Attachment 7

Los Peñasquitos

Watershed Management Area

Water Quality Improvement Plan

Los Peñasquitos
Watershed Management Area
Water Quality Improvement Plan and
Comprehensive Load Reduction Plan

Submitted to the San Diego Regional Water Quality Control Board by:

Draft

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Prepared by:

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With:

ACKNOWLEDGMENTS

The following members of the Water Quality Improvement Plan Consultation Committee have collaborated with the Responsible Agencies to make significant contributions to this plan.

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Executive Summary

Water Quality Improvement Plan for the Los Peñasquitos Watershed Management Area

The Los Peñasquitos Watershed Management Area encompasses 94 square miles of undeveloped open spaces and urban areas, draining ultimately into the Los Peñasquitos Lagoon through three main waterways, before meeting with the Pacific Ocean.

The Water Quality Improvement Plan proposes a comprehensive watershed-based program to improve surface water quality in the Los Peñasquitos Watershed Management Area (WMA), in receiving waters in the Los Peñasquitos Lagoon, and at nearby beaches. The Water Quality Improvement Plan implements the Federal Clean Water Act's objectives to protect, preserve, enhance, and restore water quality for beneficial recreational, wildlife, and other uses.

The Los Peñasquitos WMA encompasses almost 94 square miles of urban land and undeveloped open space extending from the Los Peñasquitos Lagoon beyond Highway 67 to the east. The WMA includes Torrey Pines, Del Mar, Carmel Valley, Sorrento Valley, Mira Mesa, Rancho Peñasquitos, Carmel Mountain, Sabre Springs, and Poway. Small finger canyons drain into three main creeks (Carmel Valley Creek, Los Peñasquitos Creek, and Carroll Canyon Creek) that lead into the Los Peñasquitos Lagoon and ultimately the Pacific Ocean (Figure ES-1).

The Water Quality Improvement Plan Process

The Water Quality Improvement Plan identifies goals and strategies to correct impairments in the quality of urban runoff waters. These improvements to water quality are achieved through the consistent process of evaluation, goal setting, and monitoring and reporting, according to the following process:

Step (1) determines the *priority and highest priority water quality* conditions that pose the highest threat to water quality in the affected waterbodies in the WMA (e.g., a creeks or bay) on the basis of evidence showing that a waterbody is being polluted by runoff from the municipal separate storm sewer system (MS4). Step (2) identifies the sources of pollution of the *highest priority water quality* conditions. Step (3) formulates goals, strategies, and schedules to address the highest priority water quality conditions. As part of this step, the City of San Diego estimated the projected funding needs to implement the jurisdictional strategies needed to achieve the goals identified.

The final three steps of the Water Quality Improvement Plan are designed to evaluate the progress made in addressing the priority and highest priority water quality conditions. Step (4) provides ongoing monitoring and assessment to evaluate the overall progress made in the WMA, including success in meeting the goals identified for the highest priority water quality conditions. Step (5) updates the Water Quality Improvement Plan as needed through an Adaptive Management Process, which can entail adjustments to goals and strategies, as needed, to increase effectiveness. Step (6) reports on the findings of the assessments, along with any adjustments to the Water Quality Improvement Plan. Through these steps, the Water Quality Improvement Plan provides a long-term program to measurably improve overall water quality within the Los Peñasquitos WMA.

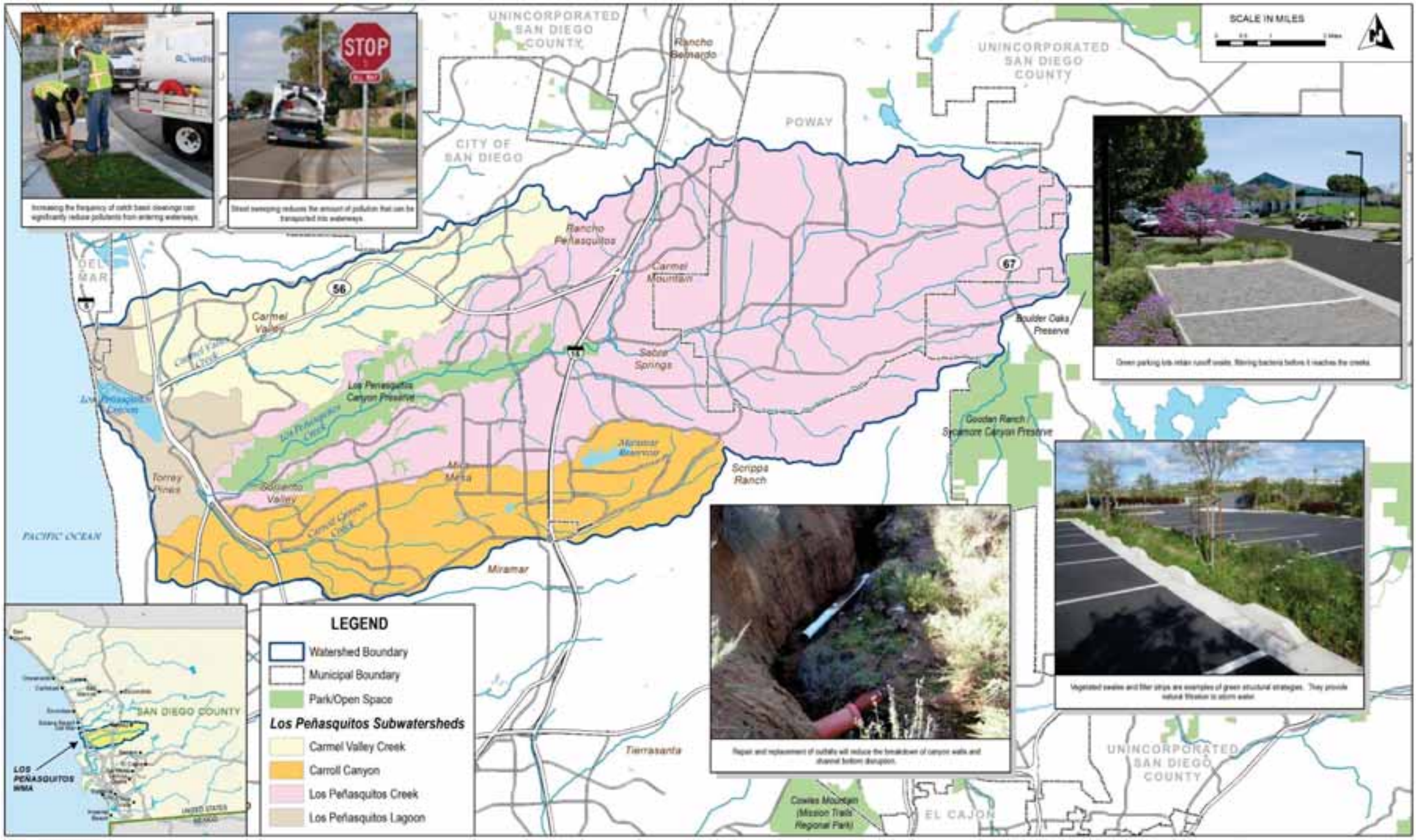

Figure ES-1
Los Peñasquitos Watershed Management Area Map

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Highest Priority Water Quality Conditions and Solutions

The Water Quality Improvement Plan identifies the following conditions/pollutants as highest priorities within the Los Peñasquitos WMA:

- Freshwater discharges during dry weather
- Transport of sediment from upstream sources (current and historical) during rain events
- Bacteria accumulations as measured during both wet and dry weather at Torrey Pines State Beach near the Los Peñasquitos Lagoon mouth

Both structural and nonstructural solutions and strategies to address these conditions/pollutants are included in the Water Quality Improvement Plan and include the following:

Nonstructural strategies, such as outreach programs and site design guidelines mandating better storm water controls, are intended as the preferred first step for addressing the highest priorities because of their relatively lower cost. These solutions do not involve construction or implementation of a physical structure to filter and treat storm water, to prevent pollution.

Structural strategies, defined as solutions that are physically constructed to address water quality conditions, are intended for distribution as needed and possible throughout the WMA. These facilities remove pollutants through a variety of chemical, physical, and biological processes, including filtration and infiltration.

Water Quality Improvement Goals, Strategies, and Schedules

To address the highest priorities within the Los Peñasquitos WMA, this Water Quality Improvement Plan includes the following goals, strategies, and schedules to improve water quality:

Goals

- Maintain water quality in the Los Peñasquitos WMA and subwatersheds to protect creeks and beaches from pollution.
- Reduce bacteria levels at the Pacific Shoreline near Torrey Pines State Beach (by FY 2021 for dry weather and by FY 2031 for wet weather).
- Reduce sediment inputs and freshwater discharges to the Los Peñasquitos Lagoon by FY 2035, to allow significant restoration of the Los Peñasquitos Lagoon.

Strategies and Schedules

Ongoing:

- ❖ Implement watershed-specific water conservation programs, including expansion of public education and outreach programs, and addition of Water$mart irrigation systems, weather-based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor systems, rain barrels, and turf removal.
- ❖ Actively maintain and improve the municipal storm water sewer system by replacing aging pipes and catch basins, augmenting current cleaning protocols with best available technologies, and enhancing pollution cleanup activities such as street sweeping.
- ❖ Increase the number of inspections of residential, commercial, and industrial land uses to identify and prevent pollution at its source.
- ❖ Stabilize portions of Rattlesnake Creek in the City of Poway to reduce sediment loading resulting from natural erosion and manmade hydromodification within this subwatershed area.
- ❖ Restore, maintain, and install new best management practices (BMPs) throughout the WMA to remove pollutants before they enter the waterways.
- ❖ Restore salt marsh habitat in Los Peñasquitos Lagoon to compensate for precious losses of this habitat type throughout the watershed.
- ❖ Develop and implement a "Green Infrastructure Policy" in the City of San Diego that will set standards for development and redevelopment efforts that will protect and improve water quality, diminish or eliminate pollutant loading, and potentially help restore this watershed.

By 2016:

- ❖ Promote water conservation and other environmental control efforts throughout the WMA.
- ❖ Implement enhanced inspection programs to identify and diminish pollutant sources.
- ❖ Expand outreach to homeowners associations to engage planned communities in water quality improvements and pollution efforts.
- ❖ Conduct frequent inspections of storm water outfalls to eliminate flow during dry weather periods, thus eliminating pollutant loading and sediment transport.
- ❖ Initiate sweeping of medians on high-traffic roadways in the City of San Diego to reduce pollutant accumulations that could potentially wash into the storm drain system.

By 2020:

- Develop a comprehensive restoration plan for the Los Peñasquitos Lagoon that identifies schedules and potential funding resources to accomplish that effort.

By 2022:

- Ensure that new infrastructure projects in public rights-of-way throughout the watershed are constructed using best available “Green Infrastructure” techniques so they better intercept, capture, and control pollutants.
- Construct other structural BMPs as needed and as possible within the City of Poway, including a constructed wetland and/or extended detention basin that will capture and slow storm water flows, helping to remove transported pollutants and sediment.
- Begin construction and regular maintenance of bioretention facilities throughout the City of San Diego portions of the WMA to capture and infiltrate storm water flows so that pollutants can be filtered out as water reenters local aquifers.

By 2035:

- Coordinate with WMA partners to complete restoration of 346 acres of habitant within the Los Peñasquitos Lagoon (habitat types to be selected by partner agencies involved in the development of this Water Quality Improvement Plan).

Public Participation and Outreach

The development of the Water Quality Improvement Plan included substantial input from stakeholders and community leaders throughout the Los Peñasquitos WMA. This outreach included formation of a Consultation Committee consisting of representatives from community organizations, neighborhood groups, and businesses sharing a commitment to improve water quality. Future public input from the Consultation Committee and the general public will be considered during updates to the Water Quality Improvement Plan.

How to Stay Involved

Any questions, comments, or requests for more information regarding the Water Quality Improvement Plan may be submitted via email to Karina Danek at KDanek@sandiego.gov.

In addition, once the Water Quality Improvement Plan is submitted to the Regional Water Quality Control Board (Regional Board), comments will be formally collected by Regional Board staff during the 30-day comment period. More information is available on the Regional Board’s website: www.waterboards.ca.gov.

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition
%	percent
303(d)	Clean Water Act Section 303(d) list of impaired waters
AB 411	California Assembly Bill 411 (Beach Safety Act)
Ag Waiver	Conditional Waiver of Discharges from Agricultural and Nursery Operations
AGR	Agricultural Supply (beneficial use)
ASBS	Area of Special Biological Significance
Bacteria TMDL	San Diego Regional Water Quality Control Board Resolution Number R9-2010-0001, *Revised TMDL for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region (Including Tecolote Creek)*
Basin Plan	*Water Quality Control Plan for the San Diego Basin* (Regional Board, 1994)
Bight '13	Southern California Bight 2013 Regional Monitoring Survey
BIOL	Preservation of Biological Habitats of Special Significance (beneficial use)
BMI	benthic macroinvertebrates
BMP	best management practice
BOA	business owners association
BOD	biological oxygen demand
Caltrans	California Department of Transportation
CEDEN	California Environmental Data Exchange Network
CLRP	Comprehensive Load Reduction Plan
Consultation Committee	Water Quality Improvement Plan Consultation Committee
Copermittee	Operator of a municipal separate storm sewer system in San Diego County that is party to the MS4 Permit

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
County	County of San Diego
CRAM	California Rapid Assessment Method
CWA	Clean Water Act
CWP	Clean Water Program
DEH	(County) Department of Environmental Health
DPR	(California) Department of Pesticide Regulation
DSD	(City of San Diego) Development Services Department
DWR	(California) Department of Water Resources
EST	Estuarine Habitat (beneficial use)
FIB	fecal indicator bacteria
FY	Fiscal Year
GIS	geographical information system
HMP	Hydromodification Management Plan
HOA	home owners association
HPWQC	Highest Priority Water Quality Condition
IBI	Index of Biological Integrity
IC/ID	illicit connection and/or illicit discharge
IDDE	illicit discharge detection and elimination
IGP	Industrial General Permit
JRMP	Jurisdictional Runoff Management Program (2013 MS4 Permit)
JURMP	Jurisdictional Urban Runoff Management Program (2007 MS4 Permit)
Lagoon	Los Peñasquitos Lagoon

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
LID	low-impact development
LPC-MLS	Los Peñasquitos Mass Loading Station
LTEA	Long-Term Effectiveness Assessment
MEP	maximum extent practicable
MLS	mass loading station
MOU	Memorandum of Understanding
MS4	municipal separate storm sewer system
MS4 Permit	San Diego Regional Water Quality Control Board Order Number R9-2013-0001, *National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer System (MS4) Draining the Watersheds Within the San Diego Region*
MST	microbial source tracking
MSWSMP	Master Storm Water System Maintenance Program
MWD	Metropolitan Water District of Southern California
NA	not applicable
NAL	non-storm water action level
NCC	North Coast Corridor
NCTD	North County Transit District
NIH	National Institutes of Health
NLCD	National Land Cover Database
NOI	Notice of Intent
Non-MS4	Non-Phase I MS4s
NPDES	National Pollutant Discharge Elimination System
O&G	oil and grease

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
OAL	(California) Office of Administrative Law
PDP	priority development project
PFC	permeable friction course
PGA	pollutant-generating activity
Porter-Cologne	Porter-Cologne Act
POTW	publicly owned treatment works
PUD	Public Utilities Department
PWQC	Priority Water Quality Condition
REC-1	Contact Water Recreation (beneficial use)
REC-2	Non-Contact Water Recreation (beneficial use)
Regional Board	San Diego Regional Water Quality Control Board
Responsible Agency	A party subject to the Bacteria TMDL and/or Sediment TMDL and participating in this Water Quality Improvement Plan (specifically, the Copermittees and Caltrans)
ROWD	Report of Waste Discharge
RWL	Receiving Water Limitation
SAL	storm water action level
SANDAG	San Diego Association of Governments
SCCWRP	Southern California Coastal Water Research Project
SDCWA	San Diego County Water Authority
Sediment Control Plan	State Water Board's *Water Quality Control Plan for Enclosed Bays and Estuaries of California – Part I Sediment Quality*
Sediment TMDL	San Diego Regional Water Quality Control Board Resolution Number R9-2012-0033, *Total Maximum Daily Load for Sedimentation in Los Peñasquitos Lagoon*

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
SHELL	Shellfish Harvesting (beneficial use)
SMARTS	Storm Water Multiple Application and Report Tracking System
SMC	Southern California Stormwater Monitoring Coalition
SMC Regional Bioassessment Program	SMC Regional Freshwater Stream Bioassessment Monitoring Program
SOP	standard operating procedure
SQO	Sediment Quality Objective
SSC	suspended sediment concentrations
SSID	stressor/source identification
State	State of California
State Board	State Water Resources Control Board
SUSMP	Standard Urban Storm Water Mitigation Plan
SWAMP	Surface Water Ambient Monitoring Program
SWMP	Stormwater Management Plan
T&SW	(City of San Diego) Transportation and Storm Water Division
TBD	to be determined
TDS	total dissolved solids
TIE	toxicity identification evaluation
TMDL	total maximum daily load
TRE	toxicity reduction evaluation
TSS	total suspended solids
TWAS	temporary watershed assessment station
USEPA	United States Environmental Protection Agency

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
WARM	Warm Freshwater Habitat (beneficial use)
WLA	wasteload allocation
WMA	Watershed Management Area
WMAA	Watershed Management Area Analysis
WPP	Watershed Protection Program
WQBEL	water quality-based effluent limit
WQIP	Water Quality Improvement Plan
WQO	water quality objective
WRI	World Resources Institute
WURMP	Watershed Urban Runoff Management Program

1 Introduction

Local government agencies work hard to protect water quality throughout the San Diego region. New regulations along with existing environmental protections create the need for new plans and programs that will address concerns about pollution in local rivers, streams, and other waterways leading to the ocean. Local agencies worked to develop Water Quality Improvement Plans that will help protect and improve the quality of waters in each community of San Diego. These plans address protections in what are known as Watershed Management Areas. A Watershed Management Area (WMA) includes the lands, stream systems, and other tributaries draining to a specific ocean or bay shoreline (or other receiving water). This document is the Water Quality Improvement Plan for the Los Peñasquitos WMA.

The Los Peñasquitos WMA is a highly urbanized 94-square-mile portion of central San Diego County (County). It includes three distinct hydrologic areas draining to the Los Peñasquitos Lagoon and ultimately the Pacific Ocean. Five local agencies share jurisdictional authority in this WMA and worked collaboratively to prepare this Water Quality Improvement Plan.

