definition of undefined attributes necessary for a realizable ecosystem assessment, and aggregation of biological and physical observations. Ecosystem data will also need to be saved in a format which allows for correlating physical and biological processes with sampled results such as bacteriological and chemical data. Relationship attributes necessary for retrieval and analysis include latitude, longitude, time, and elevation. Sampled data without these fields make it extremely difficult to not only analyze processes and ASBS impact, but also display data in a visual and digestible format.

Currently SWAMP consists of a set of templates for data entry created and saved in MS excel and a relational database created and saved in MS Access for which those templates are ingested, stored, and queried. The system includes lookup tables for most parameters and standardized templates for chemical and toxicity results. Full utilization of a data management system includes data collection, automated data transfer and ingestion, data archiving and backup, public display of data and historical data download. These recommendations have been implemented at a local level at Scripps Institution of Oceanography. The primary example consists of regulatory water quality data that has been fully integrated in the SWAMP data system and queried for public display. Full implementation details and methods will be discussed in the white paper – Framework Recommendations for a Statewide ASBS Information Management System.

4.3.2 Public Display of Data

Southern California Ocean Observing System (SCCOOS) has developed a number of innovative data interfaces and products, leveraging Google maps to provide localized, zoomable, and navigable interactive display of data. Data sets consist of historical and recent meteorological data from shore stations along the Southern California bight dating from 1916 to the present day; water quality cast data from the Bight Water Quality program from 1998-2005; shoreline water quality data from the county of San Diego Department of Environmental Health; MODIS, OCM, and GOES satellite imagery; surface current data; and surface wind data provided by NRL.

SCCOOS is in communication with water quality sampling Environmental Health Agencies to provide automated reports to the public on a regular interval. These measurements are accessible from the SCCOOS data page in a user friendly format utilizing Google maps for station location. The values are shown in a tabular display of recent data, graphical time series plot of historical data, and downloadable ascii format for individual user analysis. Providing data visually online is a powerful tool, enabling academics, decision makers, and the public easy access to public data. Users are able to download data values. With manageable data sets, ascii download is often times the preferred method. It's easily understood and ingestible into an alternate analysis software package. Most spatial or Geographic Information System (GIS) data is less suited for such transfer methods and requires alternate packaging for data download. These types of data are far too voluminous for tab or common delimited files. The SIO data management team plans to display regulatory bacteria, toxicity, and chemical analysis data in a similar format to the tiled Google display. Data will be made publicly available through the Coastal Observing Research and Development Center (CORDC) website. Figure 18 displays regulatory data sampled at an ASBS location utilizing Google maps to show location in geographical context. Station ID, location, and date last sampled are shown in tabular format, with measurement values listed below. The history link opens a new window showing graphical time series and downloadable data. The complete data set can be found: http://cordc.ucsd.edu/projects/asbs/waterquality.php .

Visualization tools for ecosystem assessment must be developed further in order to comprehensively analyze the ASBS in context with surrounding areas. The data management community is struggling with those visualization tools. Often times, a GIS tool is used for layering environmental data. Unfortunately, those tools prove to be sluggish and burdensome due to the shear volume of data trying to be displayed. Most servers either take a significant amount of time to display the data or cause an error upon retrieval of multiple layers. They also can not display time series of events such as a developing current field or bacteria results over the latest wet period. Standalone software programs such as Google Earth and Fleudermaus provide an excellent visualization tool, but require local access to data sets. Serving capabilities have not yet been fully developed. Solutions to this problem include automated processing of established data products, faster indexing methods for data retrieval, multiple processors within data servers, and increasing internet bandwidth. Development and technological advancement of these improvements require planning, engineering, and resources. The data management team has implemented improved data dissemination utilities through the use of recent web based technologies and mapping capabilities. Future data products can be integrated and designed based on user needs assessment and utility.

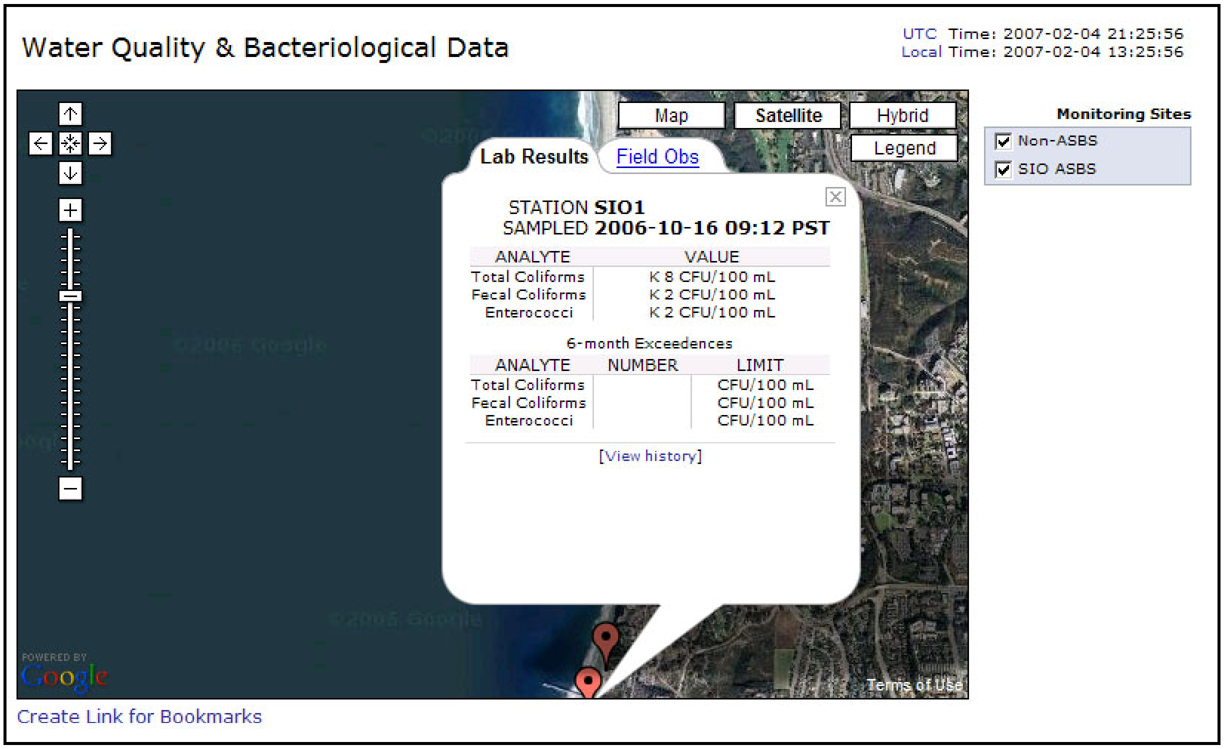
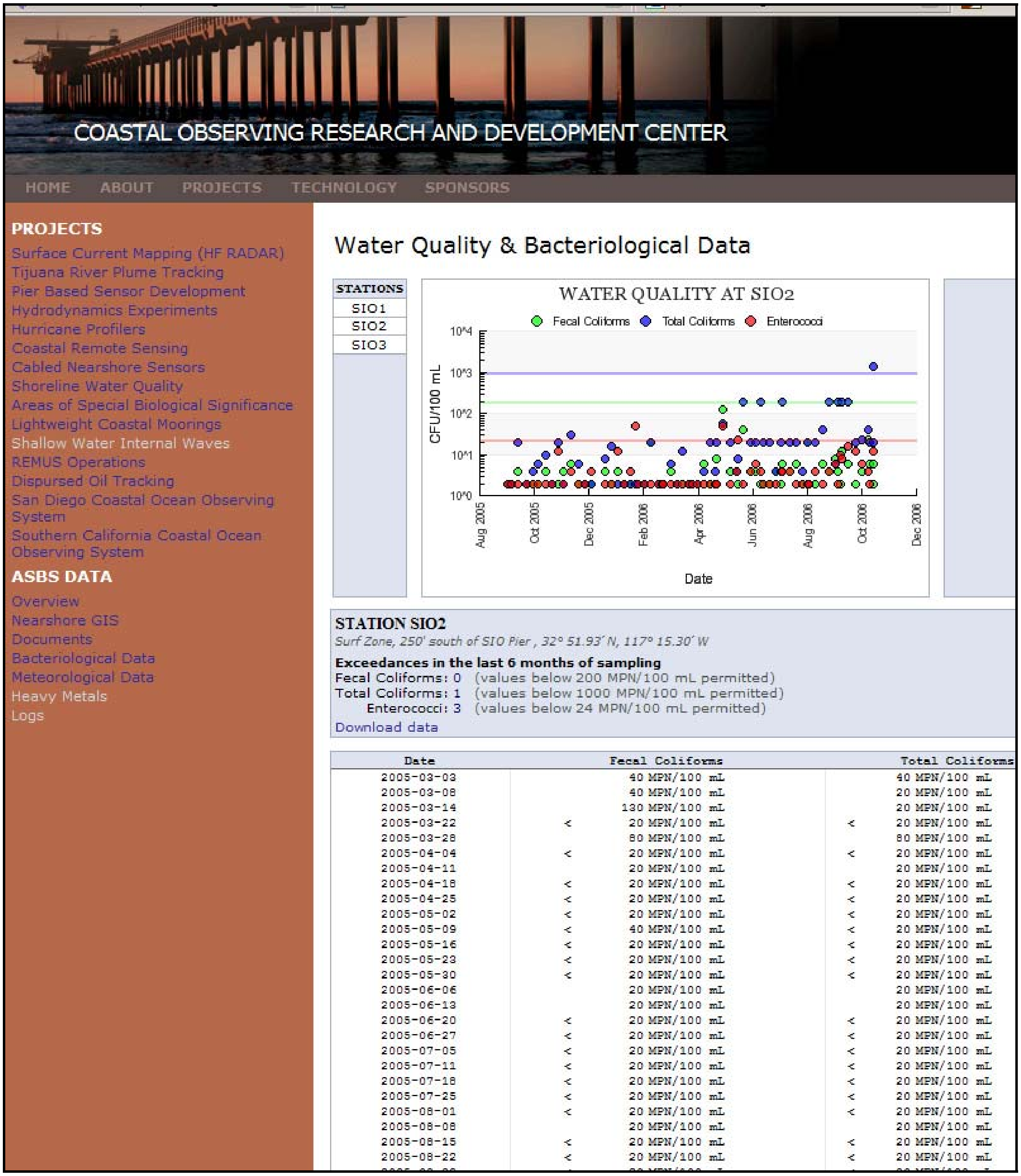


Figure 18. Water quality data visual display from La Jolla Cove sampling station.



Date		Fecal Coliforms		Total Coliforms
2005-03-03		40 MPN/100 mL		40 MPN/100 mL
2005-03-08		40 MPN/100 mL		20 MPN/100 mL
2005-03-14		130 MPN/100 mL		20 MPN/100 mL
2005-03-22	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-03-28		80 MPN/100 mL		80 MPN/100 mL
2005-04-04	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-04-11		20 MPN/100 mL		20 MPN/100 mL
2005-04-18	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-04-25	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-05-02	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-05-09	<	40 MPN/100 mL	<	20 MPN/100 mL
2005-05-16	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-05-23	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-05-30	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-06-06		20 MPN/100 mL		20 MPN/100 mL
2005-06-13		20 MPN/100 mL		20 MPN/100 mL
2005-06-20	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-06-27	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-07-05	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-07-11	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-07-18	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-07-25	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-08-01	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-08-08		20 MPN/100 mL		20 MPN/100 mL
2005-08-15	<	20 MPN/100 mL	<	20 MPN/100 mL
2005-08-22	<	20 MPN/100 mL	<	20 MPN/100 mL

Figure 19. Time series data display and ascii downloadable water quality data.

4.3.3 GIS Display of Spatial Data

The monitoring activities of an ASBS can be classified into two broad groups: a) those variables which are sampled on a spatial grid to assess the current state of the system and b) those variables which are rapidly sampled to assess trends. Classification is often predicated on fiscal or technical constraints, which prevent rapidly sampling all variables at all places and times. Spatial assessments which are labor intensive (e.g., habitat mapping) are well suited for examination using a multi-layer GIS. The data management team has incorporated ASBS drainage areas and watershed basin characteristics collected by SIO and the City of San Diego into an existing system developed through a program initiated under the California State Coastal Conservancy and the San Diego Association of Governments (SANDAG). The Inventory and Evaluation of Habitats and Other Environmental Resources in the San Diego Region's Nearshore Coastal Zone (Nearshore Program) hoped to serve as a tool for marine resource conservation and management. The program culminated in the development of a GIS based mapping system with designated areas of marine resources. Layering watershed characteristics with this dataset is an example of spatial display of geographic data for visualization and dissemination. As previously mentioned, most mapping servers, unfortunately, are currently limited by data volume and bandwidth, and although provide an integral part in data display cannot fulfill all analysis and information management needs. The San Diego regional ASBS GIS display can be found at http://nearshore.ucsd.edu.

4.3.4 Statewide Framework for ASBS Information Management

The data management team recommends implementation of a relational data base management system (RDBMS)-based data system modeled after the Microsoft Access-based SWAMP system developed by Moss Landing Laboratories for regulatory data needs. Data management aims are twofold; to archive and display data for our permit requirements and to make data available to users. Although Microsoft Access is a readily available and somewhat user friendly database, the SIO data management team does not recommend adapting the exact system. Microsoft Access has database limitations that are not conducive for storing large time series data (e.g., record number limits). Figure 20 is a screenshot of the Microsoft Access backend data system depicting the multiple lookup tables for analytes, units, station codes, lab contacts, etc. The relational system is a comprehensive data system for regulatory data. Web display and data queries will also be limited to running a windows server. The data management team recommends development of a utility based on the existing architecture, but structured within a more robust database environment. SIO ported

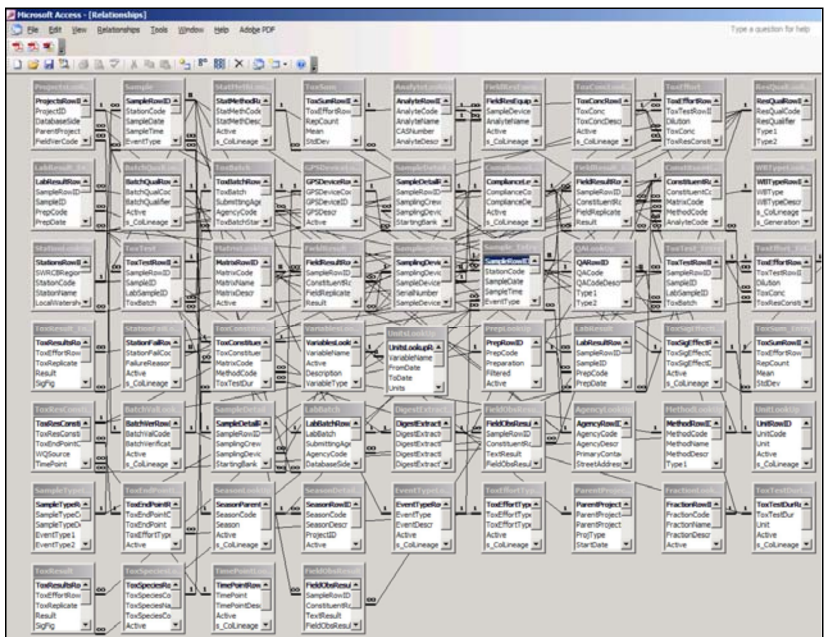


Figure 20. Relational view of the SWAMP database.

the access database into LINUX- based MySQL for scalability and consistency with existing data display mechanisms.

Due to the complexity of this backend relational database, data is entered in the SWAMP excel template. These templates contain fields from multiple tables, but format them in a way so all data entry is aggregated on one spreadsheet called the results table. A secondary results table has been adopted for ASBS required observational fields that were not present within the current SWAMP system. This template is then automatically parsed into the backend database. Because the templated fields do not directly translate into the backend system and are an aggregated collection, those fields have been coded to insert into the correct tables. In order to maintain system integrity and dependability this database has been saved on a mirrored system and is periodically backed up to an offsite facility. This method prevents data loss from system errors and hardware failure. A sound information management system will always include backup and data loss prevention utilities. As discussed in the previous section, algorithms and queries have been developed to display and disseminate the data after the data has been ingested and stored in the relational database. Figure 21 below shows the primary path of laboratory analyzed bacteriological data currently integrated into the enhanced SWAMP data management system.

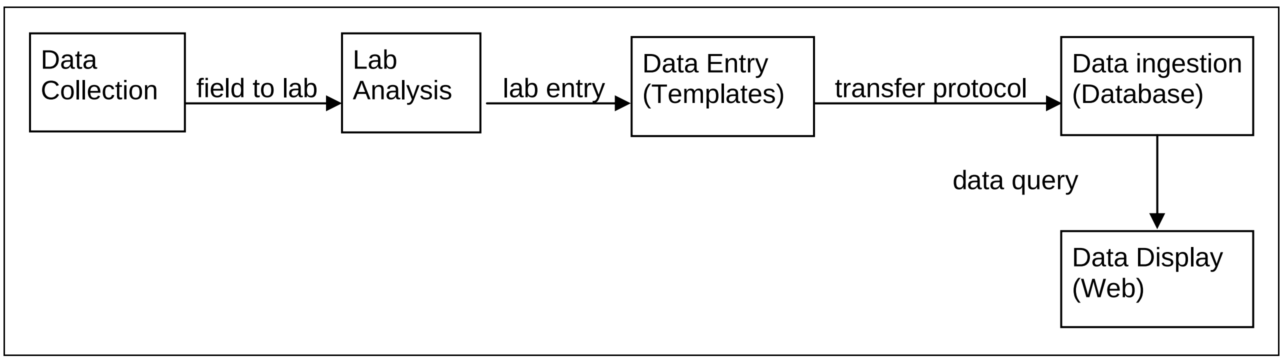


Figure 21. Flow chart showing the primary path of laboratory analyzed bacteriological data currently integrated into the enhanced SWAMP data management system

Management and assessment of the ASBS extends far beyond collection, ingestion, and display of regulatory data. Designated ASBS along the coast of California exist in a complex coastal regime subject to ever-changing land-sea-atmospheric interactions. As a result, when evaluating the performance and behavior of an ASBS, it will be important to understand the physical environment both within and surrounding its environs. This regional description of the time-varying coastal environmental processes relevant to the ASBS will be critical to understanding ecosystem changes within the ASBS. A critical assessment question coastal zone managers face will be in attributing changes in the monitoring data to the management decisions made within the ASBS, assessing whether the observed changes are a result of climate/natural variability, or if external, anthropogenic influences are impacting the ASBS. Integration of physical and biological data is necessary for full ecosystem analysis. These data must be correlated over space and time and packaged for display and dissemination.