Water Quality Improvement Plans are required for each WMA under regulations adopted by the San Diego Regional Water Quality Control Board (Regional Board). The plans address only water flows and discharges from the storm drain systems maintained by the local agencies sharing authority in each area. Other discharges and sources of pollution are considered in

<u>Section 1 Highlights</u>

- This Water Quality Improvement Plan helps to protect and improve waters in the Los Peñasquitos Watershed Management Area.
- The plan specifically addresses conditions within storm water systems and receiving waters of this area.
- Los Peñasquitos WMA = 94 square miles
- Main Subwatersheds:
  - Carroll Canyon
  - Los Peñasquitos Creek
  - Carmel Valley Creek
  - Los Peñasquitos Lagoon
- Responsible Agencies:
  - City of Del Mar
  - City of Poway
  - City of San Diego
  - County of San Diego
  - California Department of Transportation (Caltrans)
- Other Discharge Impacts:
  - Phase II Permittees – Marine Corps Air Station Miramar, University of California, San Diego, and North County Transit District
  - Construction General Permits
  - Industrial General Permits
  - Federal/State Lands
  - Agricultural Lands
- This document serves as the Comprehensive Load Reduction Plan for the Sediment Total Maximum Daily Load.

the plan to the extent that they affect conditions in the storm drain system.

Following the passage of the Federal Clean Water Act (CWA) in 1972, surface water quality throughout the United States has improved substantially. However, poor water quality still impairs some beneficial uses of surface waters in the Los Peñasquitos WMA. Beneficial uses are “the uses of water necessary for the survival or well-being of man, plants, and wildlife” (Regional Board, 1994).

1.1 Jurisdiction and Responsibilities

The Water Quality Improvement Plan outlines a framework to improve the surface water quality in the Los Peñasquitos WMA by identifying, prioritizing, and addressing impairments related to urban runoff discharges. On May 8, 2013, the San Diego Regional Water Quality Control Board adopted Order Number R9-2013-0001, *National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer System (MS4) Draining the Watersheds Within the San Diego Region* (MS4 Permit), establishing requirements for discharges from MS4s in the San Diego region. On February 11, 2015, the Regional Board adopted Order Number R9-2015-0001 amending the MS4 Permit. The amended MS4 Permit became effective on April 1, 2015.

The MS4 Permit affects local municipal agencies, including those with jurisdictional responsibilities in the Los Peñasquitos WMA. As defined in the MS4 Permit, a permittee to an NPDES permit is responsible only for permit conditions relating to the discharges for which it is an operator. In the case of the MS4 Permit, this responsibility includes discharges from Copermittees (jurisdictions party to the MS4 Permit) in the San Diego region. The San Diego County Copermittees are listed in Table 1a of the MS4 Permit and the Copermittees with jurisdictional area within the Los Peñasquitos WMA are as follows:

- City of Del Mar
- City of Poway
- City of San Diego
- County of San Diego

Each Copermittee must comply with the MS4 discharge prohibitions and receiving water limitations outlined in the MS4 Permit through timely implementation of control measures, other actions specified in the MS4 Permit, and adherence to this Water Quality Improvement Plan.

The Los Peñasquitos WMA also includes land area and MS4s that are owned and operated by parties other than the Copermittees or that are regulated by separate NPDES permits.

Discharges from non-municipal sources and activities (e.g., runoff from agriculture and industrial land uses, federal and state facilities, the California Department of Transportation [Caltrans], and discharges from Phase II storm water permittees [small MS4s]) are regulated separately. For example, facilities designated as Phase II permittees are regulated under the Phase II General Permit (State Water Resources Control Board [State Board] Order No. 2013-0001-DWQ). Phase II permittees in the Los Peñasquitos WMA include the North County Transit District, the University of California, and MCAS Miramar. In California, industrial and construction activities are regulated under the General Industrial Permit (State Board Order No. 2014-0057-DWQ) (State Board, 2014) and General Construction Permit (State Board Order No. 2012-0006-DWQ) (State Board, 2012a). Finally, conditional waivers that remove the need to file a report of waste discharge and that avoid coverage under the NPDES permit program are given to activities such as agriculture and nursery operations, onsite disposal systems, silvicultural operations, and animal operations. Recently, draft general water discharge requirements for commercial agricultural and nursery operations were released for public review. The tentative draft order may be finalized during the development of this Water Quality Improvement Plan, affecting the ways in which discharge from commercial agricultural and nursery operations are managed.

Under this regulatory framework, there are two general areas of storm water management responsibilities: (1) jurisdictional inspection and oversight (such as education, enforcement, and other Illicit Discharge Detection and Elimination (IDDE) activities), as described in the Jurisdictional Runoff Management Programs (JRMPs) in the MS4 Permit, and (2) control of pollutant discharges.

(1) The Los Peñasquitos WMA Copermittees require minimum Best Management Practices (BMPs) and have inspection responsibilities over all lands within their jurisdictional boundaries (including industrial lands and construction sites), except for NPDES Phase II, agricultural, state, federal, Caltrans, and Indian reservation lands. The United States Environmental Protection Agency (USEPA), State Board, and Regional Board are responsible for inspections of Phase II, agricultural, state, federal, and Indian reservation lands. Caltrans is subject to its own State of California (State)-issued MS4 Permit. In addition, the USEPA, State Board, and Regional Board have dual permitting and oversight responsibilities over industrial lands and construction sites.

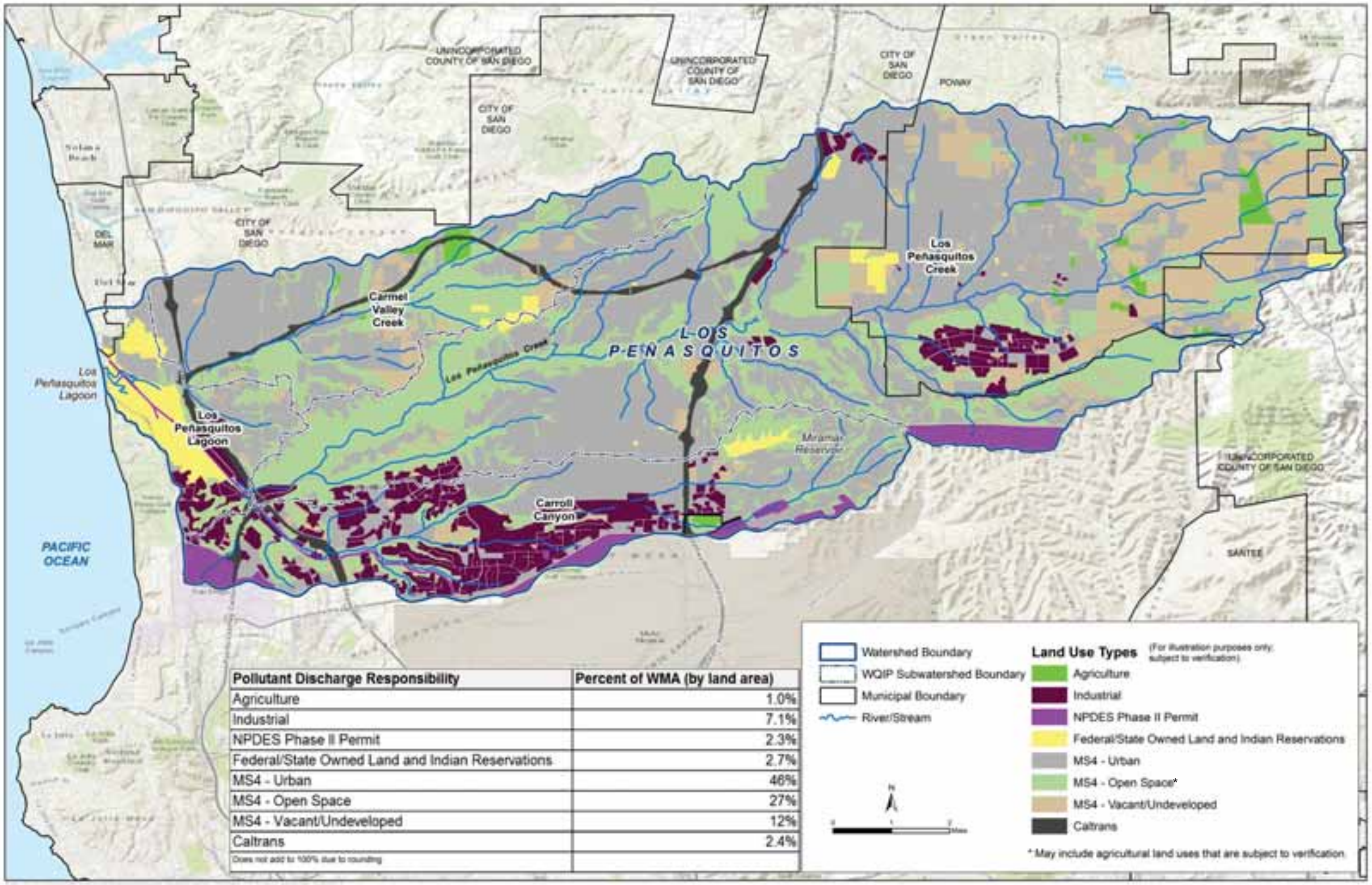
    Copermittees do have limited regulatory oversight over industrial lands, construction sites, Phase II MS4s, and agricultural, state, federal, and Indian reservation lands. For example, the Copermittees implement IDDE activities to identify, investigate, and enforce discharges to their MS4s. Discharges to receiving waters from non-municipal sources and activities (e.g., runoff from agriculture and industrial land uses, federal and state facilities, Caltrans, and Phase II storm water permittees) are not regulated or controlled by the Copermittees when they do not enter a MS4. Accordingly, the scope of the Water Quality Improvement Plan is limited to the regulatory oversight of the Copermittees specified above.

(2) In regard to controlling pollutant discharges, various NPDES permits or conditional waivers regulate storm water and non-storm water discharges within the Los Peñasquitos WMA, as shown in Figure 1-1. The Copermittees are responsible for controlling pollutant discharges from lands within their jurisdictional boundaries, except for agriculture and industrial land uses, federal and state facilities, Caltrans, and Phase II storm water permittees. The Copermittees do not have regulatory authority under the MS4 Permit to require entities regulated by other permits issued by the USEPA, State Board, or Regional Board to implement and/or construct BMPs to treat wet/dry weather pollutant discharges originating from their properties, facilities, and/or activities. However, the MS4 Permit requires the Copermittees to control pollutants originating from Non-Phase I MS4s (Non-MS4) or non-municipal lands if those pollutants ultimately discharge into the MS4. Therefore, the Copermittees recognize the need to collaborate with and improve communication between non-municipal entities within the WMA and the appropriate regulatory agencies to ensure that discharges are appropriately regulated before entering the MS4, and to improve water quality throughout the Los Peñasquitos WMA.

To help identify non-municipal sources, the Copermittees are participating in special source identification studies to determine potential sources (including non-municipal sources) of pollutants entering the MS4; these studies are presented in Section 5. Additionally, the Copermittees are conducting additional watershed modeling to quantify the amount of pollutant loads coming from non-municipal sources and activities, and the results are presented in Section 4.

This document also serves as the *Comprehensive Load Reduction Plan (CLRP) for the Total Maximum Daily Load (TMDL) for Sedimentation in Los Peñasquitos Lagoon*, Resolution No. R9-2012-0033 (Sediment TMDL) (Regional Board, 2012), which is due to the Regional Board within 18 months of California Office of Administrative Law (OAL) approval of the Sediment TMDL. The goal of a CLRP is to describe in detail the programmatic and adaptive management approach developed by the Responsible Agencies to meet the requirements of the Sediment TMDL. A CLRP should outline the strategies planned to attain the necessary load reductions spelled out in the TMDL and this plan will meet these requirements, as described in Section 4 of the document.

Caltrans has partial responsibility for the implementation of the CLRP for the TMDL for indicator bacteria, *Project I—Twenty Beaches and Creeks in the San Diego Region (Including Tecolote Creek),* Resolution No. R9-2010-0001 (Regional Board, 2010), referred to as the Bacteria TMDL. Note that while Caltrans has its own separate NPDES permit (Order No. 2012-0011-DWQ) (State Board, 2012b) and is not subject to the MS4 Permit, it is participating voluntarily along with the Copermittees in the development of the Water Quality Improvement Plan for the Los Peñasquitos WMA and other WMAs across the region.



Pollutant Discharge Responsibility	Percent of WMA (by land area)
Agriculture	1.0%
Industrial	7.1%
NPDES Phase II Permit	2.3%
Federal/State Owned Land and Indian Reservations	2.7%
MS4 - Urban	46%
MS4 - Open Space	27%
MS4 - Vacant/Undeveloped	12%
Caltrans	2.4%
Does not add to 100% due to rounding	

Figure 1-1
Los Peñasquitos WMA
Pollutant Discharge Responsibilities

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This plan has been prepared, as required by the MS4 Permit, by the Responsible Agencies in the Los Peñasquitos WMA. The Responsible Agencies that are party to the development of this Water Quality Improvement Plan are:

- City of Del Mar
- City of Poway
- City of San Diego
- County of San Diego
- Caltrans

Collectively, the Copermittees and Caltrans are referred to as Responsible Agencies.

Currently, some of the Copermittees are pursuing a subvention of funds from the State to pay for certain activities required by the 2007 MS4 Permit, including activities that require Copermittees to perform activities outside their jurisdictional boundaries and on a regional or watershed basis. Nothing in this Water Quality Improvement Plan should be viewed as a waiver of those claims or as a waiver of the rights of Copermittees to pursue a subvention of funds from the State to pay for certain activities required by the 2013 MS4 Permit, including the preparation and implementation of the Water Quality Improvement Plan. In addition, several Copermittees have filed petitions with the State Board challenging the requirement to prepare Water Quality Improvement Plans that are not voluntary and that are not linked to a receiving water limitations language compliance path. Nothing in this Water Quality Improvement Plan should be viewed as a waiver of those claims. Because the State Board has not issued a stay of the 2013 MS4 Permit, Copermittees must comply with the MS4 Permit’s requirements while the State Board process is pending.

1.2 Regulatory Background

In 1972, the CWA amended the Federal Water Pollution Control Act in 1972, providing the mechanism for regulating discharges to waters of the United States through the NPDES permit program. The CWA requires appropriate NPDES permits for specific types of discharges (e.g., municipal and industrial storm water) to surface waters of the United States. Individual states may administer the federal law through their own legislation, in addition to regulating other types of discharges, such as those to land and irrigated agriculture.

California passed the Porter-Cologne Water Quality Control Act (Porter-Cologne) to control water pollution in 1969 (prior to the CWA), and has since amended it to comply with and implement the CWA. Porter-Cologne gave the State Board and the nine Regional Water Quality Control Boards the authority to regulate discharges to waters of the state (which include all waters of the United States) and to issue NPDES permits.

The jurisdictions of the nine Regional Water Quality Control Boards correspond to nine large watershed areas across the state, which are referred to as basins. These basins are delineated using topographical maps surveyed by the United States Geological Survey and are further subdivided into (smaller) watersheds and subwatersheds. The water quality standards, including the beneficial uses and water quality objectives, for each basin are detailed in the Water Quality Control Plan (Basin Plan) for each region. For the San Diego region (Region 9), the Basin Plan was adopted in 1994 and has been amended several times since. The Los Peñasquitos WMA is one of ten watersheds (otherwise known as a WMA) within the San Diego Basin and is regulated by the Regional Board using its authority under Porter-Cologne in conjunction with the water quality standards described in the Basin Plan.

For approximately 20 years after the CWA's passage, NPDES permits were primarily issued to wastewater and industrial facilities (such as publicly owned treatment works [POTWs], paper mills, and power plants) that discharged waste to natural surface water as part of their operations. These regulations substantially improved surface water quality throughout the country. However, many waterbodies still suffered from suboptimal water quality and their benefits (termed "beneficial uses" in the CWA) were not always attained.

The pathways by which pollutants can enter waters of the state are not limited to wastewater discharging from a pipe. In the early 1990s, the California Regional Water Quality Control Boards began to issue NPDES permits to municipalities and other agencies that discharge water via a storm drain system (identified as an MS4). The MS4s, which are systems of conveyances that may include the storm drains and flood control structures associated with land development, are primarily owned and operated by municipalities. MS4s are distinguished from combined sewers, which direct storm drain flows to a wastewater treatment plant. In contrast, MS4s convey water flowing from streets, buildings, and other land areas directly and indirectly into surface waters; they may convey both storm water and authorized non-storm water discharges.

The initial ("Phase I") MS4 Permits, typically issued for a five-year term, focused on actions to be taken by Copermittees. These actions included regulation of residential and commercial activities, new and existing development, other construction activities, facility inspections, water quality monitoring, and programs to detect and eliminate illegal discharges.

The Phase I MS4 Permits also established the following regulatory mechanisms:

- ***Receiving water limitations*** prohibit discharges from MS4s that cause or contribute to the violation of water quality standards or water quality objectives.
- ***Effluent limitations*** are based on either technology, to require pollutants to be reduced to the maximum extent practicable (MEP), or on water quality, to specify the maximum concentration of pollutants in storm water discharges from MS4s.

- ***Discharge prohibitions*** detail what may and may not be legally discharged to a state waterbody in a manner causing, or threatening to cause, a condition of pollution, contamination, or nuisance.

Monitoring programs required by these early permits were effective in characterizing the receiving waters in urban areas and the pollutants typically found in MS4 discharges. Furthermore, the permit programs developed and implemented numerous BMPs, ranging from street sweeping to public education and outreach to true source control (e.g., eliminating copper from automotive brake pads through state legislation). However, despite the implementation of program activities meeting the MEP standard, impairments of beneficial uses remain. Because the impairments exist, the Regional Board is required to review existing policies and develop new policies, such as TMDLs. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards, and an allocation of that load among the various sources of the pollutant.

The Regional Board worked closely with the Copermittees and interested parties during development of the most recent version of the MS4 Permit to institute a new scientifically based approach to water quality management. The new approach is based on water quality outcomes, rather than on fulfillment of prescriptive activities. While maintaining each jurisdiction’s authority and accountability, monitoring is conducted to answer specific questions and provide the basis for implementation actions in the Los Peñasquitos WMA.

1.3 Water Quality Improvement Plan Process

During development of the Water Quality Improvement Plan, the Responsible Agencies solicited data, information, and recommendations through a public participation process, as mandated by Provision F.1.a of the MS4 Permit. The public participation process included public workshops (described in Sections 2 and 3 of this document) and the creation of a Water Quality Improvement Consultation Committee (Consultation Committee), which provided recommendations during the development of this Water Quality Improvement Plan.

The Consultation Committee included the following required representatives:

- A representative of the Regional Board
- A representative of the environmental community (i.e., a non-governmental organization) associated with a waterbody within the WMA
- A representative of the development community familiar with the opportunities and constraints of implementing structural BMPs, retrofitting projects, and stream, channel, or habitat rehabilitation projects in the WMA

In addition to the three required Consultation Committee members, the Responsible Agencies chose six members at-large based on interest forms received after the first public workshop.

The Consultation Committee reviews drafts of key sections of this Water Quality Improvement Plan, and meets periodically during the two-year development process to discuss the following topics:

- Priorities, potential strategies, and sources of pollutants and stressors (November 2013 [completed])
- Numeric goals, strategies, and schedules (July 2014 [completed] and October 2014 [completed])
- Final Water Quality Improvement Plan (June 2015, 30-day comment period)

1.4 Water Quality Improvement Plan Goal and Approach

The goal of the Water Quality Improvement Plan is to reduce pollutants and stressors in MS4 discharges to further the CWA's objective to protect, preserve, enhance, and restore the water quality and designated beneficial uses of waters of the state. As schedules allow, the Water Quality Improvement Plan is being developed in coordination with the Lagoon Enhancement Program currently being designed by the Los Peñasquitos Lagoon Foundation.

Since the inception of Phase I MS4 Permits more than 20 years ago, the Copermittees have directed substantial resources (through the Watershed Urban Runoff Management Program [WURMP], the Jurisdictional Urban Runoff Management Programs [JURMPs], and other various programs) to improve water quality in the WMA. This Water Quality Improvement Plan represents the next phase in watershed management and enhancement following many years of monitoring and program implementation. Additionally, this Water Quality Improvement Plan serves as the comprehensive planning document for the proposed management program that will be implemented within the Los Peñasquitos WMA. As the comprehensive planning document, this Water Quality Improvement Plan incorporates and replaces all previously submitted comprehensive planning documents for this WMA.

This Water Quality Improvement Plan is intended to be a living document and proposes an iterative and adaptive management process to meet the MS4 Permit goal. The overall process is shown in Figure 1-2 and described in this section.

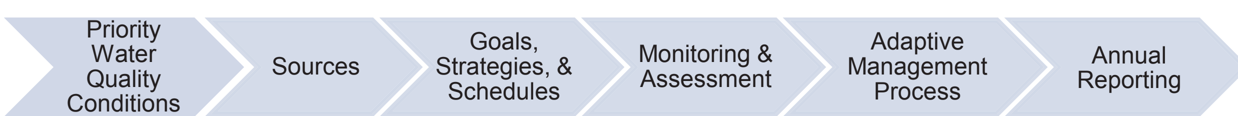

Figure 1-2
Water Quality Condition Improvement Plan Process

The initial step in developing this plan was reviewing known receiving water impairments and the water quality data that had been collected during prior MS4 Permit cycles, along with other available data and public input. This process identified a set of receiving water conditions within the Los Peñasquitos WMA (Section 2.1).

For each identified receiving water condition, available data from upstream MS4 discharges were reviewed to determine whether there was evidence that the MS4 discharges may be a source of pollutants to the receiving water condition (Section 2.2). When evidence of a potential linkage was found, the receiving water condition became a “priority water quality condition” (Section 2.3). A subset of these priority water quality conditions was selected to represent the highest priority water quality conditions (Section 2.4). The CWA regulatory process and the NPDES monitoring programs performed to date have generally been successful in identifying the highest priorities in the Los Peñasquitos WMA. Selection of the highest priority water quality conditions is based on the methodology developed by the Responsible Agencies (Appendix A) and these conditions reflect some of the most challenging water quality issues to address in the WMA. The highest priority water quality conditions identified in this plan were subject to review and input from the Regional Board; environmental, business, and development organizations; and the public.

Current water quality issues identified by the Responsible include impaired waterbodies with designations that have been approved by the USEPA per CWA Section 303(d) (303(d) or 303(d) list or listing). Goals and schedules for addressing these issues have been developed and included in the Basin Plan as TMDLs for certain 303(d) listings.

With the highest priority water quality conditions established, the next step was to identify the potential sources of the pollutants and stressors contributing to the highest priority water quality conditions (Section 3). Concurrently, potential strategies to address the highest priority water quality conditions were identified. These potential strategies ranged from activities such as street sweeping, public outreach, and construction of water quality treatment structures to the development of standards and regulatory initiatives. The potential strategies were selected from existing plans, public feedback, and suggestions from the Consultation Committee.

Given the potential strategies, interim and final Water Quality Improvement Plan goals numeric goals have been developed using the latest research and currently available technology (Section 4). These interim goals provide a schedule for measuring progress toward final numeric goals. Final numeric goals are intended to protect and restore beneficial uses when achieved. According to the MS4 Permit (Provision B.3), “the water quality improvement goals and strategies must address the highest priority water quality conditions by effectively prohibiting non-storm water discharges to the MS4, reducing pollutants in storm water discharges from the MS4 to the MEP, and protecting the water quality standards of receiving waters.” Numeric goals and schedules have been developed to track improvements related to the highest priority water quality conditions detailed in this plan, while prioritizing strategies that can address multiple pollutants at one time. As part of this step, the City of San Diego estimated the funding needs to implement the jurisdictional strategies needed to achieve the goals identified.

In coordination with the Regional Board and other interested parties, the Responsible Agencies have developed a list of recommended strategies with an implementation schedule and the estimated dates for achievement of interim and final numeric goals. The list of recommended strategies has been developed by evaluating the potential strategies developed under the previous step for their estimated ability to ultimately achieve the numeric goals, while providing a multi-pollutant benefit. The Responsible Agencies have prioritized the list of recommended strategies by incorporating a comprehensive approach to all pollutants and conditions. The end goal is to optimize the improvement to water quality in relation to the overall cost of implementation and assessment. The Responsible Agencies are committed to contributing to improved water quality in the Los Peñasquitos WMA by reducing the discharge of pollutants from their MS4s through implementation of the recommended strategies identified in this Water Quality Improvement Plan. Lastly, the City of San Diego estimated the funding needs to implement the jurisdictional strategies needed to achieve the goals identified (Appendix I.4).

To evaluate progress toward improving water quality and meeting scheduled goals, a question-based program to monitor and assess water quality improvement has been developed (Section 5). The program will be implemented on a WMA basis so that the Responsible Agencies can efficiently combine their resources.

This Water Quality Improvement Plan includes an iterative and adaptive management process for Responsible Agencies to re-evaluate conditions and improve strategies and assessments (Section 6). The process will draw from the data collected as part of the Monitoring and Assessment Program and the JRMP to create a water quality improvement program that is dynamic and proactive.

The Water Quality Improvement Plan is being developed in collaboration with the updates to the Los Peñasquitos Lagoon Enhancement Plan. The Los Peñasquitos Lagoon Enhancement Plan provides the Los Peñasquitos Lagoon historical background, baseline conditions, current activities, and accomplishments to date, and the development and assessment of conceptual restoration alternatives. The Los Peñasquitos Lagoon Enhancement Plan update is based on a stakeholder process that included eight workshops to update restoration goals and objectives, identify opportunities and constraints, and develop preliminary phased alternatives.

1.5 The Los Peñasquitos WMA

The Los Peñasquitos WMA drains an area of approximately 94 square miles in central San Diego County. The WMA includes portions of the cities of San Diego, Poway, and Del Mar; a small portion of San Diego County (in the eastern headwaters area); and several major transportation corridors maintained by Caltrans. Respective jurisdictional land areas are provided in Table 1-1.

**Table 1-1
Jurisdictional Land Areas
for the Los Peñasquitos WMA**

Responsible Agencies	Land Area (Acres)
City of Del Mar	151
City of Poway	15,441
City of San Diego	41,548
County of San Diego	1,834
Caltrans	1,445

To develop this Water Quality Improvement Plan, the Los Peñasquitos WMA was separated into four main subwatersheds to focus on receiving waters when selecting priority water quality conditions and implementing jurisdictional programs. These subwatersheds are used to aid organization and to help give geographical context to the conditions and strategies. However, the locations of the receiving waters were not a factor in the determination of the priority water quality conditions.

Three major streams drain the WMA and flow into the Los Peñasquitos Lagoon (Lagoon), which is a State Marsh Natural Preserve in the Torrey Pines State Reserve, before discharging to the Pacific Ocean. These subwatersheds, which are delineated by the major hydrologic boundaries in the WMA, encompass the drainage areas of the three main tributaries in the Los Peñasquitos WMA. These three subwatersheds are Carmel Valley Creek, Los Peñasquitos Creek, and Carroll Canyon. The area around the Lagoon also encompasses many small drainage areas that drain directly to the Lagoon, comprising a fourth subwatershed referred to as Los Peñasquitos Lagoon subwatershed in this document.

In Carroll Canyon, Carroll Canyon Creek flows from its headwaters near Miramar Reservoir until it reaches Highway 805. After crossing under Highway 805, it is known as Soledad Canyon Creek or sometimes Sorrento Valley Creek. Soledad Canyon Creek continues under Interstate 5 and joins Los Peñasquitos Creek in Sorrento Valley before flowing into the Los Peñasquitos Lagoon. A figure providing an overview of the subwatersheds and the jurisdictions within the WMA is included in Appendix B.

Many of the natural vegetative communities in the WMA and the floodplain have been altered by development. Historically, the floodplain was a natural, braided system, dissipating storm water runoff and sediment (Prestegaard, 1979). As the floodplain and tributaries were developed and urbanized, storm water runoff and sediment now continue in more channelized paths toward the Lagoon. However, native chaparral scrub habitats remain in the headwaters and in the lower portion of the WMA near the Lagoon (Appendix B). The Lagoon is one of the last remaining native salt marsh lagoons in California and is home to several endangered species and 25 sensitive plant species.

Although more than 50 percent of the WMA has been developed, open space/recreation is the single largest land use type (approximately 33 percent). Table 1-2 shows the breakdown of land uses in the Los Peñasquitos WMA (San Diego Association of Governments [SANDAG], 2009). A figure illustrating land use is also included in Appendix B. Land use information was obtained from the Land Layer of the SANDAG geographical information system (GIS), which contains over 80 different land use classifications. These land use classifications were aggregated into nine general land use classifications.

Table 1-2
Los Peñasquitos WMA Land Uses

Aggregate Land Use	Area (Acres)	Percentage of Total (%)[1]
Open Space/Recreation	19,841	32.84
Residential	16,589	27.46
Vacant/Undeveloped	8,043	13.31
Freeway/Road/Transportation	7,510	12.43
Industrial	3,721	6.16
Office/Institutional	2,855	4.73
Commercial	1,109	1.84
Agriculture	583	0.97
Water	166	0.27

1. Does not add to 100.00% due to rounding.

The map illustrating the impervious areas of the Los Peñasquitos WMA is provided in Appendix B. Impervious cover in this map is any surface in the landscape that cannot effectively absorb or infiltrate rainfall. Impervious areas include driveways, roads, parking lots, rooftops, and sidewalks. The amount of impervious cover reflects the amount of urbanization in a WMA. Increased impervious cover adds to the rainfall runoff potential in the WMA, with implications for water quality and flood control. Soils on this map are depicted as pervious; however, some local soil types may exhibit such low infiltration rates that they may be nearly impermeable.

1.6 Water Quality Improvement Plan Organization

The organization of the Water Quality Improvement Plan follows the requirements of the MS4 Permit. The Water Quality Improvement Plan sections and the corresponding MS4 Permit Provisions are organized as follows:

Section 1, Introduction—This section provides the purpose of the Water Quality Improvement Plan and summarizes the spatial context of the WMA.

Section 2, Priority Water Quality Conditions—This section describes the process for selecting the priority water quality conditions, including assessing receiving water conditions (Provision B.2.a), assessing impacts of the MS4 discharges (Provision B.2.b), and identifying the priority water quality conditions (Provision B.2.c(1)). This section also identifies the highest priority water quality conditions (Provision B.2.c(2)).

Section 3, MS4 Sources of Pollutants and/or Stressors—This section identifies known and suspected sources of pollutants or other stressors that cause or contribute to the highest priority water quality conditions, describes the prioritization process of the sources or stressors, and summarizes the priority sources or stressors by jurisdictions (Provision B.2.d).

Section 4, Water Quality Goals, Strategies, and Schedules—For the highest priority water quality conditions, this section details the WMA interim and final numeric goals and the schedule for measuring progress toward achieving these goals (Provision B.3.a(1)). These goals are used to develop the jurisdictional specific water quality improvement strategies (Provision B.3.b(1)) and the schedules for jurisdictional specific water quality improvement strategies (Provisions B.3.a(2) and B.3.b(3)). A watershed model will be created to help develop strategies. This section will also address how the Responsible Agencies will meet the load reductions required by the Sediment TMDL.

Section 5, Water Quality Improvement Monitoring and Assessment Program—This section summarizes the integrated Monitoring and Assessment Program (Provision B.4).

Section 6, Iterative Approach and Adaptive Management Process—This section describes the methodology to re-evaluate the priority water quality conditions (Provision B.5.a); adapt the goals, strategies, and schedules (Provision B.5.b); and adapt the Monitoring and assessment program (Provision B.5.c). It also describes the processes to modify the Water Quality Improvement Plan (Provision B.6.b) and the JRMP (Provision F.2.a) following re-evaluation.

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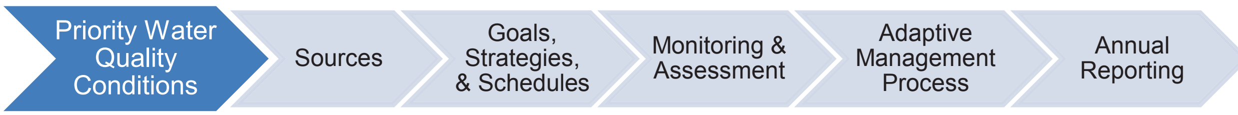
2 Priority Water Quality Conditions

Local agencies have long worked in partnership to protect and improve water quality throughout the Los Peñasquitos Watershed Management Area. Over the years, there have been substantial improvements to water quality in the streams and other tributaries leading to the Los Peñasquitos Lagoon. Even so, there are segments of waterbodies in the Los Peñasquitos Watershed Management Area that continue to suffer from impairments to water quality.



Working collaboratively with the Regional Board and the public, the agencies with jurisdictional responsibilities in the Los Peñasquitos WMA have identified a total of 29 priority water quality conditions associated with discharges from storm drain systems within this area. This identification effort is the first step required for the new Water Quality Improvement Plan process (described in Section 1 and illustrated in the graphic above). The plan developed for the Los Peñasquitos WMA employs a scientific process of pollutant source identification and management.

Section 2 Highlights

- Describes the process to determine priority water quality conditions and identify the highest priority water quality conditions
- Identifies the priority water quality conditions:
  - Carroll Canyon – 8 priority water quality conditions (3 selected on the basis of monitoring data)
  - Los Peñasquitos Creek – 11 priority water quality conditions
  - Carmel Valley Creek– 3 priority water quality conditions
  - Los Peñasquitos Lagoon – 7 priority water quality conditions (3 selected on the basis of monitoring data)
- Identifies the highest priority water quality conditions for all four subwatersheds:
  - Impairment of estuarine habitat and biological habitats of special significance in Los Peñasquitos Lagoon from:
    - Hydromodification and siltation/sedimentation during wet weather
    - Freshwater discharges during dry weather
  - Potential impairment of contact recreation along the Pacific Shoreline at Torrey Pines State Beach at Del Mar from indicator bacteria during both wet and dry weather

Four highest priority water quality conditions were identified for the Los Peñasquitos WMA. Three of the four highest priority water quality conditions incorporate the impacts of sediment in wet weather and freshwater discharges during dry weather on the biological and estuarine environment in the Los Peñasquitos Lagoon. The potential impairment of contact recreation along the Pacific Shoreline at Torrey Pines State Beach at Del Mar from bacteria during both wet and dry weather is the other highest priority water quality condition.

Discharges that are not conveyed by the MS4 are regulated separately. However, the Responsible Agencies are responsible for discharges originating from these Non-MS4 lands outside of their regulatory control (industrial, agricultural, Phase II, state, federal, and Indian reservation lands) if those pollutants are ultimately discharged from the MS4 of a Responsible Agency. Non-MS4 discharges also affect water quality in the Los Peñasquitos WMA. Therefore, Responsible Agencies will seek opportunities to collaborate and improve their communication with non-municipal sources and the appropriate regulatory agencies to ensure that these discharges are regulated before they enter the Responsible Agencies' MS4s to improve water quality throughout the WMA.

A water quality condition is an impairment of a receiving water beneficial use. Priority water quality conditions are defined in this Water Quality Improvement Plan as receiving water conditions that have evidence of being caused or contributed to by MS4 discharges, and may be "pollutants, stressors, and/or receiving water conditions that are the highest threat to receiving water quality or that most adversely affect the quality of receiving waters" (Provision B.2.c).

The priority water quality condition identification process began by assessing the receiving water conditions (Provision B.2.a) and then the impacts from MS4 sources (Provision B.2.b). Combining these assessments resulted in a list of priority water quality conditions. During these assessments, data gaps were discovered. A data gap is defined in this Water Quality Improvement Plan as an area where there is a lack of information needed to assess the receiving water conditions or impacts from MS4 sources. Data gaps are addressed by the Monitoring and Assessment Program and the Iterative and Adaptive Management Process. The highest priority water quality conditions were selected by the Responsible Agencies from the list of priority water quality conditions using the process detailed below and summarized in Appendix A.

Figure 2-1 summarizes the selection sequence to identify the priority and highest priority water quality conditions.