Future efforts for regulatory data management should involve expertise found at Moss Landing Marine Laboratory who is currently expanding the SWAMP data system. The system should consist of a relational database within a UNIX/LINUX operating system environment (e.g. MySQL, Postgres, Oracle). For security purposes data management best practices should be stored on a system with backup capabilities. Ideal programming would include a redundant array of independent disks (RAID) and offsite backup utility. Finally, reasonable products and public display is an essential component of the information management system.

4.4 Public Participation

The Public Participation component for La Jolla Shores Coastal Watershed Management Plan was conducted throughout the planning process. Coastkeeper and The City of San Diego worked collaboratively to engage and empower the public and key decision-makers to provide meaningful input in the establishment of the Plan. Community input and feedback will lay the foundation for the second phase of the Public Participation component, which will involve utilizing a Community Based Marketing Strategy (CBSM) to further engage the public.

The specific activities that were undertaken for the planning phase of the task are discussed below.

4.4.1 Stakeholders

Coastkeeper conducted outreach to a variety of stakeholders throughout the planning phase, including environmental organizations, local politicians, students, businesses, and local residents. Other interested individuals who participated in the planning process included divers, academics and the local press. Following is a list of the various stakeholders that were involved in the process:

- SIO Faculty
- SIO students
- La Jolla residents
- Surfrider Foundation
- Natural Resource Defense Council (NRDC)
- The Ocean Conservancy
- Department of Fish and Game
- State Water Resources Control Board
- San Diego Regional Water Quality Control Board
- La Jolla Town Council
- La Jolla Shores Association
- La Jolla Chamber of Commerce
- REI
- Local dive shops

In addition, Coastkeeper worked with The Friends of Kellogg Park to develop ASBS content for a permanent Lithocrete (crushed glass in concrete) Map which will serve as an educational tool for the 2-3 million visitors that use La Jolla Shores for recreational purposes each year. The focus of the Map content will be on the ecological, cultural and conservation aspects of the area. The most important objective of the Map is to raise awareness of the ASBS, therefore encouraging the public to be stewards of the Area.

Coastkeeper estimates that approximately 10,000 people were contacted regarding La Jolla Shores Coastal Watershed Management Plan in 2006.

4.4.2 Speakers Bureaus

The project partners began a public education campaign aimed at highlighting the Plan to educate the public. The audience included elected officials and key decision-makers, particularly those in the La Jolla area. The Speakers Bureaus focused on presenting the Watershed Plan to local universities (UCSD and SIO) and community groups such as the La Jolla Town Council and the La Jolla Shores Association. Presentations were also given to business interests such as the La Jolla Chamber of Commerce, REI, local dive shops and small businesses in the La Jolla Shores area.

The Speakers Bureau Presentations served as educational seminars that stimulated community interest and involvement in the initial planning phase of the project. The presentations involved an overview of ASBS requirements, a historical look at the La Jolla Shores area (including pollution trends), a discussion of watersheds and their role in carrying runoff to receiving waters, and an overview of the goals and objectives of the La Jolla Shores Coastal Watershed Management Plan.

4.4.3 Information Dissemination

4.4.3.1 Coastkeeper Watermarks Newsletter

While Public Participation was aimed at engaging public input on the *development* of the La Jolla Shores Coastal Watershed Management Plan, outreach activities were also intended to foster a sense of community ‘ownership’ of the Plan and to provide the foundation for the Implementation Plan once adopted.

Coastkeeper reached the community through the quarterly *Watermarks* newsletter sent to over 5,000 supporters. Each newsletter published in 2006 featured a ½ page article about a particular aspect of the Plan. Below is an outline of each ASBS feature:

- ***Winter 2006*****:** Introduced the public to the concept of ASBS, the location of the La Jolla ASBS and how Coastkeeper and project partners were working to protect the areas.
- ***Spring 2006*****:** Briefly introduced the Plan to the public and announced the July workshop.
- ***Summer 2006*****:** Focused on the Map project, how it highlighted the educational aspects of the ASBS and how Coastkeeper was in charge of the educational content piece.
- ***Fall 2006*****:** Wrap up of the Plan, 2006 accomplishments, and mention plans for the future to protect the ASBS.

4.4.3.2 Coastkeeper Email Alerts

Coastkeeper sent six emails to the email distribution list (Approx. 5,000 members) informing the public about ASBS, notifying the public about upcoming workshops and highlighting pollution prevention practices.

4.4.3.3 ASBS Informational Brochures and Fact Sheets

Coastkeeper produced 5,000 full color tri-fold brochures about the La Jolla ASBS that included general information on the issues impacting the ASBS, MPA information and pollution prevention practices for local businesses and residents (Figure 22). This brochure has been well received by all stakeholders. Approximately 2,000 brochures were distributed in 2006 to the community.

Figure 22. ASBS Awareness Brochure Produced By Coastkeeper

The City of San Diego produced over 500 2-sided, full color ASBS Fact Sheets as a follow up to the brochure and to supplement the Speaker's Bureaus and Workshops. The Fact Sheets are presented in Appendix C ASBS Facts Sheets were distributed in the community and focused on the La Jolla Watershed as it relates to the ASBS. The Fact Sheets highlight the City's involvement in the Plan regarding the recommendation of both structural and non-structural Best Management Practices (BMPs) tailored to the La Jolla Shores area that will help reduce pollution and waste that is discharged into the ASBS.

4.4.3.4 Public Relations and Press

The City, SIO, Coastkeeper and the Project Manager contributed to several articles published in local papers, including the Union Tribune (front page article), and two articles in the La Jolla Village News (May 19th and October 9th, 2006) that focused on the collaborative approach towards the clean-up efforts for the La Jolla ASBS. The article further mentioned solutions currently being implemented by Scripps Institution, along with several being recommended by the City and various engineering consultants involved in the Project.

4.4.3.5 Project Presentations

The project partners presented overviews of the Plan at several trade conferences and committee meetings, including:

- California World Ocean '06 Conference, Sacramento, California, September 2006
- California Association of Stormwater Quality Managers (CASQA) Annual Conference, October 2006 – Sacramento California
- Statewide Integrated Coastal Watershed Management (ICWM) Planning Grant Workshop, March 2007 – SIO, La Jolla California
- SWRCB Natural Water Quality Committee, May 2007 – SIO, La Jolla, California

4.4.4 Public Workshops

Three public workshops were conducted aimed at involving key stakeholders in the process of developing and ultimately implementing the Plan. The first workshop was hosted by SIO on February 28th, 2006. The theme of the workshop was "Protecting California's Ocean – Our Role in Developing a Model to Address Urban Run-off and Aquaria Discharges". Over 50 people attended this workshop. The primary purpose was to train University staff, inform stakeholders of Scripps efforts towards meeting their California Ocean Plan exception conditions and introduce the ICWM Planning Grant process. The project team hosted the first ASBS Public Workshop on July 20th, 2006 at Scripps' Sumner Hall. Approximately 40 people attended, representing environmental organizations, local politicians, local residents and interested individuals, academics and the press.

The second workshop was held on November 15th, 2006. Once again, stakeholders were invited to attend in order to view and provide feedback on a draft outline of the Plan so project partners could incorporate public input. This workshop focused on Best Management Practices (BMPs) and how upcoming projects may utilize resources and impact local residents. Stakeholder feedback was then taken into account by the BMP team and evaluated. Approximately ten members of the public attended this workshop.

Both of the workshops were publicly noticed, and the project partners made every effort to involve stakeholders early in the process of Plan development to ensure their 'buy-in', which was essential to move into the Implementation stage of the project.

A third workshop will be held August 22, 2007 at the Scripps Institution of Oceanography, at which the public and stakeholders are invited for the purpose of reviewing the completed Draft Plan and providing commentary and feedback for incorporation into the finalized document.

The August 22nd Public Workshop for Public Comment on the Draft Plan will be advertising on the respective websites of all the Plan partners, as well as in the local community newspapers, such as the La Jolla Light and the La Jolla Village News.

4.4.5 Potential Obstacles

There were no notable obstacles to Public Participation during the planning phase of this grant. However, the primary challenge was the ability to reach as many members of the community as possible. Although email distribution lists, flyer postings and newspaper announcements may be distributed to thousands of citizens; there is no efficient tracking system or guarantee of the receipt of such announcements. Attendance at the workshops was lower than anticipated, so future outreach efforts will include attending scheduled community meetings and workshops. This will enable us to reach a wide range of people, while ensuring a high attendance. Coastkeeper and the City will continue to broaden the constituent base and to engage La Jolla residents and the general public alike.

4.4.6 Environmental Justice

The EPA defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental Justice will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work.

Although La Jolla is not a disadvantaged community, the local residents, along with the 2-3 million visitors who use the beaches in the area, are entitled to clean water as a basic human right. The La Jolla Shores ASBS Dry Weather Flow Control and Coastal Watershed Management Plan will monitor the area to ensure clean water is achieved for all users of the resource, not just La Jolla residents. All project partners are working to ensure that clean water in this area is of the highest priority.

Project Partners addressed local Environmental Justice needs and issues by implementing the five key objectives for the plan. Coastkeeper, with the support of The City's Think Blue Program, has spearheaded efforts to educate the entire public about pollution prevention and practices that minimize the impact of urban run-off on the ASBS.

4.4.7 Disadvantaged Communities

Coastkeeper works in many of the disadvantaged communities in San Diego, and informs the general public about pollution prevention with general outreach efforts. For instance, the Map is the first step in our quest to provide a broad-based educational experience at La Jolla Shores. Coastkeeper will work with the contacts at schools in disadvantaged communities to bring them to visit the Map at La Jolla Shores to learn about the ASBS and ways they can prevent pollution.

Coastkeeper targets disadvantaged communities in the majority of its education and outreach programs. The Education Director for Coastkeeper informs students county-wide about the ASBS.

It is only through the fostering of environmental responsibility in school students and their families that we can hope to regain and preserve the long-term health of our local natural resources. The detrimental activities of the growing human population of San Diego are a large part of the environmental crisis facing our county. Yet, most children (as well as their parents) are unaware that the ocean is dangerously polluted, and even fewer understand the role we play in this problem and must necessarily play in its solution. We seek to reverse these trends by not only informing children and the community about the marine environment of San Diego and the sources of pollution that are threatening this important habitat, but also training them to play a vital "hands-on" role in taking back our environment.

UCSD has partnered with the Urban Corps to develop a program dedicated to training Corps members in storm water pollution prevention management skills. Urban Corps provides job training and educational opportunities for young men and women 18 to 25 years old from disadvantaged inner-city communities; job opportunities that also conserve our natural resources. In June 2007, Urban Corps began a pilot project at SIO that included the following:

- **Pollution Prevention** – Implement source control BMPs to prevent or reduce the discharge of pollutants into the ocean
- **Pollutant Load Reduction Assessments** – Develop a program to monitor, quantify, and document the benefits of source control BMP implementation (e.g., visual inspections, weighing and documenting the amount of trash/pollutants collected from cleaning activities, calculating the square footage of eroded landscape that is restored, etc.).

Additional projects with Urban Corps are recommended that will also include the following:

- **Sediment/Erosion Control** – Understand the natural ecology in the La Jolla Shores watershed and implement conservation and preservation measures to protect, restore, and maintain the natural urban ecology in and around UCSD and SIO.
- **Storm Water Monitoring** – Evaluate BMP effectiveness through water quality monitoring.

4.4.8 Coordination with State and Federal Agencies

Coastkeeper staff regularly works with the California Coastal Commission, Department of Fish and Game and other government agencies. The City of San Diego also contributes to this effort by maintaining regular communication with the Unified Port of San Diego, the County of San Diego, the California State Water Board, the San Diego Regional Water Board, the Regional Copermittees and California Stormwater Quality Association (CASQA). On March 5th and 6th, 2007, the La Jolla Shores WMG hosted a statewide Integrated Coastal Watershed Management (ICWM) Planning Grant Workshop to discuss outcomes from the ICWM Plans statewide and how to work with the SWRCB Division of Financial Assistance on securing implementation funding for the plans. The La Jolla WMG presented their ASBS Protection Model as a proposed strategy for ASBS planners to move towards an ecosystem impacts approach to ocean protection. In addition, the WMG continues regular coordination with the Natural Water Quality Committees, which includes state regulators and experts in the ocean protection field, to keep current on ocean protection issues and findings from the La Jolla Shores ICWM program.

UCSD AND SIO continues to work closely with the SWRCB and RWQCB on issues related to ASBS protection and participates in Natural Water Quality Committee meetings hosted by the SWRCB. In addition, UCSD and SIO is working closely with the California Department of Fish and Game on a pilot non-indigenous species (NIS) treatment study designed to identify an effective treatment combination to eliminate NIS from seawater aquaria effluent.

5.0 GOALS AND OBJECTIVES

This section identifies the goals and objectives of the La Jolla Shores Coastal Watershed Management Plan that were developed by the Watershed Management Group. It describes the method used by the project team to develop the goals and objectives, the key management issues for the watershed, an outline and description of the goals and objectives, the management strategies considered to meet the objectives, and how they fit into other state, regional and coastal planning goals and objectives.

5.1 Methodology for Determination

The goals and objectives for this project were developed throughout the development of the Plan by the Watershed Management Group based on meetings with experts in the field, project team members and stakeholders. As discussed previously, the primary purpose of the Plan is ASBS protection by characterizing the issues related to ASBS protection and developing a strategy to manage and protect the ASBS. The project team identified five primary planning areas for development of the Plan:

1. Identify water quality pollutants of concerns, their potential sources specific to the coastal watershed, and how they may impact the ASBS
2. Identify, evaluate, and prioritize urban runoff management activities, both structural and non-structural in nature, to address the pollutants of concern
3. Develop a model for science-oriented, ecosystem-based ASBS assessment and protection that is transferable to other ASBS statewide
4. Create a data management system at the core of the watershed plan that serves data providers, analysts, partner agencies and the community, and is transferable statewide
5. Encourage stewardship of the ASBS through a pioneering public involvement and outreach strategy that utilizes University tools and science

These planning areas were carried out and are described in detail in Section 3 through 4 above. The team coordinated closely while performing the activities, always keeping in mind the desire to use a holistic, ecosystem-oriented approach for ASBS management. Through the studies and the team coordination efforts several ASBS management issues were identified. The plan findings were discussed and management issues were developed at multiple TAC meetings where Watershed Management Group agreed upon goals and objectives for the Plan. The goals and objectives were also discussed at public workshops and speakers bureaus.

Other considerations taken into account in developing the goals and objectives were regional and state programs such as the San Diego Integrated Regional Water Management (IRWM) Plan, the Basin Plan, the California Ocean Plan, and the newly formed Ocean Protection Council. The project team was involved in the development of the San Diego IRWM goals and objectives, the Basin Plan Triennial Review, and the ongoing development of ASBS Special Protections under the California Ocean Plan. In addition, the team has closely followed the actions of the Ocean Protection Council and their recently issued Five-Year Strategic Plan. The relation of these programs to this Plan is discussed below in Section 5.5.

5.2 Key Management Issues

The key issues and findings related to each component are listed below. Once the findings were combined, the team developed the project objectives. The objectives are closely aligned with the original project planning areas although they better reflect the interconnectedness of the planning areas.

5.2.1 Key Issues and Findings from Each Component

Urban Runoff Management (Water Quality)

- Pollutants in urban runoff can potentially impact ecosystem health and beneficial uses and need to be identified using a triad approach considering water chemistry, physical conditions in the ASBS, and biological impacts in the ASBS. For the La Jolla ASBS, high priority pollutants of concern were identified as bacteria, copper, and turbidity
- Management Measures (BMPs) should be focused on reducing pollutants that impact the ecosystem health and beneficial uses
- BMPs should be prioritized using a tiered approach considering mass-loading and reduction of pollutants – pollution prevention, source control and then treatment
- Effectiveness monitoring/assessment must be built in to the implementation process as an adaptive management tool

ASBS Ecosystem Assessment

- Urban runoff can potentially impact ecosystem health, but there is a large knowledge gap about the relationship between urban runoff and ecosystem health
- Existing regulatory requirements do not adequately characterize ecosystem impacts
- Physical conditions have a significant influence on the degree of impact
- Biomarkers must be assessed to evaluate the condition of the ASBS
- An ecosystem index, based on ecosystem health, is needed to prioritize ASBS protection both locally and statewide.

Information Management

- ASBS monitoring data is complex and includes a broad variety of data so that one system is not adequate for all data
- The statewide information system for regulatory data should leverage from existing SWAMP design and protocols
- Study of physical and biological data is necessary for full ecosystem analysis and should be correlated over space and time
- Data dissemination and display should be easily understood and publicly accessible
- Development of a statewide system should involve multiple stakeholders
- The ASBS management process should be iterative (build, test, build) for continued improvement and regional integration

Public Involvement

- ASBS stewardship is essential to changing pollutant generating habits throughout the watershed

- The connection between personal habits and ASBS protection is not widely understood
- Public involvement requires reaching out to existing groups
- Stimulation of behavioral and long-lasting social change for stormwater pollution prevention requires new, innovative and effective techniques, such as Community Based Social Marketing (CBSM).

5.3 Goals and Objectives

5.3.1 Plan Goals

The overarching goal of the La Jolla Shores Coastal Watershed Management Plan is:

Protect the ASBS and the many designated beneficial uses in the La Jolla Shore marine areas.

Although the Plan focuses primarily on water quality improvement issues, it aims to move the focus of ASBS protection towards an ecosystem-based scientific approach.

5.3.2 Plan Objectives

To achieve this goal, four objectives were developed by the project team and stakeholders:

Objective 1: Develop a science-based ecosystem approach to ASBS/ocean protection.
Objective 2: Protect and improve water quality and reduce ecosystem impacts

Objective 3: Facilitate watershed/ocean resource information management and knowledge transfer.
Objective 4: Encourage community involvement and ocean stewardship

Following is a discussion of each of the objectives.

Objective 1: Develop a science-based ecosystems approach to ASBS/ocean protection.
This objective was developed as an overarching aim of the Plan. The restoration and maintenance of California's coastal marine ecosystems and resources are of critical importance for Californians now and in the future. Healthy, resilient, diverse, and productive marine ecosystems have been specifically identified as achievable goals by the California Ocean Protection Council to ensure that the valuable services these ecosystems provide are not diminished or lost. However, approaches for assessing the health of coastal ecosystems and the impacts from human factors that profoundly affect these systems have not yet been developed. Objective 1 will provide a more thorough understanding of interacting biological and physical processes within the ASBS through the implementation of ASBS ecosystem studies. The activities within this objective include biological evaluations, circulation studies, physical system evaluations, and specific ASBS studies to follow up on findings from the planning process. These would consist of habitat structure mapping, estimations of patterns of circulation and retention, physical effects on marine habitat structure, and water mass properties to better understand the effect of the physical circulation on ecosystem community structure, location, and susceptibility to environmental stress.