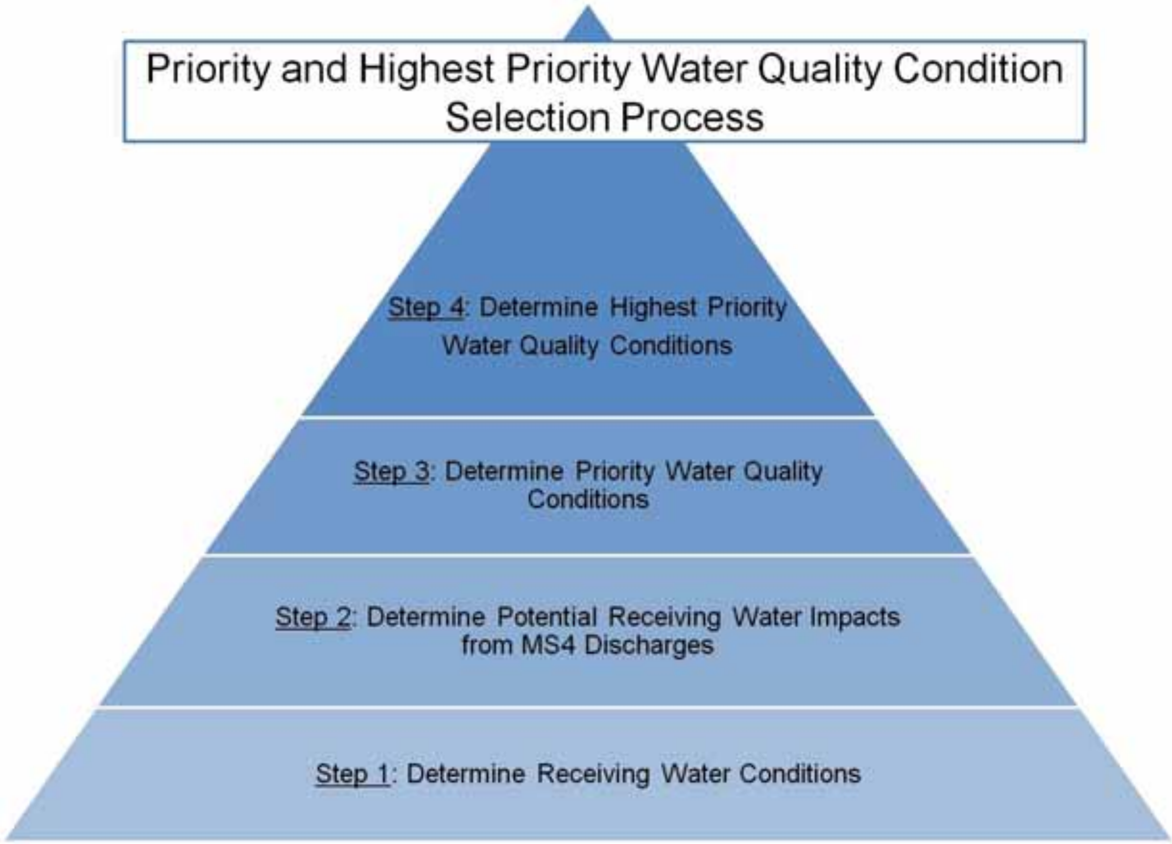


Figure 2-1
Los Peñasquitos WMA Priority and Highest Priority Water Quality Condition Selection Process

2.1 Step 1: Determine Receiving Water Conditions

As defined by the USEPA, a receiving water is any body of water (for example, a creek, river, lake, or estuary) into which surface water, treated waste, or untreated wastewater is discharged (USEPA, 2012a).

Identification of receiving water conditions is based on the following considerations, as listed in Provision B.2.a of the MS4 Permit:

(1) Receiving waters listed as impaired on the 2010 303(d) list of impaired waters

(2) TMDLs adopted or under development by the Regional Board

(3) Receiving waters recognized as sensitive or highly valued by the Copermittees, including estuaries designated under the National Estuary Program under CWA Section 320, wetlands defined by the state or U.S. Fish and Wildlife Service's National Wetlands Inventory as wetlands, waters having the Preservation of Biological Habitats of Special Significance beneficial use designation (BIOL), and receiving waters identified as Areas of Special Biological Significance (ASBS)

(4) The receiving water limitations of Provision A.2 of the MS4 Permit

(5) Known historical versus current biological, physical, and chemical water quality conditions

(6) Available, relevant, and appropriately collected and analyzed biological, physical, and chemical receiving water monitoring data, including, but not limited to, data describing:

(a) Chemical constituents

(b) Water quality parameters (e.g., pH, temperature, conductivity)

(c) Toxicity identification evaluations for both receiving water column and sediment

(d) Trash impacts

(e) Bioassessments

(f) Physical habitat

(7) Available evidence of erosional impacts on receiving waters that are due to accelerated flows (i.e., hydromodification)

(8) Available evidence of adverse impacts on the biological, physical, and chemical integrity of receiving waters

(9) The potential improvements in the overall condition of the WMA that can be achieved

The following subsections detail how these considerations are incorporated into the assessment.

2.1.1 The 2010 303(d) List and Beneficial Uses (Consideration 1)

2010 303(d) Listings

The 303(d) list is named after the section number of the CWA that established the requirements to create a list of impaired waterbody segments. An impaired waterbody is a waterbody with "chronic or recurring monitored violations" of "applicable numeric and/or narrative water quality criteria" (USEPA, 2012a). Under the 303(d) list, states, territories, and authorized tribes are required to develop lists of impaired waters (303(d) list) and submit for USEPA approval every two years. The Regional Board is tasked with developing the 303(d) list in the San Diego region.

The latest 303(d) list was updated in 2010 and identifies these impaired waterbodies by specifying:

- The particular waterbody that is impaired (which, in the Los Peñasquitos WMA, can range in scale from an ephemeral stream to a portion of the Pacific Ocean Shoreline)
- If known, the pollutant causing the impairment (e.g., bacteria or sediment)
- The beneficial use(s) being impaired
- The potential pollutant source(s)

The Los Peñasquitos WMA has several 2010 303(d) listed waterbodies, which are mapped in Figure 2-2. The names of the listed waterbodies are provided in Table 2-1.

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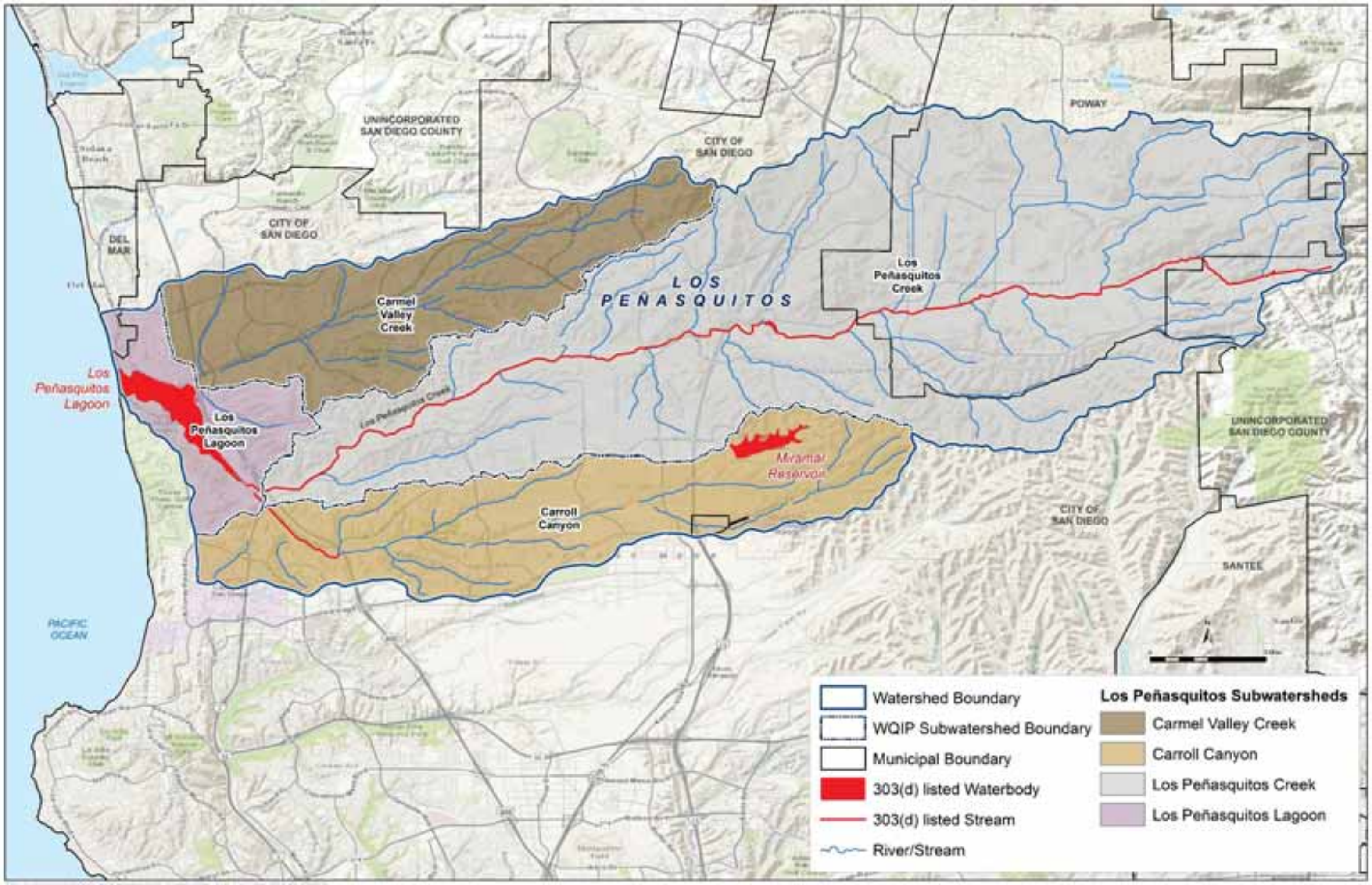

Figure 2-2
Los Peñasquitos WMA
2010 303(d) Listed Waterbodies

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Beneficial Uses

The beneficial uses of a waterbody are designated in the Basin Plan and are defined as "the uses of a waterbody necessary for the survival or well-being of man, plants, and wildlife" (Regional Board, 1994). The development and the adoption of the Basin Plan are the responsibility of the Regional Board. The beneficial uses listed as impaired on the 303(d) list of impaired waterbodies within the Los Peñasquitos WMA are described in Appendix C. The vast majority (92 percent) of the waterbodies in the Los Peñasquitos WMA are not impaired or have not been assessed by the Regional Board. Of those waterbodies that are listed in Appendix C as having impairments, most beneficial uses are attained. The Basin Plan provides additional details on the beneficial uses in the Los Peñasquitos WMA, and is online at http://www.waterboards.ca.gov/sandiego/water_issues/programs/ basin_plan/.

Beneficial uses may be impaired by various pollutants and stressors, which may be biological (e.g., indicator bacteria), physical (e.g., sedimentation), or chemical (e.g., metals) in nature. Pollutants, stressors, and conditions that may indicate impairment of beneficial uses in the Los Peñasquitos WMA include the following:

Bifenthrin is a pyrethroid pesticide that is highly toxic to aquatic organisms and is currently regulated as a restricted use pesticide (California Department of Pesticide Regulation [DPR], 1999; USEPA, 2006).

Chloride is a common mineral that is highly soluble in water. Chlorides may also come from seawater intrusion, agricultural processes, and industrial wastes. Elevated levels of chloride may harm plant life and corrode metals (Regional Board, 1994).

Freshwater discharges are releases of freshwater into the surrounding environment from sources such as irrigation runoff. Freshwater discharges may cause an impairment to saline habitats when levels are higher than natural conditions (Regional Board, 1994).

The **Index of Biological Integrity (IBI)** is a comprehensive method used to evaluate the health of the benthic macroinvertebrate community on a scale of 0 to 100, where 100 is very good condition and 0 is very poor condition. This information can be used to assess the health of the stream and is commonly used with bioassessment (State Board, 2013b). The IBI score is not a pollutant or stressor itself, but instead is a measure of the biological condition of a waterbody. It is used as a surrogate for anthropogenic impacts on receiving water health.

Indicator bacteria are surrogates used to measure the potential presence of harmful bacteria, fecal material, and associated fecal pathogens. The common indicator bacteria include total coliform, fecal coliform, *Escherichia (E.) coli*, and *Enterococcus*. Indicator bacteria may include non-fecal bacteria or bacteria that are non-fecal in origin (Regional Board, 1994; Southern California Coastal Water Research Project [SCCWRP], 2012a).

Potential eutrophication (nitrogen and phosphorous) conditions exist when excessive amounts of nutrients (commonly nitrogen and phosphorus) are in an aquatic environment. Nutrients can accelerate the growth of algae and phytoplankton, which can reduce dissolved oxygen content and harm aquatic organisms (World Resources Institute [WRI], 2013). This condition can unbalance the aquatic system and so harm fish, wildlife, and human health.

Sedimentation is an excessive buildup of sediment in downstream waterbodies resulting from high-flow events. Increased sedimentation can affect tidal lagoons and salt marsh habitats (Regional Board, 1994).

Sediment toxicity is the measure of sediment quality to assess the adverse biological effects of pollutants. Many pollutants bind to sediment, which can produce toxicity in the surface and near-surface sediment (Regional Board, 1994).

Selenium occurs naturally in sulfide ores and volcanic deposits, and may be in receiving waters through interaction with groundwater. It can also be related to the irrigation of soil, discharge of coal-fired power plants, mining activities, and petroleum refineries (USEPA, 2014b). Acute and chronic exposure can lead to health effects such as damage to the circulatory and nervous systems (USEPA, 2012b). However, selenium is an essential micronutrient for human health and selenium deficiency may play a role in cancer, cardiovascular disease, cognitive decline, and thyroid disease (National Institutes of Health [NIH], 2013)

Sulfate is a common anion in water that can occur naturally from gypsiferous deposits and sulfide minerals associated with crystalline rock. High sulfate concentrations in drinking water can cause laxative effects (Regional Board, 1994).

Toxicity, as defined in the Basin Plan, is the adverse response of organisms to chemicals or physical agents. Toxic substances or concentrations thereof produce harmful physiological responses in humans, plants, animals, or other aquatic life (Regional Board, 1994). Toxicity is measured in terms of the lethality (acute) or reproductive impacts (chronic) of the waterbody to aquatic organisms.

Total dissolved solids (TDS) consist of carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, magnesium, sodium, iron, manganese, and other substances. TDS can affect the water based in the cells of aquatic organisms. High TDS concentrations can change soil permeability, thereby affecting vegetation (Regional Board, 1994).

Total suspended solids (TSS) include particles in water that will not pass through a 2-micron filter. Increased TSS levels lead to increased turbidity, which can reduce light and photosynthesis and harm aquatic life (USEPA, 2012c).

Turbidity is a measure of the clarity of water, which is attributed to the amount of suspended particles. Increased turbidity can reduce light penetration, which can reduce photosynthesis and adversely affect aquatic life. High levels of turbidity may also affect drinking water (Regional Board, 1994).

2.1.2 Applicable TMDLs, Special Biological Habitats, and Receiving Water Limitations (Considerations 2, 3, and 4)

Los Peñasquitos WMA TMDLs

TMDLs identify the total pollutant loading that a receiving water can accept and still meet water quality standards. The Regional Board is required to develop TMDLs or follow an alternative regulatory process to address 303(d) listed impairments. Two TMDLs have been adopted in the Los Peñasquitos WMA. Table 2-1 summarizes the impaired 2010 303(d) listed waterbodies in the Los Peñasquitos WMA, the assessed length or area of the impairment in the waterbody, and the pollutants listed as causing the impairment. The locations of these waterbodies are mapped in Figure 2-2.

Table 2-1
2010 303(d) Listed Waterbodies and Total Maximum Daily Loads (TMDLs) in the Los Peñasquitos WMA

Waterbody Name	Assessed Length or Area	Pollutant or Stressor	TMDL Approved by OAL
Miramar Reservoir	138 acres	Total nitrogen as N	To be developed
Soledad Canyon	1.8 miles	Sediment toxicity	To be developed
		Selenium	To be developed
Poway Creek	7.3 miles	Selenium and toxicity	To be developed
Los Peñasquitos Creek	12 miles	*Enterococcus*, fecal coliform, selenium, total dissolved solids (TDS), and total nitrogen as N	To be developed
		Toxicity	To be developed
Los Peñasquitos Lagoon	469 acres	Sedimentation and siltation	July 2014

Table 2-1 (continued)
2010 303(d) Listed Waterbodies and Total Maximum Daily Loads (TMDLs) in the Los Peñasquitos WMA

Waterbody Name	Assessed Length or Area	Pollutant or Stressor	TMDL Approved by OAL
Pacific Ocean Shoreline at Torrey Pines State Beach, Del Mar	0.39 mile	*Enterococcus,* fecal coliform, and total coliform[1]	June 2011
Pacific Ocean Shoreline at Los Peñasquitos River Mouth	0.39 mile	Total coliform[2]	To be developed

1. Pollutants are not on the 303(d) list but are included in the Bacteria TMDL as potential stressors to Contact Water Recreation (REC-1) beneficial use.
2. Potential stressor for impairment of Shellfish Harvesting beneficial use (SHELL).

Note: See Figure 2-2 for a map of the 303(d) listed waterbodies.

OAL = California Office of Administrative Law

The Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar was 303(d) listed in 2002 for bacterial indicators as impaired for contact recreation. The 2010 303(d) listing was clarified by individually analyzing for the bacteria indicators (*Enterococcus*, fecal coliform, and total coliform) and narrowing down the listing area into a smaller segment near the sampling point of the data being assessed. In this individual data analysis, *Enterococcus* and fecal coliform were removed from the 303(d) listing, leaving only total coliform (as impairing shellfish beneficial use) on the 2010 303(d) list. The Bacteria TMDL included the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar prior to its removal (Regional Board, 2010). The Bacteria TMDL was considered a receiving water condition to develop goals and strategies to continue compliance with the Bacteria TMDL requirements and to meet water quality-based effluent limits (WQBELs), as required by the MS4 Permit. Therefore, *Enterococcus* and fecal coliform are still considered as potential stressors at the Pacific Ocean Shoreline per the TMDL, although they are no longer on the 2010 303(d) list.

The Sediment TMDL for the Lagoon (Regional Board, 2012) was adopted on June 13, 2012. This TMDL Basin Plan amendment was approved by the State Board on January 21, 2014, and by the California OAL on July 14, 2014; it is now pending approval by the USEPA. The Sediment TMDL assigns a single wasteload allocation (WLA) to all subwatersheds draining into the Los Peñasquitos Lagoon. The WLA will address upstream sources of sediment, which are conveyed to the Lagoon via direct discharge from Carmel Valley Creek, Los Peñasquitos Creek, and Carroll Creek (Regional Board, 2012).