Objective 2: Protect and improve water quality and reduce ecosystem impacts.
Objective 2 will be attained through the implementation of best management practices (BMPs) to reduce pollutant discharges into the ASBS. This requires the installation, operation, and assessment of BMPs throughout the watershed that will result in the elimination of dry weather discharges and measurable reductions of pollutants in storm water runoff. The BMPs include pollution prevention, source control and treatment controls that will achieve multiple benefits, including protecting public health, maintaining recreational opportunities such as swimming, surfing and fishing or shellfish harvesting, preserving valuable marine habitats, and protecting rare, threatened or endangered species. The BMPs will primarily be focused on eliminating dry weather flow and treatment of the pollutants of concern that have been identified specifically for the ASBS.

Objective 3: Facilitate ASBS Data Storage and Knowledge Transfer.
In recent years there has been an awakening to the need for integrated information management systems to provide efficiency in assessing and managing regulatory programs. The statewide network of ASBS is one example in which a robust and persistent data system is required. A large amount and wide variety of data have been, and will be, collected in the watershed and ASBS through both regulatory permitting requirements and ancillary data collection efforts required to assess ASBS conditions. Currently, these datasets are relatively isolated and unavailable to a wide range of users. Information management systems are needed for integration and public data dissemination so that interrelated biological-physical-chemical processes present in the watershed and marine environment can be assessed. These data requirements span both regulatory and non-regulatory based data collection efforts.

Activities within this objective include; 1) designing and implementing a robust and scalable data management system for storage, archival, retrieval, dissemination, and display of regulatory data leveraging from the SWAMP data system, 2) integrating and aggregating of biological and physical data based on location (latitude, longitude), time, and elevation, 3) determining undefined attributes necessary for realizable ecosystem assessment of ASBS, 4) displaying ASBS data in an organized and digestible format easily accessible to scientists, decision makers, and the general public., and 5) creating an iterative management process for continued improvement and regional integration

Objective 4: Encourage Community involvement and ocean stewardship.
Ultimately, it is the community that must embrace the La Jolla Shores ASBS protection program since often it is their actions that have a significant impact on the quality of the runoff within the watershed and the activities within the ASBS. Preventing pollution at its source remains the most efficient and cost-effective way to preserve the health of our coast. Education and outreach activities must be implemented over a long period of time, especially in an area such as ocean protection where the public generally does not understand their potential impact. The groundwork for public education and outreach has been laid in the watershed beginning in 2005. These efforts should be continued using past methods and expanded into new areas to reach a broader audience. This objective is closely tied to Objectives 1 and 2 as it transfers information to the public regarding impacts to the ecosystem, BMPs being implemented, and practices that can protect the ASBS. It is also closely integrated to Objective 3 as information management tools will be used to disseminate data and knowledge to the public through websites and public data displays.

5.4 Water Management Strategies Considered

Over the course of development of this ICWM, the watershed Management Group discussed a wide variety of issues related to ASBS/ocean protection related to state, regional and local concerns or ongoing efforts. These issues helped to define the objectives of the project and focus project efforts. They are listed below.

State Issues:

- California Ocean Plan compliance (ASBS protection)
- Ocean Protection Council's Five Year Strategic Plan
- West Coast Governors' Agreement
- Marine Protected Areas (MPA)
- Coastal Zone Management Act (CZMA)

Regional Issues:

- Ocean Protection
- County IRWM Issues

Local Issues:

- Watershed Water Quality
  - Dry weather flows – water conservation & stewardship
  - Wet weather flows – pollution prevention and storm water treatment
  - Groundwater
  - Aerial deposition
- Point Source (seawater effluent discharges)
  - Copper and other additives
  - Non-indigenous species
- Ocean Ecosystem Health
  - Watershed water quality
  - Physical processes
  - Plumes from outside the ASBS
  - Public use
- Beneficial Uses

Water Management Strategies employed for this project include strategies required by the IRWM process, strategies that addressed the major water management issues discussed above, and strategies that were developed by the project team. These strategies are listed below:

- Environmental and habitat protection and improvement
- Recreation and public access
- Storm water capture and management
- Water conservation
- Water quality protection and improvement
- Non-Point Source (NPS) pollution control
- Watershed planning
- Urban runoff reduction

- Ocean ecosystem protection
- Ocean stewardship
- Ecosystem restoration

Other management strategies that were considered and the reason they were not included are listed below:

- Water supply reliability – this was not considered a primary management strategy for the watershed, although water conservation efforts as a part of the ASBS stewardship program would reduce water use and thus have a minor impact water supply reliability.
- Groundwater management – groundwater resources are not used within the watershed therefore were not considered in this Plan.
- Water recycling – water recycling infrastructure is not available within the watershed.
- Flood Management - flood management may be considered in the future to control erosion within the natural canyons, however, additional studies will be needed to characterize the effectiveness of this strategy.
- Wetland enhancement and creation – the watershed is highly developed and does not lend itself to wetland habitat.

5.5 Regional & State Planning Goals and Objectives

5.5.1 Regional Planning Objectives

Although this plan addresses a very specific area, it addresses both regional and state goals and objectives. On a regional level, the plan helps implement goals and objectives of the San Diego IRWM Plan. In particular, the coastal aspect of this plan rounds out the overall regional approach of the IRWM by addressing ocean issues. In addition, the *ASBS Protection Model* uses science to link the potential impact of water quality on ocean ecosystem health. The specific regional goals and objectives from the IRWM Plan that are addressed herein are shown below in bold:

San Diego IRWM Plan Goals:

- Optimize water supply reliability
- ***Protect and enhance water quality***
- ***Provide stewardship of our natural resources***
- ***Coordinate and integrate water resource management***

San Diego IRWM Plan Regional Objectives:

1. Develop and maintain a diverse mix of water resources
2. Construct, operate, and maintain a reliable water infrastructure system
3. Minimize the negative effects on waterways caused by hydromodification and flooding
4. ***Support attainment of the beneficial uses of the Region's waters.***
5. ***Effectively manage sources of pollutants and stressors***
6. Restore and maintain habitat and open space
7. Promote economic, social, and environmental sustainability

8. ***Optimize recreational opportunities***
9. ***Maximize stakeholder / community involvement and stewardship***
10. Promote integrated or regional approaches to regulatory compliance
11. ***Effectively obtain, manage, and assess water resource data and information***

5.5.2 State Planning Objectives

In addition to addressing regional objectives, the Plan also helps address several State plan and program objectives.

SWRCB NPS Control Program - The project implements the NPS Control Plan goals on a watershed level by implementing management measures to reduce and prevent NPS pollution from entering receiving waters. Monitoring and tracking programs are integrated into the project to measure the effectiveness of the management measures. The collaborative effort between government, academic and environmental organizations provides an interdisciplinary approach to public outreach and stewardship. The Plan will also address recently adopted TMDLs for bacteria at beaches.

SWRCB California Ocean Plan - The Plan meets the goals of the SWRCB California Ocean Plan implementation of BMPs to protect the marine environment within the San Diego-Scripps State Marine Conservation Area and La Jolla State Marine Conservation Area.

RWQCB Basin Plan - RWQCB Basin Plan goals are met through implementation of measures that preserve and enhance water quality and protect beneficial uses, and the SDR Watershed Management Approach (WMI Chapter) by using a collaborative approach to address high priority point and nonpoint source pollution within a geographically focused area.

Ocean Protection Strategy – The Plan helps the State implement the following goals and objectives of the Ocean Protection Council's Five Year Strategic Plan.

- Improve understanding of ocean and coastal ecosystems
- Significant improvement in ocean and coastal water quality
- Significantly increase healthy ocean and coastal wildlife populations and communities in California
- Promote ocean and coastal awareness and stewardship

5.5.3 Regional Conflicts

Regional conflicts of issues that may arise through the implementation of this plan include:

- The need for large amounts of land to implement treatment-type best management practices (BMP) to reduce storm water pollutants.
- The possible environmental impact of implementing structural treatment.
- The conflict between the need for flood control and habitat protection, particularly in the natural canyons throughout the watershed.
- End-of-the-pipe pollution control treatment BMPs do not address the cause of pollutants.
- The regional culture that values green landscape and tidy property often generates irrigation runoff that causes pollutant discharges into the ASBS. This culture is also in direct conflict with the regions need to conserve water resources.

- Dry weather flow diversions can impact the capacity of wastewater treatment plants.

These conflicts are addressed in the identification of management measures in Chapter 7.0 and prioritization of management measures presented in Chapter 8.0.

6.0 MANAGEMENT PROGRAM RECOMMENDATIONS

This chapter describes the process used to develop management measure recommendations for the protection of the La Jolla Shores ASBS. The process begins by outlining the ASBS Protection Model that was developed by the Watershed Management Group through monthly Technical Advisory Committee (TAC) meetings of the interdisciplinary Project Team. The direct application of this Model to the La Jolla Shores watershed is then presented. Chapter 7 identifies and prioritizes potential management measures designed to address priority COCs and Chapter 8 describes the implementation plan for identified management measures.

6.1 ASBS Protection Model

As the initial project technical analysis components of the Plan (described in Chapter 4) were completed, the results were presented and discussed by the TAC. Examining the inter-relationships between these initial planning activities, led to the development of the ASBS Protection Model that uses an iterative approach to ASBS management and is based on a holistic approach to ASBS assessment which considers chemical, physical and biological processes that potentially impact ASBS.

The ASBS Protection Model, as shown in Figure 23, consists of four key elements which are described below.

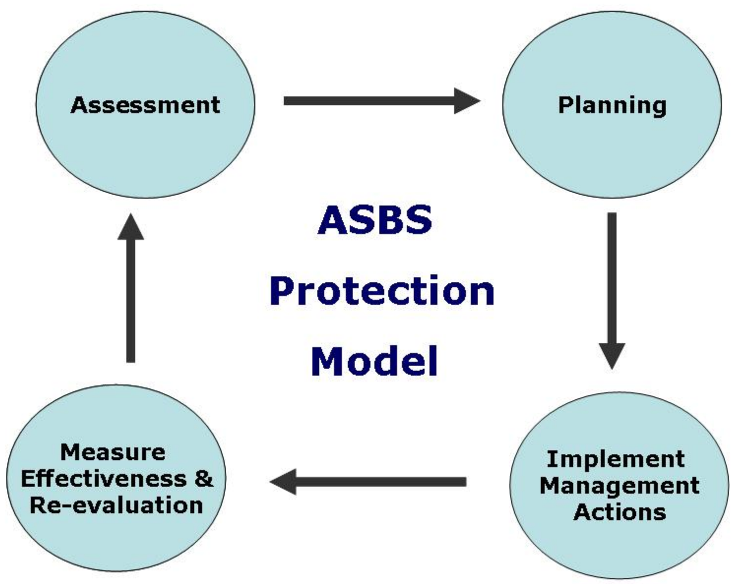


Figure 23. ASBS Protection Model

- Assessment – The assessment element of the ASBS Protection Model consists of collecting and assessing watershed and marine data that is initially used to determine biological and beneficial use impacts to the ASBS through the ASBS Triad Assessment Approach. The Triad Assessment Approach uses a holistic, scientific-based process to identify constituents of concern and their potential impact on the ASBS by examining chemical, physical and biological processes in the watershed and adjacent marine environment. The ASBS Triad Assessment Approach is described in more detail in Section 6.2.

- Planning – The planning element consists of identifying management measures to address identified constituents of concern and impacts in order to meet the stated program objectives. The management measures are then prioritized and an implementation strategy is developed. A tiered approach is used to prioritize management measures beginning with source control and pollution prevention activities (Tier I); followed (as necessary) by source reduction through structural BMPs (Tier II); and as a final resort treatment controls (Tier III). Key components of this prioritization process are public participation and integration of Plan components in an overall information management system. Chapter 7.0 describes the Planning Management Measures identified specifically for the La Jolla Shores Coastal Watershed, based on the conclusions of the initial iteration of the Assessment element of the Model and the ASBS Triad Assessment Approach.

- Implementation of Management Measures – In the Implementation element, management measures are implemented using an integrated and phased approach that addresses current and potential constituents of concern in an effective and cost-efficient strategy. The first implementation phase (Phase I) focuses on short-term (3-5 years) implementation of Best Management Practice (BMP) management measures such as source control, runoff reduction, and lower capital investment pollutant reduction measures. The second phase starts the long-term (5-10 years) aspect of the project and begins with an assessment of the effectiveness of the Phase I measures and continues with the implementation of management measures which may have higher capital costs and/or community impacts. A third long-term implementation phase (>10 years) involves further assessment and refinement of the Phase I and II measures with potential additional implementation of treatment measures that may require more infrastructure and capital investment. The Implementation element for the La Jolla Shores ASBS is described in Chapter 8.0 of this Plan.

- Effectiveness Assessment/Measurement and Re-evaluation – Throughout the ASBS Protection Model, effectiveness assessments of management measures are conducted to determine if impacts are lessened, expected outcomes are achieved and where management measure refinements are required. Effectiveness assessments utilize the overarching information management element of this Plan to coordinate assessments of the coastal ecosystem, prioritize management measures, determine effects of adaptive watershed management, involve community stakeholders and link pollutant stressors with population and community biological effects.

Once BMP effectiveness has been evaluated, the adaptive management process of the Model allows for reassessment of impacts using appropriate sections of the ASBS Triad Assessment Approach. Based on this approach, an implementation plan is developed that outlines a series of successively more detailed levels of management measures based on previous data, tiered management actions, and the assessment of implemented actions.

6.2 Assessment - ASBS Triad Approach

The first element of the ASBS Protection Model is Assessment. The assessment approach developed by the Project Team is the ASBS Triad Assessment Approach represented in Figure 24.

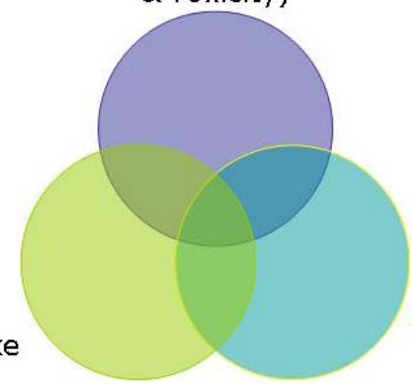


Figure 24. ASBS Triad Assessment Approach

The ASBS Triad Assessment Approach is used primarily for identification of constituents of concern. This approach was adopted by the Project Team based on the results of the water quality and ASBS ecosystem assessment studies. The results of the studies indicated that pollutants of concern identified by water quality tests were not consistently the same pollutants identified as having biologically significant effects to organisms in the ASBS.

The ASBS Triad Assessment Approach consists of three main assessment elements:

- Constituent Inputs to Ecosystem – Constituent inputs to the ASBS are measured by performing an urban runoff characterization through monitoring of wet and dry weather flows (if applicable), sediment carried from the watershed and in the ASBS, and other relevant media such as air deposition and migration of pollutants from adjacent watershed into the ASBS (Figure 25). These measurements are then compared to applicable criteria that are based on ecological and human health risk studies to establish preliminary constituents of concern (COCs) for the area. These criteria include the California Ocean Plan and Basin Plan water quality criteria and NOAA sediment quality criteria. A watershed characterization is also performed to estimate the constituent loading into the ASBS and identify the sources of constituents of concern detected in the ASBS Triad Assessment.

Key Project Finding – The results of the ecological assessment indicated that long term monitoring of the ASBS ecosystem is required to conduct effectiveness assessment of management measures and identify emerging issues. A multiple species and longer term approach is needed in order to distinguish impact reductions from multiple potential sources that include both natural (storms, rise in temperature and sea levels) and anthropogenic. Therefore, Phase I requires a minimum of 5 years to assess measures and establish trends.

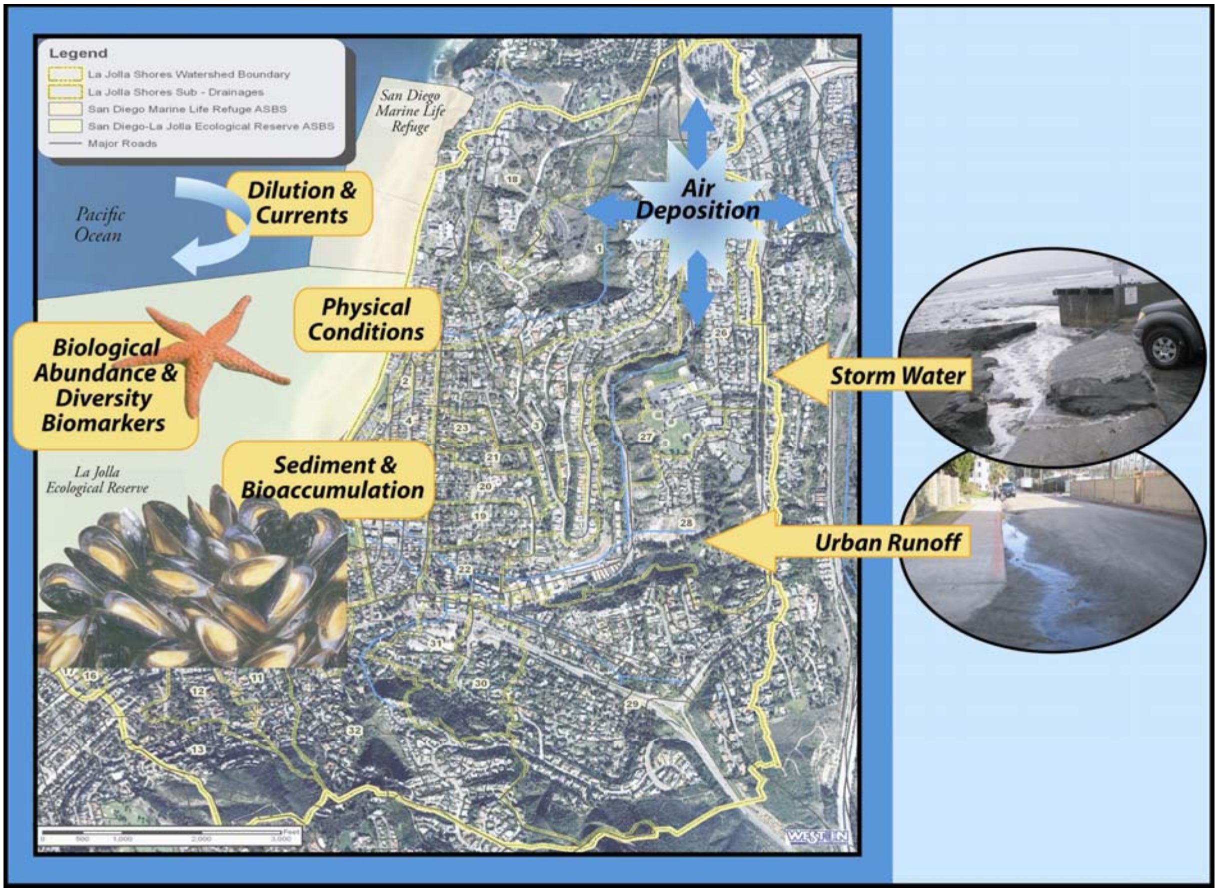


Figure 25: ASBS Triad Approach – Modeled for La Jolla Shores ASBS

- Constituents Fate and Physical Conditions – Once constituents enter the ASBS, the fate of those constituents as they relate to physical conditions and ecosystem health is of concern. Evaluating constituent fate and transport in the ASBS requires ecosystem assessment studies of the marine environment such as ocean circulation and urban runoff plume mixing and dilution. Constituents of concern such as trace metals, sediment, pathogens, nutrients, pesticides, and organic wastes are carried into the coastal zone through multiple pathways. Direct input of constituents contained in storm water runoff or dry weather flows enter the ASBS through the storm drain system directly into the mixing zone. These constituents are immediately diluted and potentially undergo geochemical reactions to either increase or reduce their bioavailability as runoff mixes with the ocean. In storm water runoff, the adsorption process may occur dynamically with the transport of suspended sediments resulting in coupled transport of contaminants with sediment loads. Dilution and dynamic adsorption and re-suspension processes may make the biological effect of storm water runoff entering the ASBS difficult to detect and quantify on short time scales. Accordingly, water quality criteria which are typically applied to urban runoff water quality to detect acute effects may not relate to actual biological availability and overall deleterious effects to organisms in the ASBS. Further, other dynamic processes that occur in the ocean, such as tidal and offshore currents may act to further dilute constituents in the nearshore zone by decreasing residence time.

Other sources of direct input of constituents, such as aerial deposition of metals may allow constituents harmful to marine organisms to enter the ASBS free from the dynamic adsorption processes described above. Aerial deposition may allow fine particles that have been shown to be more bioavailable than larger particles to enter the ASBS directly (Stolzenbach *et al*., 2001).

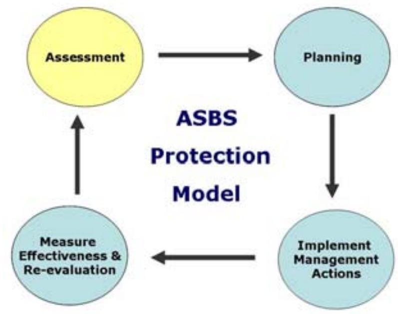
- Biological Uptake and Impacts – The final leg of the ASBS Triad Assessment Approach is assessment of the biological effect and impact of constituents of concern on organisms in the ASBS. The biological uptake and impact leg of the triad can be conducted through a suite of ecosystem assessments such as bioaccumulation studies, biomarker and toxicity studies, and population evaluations of key indicator species. For example, several metals which are micronutrients required for organism health are also toxic at elevated levels. Pollutant uptake by organisms in the San Diego region has been shown to occur through direct exposure to pollutant laden water and through exposure and/or ingestion of pollutant laden sediments (Deheyn and Latx, 2005). The chemical form of a potential pollutant can also influence the impact of a pollutant on aquatic life through direct toxicity or bioaccumulation. The various naturally-occurring oxidation states of metals which have varying degrees of toxicity and their interaction with storm water and in the nearshore coastal environment is not well understood. Dissolved metals that bind to organic matter or suspended sediments are much less bioavailable--and therefore less toxic--than those that exist as free ions. Copper is an example of a metal with multiple oxidation states that has been shown to be present at elevated concentrations in storm water in the La Jolla Shores watershed, yet a direct link to uptake and impact to organisms has not been made. Results of the bioaccumulation testing conducted in the La Jolla area indicate that copper may not be a biologically significant impact to organisms in the ASBS.

  Other potential impacts, such as natural disturbances, public use, water temperature increases, and physical damage during storms can also have significant ecological impacts to ASBS and also need to be considered by the ASBS Triad Assessment approach. There are natural conditions that can cause these populations to increase or decrease in abundance or biomass on varying scales of space and time. Distinguishing between the natural and anthropogenic causes of these changes requires assessments that compare the magnitude of change in the distribution and abundance of particular species on regional and local scales.

  Public use of the ASBS may also significantly impact organisms in ASBS. Pressures from activities such as the collection of tide pool plants and animals, picking up and handling tide pool organisms, trampling vegetation and soft-bodied tide pool organisms, legal and illegal sport fishing from the shoreline, spear fishing while SCUBA or skin diving, and commercial fishing and sports fishing party boat fisheries. Reduced density of macro invertebrate species (i.e., snails, crabs, anemones) has been documented in heavily visited intertidal areas along the San Diego coastline comparing data collected in 1971 and 1991 (Addessi, 1994). Collecting will also alter age sizes within a population, and produce changes in intertidal community structure (Murray et al., 1999; Kido and Murray, 2003). Trampling is a significant concern because it will reduce the viability of seaweeds and soft-bodied animals (i.e., anemones), and crack mussel shells. Trampling can result in changes in the community composition of the plants and animals living under the canopy provided by seaweeds (Zedler, 1978; Murray et al., 1999; Kido and Murray, 2003). Ultimately, these impacts may significantly outweigh the effect of direct pollutant toxicity or bioaccumulation to organisms in ASBS.

The ASBS Triad Assessment Approach results in the identification of the priority pollutants of concern for which management measures can be identified and prioritized as outlined in the Planning element of the ASBS Protection Model. It may also identify other sources of ASBS impact, such as contamination carried into the ASBS by currents or human disturbance. This information ultimately feeds into the ASBS Protection Model which identifies management measures to protect the ASBS.

6.3 La Jolla Shores ASBS - Assessment



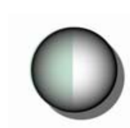
The first step in the ASBS Protection Model is Assessment. The Assessment element was applied by the Project Team to the La Jolla Shores watershed using the ASBS Triad Assessment Approach as illustrated in Figure 24. The assessment components that were applied included the Urban Runoff and Watershed Characterization and the ASBS ecosystem assessment presented in Chapter 4.0. The potential inputs into the ASBS include wet and dry weather flows, air deposition, cross contamination from on-shore currents, and public use. The first leg of the ASBS Triad Assessment included identifying the chemical constituent inputs through wet weather monitoring and evaluation of available data. Constituent fate (second leg of the ASBS Triad Assessment) was evaluated through the dilution and current studies also summarized in Chapter 4.0. The third leg of the ASBS Triad Assessment was evaluated through toxicity testing and the ASBS ecosystem assessment that included bioaccumulation studies of mussels and sand crabs.

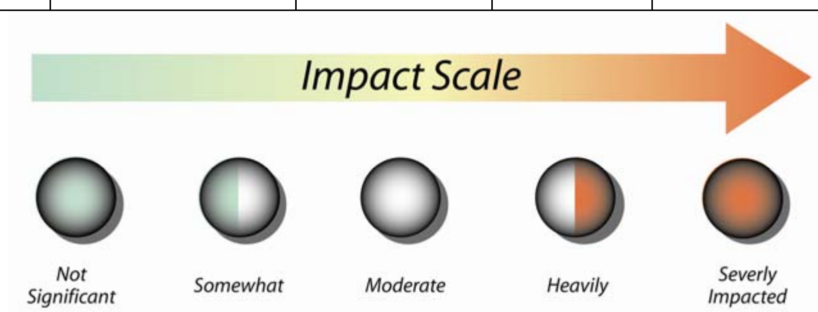
Based on the findings of the ASBS Triad Assessment Approach studies and data reviews, several key findings were concluded and the list of prioritized constituents of concern was developed (Table 7). In order to assess individual impacts to organisms in ASBS, an impact scale was developed. The pattern of response by individual species to pollutant sources is important in order to provide a framework to identify management measures that address the sources of the impact. In this system, priority impact types can be identified based on the biological effect or impact. A tiered management approach can then be employed to address the constituents deemed to have the highest degree of impact. A secondary benefit of assigning a scale to impact effects is that the effectiveness of management measures that address impacts can be assessed using biologically relevant criteria.

The list of constituents of concern was prioritized based not only on water quality testing, but also on the bioavailability of the pollutants. The prioritized constituent of concern list was then used to evaluate the potential sources of these pollutants and allow the Project Team to move forward into the Planning element of the ASBS Protection Model to develop a list of appropriate management measures. Also, the results of this initial assessment were used to identify data gaps to further define the impacts and degree of these impacts on the ecosystem, and to better define the sources of these impacts.

Key Project Finding – The results of the water quality and ecological assessment indicated that although copper was a COC based on comparisons to WQO, the initial toxicity testing and bioaccumulation did not indicate an impact from copper. Therefore, using water quality data alone did not provide a full picture of impacts and a more holistic and scientific-based approach to COC identification was needed.

Table 7. Constituents of Concern for La Jolla Shores Coastal Watershed.

Pollutant	Priority	Potential Source(s)	Pollutant Pathway to ASBS	Expected Degree of Impact	Impacted Ecosystem Component	Data Gap
Metals (arsenic, copper, chromium, nickel)	High	Brake pad wear Commercial/industrial activities Residential activities	Aerial deposition Wet weather flow Dry weather flow Cross-contamination		Possible reduced growth of filter feeders	Source contribution study required to assess contribution via aerial deposition, urban runoff or cross-contamination
Turbidity (Sediment)	High	Erosion from development Landscaping Invasive species Minor disturbances Road debris Run-off from undeveloped open spaces Bluff erosion	Wet weather flow		Potential reduced algae recruitment and growth	Source identification and classification of sediment required to assess load contribution and potential beneficial use options
Bacterial Indicators	High	Pet waste Landscape activities Restaurant establishments Organic matter Birds	Wet weather flow Dry weather flow		Public health; Shellfish contamination	Source contribution study required to assess loading potential
TCDD equivalents	Low	Air emissions Wild fires Beach bonfires Diesel exhaust	Aerial deposition		Unknown	Aerial Deposition study required to assess contribution via direct deposition and storm water runoff
PAHs	Low	Auto exhaust Asphalt roads Fossil fuel combustion	Wet weather flow		Unknown	Aerial Deposition study required to assess contribution via direct deposition and storm water runoff
Pesticides (Synthetic pyrethroids)	Low	Commercial/residential applications	Wet weather flow Dry weather flow		Unknown	Source contribution study required to assess loading potential
Oil and Grease	Low	Transportation sources	Wet weather flow		Unknown	Source contribution study required to assess loading potential



6.3.1 ASBS Ecosystem Assessment Framework

In this section, we present recommendations for a general approach to assess coastal ecosystems, prioritize them for improved management, determine the effects of adaptive watershed management, and linking stressors with effects at higher levels of biological organization such as populations and communities. The model is applicable to any coastal area of interest and is not limited to ASBS.

The recommendations outlined for future ecosystem study below are the highest priority for implementation, intended to provide a more thorough understanding of interacting biological and physical processes within the ASBS and fill gaps in coverage during the planning phase. Other programs such as CalCOFI (California Cooperative Ocean Fisheries Investigations), SCCOOS (Southern California Coastal Ocean Observing System), CDIP (Coastal Data Information Program, wave measurements and forecasting), and the California State Mussel Watch program provide necessary data outside the ASBS on a larger scale and will be incorporated into analyses of ASBS data where applicable.

6.3.2 Adaptive Monitoring

There are two components to the proposed general monitoring approach. The first is a staged adaptive approach in which biological impacts are studied beginning with the evaluation of loadings and human alteration of the receiving area and the subsequent search for the effects of loadings and alteration on the ecosystem. This “bottom-up” (BU) approach is useful for scaling assessment efforts within an adaptive monitoring scheme, prioritizing among watersheds for improved management, and provides an index to compare biological impacts among different watersheds. This approach utilizes a continuum of effects at different levels of ecosystem organization from (1) evaluation of the presence or absence of significant loadings or alterations to the physical characteristics of the receiving waters, (2) determining whether loadings and/or physical changes effect water and sediment quality, (3) evaluating the bioavailability of loadings utilizing bioaccumulation studies, (4) evaluation of the in situ and laboratory toxicities of loaded contaminants (biomarker and toxicity studies, respectively), and (5) population evaluation of key indicator species for evidence of stress, and (6) evaluation of biological communities for evidence of stress.

This approach should be applied from the bottom up in a sequential manner. Negative results at any step indicate that effects are not detectable at that level and studies at higher levels are not likely to be fruitful and therefore should not be implemented (though see linkage studies below). The level at which effects are no longer observed also provides an index of contamination for comparisons of ecosystems embedded within different watersheds. This index would then be useful for prioritizing management practices. For this approach, it is extremely important to expend much effort determining system loadings and possible physical alteration at the scale of the local watershed receiving waters so that local anthropogenic forcing can be ruled out as causes for possible ecosystem impairment at higher levels.

6.3.3 Ecosystem Linkages

The second component of the general approach is to link higher-level ecosystem endpoints, such as population and community effects, with local forcing (i.e., the results from the bottom-up approach discussed above). For instance, can the presence of a particular anthropogenic constituent be directly linked with an overall increase in population or community structure. Linking human disturbance to ecosystem alteration is difficult for all but the most grossly polluted or overfished areas and developing these linkages is currently a major focus of biomonitoring. The linkage between higher-level effects with human disturbance is typically detected at the level of the individual organism.

The linkage study components listed below lay out the framework for developing ecological studies at higher levels of biological organization and incorporates interdisciplinary studies such as studies of circulation and mixing. A degree of subjectivity is inherent to this component due to the complexity of ecosystems and the lack of truly pristine baselines. The steps outlined below formalize an approach that is most likely to provide linkages between human activities and ecosystem alteration. This component should be carried out sequentially, but at the same time that BU studies are taking place. The sequential components of this method are:

(1) Choose the most important or valuable types of community for study. It is impossible to meaningfully study every type of community within a coastal area or ASBS, therefore a subset of communities must be chosen and prioritized. The choice of community should be based on a combination of the following factors: (a) its sensitivity to anthropogenic stress (based on previous studies and existing knowledge); (b) its value for ecosystem services (e.g., resource provision, anthropogenic waste processing, etc.); and (c) it composes the most biomass, area, or productivity.

(2) Establish an expected range of baselines for chosen communities within the ASBS utilizing intensive multivariate studies of the communities within the ASBS and similar communities nearby. It is important that the choice of nearby communities is limited to those that are least likely to be affected by anthropogenic disturbance. The end product of this step is a "baseline range" for each type of community that would be expected given the physical setting, productivity, and habitat characteristics supporting the community within the ASBS. Because data from pristine, pre-human conditions is generally not available, it is recommended that an average baseline range be developed using data from ASBS communities and remote areas that are the least likely to be affected by human activities. It is also very important that the communities are studied over appropriate time scales to capture their range of temporally dynamic states.

(3) Utilize this baseline range of multivariate dynamic states for each community type developed from data for remote areas and from the ASBS to evaluate the range of states for the communities of interest within the ASBS.

(4) Assess the differences of observed community ranges with expected baseline ranges. The components having the largest residuals (the most different from expectation) are the components most likely altered by human activities.

(5) Study these components and rule out possible natural causes for these differences such as unique habitat characteristics, ocean microclimate effects, etc.

(6) The components having large residuals that are not due to natural causes are identified as useful bioindicators for that community. Bioindicators are defined as components of an ecosystem that are indicative of its well being. The formal definition of bioindicator includes all levels of organization from the level of the physiological state of an individual organism (i.e., biomarker) to the state of a species, guild, or community. With respect to this component, bioindicators are at the level of species or higher.

(7) Link bioindicators to human forcing via relevant biomarkers and ecotoxicity analysis utilizing knowledge of local and remote loadings. Attempt to determine trophic pathway(s) of contamination into system to formalize linkage.

Steps 5, 6, and 7 utilize interdisciplinary studies including physical oceanography, biogeochemistry, and ecotoxicity. Physical oceanographic studies must be undertaken in parallel with the components described above. These studies are described in the next section.

The recommended approach for ecosystem assessment highlights the difficulty of linking cause and effect but represents a quantitative approach that minimizes subjectivity. Establishing effects at higher levels and linking them to human causes for all but the most polluted areas is otherwise a chancy process based solely on professional judgment. The task is rendered even more difficult if loadings are dynamic over time scales that elicit population or ecosystem responses.

6.3.4 Assessment Summary

Based on the priority COC list, potential sources were identified in order to develop management measures. Potential sources are based on land use, source studies and source surveys/inventories that were summarized in Chapter 4.0. Table 7 presented a summary of the highest priority pollutants identified in the La Jolla watershed, the corresponding likely sources and the potential degree of impact that they may have on the ecosystem. Also highlighted are the identified data gaps in order to effectively reduce pollutants and other impacts to the ASBS.

A summary of the ASBS Triad Assessment Approach as applied to the La Jolla Shores ASBS is presented in Table 8.

Table 8. ASBS Triad Assessment Approach Summary

Results of the ASBS Triad Assessment Approach

- **Constituent Inputs to Ecosystem**
  - Water Quality Assessment – The preliminary constituents of concern based on comparisons to the water quality criteria are metals (copper, chromium, nickel, and arsenic), bacterial indicators, and turbidity. Lower priority preliminary pollutants of concern included TCDD (dioxin), PAHs and synthetic pyrethroids (pesticide). These preliminary COCs were used to design the toxicity and bioaccumulation testing program (Biological Uptake and Impact leg of the ASBS Triad Assessment)
  - Sediment Quality Assessment - Data gap. Sediment quality in the La Jolla Shores Coastal Watershed has not yet been studied.
  - Aerial Deposition – Data gap. Aerial deposition of contaminants in the La Jolla Shores Coastal Watershed has not yet been studied.

- **Constituents Fate and Physical Conditions**
  - Dilution Studies – The La Jolla near shore environment is very dynamic and has a high exchange rate resulting in dilution rates of up to 20 times. Constituents entering the ASBS from storm drains therefore are subject to these dilution effects and actual concentration in the receiving water may be much lower than in the storm drain system.
  - Current Studies – The offshore environment has dynamic current patterns likely influenced by complex coastal topography
  - Habitat/Sediment Characterization – The La Jolla Shores ASBS is dominated by sandy bottom habitat and includes two smaller areas of rocky inter-tidal habitat that are widely used by the public.