Special Biological Habitats

Biological habitats of special significance are areas designated with the BIOL beneficial use. In the Los Peñasquitos WMA, the following waterbodies and areas are of special significance and can be classified as (1) impaired for BIOL beneficial use; (2) impaired for other beneficial use(s); or (3) not impaired or assessed:

- Impairment of BIOL:
  - Los Peñasquitos Lagoon (2010 303(d) listed for sedimentation and siltation)
- Impairment of other beneficial use(s):
  - Pacific Ocean Shoreline at Los Peñasquitos River Mouth (2010 303(d) listed for impairment of Shellfish Harvesting (SHELL) due to total coliform)
  - Los Peñasquitos Creek (2010 303(d) listed for impairment of Warm Freshwater Habitat (WARM) because of *Enterococcus*, fecal coliform, and total nitrogen, and impairment of Agricultural Supply [AGR] due to TDS)
- Not impaired or assessed:
  - Del Mar Mesa/Lopez Ridge Ecological Reserve
  - Meadowbrook Ecological Reserve

Receiving Water Limitations

Under the receiving water limitations provision of the MS4 Permit (Provision A.2), discharges from MS4s must not cause or contribute to the violation of water quality standards in any receiving waters. Water quality standards are defined in various regulations, including the Basin Plan. Waterbodies that do not meet water quality standards are identified on the 2010 303(d) list (Table 2-1).

2.1.3 Data Sources Used To Assess Receiving Water Conditions (Considerations 5 and 6)

The Copermittees participated in the MS4 Permit Regional Monitoring Program under the two previous MS4 Permits. This monitoring program used a triad approach to evaluate receiving water chemistry, toxicity, and benthic community data, designed to meet the requirements of the previous MS4 Permits. Monitoring plans were submitted to the Regional Board to document sampling and analytical methodology and data quality requirements consistent with USEPA regulations and guidance and regional standard operating procedures (SOPs) such as the Surface Water Ambient Monitoring Program (SWAMP) or the SCCWRP, when appropriate.

Since 2005, three primary documents containing biological, physical, and chemical receiving water monitoring data have been developed to document the information collected under the MS4 Permit monitoring program. High priority and medium priority pollutants and stressors were identified in these documents by following the WMA Assessment Methodology developed by the Copermittees in 2010. Waterbodies for which monitoring data indicate a failure to meet standards or which are 303(d) listed have been identified as receiving water conditions. Data generated from these monitoring programs provided the basis for the assessments and conclusions of the Long-Term Effectiveness Assessment (LTEA) and the WURMP Annual Reports. These primary data sources were used to identify or assess receiving water conditions for this Water Quality Improvement Plan, as described below.

Primary Source 1: Long-term Effectiveness Assessment

The comprehensive LTEA was developed by the San Diego Municipal Copermittees in 2011 as a precursor to the 2012 Report of Waste Discharge (San Diego County Municipal Copermittees, 2011a). It presents and summarizes data for each WMA between 2005 and 2010, and considers historical trends. In addition to NPDES and MS4 outfall monitoring program data collected by the Copermittees directly, the LTEA includes third-party data from agencies and non-governmental organizations. Examples of third parties are the Southern California Stormwater Monitoring Coalition (SMC) (additional data on dry weather receiving water quality) and Coastkeeper (water quality data and observational condition assessments).

Primary Sources 2 and 3: Fiscal Year 2011 and Fiscal Year 2012 Watershed Urban Runoff Management Program Annual Reports

The two most recent Annual Reports produced by the Los Peñasquitos Watershed Copermittees under the WURMP, for Fiscal Years (FY) 2011 and 2012 (FY11 and FY12), were consulted as primary data sources. These Annual Reports include monitoring and inspection data and the activities conducted under the WURMP. The reports assess pollutants for the annual receiving water and outfall data collected since the publication of the 2011 LTEA (Los Peñasquitos Watershed Copermittees, 2012a and 2013).

Secondary Data Sources

Numerous secondary data sources augment the LTEA and the WURMP Annual Reports and are listed in Appendix D. These data sources, along with the LTEA and WURMP Annual Reports, were categorized as observational, plan-based, and quality-assured, as follows:

- Observational data may include unplanned visual record(s) of a condition or source or evidence of a condition or source from a single sample or measurement.
- Plan-based data include a structured monitoring plan that bases sampling on standard clean practices, but these data may not have associated data quality and control requirements.
- Quality-assured data include quality assurance protocols and following described procedures to collect representative samples and to certify that quality control has been performed.

One such secondary source, the City of San Diego Strategic Plan for Watershed Activity Implementation (City of San Diego, 2007), identified priority water quality problems on the basis of an assessment of the 2005 Baseline LTEA, monitoring data from the City's annual storm water monitoring reports, and additional water quality data. The priorities identified from the Strategic Plan are:

- Bacteria
- Nutrients
- Sediment
- TDS
- Benthic alterations

Since the Strategic Plan was completed in 2007, the updated (2011) LTEA and the 2011 and 2012 WURMP Annual Reports represent more recent assessments of the data available for the Los Peñasquitos WMA. The priorities identified by the Strategic Plan are similar to those of the LTEA and 2011 and 2012 WURMP reports.

The primary documents provide current and historical monitoring data for three receiving water monitoring stations, with the data reported and evaluated independently for wet weather and dry weather. During the previous two MS4 Permit cycles, the stations have been operated and maintained by the Copermittees per the requirements of the previous MS4 Permit monitoring program. Monitoring included rapid stream bioassessments, toxicity analysis, flow monitoring, trash surveys, and analytical analysis of samples. One station, in the Los Peñasquitos Creek subwatershed, has been monitored periodically since 2001, providing one of the longer data sets in the watershed. The other two stations, in the Los Peñasquitos Creek and Carroll Canyon subwatersheds, have been monitored biennially since 2008. Figure 2-3 shows the location of the NPDES monitoring stations in the Los Peñasquitos WMA. Table 2-2 provides additional details on the NPDES monitoring stations.

The Los Peñasquitos Lagoon Foundation has been conducting monitoring in the Los Peñasquitos Lagoon continuously since 1987, including bacteria sampling, analytical sampling, and vegetation monitoring. These data were also considered in development of the Water Quality Improvement Plan.

The LTEA and WURMP Annual Reports have no receiving water monitoring data from the Carmel Valley Creek subwatershed. The limited amount of receiving water quality data from the Carmel Valley Creek subwatershed is identified as a data gap in the development of this Water Quality Improvement Plan.

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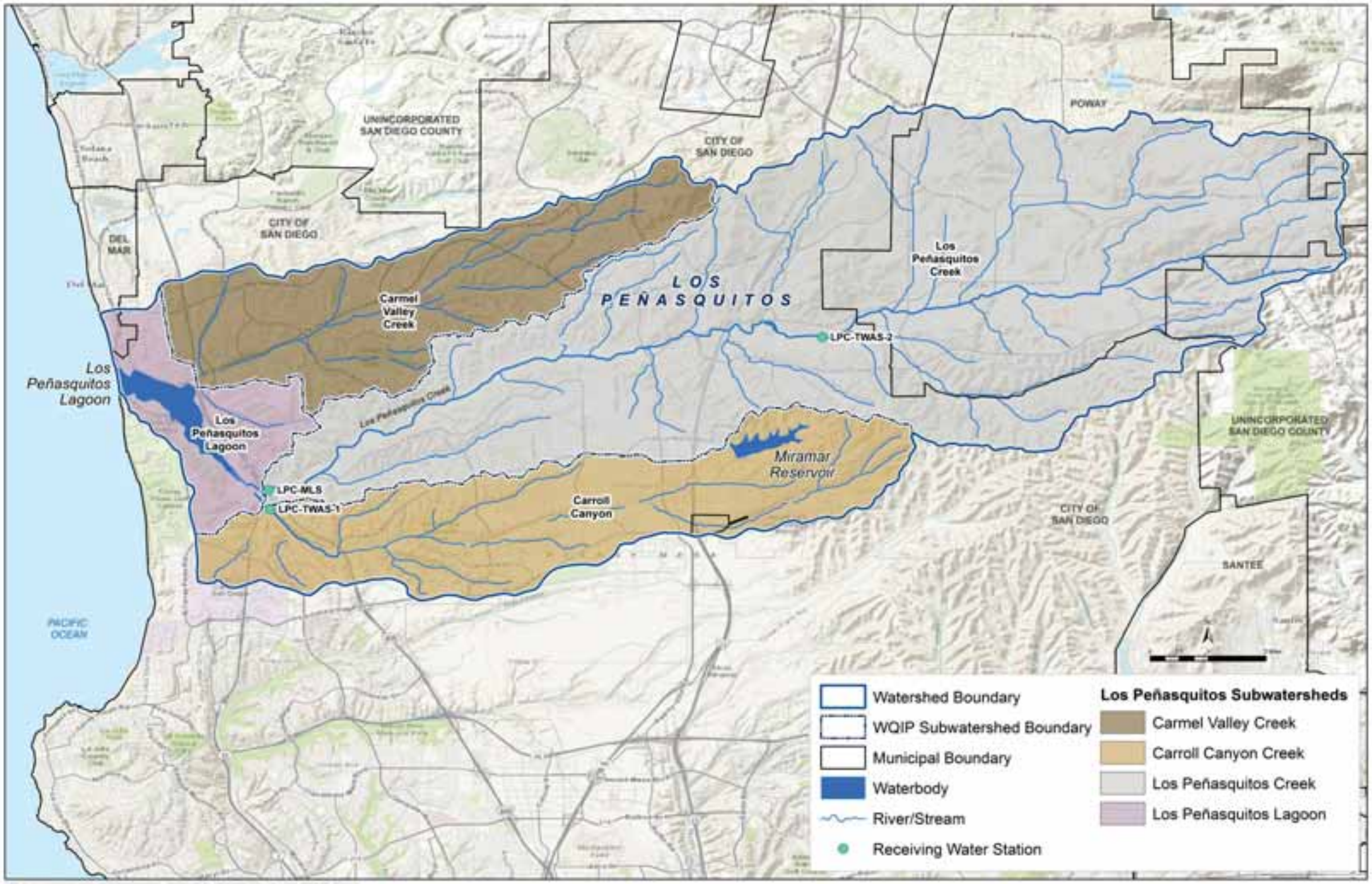

Figure 2-3
Los Peñasquitos WMA
NPDES Monitoring Stations

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Table 2-2
NPDES Monitoring Stations in the Los Peñasquitos WMA

Subwatershed	Station Name	Waterbody	Latitude	Longitude
Carroll Canyon	LPC-TWAS1	Soledad Canyon Creek	32.89959	−117.22249
Los Peñasquitos Creek	LPC-TWAS2	Los Peñasquitos Creek	32.94262	−117.08404
Los Peñasquitos Creek	LPC-MLS	Los Peñasquitos Creek	32.90444	−117.22283

MLS = mass loading station; TWAS = temporary watershed assessment station

Data from these three NPDES monitoring stations were considered to represent the receiving water quality of the subwatershed in which they were collected. The data are considered quality-assured, given the MS4 Permit monitoring program requirements. Note that water quality monitoring data can be highly variable both temporally and spatially, and water quality at any specific point in a subwatershed may vary considerably from that of the samples collected at these stations. Medium or high priorities provided in two or more of the regional monitoring reports, including the LTEA, the MS4 Permit Regional Monitoring Program (which includes the SMC program), and recent WURMP Annual Reports, are presented in Table 2-3. This table accounts for historical and current water quality monitoring findings used to inform the determination of the receiving water conditions presented in Section 2.1.7.

Table 2-3
Medium and High Priority Pollutants For Receiving Waters

Subwatershed	Dry Weather Conditions	Wet Weather Conditions
Carmel Valley Creek	No receiving water data are available	No receiving water data are available
Carroll Canyon	*Enterococcus*, poor Index of Biological Integrity (IBI), total dissolved solids (TDS), and toxicity	Bifenthrin, fecal coliform, very poor IBI, pH, TDS, total suspended solids (TSS), and turbidity
Los Peñasquitos Creek	Benthic algae, *Enterococcus*, poor IBI, total nitrogen, total and dissolved phosphorus, TDS, and toxicity	Bifenthrin, diazinon, fecal coliform, very poor IBI, TDS, TSS, toxicity, and turbidity
Los Peñasquitos Lagoon	Benthic algae, *Enterococcus*, poor IBI, total nitrogen, total and dissolved phosphorus, TDS, and toxicity	Bifenthrin, fecal coliform, very poor IBI, TDS, TSS, and turbidity

All conditions are identified in either the LTEA or recent WURMP Annual Reports.

2.1.4 Evidence of Erosional Impacts (Consideration 7)

Attachment A of the LTEA identified hydromodification and scouring of stream banks as well as TSS and turbidity transported via storm flows as potential causes of low to poor benthic community structure, as measured by IBI scores derived from bioassessment monitoring. This information is considered evidence of erosional impacts in the Los Peñasquitos WMA. The Regional Monitoring Program was not designed to identify specific areas of erosion or hydromodification; more information is needed to characterize the spatial extent of these impacts and their potential sources.

The Hydromodification Management Plan (HMP) outlines a monitoring program to assess the effectiveness of hydromodification management facilities (County of San Diego, 2011). Monitoring activities are ongoing and include inflow and outflow monitoring from BMPs, baseline cross-sectional monitoring, and flow-based sediment monitoring. Monitoring data generated by the HMP Monitoring Program will be considered in future iterations of the Water Quality Improvement Plan.

The Copermittees within the Los Peñasquitos WMA are participating in a regional effort to develop the Watershed Management Area Analysis (WMAA), as required by the MS4 Permit. The purpose of developing the WMAA at the regional level is to ensure consistency among the Copermittees and between WMAs The WMAA will develop WMA-specific requirements for structural BMPs and identify a list of candidate projects related to hydromodification, stream restoration, or structural BMPs. The WMAA is being conducted simultaneously with the development of the Water Quality Improvement Plan. The results of the WMAA have been incorporated into Section 4 of the Water Quality Improvement Plan and are submitted as part of this submittal.

2.1.5 Evidence of Adverse Impacts (Consideration 8)

The data sources used in Section 2.1.3 (Considerations 5 and 6) were supplemented with the information gathered during the public workshop and public data call to evaluate overall evidence of adverse impacts on the receiving waters. Examples of potential receiving water conditions were presented to the public in a workshop on September 4, 2013, on the basis of evaluation of the key data sources. Public input was received during and after the workshop along with a call for data. The public was asked to respond with final data by September 13, 2013.

Data provided by the public consisted of observational data and email messages from members of the public, information from regional non-governmental organizations, and additional reports provided by the Responsible Agencies. The data provided information on the evidence of pollutants and stressors at several locations. Most of the data supported the initial list of receiving water conditions. These data sources are summarized in Appendix D. Unless specified, the receiving water conditions identified by the public generally apply to the Los Peñasquitos WMA as a whole.

A list of the receiving water concerns provided by the public is as follows:

- Erosion
- Velocity
- Sedimentation and siltation
- Freshwater discharges (dry weather flows)
- Nutrients
- Bacteria

2.1.6 Potential improvements in the Overall Condition of the WMA That Can Be Achieved (Consideration 9)

The potential improvements in the overall condition of the WMA are discussed in Section 2.3. For the purposes of this Water Quality Improvement Plan, the potential improvements in the receiving waters and overall WMA are directly related to the potential improvements in the quality of the MS4 discharges and therefore these considerations were combined in the evaluation of the priority conditions.

2.1.7 Receiving Water Conditions

An initial list of receiving water conditions was developed on the basis of the evaluation of the 2010 303(d) list, associated TMDLs, waterbodies with special biological significance, priority pollutants or stressors identified from current and historical receiving water monitoring data, and public input. The criteria and data used to evaluate the receiving water conditions are detailed in Appendix E.

A receiving water condition was defined using the following four factors:

(1) The beneficial use(s) that may be associated with the water quality impairment, as determined by the 303(d) listing

(2) The type of pollutant or stressor causing the impairment

(3) The spatial extent of the impairment, based on the 2010 303(d) listing or the area near the NPDES monitoring location

(4) The temporal extents of the impairment (i.e., wet or dry weather); receiving water conditions, which were based on the evaluation of the 2010 303(d) list, and were assigned both dry and wet weather temporal extents. In some instances, this was not the case and only one temporal extent (i.e., dry weather only) was defined on the basis of best professional judgment.

When additional data become available that may change the assessment of the receiving water conditions, they will be incorporated per the iterative and adaptive management processes described in Section 6. The list of receiving water conditions identified in the Los Peñasquitos WMA and the determining factors for each condition are summarized in Appendix F. The beneficial uses identified as impaired in Appendix F are defined in Appendix C.

2.2 Step 2: Determine Potential Receiving Water Impacts from MS4 Discharges

Receiving water conditions may be caused by a wide variety of pollutants and stressors, which may or may not result from human activity or urban development. The primary focus of the MS4 Permit is to regulate discharges from MS4 outfalls into receiving waterbodies. Priority water quality conditions in the WMA are defined as receiving water conditions that are impacted by MS4 discharges. Step 1 identified the receiving water conditions in the WMA. Step 2 was to assess whether MS4 discharges may cause or contribute to receiving water conditions.

Identification of the potential impacts on receiving waters from MS4 discharges was based on the following considerations, under MS4 Permit Provision B.2.b:

(1) The discharge prohibitions of Provision A.1 and effluent limitations of Provision A.3

(2) Available, relevant, and appropriately collected and analyzed storm water and non-storm water monitoring data from the Copermittees' MS4 outfalls

(3) Locations of each of the Copermittee's MS4 outfalls that discharge to receiving waters

(4) Locations of MS4 outfalls that are known to persistently discharge non-storm water to receiving waters likely causing or contributing to impacts on receiving water beneficial uses

(5) Locations of MS4 outfalls that are known to discharge pollutants in storm water causing or contributing to impacts on receiving water beneficial uses

(6) Potential improvements in the quality of discharges from the MS4 that can be achieved

The following subsections detail how Considerations 1 through 6 are incorporated into the assessment.

2.2.1 Discharge Prohibitions (Consideration 1)

MS4 Permit Provisions A.1 and A.3 prohibit discharges from MS4s that cause or contribute to a receiving water condition, and effectively prohibit all discharges of non-storm water into an MS4. Storm water discharges from an MS4 must be free of pollutants to the MEP and all discharges must comply with applicable WQBELs defined in the MS4 Permit. As described below, potential impacts from MS4 discharges were identified by assessing MS4 outfalls with data that exceeded water quality standards or that persistently discharged non-storm water related to receiving water conditions identified in the previous section.

2.2.2 Available MS4 Monitoring Data (Consideration 2)

The LTEA and the WURMP Annual Reports described in Section 2.1 were the primary sources of monitoring data from MS4 outfalls in the Los Peñasquitos WMA. The secondary sources listed in Appendix D.1 were also considered. The WURMP Annual Reports did not contain non-storm water MS4 outfall monitoring data, so the LTEA was the primary source of dry weather outfall data for assessing MS4 impacts.