- **Biological Uptake and Impacts**
  - Toxicity Testing – No toxic effects were indicated in initial assessments with the exception of potential chronic impacts to giant kelp germination and growth.
  - Bioaccumulation Testing – The results of the mussel and sand crab tissue analysis indicated that chromium, nickel, and arsenic metals were potential COCs.

Priority COCs Based on the Triad Assessment

Metals (copper, chromium, nickel, and arsenic)
Bacterial Indictors
Turbidity

6.4 Information Management

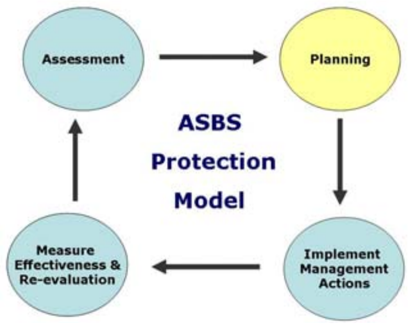
An integral part of both the Assessment component described above and the planning component described in Chapter 7 is information management. Data collected from the assessment monitoring must be managed such that it is easily accessible for evaluation and planning purposes. None of the ASBS Protection Model components will be effective without this critical piece.

Information management encompasses data integration, storage, archival, retrieval and intelligent dissemination. There are several different types of data that must be collected to thoroughly and effectively manage the ASBS as described in the Assessment component. These types include chemical, biological, and physical observations gathered at different time and space intervals. Recommendations for future data system development and management include defining changes within, adoption, and implementation of the SWAMP structure; development and design of a data system for ecosystem management; integration of environmental observational data; needs assessment with ASBS science and management community to define optimal data distribution, presentation, and analysis tools; and prototyping implementation of an end-end system in an ASBS to serve as a model for a statewide system. Appendix D Framework Recommendations for a Statewide ASBS Information Management System presents a White Paper developed by the project team that describes the recommended ASBS information management system in more detail.

Although SWAMP in its current form does not fulfill the entire suite of regulations, the system can serve as a building block for a comprehensive and transferable relational data management system for ASBS regulatory data. The SWAMP data management system was chosen over other data management systems because it is more comprehensive, including lookup tables for laboratory contacts, station ID, units, analytes, methods, etc. and the need for statewide compliance and compatibility. The SWAMP system is not a single solution data system for all required ASBS assessment measurement parameters. A fully functional information management system can be considered a system of systems. Much of the ecosystem management and environmental observational data will also need to be saved in formats which give the flexibility needed for examining multidisciplinary processes. Required spatial and temporal cross referencing attributes include latitude, longitude, elevation, and time. Sampled data without these fields make it extremely difficult to not only analyze processes and ASBS impact, but also display data in a visual and digestible format. Visualization tools for ecosystem assessment must be developed further in order to comprehensively analyze the ASBS in context with surrounding areas. Development and technological advancement of these improvements require planning, engineering, and resources. The data management team has implemented improved data dissemination utilities through the use of recent web based technologies and mapping capabilities. Future data products can be integrated and designed based on user needs, assessment, and utility.

Future efforts should involve expertise found at Moss Landing Marine Laboratory who is currently expanding the SWAMP data system. The system should consist of a relational database within a UNIX/LINUX operating system environment (e.g. MySQL, Postgres, Oracle). For security purposes data management best practices should be stored on a system with backup capabilities. Ideal programming would include some sort of redundant array of independent disks (RAID) and offsite backup utility. Finally, reasonable products and public display is an essential component of the information management system. Management and assessment of the ASBS extends far beyond collection, ingestion, and display of regulatory data. Integration of physical and biological data is necessary for full ecosystem analysis. Web-based data presentation and dissemination will allow the interrelationships of these datasets to be examined over space and time. Visualization methods should be leveraged from the SCCOOS information management system for dissemination and display. It is recommended that the future ASBS information management system should include an iterative implementation method whereas the system is designed, tested, and then improved based on performance, reliability, and comprehensiveness in a build-test-build environment.

7.0 LA JOLLA SHORES ASBS - PLANNING



This Chapter describes the Project Teams' approach to management measure identification and planning based on the Assessment element of the ASBS Protection Model. Management measures are often operationally defined as Best Management Practices (BMPs) that prevent, control, or treat constituents in urban runoff in order to lessen overall environmental impacts. This Plan also incorporates information management and public participation as individual management components that function both within specific BMP measures to optimize efforts and as components of an overall ecosystem-based scientific watershed management approach.

7.1 BMP Identification Process

A phased implementation of non-structural and structural BMPs in selected drainage areas in the La Jolla Shores Coastal Watershed is recommended to establish the actual effectiveness in reducing constituent concentrations to ASBS. This phased approach will allow the effectiveness of non-structural and lower-impact BMPs implemented in early phases to be assessed as well as allow design parameters required to implement more complex treatment systems to be measured. Effectiveness assessment activities of the early phases of the BMP implementation program will therefore accomplish two objectives: assess the effectiveness of lower impact BMPs in reducing pollutant loads and assess the runoff volume and volume of storm water requiring more complex treatment to be developed.

Reduction of pollutant loads to receiving waters can be accomplished using three main methods, non-structural BMPs, structural BMPs and treatment systems. A non-structural BMP approach can include source control, runoff reduction and pollution prevention measures that can be used to reduce pollutant sources and prevent pollutant pathways to receiving waters. Source control can be accomplished through activities such as legislative restrictions on the manufacture and use of potential pollutants and education of community stakeholders to become aware of, and change behaviors that potentially lead to pollution. Runoff reduction non-structural BMPs include activities that reduce the runoff volumes and peak flows for both dry and wet weather flows such as education of responsible irrigation practices. Together, non-structural source control and runoff reduction are accomplished through public participation efforts such as outreach, education and enforcement programs that all aim to educate watershed stakeholders and users to practice techniques to prevent pollutants from entering the watershed. This approach has the added benefit of integrating water management strategies, such as ocean stewardship, water conservation and water quality protections and improvement.

Published data indicates that the effectiveness of non-structural source control and runoff reduction measures can range widely from 30-70% pollutant reduction. The effectiveness of these non-structural BMPs will vary depending on the level of implementation and enforcement, watershed and regional hydrological characteristics, and constituent type. However, the effectiveness of non-structural BMPs in a particular watershed can not be accurately assessed without effectiveness data that compares drainage areas in which these measures are fully implemented compared to a drainage-area where little or no measures are established. Source control and pollution prevention measures can be more effective when targeted at sources and activities that have the greatest loading potential for the constituents of concern.

Nonstructural BMP techniques can be combined with structural BMPs to both control sources and reduce runoff volume to prevent pollution. Structural BMPs include source control and runoff reduction strategies that require infrastructure for implementation. Examples of structural BMPs include street sweeping, Low Impact Development (LID) structures, infiltration basins, and other techniques (Figure 26). Published data indicates that the effectiveness of structural BMPs in reducing pollutants varies from 50-90%. The effectiveness of different structural BMPs also varies depending on the level of implementation and enforcement, watershed and regional hydrological characteristics, and constituent type. Effectiveness assessment of structural BMPs in the context of local conditions is imperative to evaluating individual project pollutant reduction efforts.

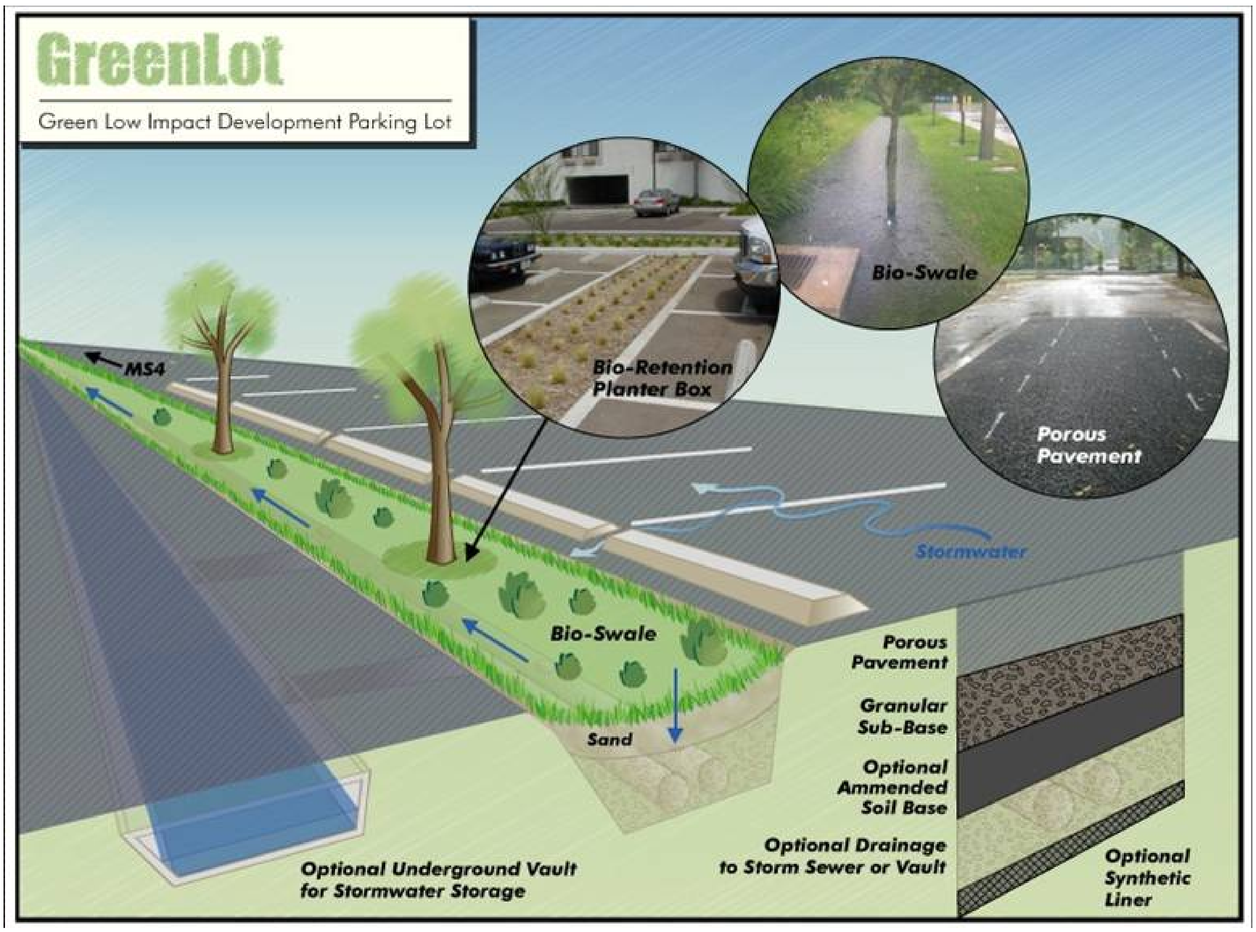


Figure 26. Example LID- Green Lot BMP schematic

A final method of pollutant load reduction can be accomplished through treatment BMP technologies that treat constituent concentrations. Published data indicates that pollutant reduction effectiveness of treatment BMPs can vary from 50-90+%. The effectiveness of treatment BMPs have been evaluated based on information presented in the Treatment BMP Technology Report (Caltrans, April 2006), USACE/USEPA BMP Database (USACE, 2006), and other technical publications. The evaluation of these technologies in the context of the La Jolla

Shores Coastal Watershed is presented in Appendix E BMP Technology Effectiveness. The result of the structural BMP technologies feasibility assessment was that in order to meet dissolved metals/total, bacteria and turbidity pollutant reduction goals, relatively complex treatment systems ("treatment trains") are required to collect and treat the complete design storm events. These treatment train technologies often require relatively large areas and capital expenditure to design and install depending on the design storm volume required to meet pollutant reduction goals. Therefore, a phased approach, discussed in the following section, is recommended that implements source control pollution prevention and runoff reduction BMPs in the first phase (Phase I). Reductions in runoff volume from infiltration BMPs and pollution reductions through source control and pollution prevention measures may significantly reduce the need for more infrastructure-intensive treatment train BMPs.

7.1.1 BMP Integrated and Tiered Approach

The development of management measures to address the protection goals of this Plan and reduce the identified impacts to the ASBS is based on an integrated and tiered approach. The integrated approach addresses all priority constituents in the BMP development. A tiered prioritization process then addresses constituents with the greatest biological impacts through the effective use of resources and is then used to rank potential BMPs. In the integrated and tiered process, each BMP is then classified according to the relative efficiency of constituent removal from the system, level of infrastructure required for implementation, and cost.

Three tiers of BMP classifications are defined. Tier I BMPs focus on non-structural source control and pollution prevention measures that are designed to reduce the amount and understand the effect of pollutants entering runoff though education, enforcement and behavioral modification programs.

Tier I – Non-structural BMPs and Activities

- Source Control Measures and Pollution Prevention BMPs
- ASBS Ecosystem Assessment Studies to Determine Biological Impacts
- Effectiveness Monitoring of BMPs
- Integrate Efforts through Information Management
- Public Participation and Community Involvement through Ocean Stewardship

Tier II includes structural BMPs such as infiltration basins, bioretention and LID techniques to reduce wet and dry weather runoff volumes and further reduce pollutant entry into the ASBS. Additionally, Tier II includes source and design studies that will aid in the further identification of pollutant sources and provide design parameters for construction of effective in-line treatment systems as part of Tier III.

Tier II – Structural BMPs and Activities

- Soil and Hydrologic Studies, Source Studies and Determination of Design Storm
- Aggressive Pollutant Source Control in Targeted Areas (e.g. Street Sweeping)
- Implementation of Urban Runoff Reduction LID Techniques
- Dry weather Flow Diversions
- Effectiveness Monitoring of BMPs

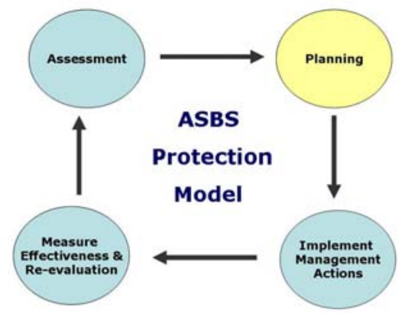
Tier III BMPs are infrastructure-intensive structural pollution reduction treatment measures that typically require significant capital investment and/or have impacts on surrounding communities.

Tier III – Treatment BMPs and Activities

- o Property Acquisition and Easements (where necessary)
- o Implementation of Treatment BMPs in Targeted Areas where Tier I and Tier II BMPs have been shown not to meet full reduction goals
- o Effectiveness Monitoring of BMPs

Effectiveness assessment, monitoring, and data incorporation into the overall information management program are components common to all three tiers. Within each tier, the effectiveness of each BMP program must be monitored in order to assess whether the program is meeting pollution reduction goals. A secondary benefit of effectiveness monitoring is that oftentimes BMP techniques can be modified or pollutant sources can be identified in order to further reduce pollutant loads as time series data becomes available.

7.2 La Jolla Shores ASBS Planning: Phased BMP Prioritization Process



The development of an implementation strategy (Chapter 8) to reduce pollution within the La Jolla Shores Coastal Watershed and impacts to the ASBS requires that potential management measures be prioritized. Criteria for the prioritization process include:

- Consistent with ASBS Protection Model
- Meets the Plan objectives
- Meets multiple regulatory objectives
- Integrates water management strategies
- Reduces priority COC inputs to ASBS
- Follows the tiered approach to urban runoff management
- Leads to understanding of ASBS ecosystem impacts
- Fills critical data gaps
- Contributes to ASBS information management
- Increases ASBS stewardship within the watershed
- Implements the most feasible and cost effective measures first
- Assesses management measure effectiveness

The prioritization process begins with current knowledge from the Assessment portion of the Protection Model (ASBS Triad Assessment Approach) about constituent inputs, the fate of constituents and ultimately the biological uptake and impact of those constituents for organisms in the ASBS. A three-phased implementation approach is then developed based on the prioritization criteria listed above. Central to the prioritization process is the iterative nature of the ASBS Protection Model where priority management actions concurrently address identified project goals, priority pollutants and identify emergent issues. This process occurs in parallel with ongoing ASBS ecosystem assessment projects and the development of an overall information management strategy that integrates specific pollutant reductions with identifiable ecological effects. The Planning element of the Model will allow effective management decisions for BMP implementation to be coordinated with long-term assessment of ASBS performance. The overall goal of the phased and integrated approach is to address individual constituents of concern and meet pollution reduction goals in a prioritized cost-efficient manner.

7.3 Management Measures: Short-term Implementation Program-Phase I

The prioritization process implements management measures defined by the tier system (Section 7.1.1) in a phased approach. Phase I of this approach consists of implementing a range of Tier I and II, and pilot Tier III, pollution prevention and source control measures to address high priority pollutant and loading areas identified in the ASBS Triad Assessment. In Phase I, Tier III activities will only be implemented on a pilot basis in small isolated drainage areas where a specific pollutant source and treatment system has been identified and the implementation of a Tier III BMP will provide a clear benefit to overall pollutant reduction. These pilot BMPs are also located in small isolated drainage areas where the storage volume required is limited and the effectiveness of the BMP can be readily assessed. Specific Tier I and II source control and pollution prevention techniques included as part of Phase I include public outreach and education, increased inspection of identified sources, increased targeted street sweeping, erosion controls, and LID runoff reduction and diversion programs. Phase I also includes effectiveness assessments to measure the performance of specific BMPs and overall ASBS ecosystem assessment studies designed to assess the long-term performance of the ASBS. Specific BMP effectiveness assessments verify the efficiency of implemented BMPs and determine whether Tier I and Tier II BMPs need to be modified or can be expanded to other subwatersheds. Additionally, data collected as part of effectiveness assessments can be incorporated into larger area-wide ASBS ecosystem assessment studies and synthesized in the information management system in order to characterize ecosystem-level impacts in the context of a holistic watershed-level approach. Overall, Phase I aims to implement a range of BMP projects designed to address identified constituents of concern from a range of community, structural and ecosystem-level activities. Phase I is also designed to build a system of ecosystem assessment studies to understand the efficiency of specific pollutant reduction efforts, assess the long-term performance of the ASBS, and to identify existing pollutant source or BMP design data gaps through the integration of data into a comprehensive information management system. The goal is to maximize the effectiveness of Tier I and II activities in Phase I to address pollutant reduction goals and guide the BMP priority rankings and implementation strategies in Phases II and III (Figure 27).

7.4 Management Measures: Long-term BMP Implementation- Phase II

Information gathered during Phase I will then used to prioritize management measures in Phase II. The integrated information management system developed as part of this Plan will combine effectiveness assessment data of programs conducted in Phase I, specific “bottom up” biomarkers studies and ASBS ecosystem assessments, and other data to prioritize specific pollutant reduction BMPs in Phase II, characterize design parameters for Phase II structural BMPs, and re-evaluate or verify constituents of concern and data gaps. Phase II will consist of continued implementation of a range of Tier I and II, and some pilot Tier III, pollution prevention and source control measures to address high priority pollutant and loading areas originally identified in the Triad Assessment and modified as a result of effectiveness and ecosystem assessments conducted in Phase I. It is assumed that Phase II may prioritize a range of specific Tier III treatment BMPs to be implemented through the analysis of Phase I effectiveness assessments and impact level analyses through the ASBS ecosystem assessment studies. Some Tier I and Tier II programs may also be modified or expanded through this analysis process. Since Tier III BMPs are often infrastructure-intensive and costly, this integrated and tiered strategy may have the potential to reduce overall project costs and community impacts and will focus Tier III efforts on pollutants with the highest biological impact and in locations where pollutants can be most effectively reduced.

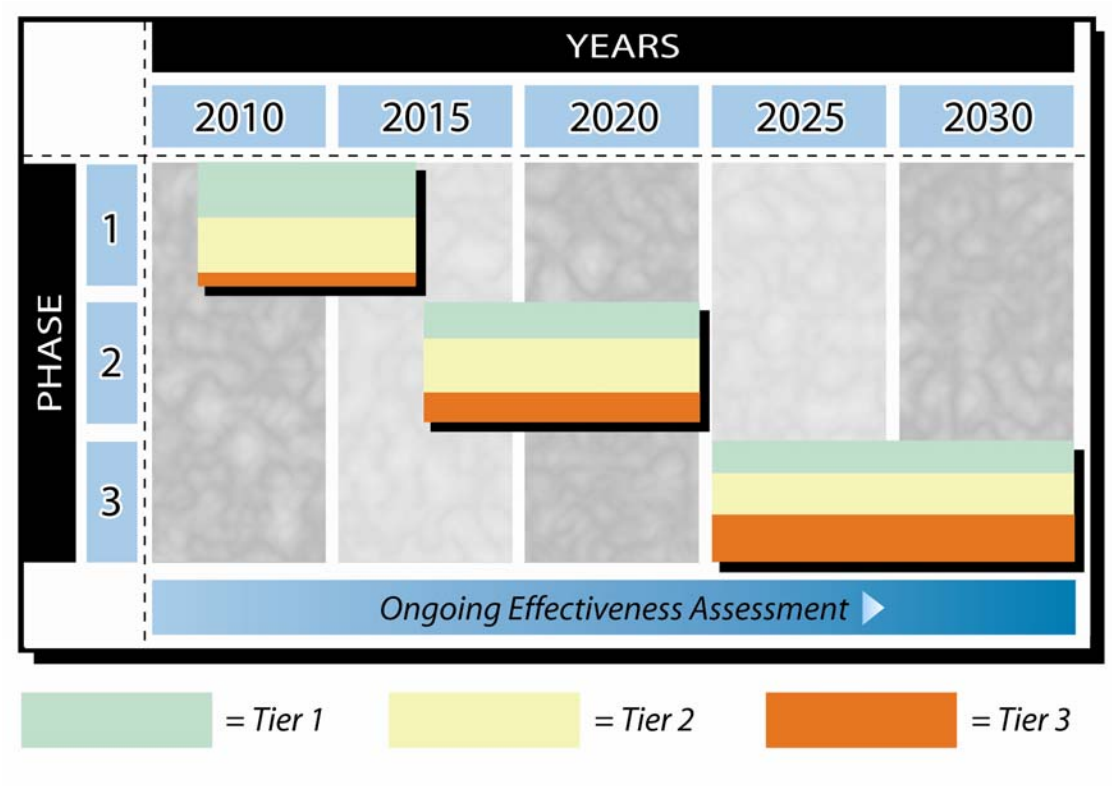


Figure 27. BMP Phased Approach.

7.5 Management Measures: Long-term BMP Implementation- Phase III

Information gathered during Phases I and II will then used to prioritize management measures in Phase III. Similar to Phase II, Phase III will incorporate data and knowledge acquired as part of previous phases to prioritize specific pollutant reduction BMPs, characterize design parameters for structural BMPs, and identify emergent constituents of concern and data gaps. Although Phase III will continue the implementation of a range of Tier I and II, and some Tier III, pollution prevention and source control measures to address high priority pollutant and loading areas, it is assumed that Phase III may prioritize a larger proportion of specific Tier III BMPs to be implemented through the analysis of Phase I and II efforts. As in Phase II, some Tier I and Tier II programs may also be modified or expanded through this analysis process.

As a result of the iterative process of the ASBS Protection Model and the nature of the phased BMP approach, specific projects to be included in Phase III of the BMP approach are not well defined. As defined above, specific management decisions and allocation of projects in subsequent phases will be driven by an integrated information analysis of identified priority pollutants, BMP effectiveness assessments, larger-scale biological impact and ASBS ecosystem assessment, and public participation and ocean stewardship activities.

7.6 Phased Approach - Summary

Throughout each phase, ongoing effectiveness assessment of implemented management measures and ecosystem-level studies will assist in the development of the next phase of the BMP approach. As described in Chapter 6.0, the overall ASBS Protection Model is based on Assessment, Planning, Implementation of Management Measures and Measuring Effectiveness. The phased approach integrates these elements by incorporating effectiveness assessment data (collected as part of specific BMP implementation) with ASBS ecosystem assessment studies. The overall information management program defined by this Plan then allows the Project Team to access data from all management measures conducted within the watershed such as ASBS ecosystem assessment studies, BMP effectiveness assessments and community outreach efforts to feed into the iterative ASBS Protection Model process. The various levels of the integrated information management framework can be used to facilitate knowledge and data transfer to achieve the overall goal of protecting the ASBS through a science-based ecosystem approach that reduces ecosystem impacts, improves water quality and encourages public participation and ocean stewardship. The overall goal of the phased and integrated approach is to address individual constituents of concern and meet pollution reduction goals in a prioritized cost-efficient manner.

7.7 Adaptive Management Strategy

As the Phased BMP Implementation process proceeds, data gathered from Phase I activities and ecosystem assessment studies will be integrated into the ASBS information management system and used to evaluate the prioritization and implementation schedule for Phase II and III. Accordingly, Phase I contains the most well defined set of Tier I, II and III projects. As new pollutants emerge or strategies to address pollutants are developed, results of effectiveness assessments of Phase I activities become available, impact assessment and ecosystem performance data is gathered from special studies, and more funding sources become available, the list of projects in Phases II and III will increase. Inherent in this strategy, therefore, is the need to continuously assess and manage each phase of the project implementation. This iterative process is depicted in Figure 28.

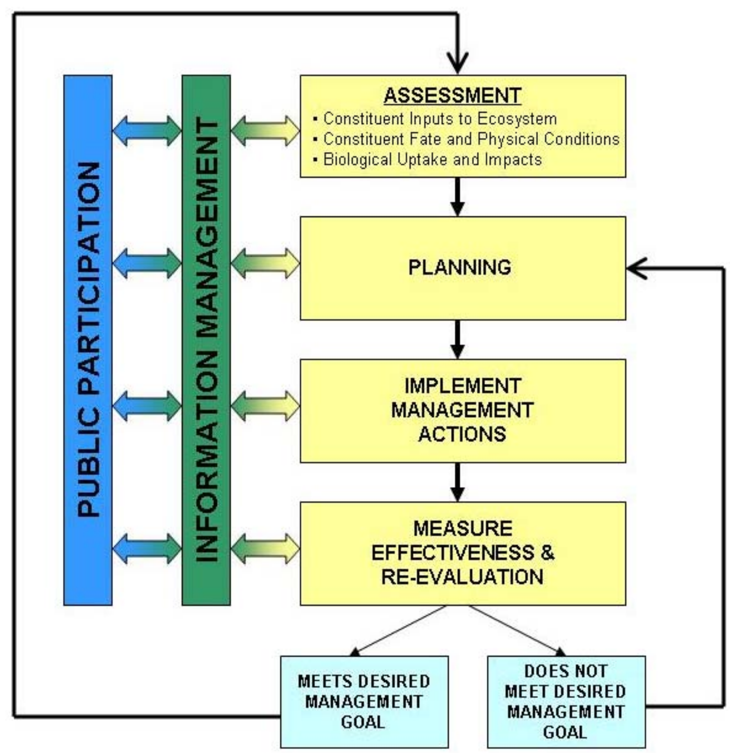


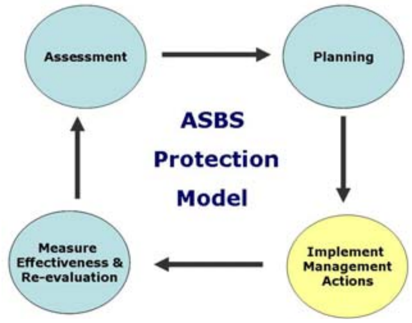
Figure 28. Adaptive management strategy for pollutant reduction process.

The ongoing information management system then both tracks effectiveness assessment programs and integrates with ASBS ecosystem assessment studies to guide the evaluation of management measures to determine if the action meets the intended pollutant reduction goal and reduces biological impacts to the ASBS. An adaptive management strategy process can then be used to either revise or replace the management action designed to address the original pollutant of concern or to identify further pollutants or issues of concern in the watershed to reduce overall biological impacts.

7.8 Public Participation and Ocean Stewardship

In order to effectively implement the Plan as described in Chapter 8, public participation and education is critical. Failure to implement public outreach and promote ocean stewardship will prevent the success of source control BMPs and run-off reduction. Public participation and Outreach must continue and expand. Based on lessons learned, implementation of a Community Based Social Marketing (CBSM) strategy, a social science model utilized to engage the public and create positive behaviors that impact pollution prevention, is proposed. Community-Based Social Marketing is an attractive alternative to information intensive campaigns. In contrast to conventional approaches, CBSM has been shown to be very effective at bringing about behavior change. Its effectiveness is due to its pragmatic approach. This approach involves: identifying barriers to a sustainable behavior, designing a strategy that utilizes behavior change tools, piloting the strategy with a small segment of a community, and finally, evaluating the impact of the program once it has been implemented across a community. This approach is similar to the iterative approach of the ASBS Protection Model. Coastkeeper, the City and other program partners will work in conjunction with consultants and community volunteers to implement and tailor this model to the specific needs of the La Jolla Shores Watershed and the ASBS.

8.0 IMPLEMENTATION OF PLAN



Previous chapters of this Plan have defined overall program goals and objectives in relation to management measures for priority constituents. This chapter provides an implementation plan for management actions to address pollutant issues in the La Jolla Shores Coastal Watershed.

8.1 Implementation Schedule

The implementation schedule for management measures within the ASBS Protection Model is based on results of the Assessment element (Chapter 6.0) and the integrated and tiered process within the Planning element (Chapter 7.0). The ASBS Triad Assessment Approach identified the preliminary constituents of concern by identifying constituent inputs to the ecosystem, the fate of the constituents and physical conditions in the ASBS and the biological uptake and impact of those pollutants in organisms in the ASBS. Based on the results of the ASBS Triad Assessment Approach, management measures designed to reduce pollutant load and impacts were developed and then prioritized based on multiple criteria. A phased BMP implementation approach is recommended in order to address high priority pollutants in an iterative and cost effective strategy. As the Tier I and II BMPs are implemented in Phase I, a series of related effectiveness assessments should be conducted in order to measure the performance of the specific BMPs. Phase I also includes concurrent ASBS ecosystem assessment studies designed to assess coastal ecosystems, determine the effects of adaptive watershed management, and link pollutant stressors with effects at higher levels of biological organization such as populations and communities. Specific details regarding the implementation of BMPs in Phase II and Phase III will be learned from adaptive management of Phase I activities.

Information management is a key component of each implementation phase that integrates BMP implementation and effective assessments with the ongoing ASBS ecosystem assessment studies. This holistic watershed-based approach follows the foundations of the ASBS Triad Assessment Approach where potential pollutants are tracked as inputs into the ecosystem, as they react as elements to the ecosystem and how the organisms uptake and are impacted by the pollutants.

Figure 29 illustrates the general implementation schedule and estimated maximum pollutant reduction goals for recommended projects in the La Jolla Shores Coastal Watershed. This schedule is consistent with work being conducted in the City of San Diego and has been approved by the Mayor. Specific project details are presented in Appendix F La Jolla Shores Coastal Watershed BMP Project List.

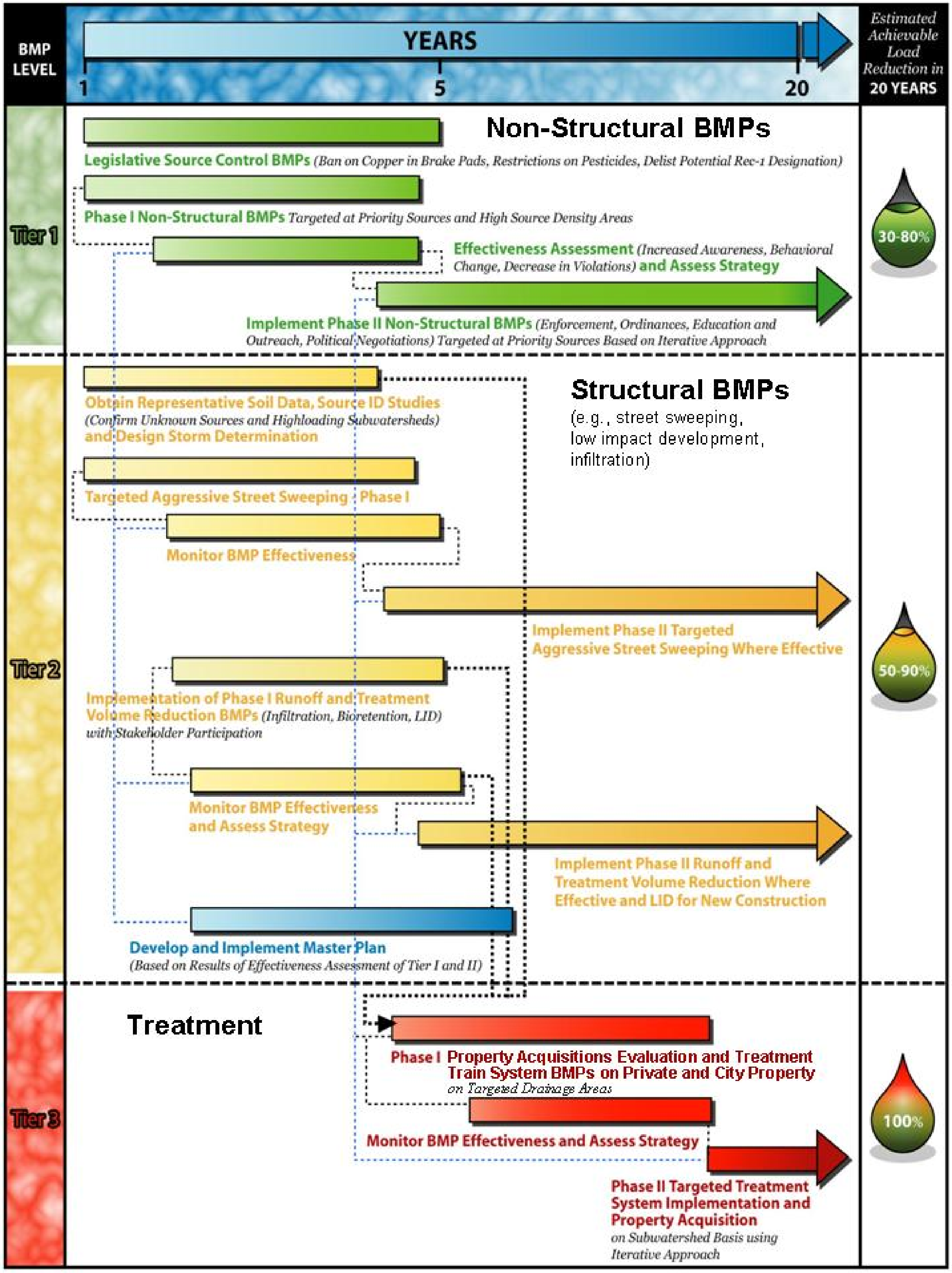


Figure 29. Phased and Tiered Approach to Project Implementation Goals

8.2 Project Implementation

Phase I projects conducted under this Plan are generally aimed at source control/pollution prevention measures and lower impact BMP implementation efforts. Potential projects include many Tier I BMPs such as urban runoff reduction, source control, restoration, and commercial inspections. Public participation and ocean stewardship is a broad but important Tier I category of BMP effort in Phase I. Public participation will be encouraged through outreach programs designed to prevent pollution and reduce runoff, speakers bureaus designed to educate the public and policy decision makers, information dissemination campaigns and school educational curricula. In addition, a Community-Based Social Marketing (CBSM) project for the purpose of encouraging citizens to adopt storm water-friendly behaviors will be utilized to further engage the public and to initiate sustainable behavior. CBSM is a Tier I activity that is unique in that it packages basic principles of social psychology with applied research methods in a way that provides a usable framework for practitioners working to promote behavior change in both residents and businesses. Tier II projects included in Phase I consist of LID projects such as Green Street and Green Lot runoff reduction projects, dry weather flow diversions, and street sweeping using a vacuum-assisted vehicle. Phase I also includes a few Tier III pilot projects on State property that have been identified using previously collected data as having high pollutant reduction capabilities. These pilot Tier III efforts are focused on specific sites with identifiable pollutant reduction potential.

Combined with these BMP management actions, a central component to Phase I is effectiveness assessments that will be employed in order to gather efficiency information to refine previously implemented actions or direct future implementation strategies. The data gathered as part of the effectiveness assessments will be evaluated both within the context of the specific targeted BMP as well as in comparison to overall project goals and ASBS ecosystem assessments.

Phase I will also include ecosystem assessment studies to assess the uptake and the impact of pollutants on organisms in the ASBS. Potential studies include ocean circulation, urban runoff plume dispersion, aerial deposition, sediment characterization and transport, biological community assessments, physical processes, and bioaccumulation and toxicity of pollutants. An essential component to the ASBS ecosystem assessment studies and effectiveness assessment activities is the development of a comprehensive information management program designed to integrate data collected as part of the various assessment activities with other historical and real-time datasets. The information management component will allow long-term assessment of ASBS performance and the related management decisions employed to protect the ASBS. It is recommended that Phase I be conducted for three to five years. Specific projects identified for inclusion in Phase I are detailed in Appendix F.