The water quality results from one or more MS4 outfalls were compiled in the LTEA and WURMP Annual Reports and are considered representative of the MS4 within the subwatershed area related to the receiving water stations. The MS4 outfall data were applied in a manner consistent with that of the LTEA and WURMP Annual Reports, where the data were used to characterize MS4 water quality in general areas of the WMA. The available MS4 outfall data were considered representative of the potential for MS4 discharges to cause or contribute to a receiving water condition on a subwatershed scale. However, data for direct MS4 discharges to a specific receiving water are not typically available.

Monitoring data were compiled from these documents and are summarized at the end of this section. The complete compilation is provided in Appendix D. In Section 2.3, these data are correlated with the receiving water conditions to determine priority water quality conditions.

Table 2-4 summarizes the constituents identified as a high or medium priority in the LTEA and recent WURMP Annual Reports.

Table 2-4
Medium and High Priority Pollutants for Receiving Waters

Subwatershed	Dry Weather Conditions	Wet Weather Conditions
Carmel Valley Creek	No MS4 monitoring data are available.	No MS4 monitoring data are available.
Carroll Canyon	*Enterococcus*, fecal coliform, total nitrogen, total phosphorus, total dissolved solids (TDS), and dissolved copper	Fecal coliform
Los Peñasquitos Creek	*Enterococcus*, fecal coliform, total nitrogen, total phosphorus, and TDS	Fecal coliform and TDS
Los Peñasquitos Lagoon	*Enterococcus*, fecal coliform, total nitrogen, total phosphorus, TDS, and dissolved copper	Fecal coliform and TDS

All conditions are identified in both the LTEA and recent WURMP Annual Reports.

The regional MS4 outfall monitoring program, as currently designed, was not able to directly link the MS4 outfall data to the water quality of downstream receiving water because the data set available to correlate MS4 impacts to receiving water conditions was limited. This limited data availability is identified as a data gap. The MS4 outfall monitoring program was designed to monitor the high priority constituents of concern, on the basis of priorities when the program plan was developed. The constituents monitored under the MS4 outfall monitoring program include general physical characteristics and inorganic non-metals, organics, dissolved and total metals, and bacteriological parameters. As a result, some receiving water conditions lack supporting MS4 impact evidence because of the limited constituent list monitored under the MS4 outfall monitoring program. It is at the discretion of the Responsible Agencies to determine whether a receiving water condition merits additional monitoring to assess MS4 impact.

2.2.3 Location of MS4 Outfalls (Considerations 3, 4, and 5)

The Responsible Agencies maintain maps of the conveyance systems within their jurisdictions. The locations and density of the outfalls may be a general indicator of MS4 sources in the WMA. Based on available data, Figure 2-4 illustrates the MS4 within the Los Peñasquitos WMA and identifies major MS4 outfalls that discharge to receiving waters. The Responsible Agencies have updated their current inventories to only contain outfalls that meet the definition of a major MS4 outfall per the MS4 Permit.

The Responsible Agencies have reviewed their updated major MS4 outfall inventories to determine which of these outfalls have persistent discharges of non-storm water, on the basis of the requirements of the MS4 Permit. This review involved visiting major outfalls during dry weather and recording observations including whether there was flow or ponding at each site. When determining if a site had persistent flow, the Responsible Agencies referred to the most recent three monitoring visits in their flow databases. If a site had flow and/or ponding during the most recent three visits, it was determined to be persistent. If one of the visits had dry conditions, the site was considered transient. If all three visits were dry, it was considered a dry site. Dry weather field screening will continue during subsequent monitoring years according to the schedule provided in Section 5.1.3. The persistent flow outfall inventory will be updated accordingly.

> The MS4 Permit defines persistent flow as "…*the presence of flowing, pooled, or ponded water more than 72 hours after a measureable rainfall event of 0.10 inch or greater during three consecutive monitoring and/or inspection events. All other flowing, pooled, or ponded water is considered transient*."

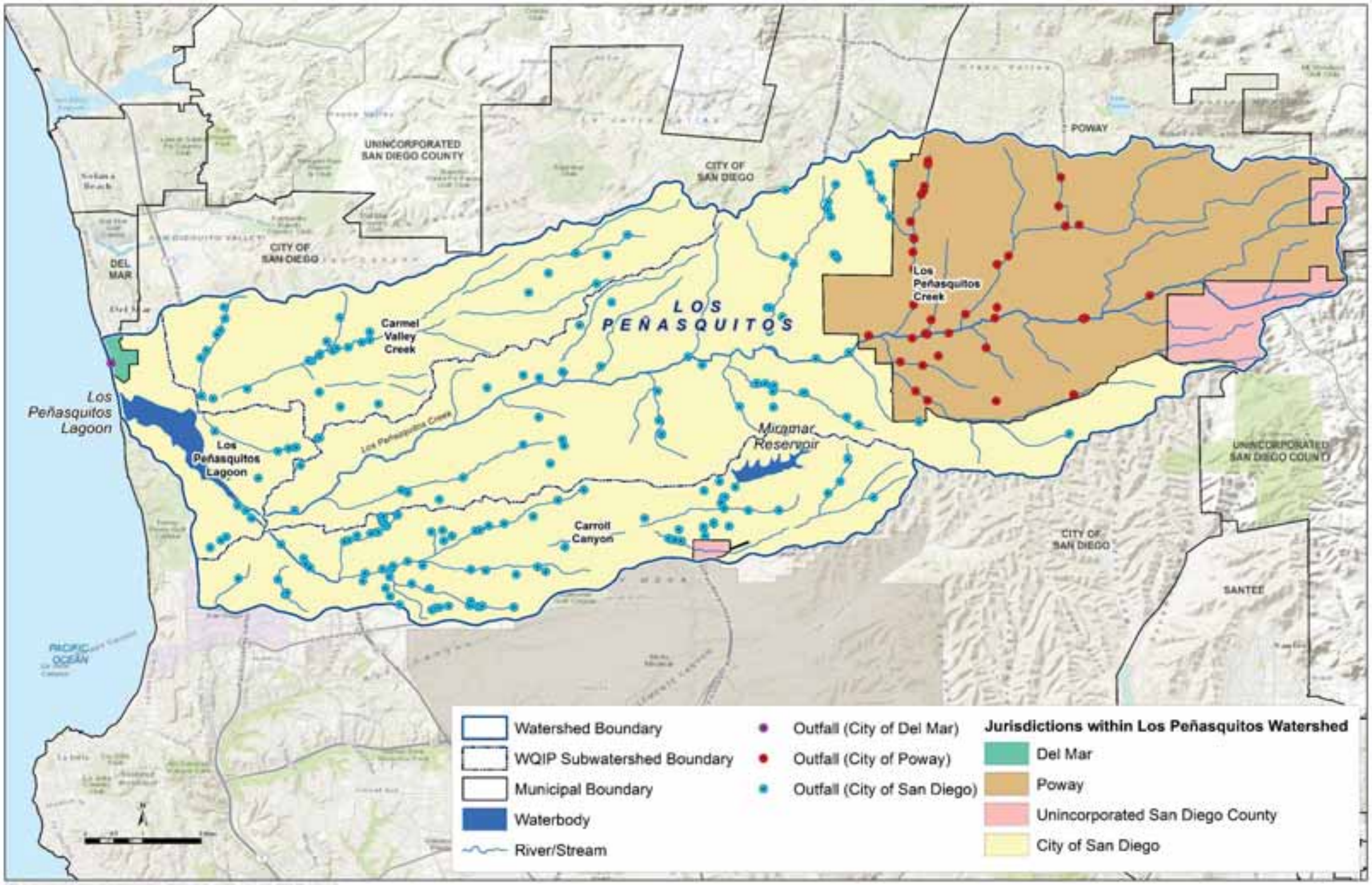

Figure 2-4
Los Peñasquitos WMA
Major MS4 Outfalls

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The Responsible Agencies have provided a preliminary list of major MS4 outfalls that may have persistent flow based on their Fall 2014 inventory. These outfalls are summarized in Appendix D.3. There are 34 outfalls in the Los Peñasquitos WMA that may persistently discharge non-storm water, as summarized by jurisdiction below:

- Caltrans: No outfalls with identified persistent non-storm water discharge at this time
- City of Del Mar: 1 outfall
- City of Poway: 5 outfalls
- County of San Diego: No outfalls with identified persistent non-storm water discharge at this time
- City of San Diego: 28 outfalls

2.2.4 Potential Improvements in the MS4 Discharges That Can Be Achieved (Consideration 6)

Existing water quality regulations, such as TMDLs, have mandated water quality goals and schedules. The Responsible Agencies have diligently planned, developed, and implemented BMP programs throughout the WMA on the basis of the resources available to meet the requirements of these regulations, as well as the MS4 Permit requirements. The potential improvements in the quality of MS4 discharges are directly linked to the potential for improvements in the receiving waters for the purposes of the Water Quality Improvement Plan, and provide an opportunity to build on other previous and planned efforts. Therefore, potential improvements are integral to the evaluation of potential priority water quality conditions and are included in this report as Section 2.3.1.

2.2.5 Potential Receiving Water Impacts from MS4 Discharges

An initial list of potential impacts from MS4 discharges on receiving water conditions was developed from the evaluation of MS4 outfall monitoring data and the MS4 maps. Impacts from MS4 discharges were identified when one or both of the following criteria were met:

(1) MS4 outfalls exhibit current or historical monitoring results that exceed water quality standards related to the receiving water condition, based on the subwatershed analysis allowed by the data presented in the LTEA or WURMP Annual Report.

(2) The MS4 or urban runoff was named as a source or potential source in the 2010 303(d) list of impaired waterbodies or in a TMDL.

The final list of potential impacts from MS4 discharges in the Los Peñasquitos WMA is provided in Appendix F. The estimated temporal extent of the MS4 impact is based on the monitoring data or best professional judgment, because the 303(d) list does not provide temporal extent. When additional data that may change assessment of the potential impacts from MS4 discharges become available, the data will be incorporated per the iterative and adaptive management processes described in Section 6.

2.3 Step 3: Determine Priority Water Quality Conditions

The information gathered to identify receiving water conditions (Section 2.1, MS4 Permit Provision B.2.a) and impacts from MS4 discharges (Section 2.2, MS4 Permit Provision B.2.b) was assessed to "develop a list of priority water quality conditions as pollutants, stressors, or receiving water conditions that are the highest threat to receiving water quality or that most adversely affect the quality of receiving waters" (MS4 Permit Provision B.2.c(1)).

Priority water quality conditions are defined as receiving water conditions for which there is evidence that MS4 discharges may cause or contribute to the condition. They are selected on the basis of (1) analysis of the receiving water conditions, and (2) assessment of the MS4 discharges.

An initial list of priority water quality conditions was developed by comparing receiving water conditions with evidence of MS4 contributions. Characterizing the receiving water quality and identifying the potential impacts caused by MS4 discharges to receiving waters in the WMA was necessary to identify the impacts to receiving waters associated with MS4 discharges that were of the most concern to the Responsible Agencies. This initial list was created in compliance with Provisions B.2.c(1)(a)-(e). The initial list was then compared with the public input that was provided during the September 4, 2013, workshop and the public data call. The priorities identified in previous planning documents were also considered. Many of the same concerns were provided during the workshop and were evident in the third-party data. Finally, the overall potential for improvement of MS4 discharges to affect conditions within the overall WMA was considered. The list of priority water quality conditions was then finalized on the basis of these factors. The final list of priority water quality conditions is included in Appendix F.

2.3.1 Potential Improvements in MS4 Discharges and the Overall WMA

Regional Reference Studies led by Copermittees are underway to better understand the potential improvements in the Los Peñasquitos WMA on the basis of reference receiving water conditions in the San Diego region. Reference receiving water conditions are determined by assessing the water quality in areas with minimal human impact. These conditions will provide important background for understanding and characterization of the health of receiving waters affected by human activities (SCCWRP, 2010). Copermittees have committed funds to study bacteria and other stressors throughout the San Diego region in the natural environment under both wet and dry weather conditions, to better inform solutions and regulations.

The physical features of the Los Peñasquitos Lagoon must be taken into account when considering potential improvements in the WMA. This includes the railway berm constructed in 1925 that runs through the middle of the lagoon. It is known to impact tidal circulation in the lagoon.

Given current regulations, the Bacteria TMDL, the Sediment TMDL, monitoring data, and public input, there are four primary concerns in the WMA receiving waters that are well documented: freshwater inputs, hydromodification, sediment, and bacteria. Since the Bacteria TMDL was adopted in 2011, the Responsible Agencies have been developing strategies and programs to address bacteria and to maintain the Contact Water Recreation (REC-1) and Non-Contact Water Recreation (REC-2) beneficial uses throughout the Los Peñasquitos WMA. Since 2011, studies have been initiated by the City of San Diego to determine sediment loadings within in its jurisdiction in the WMA. The WMA strategies included in Section 4 target freshwater inputs, hydromodification, sediment, and bacteria stressors, and provide secondary benefits for water quality by potentially reducing other pollutants and stressors. Most of the strategies that will be implemented through this Water Quality Improvement Plan are expected to address multiple receiving water conditions.

The Responsible Agencies are responsible for controlling their MS4 discharges and the impact of these discharges on the receiving waters. The potential improvement in MS4 discharge quality and how it will affect the health of the overall WMA is often unclear. In addition to the MS4 discharges, many factors, such as discharges outside the Responsible Agencies' jurisdictions, natural conditions, or climatic conditions such as drought, influence the receiving water quality. Therefore, it is important clearly understand the relationship between the MS4 discharges and receiving water conditions. The previous MS4 Permit monitoring program design began to link the MS4 outfall data to the quality of downstream receiving waters and generated a limited data set that can begin to correlate MS4 impacts on receiving water conditions. However, the contributions from MS4 discharges are not well known for certain priority conditions, and therefore the potential for improvement is unknown. These limitations were considered to be data gaps for these priority water quality conditions and are described in Section 2.3.3.

2.3.2 Priority Water Quality Conditions

The identified priority water quality conditions are summarized in Appendix F. The following information is included for each priority water quality condition, per the MS4 Permit:

(1) The beneficial use impairment(s) associated with the priority water quality condition

(2) The pollutant or stressor causing the beneficial use impairment, if known

(3) The temporal extent of the priority water quality condition (dry and/or wet weather)

(4) The geographical extent of the priority water quality condition within the WMA, if known

(5) Lines of evidence leading to identification as a priority water quality condition, including evidence of MS4 discharges that may cause or contribute to the condition

(6) An assessment of the adequacy of the monitoring data to characterize the factors causing or contributing to the priority water quality condition, including consideration of spatial and temporal variation

The impaired beneficial use as, potential stressor, temporal extent of the priority water quality condition, lines of evidence clarifying the selection as a priority water quality condition (i.e., determining factors), and data gaps were determined during the assessment of the receiving water conditions and the MS4 impacts. Data gaps are discussed in more detail in Section 2.3.3. The geographical extent of the priority water quality conditions is based on the extent of the associated 303(d) listing or the location of the associated NPDES monitoring site. For each priority water quality condition, the Responsible Agencies were determined through an analysis of the geographical extent of the condition and jurisdictional boundaries.

2.3.3 Priority Water Quality Condition Data Gaps

From a review of the priority water quality conditions presented in Appendix F, some of monitoring data associated with a number of conditions are not adequate to represent the spatial and temporal variations of the conditions. Additionally, there may be other considerations that should be taken into account when analyzing the data gaps. The priority water quality conditions with data gaps and considerations, where applicable, are as follows:

- Impairment of WARM in the Los Peñasquitos Creek subwatershed:
  - The physical and biological impacts within receiving waters for the affected waterbodies have not been adequately characterized in relation to nutrient impacts.
  - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment. MS4 outfall monitoring conducted under previous MS4 Permit monitoring programs varied the suite of potential pollutants or stressors analyzed or did not include the stressors monitored in the receiving waters, based on priorities at the time of program development.

  Consideration

  - There are potential Non-MS4 sources that may contribute to the receiving water condition and these sources have not been evaluated, as follows:
    - For selenium, natural geology may be a contributing source in the San Diego region.

        - For toxicity in the receiving water, the source is unknown.
        - There is a potential contribution from agricultural activities to the MS4; Responsible Agencies may collaborate with the agricultural agencies to address water quality concerns in the WMA.

- Impairment of AGR in Los Peñasquitos Creek subwatershed:
    - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment.

    Considerations

    - The Commercial Agricultural entities monitor their activities, facilities, and discharges in accordance with the current Agricultural Waiver, issued by the Regional Board.
    - Groundwater may be a contributing source, as noted throughout the San Diego region (City of San Diego, 2011a).

- Impairment of REC-1 in Los Peñasquitos Creek subwatershed:
    - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment.

- Impairment of WARM in Carroll Canyon subwatershed:
    - The physical and biological impacts within receiving waters for the affected waterbodies have not been adequately characterized in relation to nutrient impacts.
    - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment because MS4 outfall monitoring conducted under previous MS4 Permit monitoring programs varied the suite of potential pollutants or stressors analyzed or did not include stressors monitored in the receiving waters based on priorities at the time of program development; specifically, selenium was not consistently monitored as part of the MS4 monitoring program.

    Consideration

    - There are potential Non-MS4 sources that may contribute to the receiving water condition, including the following:
        - For TDS and nutrients, groundwater may be a contributing source, as noted throughout the San Diego region (City of San Diego, 2011a).
        - There is a potential contribution from agricultural activities to the MS4, and Responsible Agencies may collaborate with the agricultural agencies to address water quality concerns in the WMA.

- Impairment of REC-1 in Carroll Canyon subwatershed:
  - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment.
- Impairment of Estuarine Habitat (EST), BIOL, and REC-1 in the Carmel Valley Creek subwatershed:
  - There are no receiving water monitoring data for this subwatershed, nor has any evidence of receiving water impairment been provided by the public.
  - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment.
- Potential Impairment of WARM/BIOL in the Los Peñasquitos Lagoon:
  - The receiving water condition is not characterized well enough to validate the potential for impairment; this condition is based on monitoring data collected upstream of the Lagoon.
  - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment because MS4 data were collected upstream of the Lagoon and do not represent direct discharges to the Lagoon.

  Consideration
  - The Sediment TMDL is designed to address the restoration of WARM and BIOL beneficial uses in the Lagoon.
- Potential Impairment of REC-1 in Los Peñasquitos Lagoon:
  - The receiving water condition is not characterized well enough to validate the potential for impairment; this condition is based on monitoring data collected upstream of the Lagoon.
  - MS4 data collected on the subwatershed level do not directly link outfall discharges with the impairment because MS4 data were collected upstream of the Lagoon and do not represent direct discharges to the Lagoon.