Phase II of the project implementation plan will be dependant on the adaptive management of Phase I strategies and directed by analysis of assimilated data collected under the integrated information management component of this Plan. Data sources will include effectiveness assessments of early implementation efforts, community and stakeholder participation, future regulatory changes, and ASBS ecosystem assessment studies. These sources will be used to address any data gaps and focus BMP efforts to address priority pollutants and locations. It is assumed Tier I, II and some pilot Tier III projects will be employed during Phase II. The final design and implementation schedule of these projects will be based on design parameters and effectiveness assessments of management activities conducted as part of Phase I projects. The adaptive management strategy will also allow for refinements to the prioritization process based on results of the ASBS ecosystem assessment and information management components of this Plan. In addition, special studies will be conducted to provide information in areas with identified data gaps. It is recommended that Phase II be conducted for at least 5-10 years. Specific projects currently identified for inclusion in Phase II are detailed in Appendix F.

Similar to Phase II, Phase III of the project implementation plan will be based on adaptive management of Phase I and Phase II strategies and directed by analysis of assimilated data collected under the integrated information management component of this Plan. It is assumed that Phase III will include a suite of Tier I and Tier II activities that have been modified or expanded for maximum effectiveness. Phase III will presumably also include some Tier III BMPs designed to address specific pollutant types or areas with high pollutant potential identified in the previous Phases. It is recommended that Phase III be conducted for 10+ years. Specific projects currently identified for inclusion in Phase III are detailed in Appendix F.

The overall tiered and prioritized adaptive management process defined by this Plan will allow efficient pollutant and impact reduction strategies to be implemented in a prioritized and cost-effective manner. Ultimately, this strategy will allow the overall goal of the Plan to *"protect the ASBS and the many designated beneficial uses in the La Jolla Shore marine areas"* to be achieved.

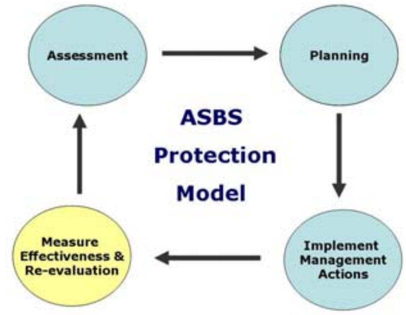
8.3 BMP Effectiveness Monitoring

In conjunction with BMP implementation efforts, effectiveness assessment and monitoring efforts will be conducted in order to further refine identified or emerging pollutants and/or sources, BMP effectiveness, and address any data gaps. Effectiveness monitoring is vital for accurate adaptive management and will be tailored to specific BMPs. For instance, effectiveness monitoring of outreach activities should include surveys, community dialogue and polls. Structural BMP effectiveness should include assessments of baseline conditions, calculated flows, assessment of concentrations of contaminants of concern and assessment of overall efficacy.

The effectiveness of each BMP program must be monitored in order to assess whether the program is meeting pollution reduction goals. Effectiveness assessment activities can sometimes be combined to allow multiple BMP efforts to be assessed concurrently. An example of this synergistic effort may be a comparison of dry weather flow in the upper portions of the watershed prior to the implementation of an aggressive public outreach runoff reduction campaign combined with similar monitoring efforts lower in the watershed in conjunction with increased street-sweeping activities. The comparison of these datasets may allow a comprehensive assessment of load reductions during dry weather as a result of disparate management activities. A secondary benefit of effectiveness monitoring is that oftentimes BMP techniques can be modified or pollutant sources can be identified in order to further reduce pollutant loads as time series data becomes available.

8.4 Implementation Effectiveness Assessment/Measurement and Re-evaluation

The final key component of the ASBS Protection Model is the Measurement of Effectiveness and Re-evaluation of the Plan components. The ASBS Protection Model is designed as an iterative process that includes four main components:



- Assessment
- Planning
- Implementation of Management Actions
- Measurement of Effectiveness and Re-evaluation.

This Plan has been designed to incorporate ASBS Ecosystem Assessments and information management as important elements in each phase of the Model. During the Assessment element, ecosystem-level assessments are conducted as part of the ASBS Triad Assessment Approach in order to correlate water quality data with constituent fate and physical processes and also determine the uptake and biological impact of pollutants in ASBS. Using an integrated information management approach, these data feed into a Planning element where potential BMP activities are identified and then prioritized based on multiple criteria. The integrated information management approach of this Plan is then used to prioritize BMPs and then implement them in a phased approach during the Implementation element of the Protection Model. The final Measure Effectiveness and Re-evaluation element of the Model both builds on, and feeds back into, the integrated information management portions of the Assessment, Planning and Implementation elements of the Protection Model. The Measure Effectiveness and Re-evaluation element is designed to assess data collected as part of each element, BMP effectiveness assessments, and the ongoing ecosystem assessment activities in order to provide feedback into the Model to continue the iterative protection process. Ultimately, the iterative process defined by the ASBS Protection Model will result in a comprehensive strategy to address priority pollutants in a phased and logical approach in order to efficiently and effectively protect the resources within ASBS.

8.5 Implementation Responsibilities

The project partners will work cooperatively and with other stakeholders to identify funds including grant funding to implement the various projects identified in the Plan. Responsibilities for implementation of the Plan will vary depending on the activity. Some activities will be implemented jointly; however, because of differing land use authority, some activities will be implemented separately to address specific conditions. Examples of activities that will likely be performed jointly include education and outreach and monitoring, whereas construction of BMPs will likely be implemented independently. Project implementation will be phased based upon available funding.

The project partners have taken an active role in conducting early pollutant source and impact assessments using the ASBS Triad Assessment Approach through the development of this Plan. SIO has been conducting management measures for ASBS protection related to implementing the California Ocean Plan requirements. These have included water quality monitoring, development and implementation of a Storm Water Management Plan, and separation of its sea water and storm water conveyance systems. The City has been implementing its Jurisdictional Urban Runoff Management Plan and Watershed Urban Runoff

Management Plan city-wide, conducting baseline water quality monitoring, and continuing to plan a low-flow diversion program to improve public health at local beaches. Coastkeeper has also been actively encouraging ocean stewardship both regionally and locally. In addition, development of this Plan led the Project Team to identify and fund an initial BMP program through the SWRCB 2005-06 Consolidated Grant Program.

With this Plan the project partners will continue their collective implementation programs in a focused and organized manner. Plan implementation will be coordinated with and expand upon the on-going urban runoff management efforts by the City and SIO.

8.6 Linkages with Regional Planning Objectives

The implementation of this Plan needs to link with the surrounding region. This linkage will allow for optimal implementation while ensuring that efforts are not duplicated or omitted.

The following optimal linkages would ensure maximum benefit from the implementation of the plan:

- Ensuring that projects and regulations outside of the La Jolla Shores Coastal Watershed are understood and coordinated;
- Ensuring that projects in adjacent areas are coordinated and optimized to the maximum extent practicable.

This coordination will occur through SIO, the City and Coastkeeper maintaining an active role on regional and state programs. These include the SWRCB-established Natural Water Quality Committee, Marine Protected Area (MPA) legislation, Ocean Protection Council activities, the California Stormwater Quality Association (CASQA), and the San Diego Regional Integrated Water Management (IRWM) Program.

The proposed projects and management measures outlined in Appendix G La Jolla Shores Coastal Watershed BMP Project List Strategy Evaluation are consistent with both the project goals of this Plan as well as overall Watershed Management Strategies as set forth by the IRWM process, Ocean Protection Council, California Ocean Plan, Basin Plan and various TMDLs. The management measures identified in this plan are specifically linked to the following regional planning objectives:

- *Support attainment of the beneficial uses of the Region's waters.*
- *Effectively manage sources of pollutants and stressors*
- *Optimize recreational opportunities*
- *Maximize stakeholder / community involvement and stewardship*
- *Effectively obtain, manage, and assess water resource data and information*

8.7 Economic and Technical Feasibility

The economic and technical feasibility of BMPs considered and recommended for implementation varies depending on the type (or Tier) of BMP. Generally, Tier I BMPs are the most economically and technically feasible, as they focus on non-structural BMPs. Non-structural BMPs typically require little or no capital construction costs, have little impact to the environment, do not have significant space limitations, and have, as shown in Figure 29, the potential for relatively high load reductions. Therefore, the implementation program focuses first on implementing Tier I BMPs.

The feasibility of structural Tier II and Tier III BMPs depends on several factors, including constructability (e.g., the presence of underground utilities and/or groundwater), environmental considerations (e.g., the need for permitting and/or remediation), operation and maintenance considerations, space limitations/availability, whether existing facilities can be used or entirely new facilities must be constructed, and the anticipated benefits. Also, the feasibility of these BMPs depends on the design storm for which the BMPs are designed to treat (e.g., 85th percentile, 2-year, 10-year, or 50-year storm event).

One method for determining the economic and technical feasibility of structural Tier II and III BMPs is by quantifying the value for money for the BMPs. This can be accomplished through the "Cost Effectiveness Ratio" analytical technique. The Cost Effectiveness Ratio links water quality benefits with their costs. Although water quality benefits (e.g., through the reduction of constituent concentrations) typically increase from Tier I to Tier III BMPs, the costs also increase, sometimes significantly.

A study conducted for the Pacific Grove and Carmel Bay ASBS (Alternatives Analysis and Data Acquisition for the Pacific Grove and Carmel Bay ASBS, 2006) found that BMPs targeting the capture of the 85th percentile storm event had the smallest Cost Effectiveness Ratios, i.e., the greatest water quality benefits for the least cost. This is because the cost to construct structural BMPs greatly increases due to the increase in size requirements to equalize, transport, and treat the flows and volumes. As shown in Table 9, the corresponding reduction in pollutants (as measured by the percent of the storm captured for treatment) was found to be only marginally greater for larger design storms. The costs shown represent the 20-year life cycle costs of treatment BMPs required to treat a watershed approximately 800 acres in size.

Table 9. Example Design Storm Percent Capture and Cost for Treatment BMPs.

Design Storm	% of Storm Captured for Treatment	Cost ($M)
85th %	93	8
2-year	96	20
10-year	98	26
25-year	100	33

Due to the higher costs of structural BMPs, the uncertainty with respect to the required design storm, possible constructability issues, and limited space availability within the watershed, these BMPs are scheduled for possible implementation during Phases II and III of the program. Higher cost Tier III structural treatment, end-of-pipe type BMPs will generally be considered for possible implementation only after data gaps have been filled, and the effectiveness of Tiers I and II BMPs have been evaluated.

8.8 Regional Benefit to La Jolla Shores Coastal Watershed Management Strategy

The La Jolla Shores Coastal Watershed provides a unique opportunity to address pollutant loading concerns in a small localized setting with implications that apply to other coastal areas of southern California. The geographic setting of the watershed is such that the overall drainage area is relatively small (<1,700 acres), land is primarily used for residential housing and open space and drains to two ASBS. Unlike many other watersheds in coastal California, there are relatively few primary constituents of concern in the watershed and little evidence thus far of cross-contamination from other watersheds. Further, a wide assortment of biological, physical and chemical process studies are currently being conducted in the offshore areas within the ASBS that may provide a more thorough understanding of interacting biological and physical processes and fill data gaps during the management process. Finally, many visitors and residents of the La Jolla area recognize the importance of protecting the natural resources of this unique area. These factors all suggest that the La Jolla Coastal Watershed an ideal region to implement an integrated and phased approach to meet pollutant reduction goals.

As described above, Phase I of the BMP implementation strategy emphasizes Tier I and Tier II activities that aim to control sources and reduce runoff in order to prevent pollution from entering the watershed. Detection of water quality improvements and overall impact reductions may prove to be relatively efficient in this compact watershed through ongoing effective assessment and ecosystem assessment activities. Information collected as part of the overall ASBS Protection Plan in an area like the La Jolla Coastal Watershed may prove valuable in future implementation and effectiveness assessments of these activities in larger, more complex watersheds. Likewise, the project partners will all bring lessons learned in other watersheds to La Jolla Shores in support of this plan in order meet overall pollution reduction goals.

9.0 PLAN PERFORMANCE

This section discusses data, technical methods, and analyses used to develop the Plan, measures to evaluate Plan performance, monitoring systems to gather performance data, and mechanisms to adapt Plan implementation based on performance data collected.

9.1 Measures to Evaluate Project/Plan Performance

Measures that will be implemented to evaluate the effectiveness of water management strategies are:

- BMP effectiveness monitoring
- Paired Watershed Approach (Handbook for Developing Watershed Plans to Restore and Protect our Waters (EPA, 2005)) using a reference watershed and a “treatment” watershed.
- Assessments of changes in ambient receiving water quality after watershed management strategies are implemented.
- Qualitative assessments (e.g., the acres of disturbed soil before and after erosion and sediment control, pounds of trash removed, and the number of stakeholders involved).
- ASBS Ecosystem Assessment monitoring. This includes:
  - Subtidal and Intertidal Algal Turf Community Study
  - Subtidal and Intertidal Soft-Bottom Community Study
  - Sediment Microbial Community Study

The Plan will also leverage existing monitoring efforts, including the City's urban runoff management programs, UCSD AND SIO NPDES monitoring efforts, the Plan ecosystem assessment and urban runoff monitoring, NCEX: Nearshore Canyon Experiment (National Science Foundation), Shore Stations (California Dept. of Boating and Waterways), San Diego Coastal Ocean Observing System (California Clean Beaches Initiative), the Southern California Coastal Ocean Observing System, HabTRAC, and the California Current Ecosystem Long Term Ecological Research area (National Science Foundation) by incorporating this data into the BMP selection process, effectiveness assessment, and watershed management approach.

Performance of pollution prevention, outreach and capacity building activities will be measured by assessing the projects ability to use the collaborative approach, engage the public and decision-makers, include agency stakeholders in the project, and increase the public’s knowledge of ASBS issues and stewardship.

9.1.1 Monitoring Systems to Gather Performance Data

Performance data for the proposed water management strategies will be gathered by monitoring representative outfalls before and after BMP construction to determine actual load reductions and life cycle costs (operation and maintenance costs). The method for conducting water management strategy performance monitoring and calculating load reductions will follow those methods recommended by the Urban Storm Water BMP Performance Guide (EPA, 2002). The Urban Storm Water BMP Performance Guide was developed by members of ASCE’s Urban Water Resource Research Council and through the development of the ASCE/EPA National Storm Water Best Management Practices Database. The protocols directly relate to requirements of the National Storm Water BMP Database and provide a recommended set of protocols and standards for collecting, storing, analyzing, and reporting BMP monitoring data to help understand the function, efficiency, and design of storm water BMPs.

The actual calculation of load reductions will be based on influent/effluent and before/after effectiveness monitoring and paired watershed monitoring. Influent and effluent effectiveness calculations will follow the procedures of the Effluent Probability Method (EPA, 2002), which includes, first, determining whether influent and effluent (or before and after) EMCs are statistically different from one another using appropriate non-parametric (or, if applicable, parametric) statistical tests. Secondly, cumulative distribution functions of influent and effluent quality and standard parallel probability plots will be examined. Paired watershed monitoring will follow procedures found in the reference document titled "Handbook for Developing Watershed Plans to Restore and Protect our Waters" (EPA, 2005).

9.1.2 Mechanisms to Adapt Plan Implementation

The ASBS Protection Model has been designed to provide the ability to adapt Plan implementation based on the results of effectiveness monitoring. As new pollutants emerge or strategies to address pollutants are developed, results of effectiveness assessments of Phase I activities become available, impact assessment and ecosystem performance data is gathered from special studies, and more funding sources become available, the list of projects in Phases II and III will be modified or may increase. This iterative process is depicted in Figure 28. Inherent in this strategy, therefore, is the need to continuously assess and manage each phase of the Plan implementation.

9.2 Data Gaps

Data gaps remain in water quality data in the watershed, source loading, soil data, hydrological data, contributions from commercial sources, contribution of aerial deposition and overall mass balance from all potential sources. In addition to these data gaps, data within the La Jolla Shores watershed on the effectiveness of water management strategies to meet the objectives of an integrated strategy is also limited. Given these data gaps, a tiered and iterative implementation strategy may provide the most sound scientific and engineering approach to the implementation of applicable water management strategies.

Based on the results from work conducted in the La Jolla Shores Coastal Watershed to date, the follow-up studies listed below are recommended:

<u>ASBS Ecosystem Assessment</u>

- Bioaccumulation Study Follow-up:
  - Confirm the positive metal findings near the Scripps Pier. If these findings are supported, then sediment contamination should be studied over relevant spatial gradients in an effort to identify the source
  - Perform toxicity tests to determine if arsenic, cadmium, lead, and/or zinc directly affect mussel growth and physiology at the concentrations mussels are exposed to in La Jolla or San Diego Bay. If metals were not the cause of decreased growth south of La Jolla, the ecological implications for the suspension feeding community off La Jolla Bay and the La Jolla headland are profound because that would indicate the food climates of these areas are substantially different.

- Subtidal and Intertidal Turf Community Study
  Intertidal and shallow subtidal algal turf communities, because of their shallow location and static boundary condition, are likely the most sensitive community to surface runoff from point and diffuse sources. The depth range of surface runoff of warm buoyant water is limited to the shallowest mixed zone, which is determined by wave action and is typically limited to the upper 5 meters of the water column. As part of the linkage approach, this study would include habitat characteristics, algal productivity, the most abundant (by biomass) primary and secondary consumers (invertebrates and fish). These data would be analyzed using multivariate data reduction and ordination techniques as well as multivariate regression and correlation techniques within the ASBS and the abundant nearby areas where these communities thrive off of La Jolla. This process will be focused around an effort to identify bioindicators.

- Subtidal and Intertidal Soft-Bottom Community Study
  The soft bottom communities (intertidal and subtidal) comprise the most area of the San Diego-Scripps Marine Conservation Area to the north, and a large fraction of the La Jolla Marine Conservation Area. This study would focus on megafaunal and macrofaunal organisms within these habitats (organisms larger than 1-2 mm).

- Sediment Microbial Community
  The microbial sediment community is an important community to study because members of this community can affect the bioavailability and toxicity of metals via biogeochemical transformation. The mussel bioaccumulation study indicated that concentrations of some metals were high relative to other open coastal areas on the west coast. However, the high energy dynamic nature of the open coastal environments of the ASBS off La Jolla may minimize the importance of the sediment microbial community in this area because sediments are highly mobile and the finer sediments (with which most microbes are associated) are resuspended and redistributed even by the typical wave climate off La Jolla.

<u>Physical Condition Studies</u>

- Focus future work in the ASBS on the effect of topography and small scale variability on nearshore circulation, and the consequences for nearshore marine habitats. The transition zone between the surfzone and inner shelf regions is particularly important for both benthic habitats, for larval spawning, and pollutant dispersion and transport. The complex topography of this area makes surfzone and nearshore processes especially complex and difficult to predict. Future studies should include both surfzone mixing and transport specific to this region, and exchange between the surfzone, nearshore, and inner shelf zones.