2.4 Step 4: Determine Highest Priority Water Quality Conditions

Once the list of priority water quality conditions was developed, “a subset of the water quality conditions (pursuant to Provision B.2.c(1))” was identified as the highest priority. The MS4 Permit provides the Copermittees with the discretion to justify the highest priority water quality conditions for program development and implementation on the basis of a number of factors, including the potential to improve watershed health, available resources, and best professional judgment. The methodology used to select the priority and highest priority water quality conditions is described in Appendix A. According to the methodology, the highest priority water quality conditions are priority water quality conditions that either (1) are associated with a TMDL, ASBS requirements, or other water quality regulations, or (2) have been elevated to highest priority on the basis of an evaluation of four additional selection criteria discussed later in this section.

Each priority water quality condition identified in Appendix F was screened against these criteria and the results are summarized below.

Based on a review of TMDLs, ASBS requirements, and other water quality regulations, the two highest priority water quality conditions in the Los Peñasquitos WMA are the impairment (by several stressors) of EST and BIOL beneficial uses in the Los Peñasquitos Lagoon and the potential impairment (by indicator bacteria) of REC-1 beneficial uses along the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar (Table 2-5). The highest priority water quality conditions are associated with the Sediment TMDL and Bacteria TMDL. Research has been conducted and plans drafted to reduce the contribution of MS4 discharges to these impairments. Of important note is that impairments related to the Sediment TMDL are largely tied historical inputs. The bacteria impairment has the greatest potential for near-term improvement in water quality that can be achieved by controlling discharges from the MS4. Over the past five years, tremendous effort has been invested by the Responsible Agencies to develop and plan BMPs to control bacteria. With the development of this Water Quality Improvement Plan (which serves as a CLRP for the implementation of the Sediment TMDL), strategies and schedules will be developed to control discharges of freshwater and sediment from the MS4 to restore saltwater habitat in the Los Peñasquitos Lagoon. The selection of these highest priority water quality conditions will provide water quality benefits to the remaining priority water quality conditions. The strategies described in Section 4 will help address other priority water quality conditions, because many of the strategies needed to reduce freshwater discharge, hydromodification, sediment, and bacteria also target other pollutants.

Table 2-5
Highest Priority Water Quality Conditions in the Los Peñasquitos WMA

Highest Priority Condition	Potential Stressor	Temporal Extent		Subwatershed(s)
		Wet	Dry	
Impairment of EST and BIOL in Los Peñasquitos Lagoon	Hydromodification, Siltation/ Sedimentation	✓	—	Carroll Canyon, Carmel Valley Creek, Los Peñasquitos Creek, Los Peñasquitos Lagoon
Impairment of EST and BIOL in Los Peñasquitos Lagoon	Freshwater Discharges	—	✓	
Potential impairment of REC-1 along the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar[1]	Indicator Bacteria	✓	✓	

1. This condition applies to all four subwatersheds during wet weather because of the potential for flow to the shoreline from the upper watershed.

The highest priority water quality conditions apply to all four subwatersheds in the WMA during wet and dry weather because each subwatershed discharges to or encompasses the Los Peñasquitos Lagoon. Freshwater intrusion affects the Lagoon during dry weather and hydromodification and siltation/sedimentation impact the Lagoon in wet weather. Discharges of indicator bacteria may affect the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar during both wet and dry weather. There is a data gap for the impairment of EST and BIOL beneficial uses in the Los Peñasquitos Lagoon and REC-1 along the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar from the Carmel Valley Creek subwatershed. There are no monitoring data or public information provided regarding contributions to the receiving water impairments for this subwatershed.

Priority water quality conditions not associated with regulatory drivers were further considered for elevation to a highest priority on the basis of four additional factors:

(1) The supporting data set is sufficient to adequately characterize the degree to which the priority water quality condition changes seasonally, and over the geographic area, to support its consideration as a highest priority water quality condition.

(2) Storm water/non-storm water runoff is a predominant source for the priority water quality condition.

(3) The priority water quality condition is controllable by the Responsible Agencies.

(4) The priority water quality condition would not be addressed by strategies identified for other highest priority water quality conditions in this Water Quality Improvement Plan.

Each of these additional factors must be evaluated to determine whether the priority water quality condition should be elevated to a highest priority water quality condition. Appendix F summarizes the evaluation of the priority water quality conditions not associated with a regulatory driver. This analysis determined that most of the priority water quality conditions will be addressed by strategies applicable to the highest priority water quality conditions, which justifies not elevating these conditions to highest priority. Furthermore, for some priority water quality conditions, there is a lack of data to adequately characterize the condition and to definitively state that storm water/non-storm water runoff is the predominant cause of the condition. These data gaps are discussed in Section 2.3.3, and further justify not elevating these conditions to highest priority. When additional data become available to assess these priority water quality conditions, the data will be incorporated per the iterative and adaptive management processes that are described in Section 6, and the conditions may be re-evaluated for potential elevation to highest priority. This Water Quality Improvement Plan is designed to concentrate efforts on the highest priority water quality conditions and to simultaneously develop programs to address the other priority water quality conditions.

3 MS4 Sources of Pollutants and/or Stressors

The previous section of this Water Quality Improvement Plan described the process for selecting the highest priority water quality conditions in the Los Peñasquitos Watershed Management Area. Those highest priority water quality conditions include:

- The potential impairment of the EST and BIOL beneficial uses in the Los Peñasquitos Lagoon because of:
  - Impacts of freshwater flowing during dry weather, including their influence on water chemistry within the Lagoon
  - Hydromodification and siltation/ sedimentation caused by uncontrolled wet weather flows
- The potential limitation of the REC-1 beneficial use along the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar due to the presence of bacteria indicating impairments during dry and wet weather

As shown in the graphic below, the second step of the Water Quality Improvement Plan (“Sources”) is to identify and prioritize sources of stressors in the Los Peñasquitos WMA (Provision B.2.d). Source identification and prioritization in this Water Quality Improvement Plan are based upon the source assessments previously conducted as a part of the 2011 LTEA and as refined by the 2012 WURMP Annual Report. Freshwater discharges and hydromodification were found to have six high priority sources. Bacteria

Section 3 Highlights

- Identifies and prioritizes sources of freshwater discharges, hydromodification, siltation/sedimentation, and bacteria
- High Priority Sources:
  - Freshwater Discharge – Irrigation Runoff, Outfalls with Persistent Dry Weather Flows, Parks and Recreation (including Golf Courses and Cemeteries), Residential Areas, Roads, Streets, Highways, and Parking, Sanitary Sewer Overflows
  - Hydromodification – Outfalls Discharging to Canyons and Bluffs, Flood Control Basins, Channel Drop Structures, Impervious Surfaces, and Land Development
  - Sediment – Aggregates/Mining Agriculture, Animal Facilities, Auto Parking Lots and Storage, Building Materials Retail, Concrete Manufacturing, Construction, General Contractors, General Retail, Health Services, Mobile Landscaping, Municipal, Nurseries/Greenhouses, Recycling and Junk Yards, Residential Areas, Stone/Glass Manufacturing, and Storage/Warehousing
- Bacteria – Residential Areas, Sanitary Sewer Overflows and Septic Systems

has only two high priority sources and sediment has 17 high priority sources. The goal of the source analysis is to identify and prioritize sources on the basis of the MS4 Permit requirements. It is not required or intended to be an independent source characterization.

Figure 3-1 outlines the process for identifying MS4 sources potentially contributing to the highest priority water quality conditions (Step 1) and the method for prioritizing the sources (Step 2). Data gaps identified as part of the source identification are highlighted to guide future analysis. As more source information is gathered, the source identification process may be refined, as described in the iterative and adaptive management processes in Section 6, and source priorities may vary by Responsible Agency.

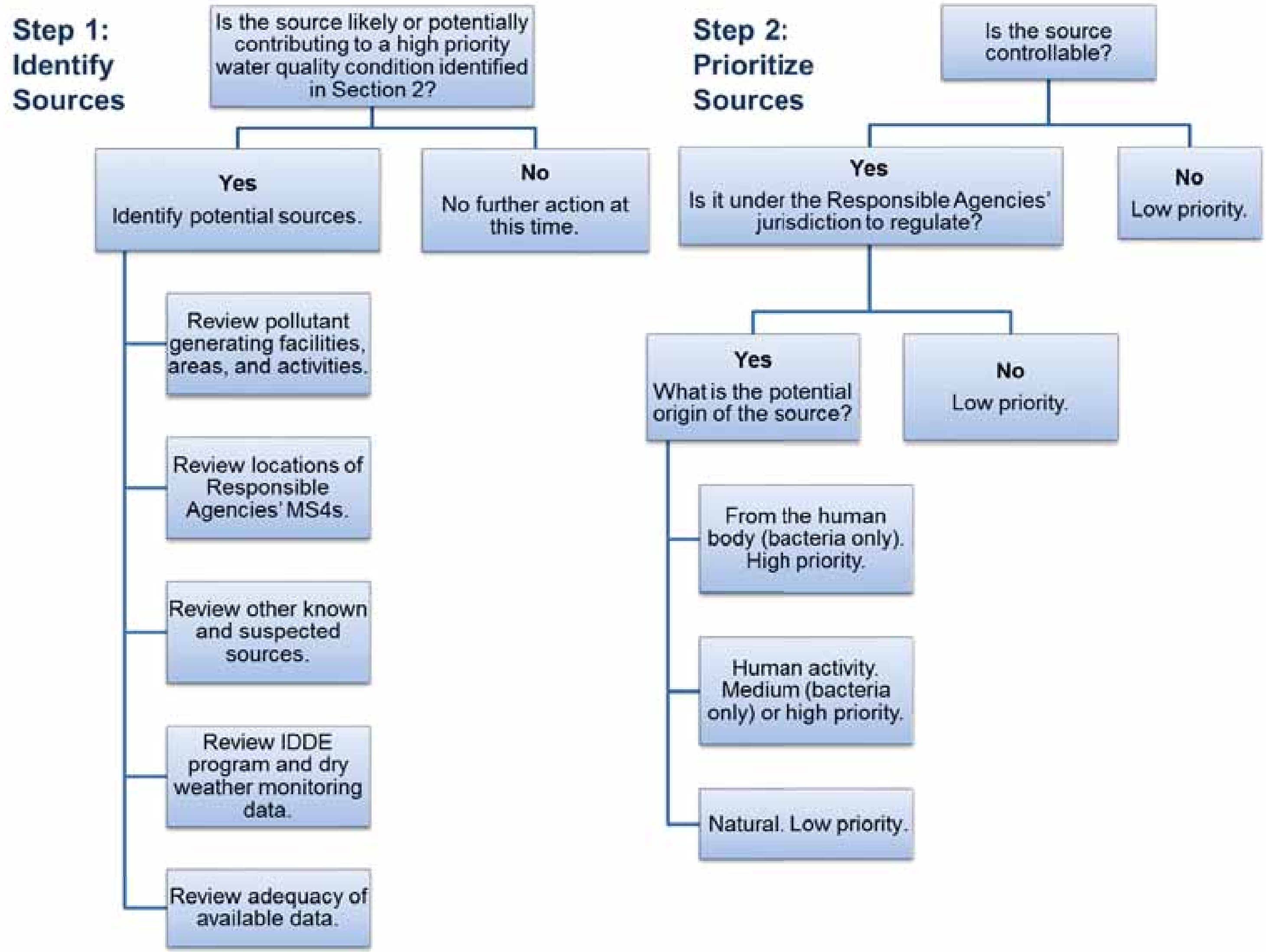

Figure 3-1
Highest Priority Water Quality Conditions Source Identification Process

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3.1 Step 1: Identification of Freshwater Discharge, Hydromodification, Sediment, and Bacteria Sources

Per the MS4 Permit, sources of freshwater discharge, hydromodification, sediment, and bacteria were identified on the basis of the following five considerations:

(1) Pollutant-generating facilities, areas, and activities within the WMA

(2) Locations of the Responsible Agencies' MS4s

(3) Other known or suspected sources of non-storm water or pollutants in storm water discharges to receiving waters

(4) Available data from the Responsible Agencies' monitoring and IDDE programs

(5) Adequacy of available data

Seven primary resources provided the information for these considerations:

(1) 2011 LTEA, as described in Section 2

(2) 2010–2011 WURMP Annual Report, as described in Section 2

(3) 2011–2012 WURMP Annual Report, as described in Section 2

(4) Maps of the MS4 system maintained by each Responsible Agency

(5) JURMP Annual Reports submitted by the Responsible Agencies, which contain agency-specific monitoring data and IDDE data, including identification of outfalls that persistently flow during dry weather; the most recent JURMP Annual Reports were utilized (City of Del Mar, 2010; City of Poway, 2012; City of San Diego, 2012a; County of San Diego, 2012)

(6) Bacterial Conceptual Models and Literature Review that were developed by the San Diego County Municipal Copermittees in 2012 and are appended to this Water Quality Improvement Plan as Appendix G of this Water Quality Improvement Plan

(7) Stakeholder input

Additional data sources were used to augment the primary sources and a complete list is provided in Appendix D. Examples of additional sources are the Sediment TMDL (Regional Board, 2012), the Bacteria TMDL (Regional Board, 2010), and the 2010 303(d) list.

3.1.1 Pollutant Generating Facilities, Areas, and Activities in the WMA

The LTEA evaluated the known pollutant-generating facilities, areas, and activities in the San Diego region, which are defined as follows:

- A **facility** is a type of existing development, such as a commercial or industrial business, a parking structure, a municipal airfield, or a landfill; an MS4 is considered to be a facility.
- An **area** is a communal area such as the trash dumpsters in a commercial strip mall, an open space, a wildlife preserve, or a residential neighborhood.
- **Activities** are practices such as irrigation, portable toilet cleaning, storage of pet wastes, and fertilizer use (Regional Board, 2013).

To identify sources, the LTEA evaluated the available wet and dry weather receiving water and outfall monitoring data and IDDE program results, as well as the adequacy of the data, pursuant to MS4 Permit Provision B.2.d(4). The 2011 LTEA identified sources from the previous MS4 Permit (R9-2007-001) and updated the list on the basis of the 2009-2010 inventory. The sources were scored using a matrix that accounted for the number of pollutant-generating activities associated with each source (in categories of 0, 1–4, and >4 activities) and the potential for wet weather discharge from each source (from 1 = no discharge potential to 5 = high discharge potential). These scores were then converted into the following qualitative source loading potentials:

- **None (N)** includes sources with no identified pollutant-generating activities and low discharge potential.
- **Unknown (UK)** includes sources with one or more identified pollutant-generating activities, but very low discharge potential.
- **Unlikely (UL)** includes sources with no pollutant-generating activities, but high discharge potential, or sources with moderate discharge potential and one or more pollutant-generating activities.
- **Likely (L)** includes sources with high discharge potential and identified-pollutant generating activities.

Beginning with the sources identified in the 2007 MS4 Permit and updating the list with the most recent inventory, the 2011 LTEA evaluated 37 facilities, areas, and activities (sources) and identified a number of likely sources of sediment and bacteria. The WURMP Annual Reports identify the likely sources from the LTEA that are within the Los Peñasquitos WMA, as well as the quantity of each source that is in the WMA. These sources, land use categories, quantities, and impairments of sources are summarized in Table 3-1. Sources classified as having an unknown loading potential in the 2011 LTEA are included in the assessment of the adequacy of available data (Section 3.1.6).

Table 3-1
Likely Sources of Sediment and Bacteria Identified in WURMP Annual Reports

Source Type	Category	Number of Identified Likely Sources in Los Peñasquitos WMA[1]	Highest Priority Water Quality Conditions[2]	
			Sediment	Bacteria
Aggregates/Mining	Industrial	3 facilities	✓	—
Agriculture	Other	3 facilities (583 acres)	✓	✓
Animal Facilities	Commercial	78 facilities	✓	✓
Auto Parking Lots and Storage	Commercial	14 facilities	✓	—
Building Materials Retail	Commercial	66 facilities	✓	—
Concrete Manufacturing	Industrial	20 facilities	✓	—
Eating or Drinking Establishments	Commercial	980 facilities	—	✓
General Contractors	Commercial	399 facilities	✓	—
General Retail	Commercial	228 facilities	✓	—
Health Services	Commercial	4 facilities	✓	—
Mobile Landscaping	Commercial	41 facilities	✓	✓
Nurseries/Greenhouses	Commercial	8 facilities	✓	✓
Recycling and Junk Yards	Industrial	9 facilities	✓	—
Stone/Glass Manufacturing	Industrial	13 facilities	✓	—
Storage/Warehousing	Commercial	657 facilities	✓	—
Municipal	Municipal	171 facilities	✓	—
Construction	Other	2,088 facilities	✓	—
Residential Areas	Residential	16,351 acres	✓	✓

1. Sources are quantified by facility counts or acreage. Facility counts help define the sources during dry weather and land uses help define sources during wet weather. Counts are based on the 2010 JURMP Annual Reports.
2. Freshwater discharge and hydromodification are not directly addressed in WURMP and so are not listed in this table.

"✓" = Source applies to highest priority water quality condition.
"—" = Source does not apply to highest priority water quality condition.

The WURMP identified sanitary sewer overflows and bacteria regrowth in the MS4 as potential sources of bacteria. The WURMP also identified irrigation runoff and sanitary sewer overflows as potential sources of freshwater discharge from dry weather flows, although they are not identified as likely sources. Responsible Agency monitoring data from the dry weather transitional monitoring program have also identified potential outfalls with persistent flow; these outfalls are currently being reviewed to determine which of them meet the MS4 Permit-defined requirements. The outfall locations were mapped using a GIS and were compared with the Responsible Agencies' land use data.

Of the potential outfalls with persistent flow, 56 percent were in residential areas, 29 percent were in areas associated with industrial land use, and 18 percent of the outfalls were in parks and recreation land use (including open space). Both residential and parks and recreation areas have been identified as potential sources of dry weather freshwater discharge. It is not assumed that these persistently flowing outfalls are potentially contributing to sediment or bacteria priority conditions; additional monitoring data are needed to identify persistently flowing outfalls as potential or likely sources of sediment or bacteria.