- In addition to resolving spatial variability and small-scale processes, seasonal and interannual variability should be a focus of any additional long-term circulation research. To accomplish this, future study in this region should include both extended time series in-situ field monitoring (currents, temperature), as well as process studies using dye and drifter experiments and high-resolution circulation and surfzone modeling.

<u>Public Participation</u>

- Barriers to Behavioral Change
  The first step towards creating behavioral change is to identify the barriers to the targeted behaviors you wish your audience to adopt, in this case non-polluting

sustainable behaviors that protect the ASBS. The CBSM approach starts by exploring and identifying the conditions that prevent people from engaging in the desired behavior. Barriers can vary depending on the population, context, and behavior of interest. These barriers can be either internal to the individual (i.e. lack of motivation) or external to the individual (i.e., insufficient number of trash receptacles on the beach). Uncovering such barriers is a hallmark feature of the CBSM approach, and an essential first step in creating an effective outreach campaign or improving an existing program. Barriers for the target behavior are typically identified through carefully conducted research such as literature reviews, focus groups, observational studies and surveys. This research is necessary in order to move to the next step of behavioral change: developing the outreach tools aimed at removing behavioral barriers.

Information Management

Designated ASBS along the coast of California exist in a complex coastal regime subject to ever-changing land-sea-atmospheric interactions. As a result, when evaluating the performance and behavior of an ASBS, it will be important to understand the physical environment both within and surrounding its environs. This regional description of the time-varying coastal environmental processes relevant to the ASBS will be critical to understanding ecosystem changes within the ASBS. Ecosystem and supporting environmental data necessary for full ASBS assessment must be integrated with the regulatory water quality, chemistry, toxicity, and field observations. Critical assessment questions facing coastal zone managers will be:

1. How to link trends and changes in the monitoring data to the management decisions made within the ASBS.
2. Assessing whether the observed changes are a result of climate/natural variability, or if external, anthropogenic influences are impacting the ASBS.

BMP Design

Effective runoff reduction and treatment BMP technologies that reduce runoff volumes, constituent concentrations and loading in dry weather and storm water flows require adequate design storm data. The runoff volume and constituent characteristics of a design storm can then be estimated and used to determine appropriate runoff reduction BMPs to reduce the volume of urban runoff or storm water that requires treatment. The tiered and phased approach to BMP implementation recommended by this Plan will allow some design storm characteristics to be measured and thus be able to adapt BMP implementation strategies as the phased approach progresses. Ultimately, the iterative approach presented in this plan provides the basis from which existing data gaps can be identified and addressed and overall pollution reduction goals can be met.

10.0 FINANCING

10.1 Implementation Funding

Funding for implementation of this plan will be provided through a variety of means. The Watershed Management Group (WMG) will fund individual projects to the extent that their budgets can support them. Each party has secured some level of funding over the next few fiscal years as described below. However, the WMG will depend largely on grant funding for implementation of larger projects and the ASBS Protection Model studies. Grants will continue to be sought on an individual and collective basis, and grant funding mechanisms will be expanded where possible to include not only State, but federal and local funding sources.

The WMG has been successful in funding a portion of the first phase of implementation projects through a SWRCB 2005-06 Consolidated Grant program. The project, titled the La Jolla Shores ASBS Dry Weather Flow and Pollution Control Program, was funded in January of 2007 and includes $3.7 million in best management practices aimed at reducing dry weather flows and treating storm water flows into the ASBS. UCSD also contributed over $1 million towards the project in matching funds to treat return seawater from the Birch Aquarium to reduce pollutants and introduction of non-indigenous species into the ASBS. These funded projects are included in the list of BMP projects in Appendix F.

10.1.1 City of San Diego

The City of San Diego, General Services Department, Storm Water Pollution Prevention Division's Fiscal Year 2007 budget has an Areas of Special Biological Significance (ASBS) line item for a total of $775,000. During the next fiscal year it is proposed to increase to $3 million. Projects include landside and waterside monitoring activities, planning activities, community outreach activities, the construction of Best Management Practices (BMPs) and enforcement of the Municipal Code. Additionally, the City of San Diego is pursuing grant opportunities to provide supplemental funding to perform mandated activities to meet the California Ocean Plan requirements. These grant opportunities may vary from Propositions 50 and 84 to US Environmental Protection Agency grant opportunities.

10.1.2 UCSD and SIO

UCSD and SIO currently fund more than $500,000 annually for monitoring storm water and seawater discharges, ocean and sediment sampling, weekly surfzone bacteria sampling, and marine studies related to ASBS protection efforts. In addition, SIO has funded more than $8 million for capital improvements on the seawater and storm water conveyance systems within the watershed. During the next 10 years, UCSD will fund an additional $5 million on storm water pollution prevention projects to support the La Jolla Shores Coastal Watershed Management Plan. Projects include erosion and sediment controls, storm water treatment and infiltration, and irrigation system improvements to prevent non-storm water discharges. In addition, UCSD is pursuing grant opportunities to provide supplemental funding to implement projects that support the California Ocean Plan requirements.

SCCOOS, currently funded by NOAA and the State Coastal Conservancy is streamlining, coordinating, and building an integrated, multidisciplinary coastal observatory in the Bight of Southern California to provide data, information, and science-based decision making tools for the benefit of society and will continue to seek funding for further development.

In addition, the Birch Aquarium at Scripps (BAS) will continue to seek funding for educational exhibits that provide ocean science education, interpret Scripps research, and promote ocean conservation

10.1.3 San Diego Coastkeeper

SDCK is funded through donations including Federal, Government, Corporation and member contributions. Through ongoing programs, Coastkeeper will continue to support ocean stewardship efforts in school programs such as Project SWELL, through articles in quarterly newsletters, email distribution, web sites and other public outreach efforts. Coastkeeper has not secured additional funding for ASBS activities directly associated with this Plan; however will continue to include ASBS-related information in all of its outreach materials and activities in the future. In addition, Coastkeeper will continue to identify funding sources for ASBS activities that coincide with marine conservation initiatives, which includes work on Marine Protected Areas (MPAs).

10.2 Potential Funding/Financing for Plan Implementation

The WMG will continue to seek annual funding for the implementation of components of the ICWM Plan through their annual budget processes. However, the primary source of funding will be State grants. The WMG will continue to seek funding through the Proposition 50, IRWM Chapter 8 program, the Proposition 84, Chapter 2 Safer Drinking Water and Water Quality Projects through the IRWM program, and the Proposition 84, Chapter 7, Protection of Beaches, Bays and Coastal Waters program through the Clean Beaches Program.

Because much of the ASBS Protection Model long-term study projects are oriented toward research and are closely aligned with the Ocean Protection Council (OPC) goals, the WMG will also work towards developing collaborative opportunities with the OPC.

10.3 Ongoing Support and Financing for Operation and Maintenance

Implementation of this plan will include construction of additional infrastructure that will require ongoing operation and maintenance. One of the objectives of the implementation planning for this program is to install low impact projects that utilize natural processes as much as possible, thereby reducing the need for ongoing maintenance and increasing the sustainable nature of the program. The City, SIO and UCSD have included inspection, operation and maintenance activities into their ongoing programs to support the BMPs installed as part of this program.

11.0 RELATION TO LOCAL PLANNING AND SUSTAINABILITY

The Plan is consistent and complimentary to the following completed watershed planning and urban runoff management documents shown in Table 10 below.

Table 10. Relevant Local and Regional Planning Efforts

Related Planning Documents	Comments
Mission Bay Watershed Urban Runoff Management Plan (Mission Bay Watershed Urban Runoff Management Plan (WURMP)). January 2003.	Prepared by the City's Storm Water Pollution Prevention Program (current Project partner) to address the quality of urban runoff. Mission Bay WURMP annually assesses conditions of concern and associated potential activities to address likely sources. The WURMP activity list was considered in identifying potential Plan BMPs.
City of San Diego Jurisdictional Urban Runoff Management Plan (JURMP), January 2002.	Prepared by the City's Storm Water Pollution Prevention Program as the blueprint for the City's actions to address urban runoff quality City-wide. The JURMP were considered in identifying potential Plan BMPs.
Storm Water Standards Manual, December 2002.	The City's development regulations which require both temporary (construction) and permanent storm water controls for new development projects. Project BMPs are consistent with the Standards Manual.
UCSD Long Range Planning Plan 2004	The 2004 Long Range Development Plan; Grounds and Building element emphasizes that Environmental Sustainability will be considered in the planning of the UCSD campuses. This Plan is consistent since it reduces environmental impacts from development through CEQA reviews.
University of California, San Diego, Storm Water Management Plan (SWMP)	The UCSD SWMP has recently been updated by the project team to include the coastal area at Scripps. The Plan is fully consistent and closely coordinated with the SWMP.
Scripps Coastal Reserve Management Plan, May 2003, prepared by the University of California Natural Reserve System	The Plan is consistent with two of the five Reserve Plan goals; Preservation of habitats, ecosystems and species, and Maintaining established ecological processes

Another important ongoing effort is the County of San Diego Integrated Regional Water Management (IRWM) Plan development. This IRWM Plan addresses all of San Diego County that is tributary to coastal waters. The IRWM Plan was prepared under the direction of a Regional Water Management Group (RWMG) that consists of representatives from the San Diego County Water Authority (Water Authority), City of San Diego, and County of San Diego. The IRWM Plan builds on the many individual and sub-regional management plans (including this ICWM Plan) within San Diego County, and was developed with input from a comprehensive array of water management stakeholders. The IRWM is an integrated, balanced, and consensus approach to ensuring the long-term sustainability of San Diego's water supply, water quality, and natural resources. The goals of the IRWM are to:

- Optimize water supply reliability
- Protect and enhance water quality
- Provide stewardship of our natural resources
- Coordinate and integrate water resource management

UCSD has recently begun an Environmental and Sustainability Initiative (ESI). ESI is a focal point for the development of multi-unit interdisciplinary research and teaching initiatives in environment and sustainability. The vision is to make UCSD a world leader in addressing the challenges of sustainable coastal cities. This Plan represent one of several projects are underway in which UCSD is leading the way in the area of ocean protection and moving towards a more sustainable approach to managing our discharges to protect the viability of our oceans.

12.0 IMPACTS AND REGIONAL BENEFITS

Water quality plays a significant role on public health, quality of life and the local economy of the San Diego region, known worldwide for its beautiful coast and idyllic climate. Nowhere is this more evident than the La Jolla Shores marine environment, home to the San Diego-Scripps State Marine Conservation Area established in 1929, and the adjoining 533-acre La Jolla State Marine Conservation Area. These areas, designated by the State Water Resources Control Board as Areas of Special Biological Significance (ASBS), are considered to be among the most valuable coastal waters in the State, attracting San Diegans and tourists from around the globe interested in enjoying native marine plants and animals in their natural state.

This environment must be protected if it is to remain valuable for the future. A focused effort is needed to protect and preserve it and to establish a system to assess and monitor its health. This plan and its subsequent implementation will protect these ecosystems by reducing the urban runoff pollutants discharging into them and establishing important assessment and monitoring tools that will enable us to more effectively manage impacts to these special areas over a long period of time.

The SWRCB found, when designating the local ASBS, that non-point source pollution is listed as the major threat to the area's water quality. Supporting this finding, the SWRCB has designated the La Jolla Shores beach as impaired for bacteria indicators and is establishing a TMDL. This process also lists the potential pollutant sources as non-point/point sources. As of 2001, the California Ocean Plan prohibits the discharge of waste into ASBS and the SWRCB is currently in the process of enforcing this prohibition. The coastal communities that discharge into ASBS are overwhelmed regarding their ability and the cost to comply because of the relatively scarce information available about ASBS protection. This Plan benefits these statewide efforts to protect all ASBS and marine environment by providing an ASBS Protection Model, and an integrated data management strategy aimed increasing our understanding of ecosystem process so that protective programs and practices are scientifically based, effective and practical. The ASBS Protection Model is designed to be applicable on a statewide basis. The model moves ocean protection strategies towards a more holistic approach that focuses on the actual impacts that urban runoff and storm water have on the ocean. The benefit of this approach to the state is the ability to assess where watershed actions will have the greatest impact on protection ocean resources. This will lead to more efficient use of state and local resources.

The Plan also provides a public benefit by educating the community about the precious resource they have at their shoreline, and empowering them to protect it. Public participation will ensure that the Plan considers stakeholder needs and interests. It also uses the information gathered and the analysis performed to increase site-specific awareness and stewardship within the watershed which will lead to a reduction of urban runoff pollutants being discharged into the ASBS.

12.1 Benefit to Disadvantaged Communities

As a whole, the La Jolla Shores watershed community can not be considered disadvantaged. However, the La Jolla Shores beach area is a major recreational resource for the entire County of San Diego and beyond. The beach is a public access, fee-free beach that draws 2-3 million beachgoers from all walks of life. The importance of the beach and marine environment as a regional recreational resource for swimming, surfing, snorkeling, diving and other related beach activities is substantial. Because of the unique and highly diverse underwater habitat it is important that the area be protected as a regional asset that benefits all residents of the county, including disadvantaged communities.

In addition, the WMG has sought out opportunities to serve disadvantaged communities through programs at the Birch Aquarium Scripps (BAS) and with the San Diego Urban Corps. These include educational programs at BAS that will benefit disadvantaged families by providing hands-on activities that instill a culture of stewardship which will carry into their daily lives and improve the quality of life in their communities. Working with the Urban Corps, disadvantage youth benefit from the environmental education and skills that they will develop interacting with SIO and City staff. This stewardship culture then carries back into the disadvantaged communities.

12.2 Benefit to the Region

As California's marine environment and ASBS issues come to the forefront, there is a need to develop scientific approaches to water quality protection and to expand marine conservation stewardship programs. The La Jolla Shores ICWM Plan outlines a process for protecting ASBS and the many beneficial uses associated with these important marine areas by focusing management measures on understanding and reducing the impacts of urban runoff. The Plan also includes an ASBS information management framework that will allow long-term assessment of ASBS performance and the related management decisions employed to protect the ASBS. Finally the Plan includes a public participation element through a comprehensive ocean stewardship program, recognizing that ultimately it is the public that must embrace the process of ASBS protection since it is often individuals' actions that can have significant impacts on urban runoff water quality and subsequent impacts to the ASBS.

This Plan provides a new standard for urban runoff management that addresses ASBS ecosystem impacts using a holistic scientific-based collaborative approach. It outlines a method to assess ASBS ecosystem impacts that is transferable to all ASBS in the State. Implementation of the Plan provides a methodology that focuses effort on critical water quality issues identified through an iterative and adaptive management approach to direct resources to management measures most beneficial to ASBS protection. It also provides a strategy for collection and management of ASBS-centered water quality and marine data that will assist policy and decision makers on a local and regional level. The collaborative approach taken in the development of, and advocated by, this Plan provides the benefit of collective endorsement by a wide variety of groups from NGOs to academics and practitioners that will allow valuable resources to be applied more directly to effective solutions and overall water quality protection. Finally, the public participation and ocean stewardship programs defined in this Plan provide far-reaching benefit as local residents and visitors to the La Jolla Shores area become aware of how they can make positive changes in their own daily practices that will improve water quality and lessen impacts to ASBS and ocean resources.

REFERENCES

Caltrans. 2006. Storm Water Monitoring And Research Program. Annual Data Summary Report. Final Report. (CTSW-RT-06-167.02.03).

Center for Watershed Protection, 2004. National Stormwater Quality Database. http://www.eng.us.edu/~rpitt/Research/ms4/mainms4.shtml.

City of San Diego, Water Department, The 2005 Urban Water Management Plan.

Effects of the San Diego-La Jolla Ecological Reserve on the Abundance, Diversity and Population *Structure of Reef Fishes,* Philip A. Hastings, Scripps Institution of Oceanography , Paul K. Dayton, Scripps Institution of Oceanography, California Sea Grant College Program, Research Completion Reports (University of California, San Diego), Year 2006 Paper Coastal 06 02A

La Jolla Light Thursday, January 1, 2004 Planning for Growth, By DAVE SCHWAB

La Jolla Community Plan and Local Coastal Program Land Use Plan, February 2004, City of San Diego Planning Department, 202 C Street, MS 4A, San Diego, CA 92101

McCuen, R.H. 2004. *Hydrologic Analysis and Design*, 3rd ed., Prentice Hall, Upper Saddle River, New Jersey.

Owen, C. A. 1981. *Copper deficiency and toxicity: acquired and inherited, in plants, animals, and man.* Noyes Publications, New Jersey

Regional Comprehensive Plan Performance Monitoring Report 2006, SANDAG (http://www.sandag.org/index.asp?projectid=1&fuseaction=projects.detail)

San Diego Community Profile: La Jolla (La Jolla is 99% built-out) http://www.sandiego.gov/planning/community/profiles/lajolla/index.shtml

Stolzenbach, K. D., Lu, R., Xiong, C., Friedlander, S., Turco, R, Schiff, K., and L. Tiefenthaler. 2001. Measuring and Modeling of Atmospheric Deposition on Santa Monica Bay and the Santa Monica Bay Watershed. Final Report to Santa Monica Restoration Project. 41 pp.

SWRCB, California Marine Waters Areas of Special Biological Significance Reconnaissance Survey Report, San Diego Marine Life Refuge, San Diego County. Water Quality Monitoring Report No.80-5. September 1980.

SWRCB, California Marine Waters Areas of Special Biological Significance Reconnaissance Survey Report, San Diego La Jolla Ecological Reserve, San Diego County. Water Quality Monitoring Report No. 79-1, February 1979.

University of California Natural Reserve System, Scripps Coastal Reserve Management Plan, May 2003.

University of California, San Diego 2004 Long Range Planning Plan, September 2004

University of California, San Diego 2004 Long Range Planning Plan, Final Environmental Impact Report, September 2004

USEPA, 1983. Results of the Nationwide Urban Runoff Program. PB 84-185552, U.S. Environmental Protection Agency, Washington, DC.

USEPA, 2006. http://www.epa.gov/R5Super/ecology/html/toxprofiles.htm

Woodward-Clyde Consultants, 1994. Contribution of Heavy Metals to Storm water from Automotive Disk Brake Pad Wear. October.

Weston Solutions, 2006. Chollas Creek TMDL Source Loading Assessment, BMP Evaluation, and Recommended Monitoring Strategy. Prepared for City of San Diego. August.

Weston Solutions 2006. Dry Weather Aerial Deposition Study. Prepared for City of San Diego. June.