3.1.2 Other Known and Suspected Sources

Sources other than those within the Responsible Agencies' jurisdiction and under their regulatory authority may also contribute to the freshwater discharge, hydromodification, sediment, and bacteria impairments within the Los Peñasquitos WMA. Discharges from these sources are often conveyed to receiving waters by the Responsible Agencies' MS4s. The principal sources outside the Responsible Agencies' jurisdiction are:

- Phase II MS4 outfalls
- Other permitted discharges
- Other potential point sources
- Other non-point sources

Phase II MS4s

Phase II MS4s are smaller agencies (relative to municipalities) or areas that are regulated under the State's Phase II MS4 General Permit (State Board Order No. 2013-0001-DWG) (State Board, 2013a). They are outside the authority of the Responsible Agencies and, within the San Diego region, can include, but are not limited to, correctional, transit, educational, and federal facilities. Phase II MS4 permittees are responsible for only the runoff from their facilities and activities, whereas the Responsible Agencies are responsible for receiving runoff from other sources. Phase II MS4s may contribute to the impairment of beneficial uses in the Los Peñasquitos WMA. Some Phase II MS4s have been named in the Bacteria TMDL (Regional Board, 2010).

The Los Peñasquitos WMA has three Phase II MS4s:

- Marine Corps Air Station Miramar
- North County Transit District (NCTD)
- University of California, San Diego

Contributions from Phase II MS4s are a suspected source of freshwater discharge, hydromodification, sediment, and bacteria in both storm water and dry weather non-storm water conditions. The Responsible Agencies will collaborate with the Regional Board and Phase II MS4s when possible to collect data to quantify the contribution of Phase II MS4' to the freshwater discharge, hydromodification, sediment, and bacteria impairments.

Other Permitted Discharges

Other permitted discharges, such as discharges covered under the State's Construction General Permit (State Board, 2012a) and the Industrial General Permit (State Board, 2014), may also contribute to the highest priority water quality conditions. Industrial waste treatment facilities, for example, have been identified as potential point sources of freshwater discharge (which can contribute sediment by increasing erosion) and bacteria. Agricultural discharges, which are generally covered under a conditional discharge waiver from the Regional Board, are discussed below as an example of non-point source discharges. Such discharges may be conveyed to receiving waters by the Responsible Agencies' MS4s.

In addition to the MS4 Permit, four other types of storm water discharge permits are present within the Los Peñasquitos WMA, as presented in Table 3-2.

Table 3-2
Storm Water Discharge Permits

Permit Type	Number of Permits in WMA
Municipal Storm Water	5
Industrial Storm Water	75*
Construction Storm Water	46*
Caltrans Storm Water	1
Other Individual NPDES Discharges	0
Total:	**127**

Sources: State Board, 2011a and 2011b.
*Number of individual permittees filing under statewide general permit.

Mining operations, which are addressed under industrial permits, are located adjacent to Carroll Canyon Creek and have a high potential to contribute to the significant sediment loads in the Carroll Canyon subwatershed. Sediment loads for mining areas on steep slopes have a higher loading potential as compared other land uses in the watershed (Los Peñasquitos Watershed Copermittees, 2012b). Waste management sites (e.g., landfills and waste transfer stations) and construction sites have also been identified as significant point sources of indicator bacteria in the San Diego region (Regional Board, 2010). They are also likely contributors of sediment (Los Peñasquitos Watershed Copermittees, 2013). Although there is one municipal landfill in the Los Peñasquitos WMA (CalRecycle, 2013), it was not identified as a likely source of bacteria or sediment in the 2012 WURMP Annual Report. The Responsible Agencies will collaborate with the Regional Board and other permitted dischargers when possible to collect data to quantify their contributions to the freshwater discharge, sediment, and bacteria impairments.

Other Point Sources

A point source is a discrete conveyance, such as a pipe or ditch, that may discharge pollutants from a specific area or facility. Private outfalls are point sources that may discharge freshwater, sediment, and bacteria to the MS4 or receiving waters, or may be a source of scouring and hydromodification; however, no private outfalls have been identified by the Responsible Agencies in the Los Peñasquitos WMA.

Other Non-point Sources

Non-point sources typically flow over land and discharge to receiving waters over a broad or non-discrete area, as opposed to a point location. Potential non-point source discharges may originate from a number of different activities and locations throughout the WMA. Non-point sources by their nature are diffuse sources of stressors.

The Sediment TMDL identifies excess erosion of sediment from the landscape (i.e., hydromodification) as a potential source of sediment. Hydromodification has been linked to land development, which can transform the natural landscape by exposing sediment and converting pervious surfaces to impervious. This can lead to excess volume and velocity of runoff, causing scouring below storm water outfalls in canyon and bluff areas. In particular, a 2010 geomorphic assessment of the Los Peñasquitos Lagoon subwatershed identified multiple segments of Carroll Creek that have high potential to contribute to downstream sediment (City of San Diego, 2011b).

Sediment contributions from the Pacific Ocean represent a background (natural) source in the Los Peñasquitos Lagoon itself. The Sediment TMDL also notes that sediment deposition does not adequately flush out of the Lagoon because of the impediment created by railway berms and other physical alterations. The buildup over time from potential excess erosion and inadequate flushing has impaired the habitat in the Los Peñasquitos Lagoon (Regional Board, 2012). Additionally, the Tecolote CLRP identifies aerial deposition (i.e., sediment blown and redeposited by wind) as both a natural source of sediment and a source influenced by human activity in the San Diego region.

During wet weather, storm water runoff may carry sediment and indicator bacteria from agricultural lands to the MS4. During dry weather, irrigation runoff from agricultural sites may lead to freshwater discharges. Per the Bacteria TMDL, bacteria carried by agricultural discharges that enter the MS4 conveyance system are considered to be controllable by the MS4s. Agricultural sites operate under a conditional discharge waiver from the Regional Board (Resolution No. R9-2007-0104), meaning that they are exempt from the discharge requirements of the current MS4 Permit (Regional Board, 2007). This waiver expired in 2014, and a new Agricultural Order is expected to go into effect in 2015. A draft tentative order detailing waste discharge requirements for commercial agricultural and nursery operations was released by the Regional Board on January 17, 2014. Responsible Agencies will look for opportunities to collaborate with the Regional Board and agricultural dischargers when possible and appropriate.

The Bacteria TMDL identifies wildlife areas, which include open space land uses and are sometimes not under the jurisdiction of Responsible Agencies, as sources of bacteria. The wildlife areas partially account for bacteria contributions from wild animals and decaying plant sources.

The Bacterial Conceptual Model (City of San Diego, 2012b) identifies transient encampments as a bacteria source that can directly discharge bacteria from human origins to receiving waters. Transient encampments are temporarily located in both municipal and open space land uses. The issues raised by transient encampments are socio-economic by nature. To address the sources of homelessness requires coordination with law enforcement, social services, and the legal community. Sources related to sewage infrastructure (such as sewer collection systems, sanitary sewer overflows, illicit discharges to the sewer system, and septic tanks) have also been identified by the Responsible Agencies as potential sources of bacteria. Additionally, during dry periods, bacteria can regrow within the MS4 and create biofilms (City of San Diego, 2012a). These sources may be found within the Los Peñasquitos WMA and are considered under the jurisdiction of the Responsible Agencies.

The contribution of groundwater into the MS4 through infiltration and receiving waters at areas where the groundwater table reaches surface water (rising groundwater) may also be considered a non-point source for freshwater discharges (Regional Board, 2010). During dry weather, bacteria may enter the MS4 or receiving waters through groundwater infiltration or irrigation runoff into municipal drainage channels (County of Los Angeles, 2010).

3.1.3 Locations of the Responsible Agencies' MS4s

The MS4 maps discussed in Section 2 were reviewed as part of the source identification process. The Los Peñasquitos Creek subwatershed is the area in the Los Peñasquitos WMA with the highest number of major MS4 outfalls. The Carroll Canyon subwatershed has a smaller urban land use area, but is the subwatershed with the greatest density of major MS4 outfalls, urban land uses, and impervious surfaces based on urban land use per acre. The Carmel Valley Creek and Los Peñasquitos Lagoon subwatersheds have one-third to one-sixth of the number of major MS4 outfalls as compared with the Los Peñasquitos Creek and Carroll Canyon subwatersheds.

Location of major MS4 outfalls is of particular interest when considering sources of hydromodification. In some cases, strategies intended to address hydromodification and channel scouring can exacerbate the problem downstream. For example, flood control basins intended to reduce peak discharges, if they are not designed to consider downstream impacts or if hydraulic or hydrologic conditions change substantially from design conditions, can trap sediment, ultimately releasing sediment-starved and highly erosive waters. Similarly, channel drop structures, designed to stabilize the upstream reach of a channel, may destabilize and degrade the area directly downstream if they are not designed to consider downstream impacts or if conditions change substantially from design conditions (SCCWRP, 2012b). Note, however, that when designed to minimize downstream impacts and using natural materials, flood control basins and channel drop structures can play a systematic role in improving and protecting downstream habitat.

3.1.4 IDDE Program and Dry Weather Monitoring Data

In addition to the evaluation in the LTEA, data from the IDDE program and receiving water monitoring programs were reviewed to determine whether known or suspected sources of freshwater discharge, hydromodification, sediment, and bacteria may be controllable by the Responsible Agencies' MS4s. Dry weather field screening, inspections, and complaint responses have been shown to be effective means of detecting and eliminating illicit discharges (County of San Diego, 2011).

Dry Weather Field Screening and Persistent Flow

Dry weather field screening data collected as part of the MS4 Permit's transitional monitoring program were also considered on the basis of dry weather persistent flows, where available. Flow during dry weather may result from permitted, allowed, or illegal discharges. Dry weather flow provides a mechanism for transport of sediment and indicator bacteria from facilities, areas, or activities to receiving waters, and is the key source of freshwater discharges. Per the MS4 Permit Provision D.2.a(2)(b)(iv),

> *"Persistent flow is defined as the presence of flowing, pooled, or ponded water more than 72 hours after a measureable rainfall event of 0.1 inch or greater during three consecutive monitoring and/or inspection events. All other flowing, pooled, or ponded water is considered transient."*

Based on a review of the major MS4 outfall map in Section 2, the Responsible Agencies have identified a total of 97 major MS4 outfalls in the Los Peñasquitos Creek subwatershed, 92 major MS4 outfalls in the Carroll Canyon subwatershed, 33 major MS4 outfalls in the Carmel Valley Creek subwatershed, and 15 major MS4 outfalls in the Los Peñasquitos Lagoon subwatershed. The Responsible Agencies have identified 34 major MS4 outfalls in the Los Peñasquitos WMA that may persistently discharge non-storm water. These outfalls are presented in Appendix D.3.

Facility Inspections

Facility inspections complement the IDDE program and include informing the public about storm water and dry weather runoff. Inspections also detect potential dry weather flows discharging from facilities. Inspections may confirm whether specific types of facilities are significant sources of bacteria. Although information is available on facility inspections on the basis of the previous permit JURMP annual reporting requirements, the JURMP data assessment did not provide detailed information linking facility inspections to sources. Section 5 (Monitoring and Assessment) and Section 6 (Iterative Approach) describe how JRMP report requirements will be used to answer water quality-related questions.

Storm Water Complaints

The Responsible Agencies have implemented regional and jurisdictional storm water telephone hotlines since the issuance of Order R9-2001-01 in 2001. Members of the public may call in complaints to the Regional Hotline (maintained by the County of San Diego) or report them online; the County then contacts the appropriate jurisdiction to follow up on the complaints. In addition, jurisdictions respond to complaints received by their own hotlines. Complaints received via the hotlines have helped Responsible Agencies identify and eliminate illicit discharges, particularly during dry weather (San Diego County Municipal Copermittees, 2011b).

As with facility inspections, storm water complaints were reported annually on the basis of the previous permit JURMP annual reporting requirements, but the JURMP data assessment did not provide detailed information linking storm water complaints and IDDE investigations to sources. Section 5 (Monitoring and Assessment) and Section 6 (Iterative Approach) describe how the water quality-related data associated with storm water complaints and their related follow-up IDDE investigations will be used to answer water quality related questions.

3.1.5 Summary of Freshwater Discharge, Hydromodification, Sediment, and Bacteria Sources

Freshwater discharge, hydromodification, sediment, and bacteria were identified as sources on the basis of the available resources and the considerations required by the MS4 Permit, as described above. Sources of freshwater discharge are believed to have a more significant impact during dry weather. The Sediment TMDL states that sources of hydromodification and sediment are more significant in wet weather; the Bacteria TMDL states that sources of bacteria may be the same in wet and dry weather.

While the wet and dry weather sources of bacteria may be the same, the transport mechanisms are different. During wet weather, bacteria are discharged to the MS4 and then to the receiving waters via storm water runoff, which occurs over a general area and can be well represented by land use. During dry weather, discharges are conveyed by non-storm water runoff, which includes illicit discharges, irrigation runoff, groundwater infiltration, and permitted discharges, and are associated with specific facilities, areas, or activities. The different wet and dry weather transport mechanisms require varying strategies to address the impairment, and are discussed in Section 4. Consequently, both wet and dry weather sources have been identified in this section, and strategies to address the different transport mechanisms are discussed in Section 4.

Wet and dry weather sources were also categorized by land use using the Responsible Agencies' inventories of facilities and land uses to help develop the goals, strategies, and schedules described in Section 4. Table 3-3 presents facilities, areas, and activities identified by the Responsible Agencies as known or suspected sources of freshwater discharge, hydromodification, sediment, or bacteria, and typical land uses that were associated with the sources as part of the identification process.

Table 3-3
Sources of Freshwater Discharge, Hydromodification, Sediment, and Bacteria in the Los Peñasquitos WMA

Known or Suspected Source	Land Uses								
	Construction	Commercial	Industrial	Municipal	Residential	Parks and Recreational Areas	Open Space	Landfills	Other[1]
FRESHWATER DISCHARGE									
Non-WURMP Identified Sources[2]									
Outfalls with Persistent Dry Weather Flow	—	✓	✓	✓	✓	—	—	—	✓
Irrigation runoff	—	—	—	✓	—	✓	—	—	—
Parks and Recreation (Including Golf Courses and Cemeteries)	—	—	—	✓	—	✓	—	—	✓
Roads, Streets, Highways, and Parking	—	✓	—	✓	✓	—	—	—	✓
Residential Areas	—	—	—	—	✓	—	—	—	—
Sanitary Sewer Overflows	✓	✓	✓	✓	✓	✓	—	—	✓
HYDROMODIFICATION									
Non-WURMP Identified Sources[2]									
Land Development	✓	✓	✓	✓	✓	—	—	—	✓
Impervious Surfaces	✓	✓	✓	✓	✓	—	—	—	✓
Outfalls Discharging to Canyons/Bluffs	—	✓	✓	✓	✓	—	—	—	✓
Open Space Areas	—	—	—	—	—	—	✓	—	✓
Flood Control Basins	—	—	—	✓	—	—	—	—	—
Channel Drop Structures	—	—	—	✓	—	—	—	—	—

Table 3-3 (continued)
Sources of Freshwater Discharge, Hydromodification, Sediment, and Bacteria in the Los Peñasquitos WMA

Known or Suspected Source	Land Uses								
	Construction	Commercial	Industrial	Municipal	Residential	Parks and Recreational Areas	Open Space	Landfills	Other[1]
SEDIMENT									
Facility									
Aggregates/ Mining	—	—	✓	—	—	—	—	—	✓
Animal Facilities	—	✓	—	✓	—	—	—	—	✓
Building Materials Retail	—	✓	—	—	—	—	—	—	—
Nurseries and Greenhouses	—	✓	✓	✓	—	✓	—	—	✓
Health Services	—	✓	—	✓	—	—	—	—	—
Recycling and Junk Yards	—	—	✓	✓	—	—	—	✓	—
Stone/Glass Manufacturing	—	—	✓	—	—	—	—	—	—
Storage/ Warehousing	✓	✓	✓	✓	—	—	—	—	✓
Area									
Agriculture	—	—	—	✓	✓	—	—	—	✓
Auto Parking Lots or Storage	✓	✓	—	✓	✓	✓	—	—	✓
General Retail	—	✓	—	—	—	—	—	—	—
Municipal	✓	—	—	✓	✓	✓	✓	✓	—
Residential Areas	—	—	—	—	✓	—	—	—	—

Table 3-3 (continued)
Sources of Freshwater Discharge, Hydromodification, Sediment, and Bacteria in the Los Peñasquitos WMA

Known or Suspected Source	Land Uses								
	Construction	Commercial	Industrial	Municipal	Residential	Parks and Recreational Areas	Open Space	Landfills	Other[1]
Activity									
Concrete Manufacturing	✓	—	✓	—	—	—	—	—	—
Construction	✓	—	—	—	—	—	—	—	—
General Contractors	✓	—	—	—	—	—	—	—	—
Mobile Landscaping	—	✓	—	✓	✓	✓	—	—	—
Non-WURMP Identified Sources[2]									
Hydromodification	✓	✓	✓	✓	✓	✓	—	—	✓
Ocean Sediment Contribution	—	—	—	—	—	✓	—	—	✓
Open Space Areas	—	—	—	—	—	—	✓	—	—
INDICATOR BACTERIA									
Facility									
Animal Facilities	—	✓	—	✓	—	—	—	—	✓
Eating and Drinking Establishments	—	✓	—	✓	—	✓	—	—	✓
Nurseries and Greenhouses	—	✓	✓	✓	—	✓	—	—	✓

Table 3-3 (continued)
Sources of Freshwater Discharge, Hydromodification, Sediment, and Bacteria in the Los Peñasquitos WMA

Known or Suspected Source	Land Uses								
	Construction	Commercial	Industrial	Municipal	Residential	Parks and Recreational Areas	Open Space	Landfills	Other[1]
Area									
Residential Areas	—	—	—	—	✓	—	—	—	—
Agriculture	—	—	—	✓	✓	—	—	—	✓
Activity									
Mobile Landscaping	—	✓	—	✓	✓	✓	—	—	—
Non-WURMP Identified Sources[2]									
Bacteria Regrowth and Biofilms	—	—	—	✓	—	—	—	—	✓
Transient Encampments	—	—	—	—	—	—	—	—	✓
Open Space Areas	—	—	—	—	—	—	✓	—	—
Sanitary Sewer Overflows	✓	✓	✓	✓	✓	✓	—	—	✓
Wildlife	—	—	—	✓	—	✓	✓	✓	✓

1. Other sources are those sources outside of the Responsible Agencies' jurisdictions and regulatory authorities; see Section 3.1.2.
2. Non-WURMP-identified sources have been categorized separately because this information comes from secondary sources that have not gone through the same regulatory review process as have the WURMP-identified sources.

3.1.6 Adequacy of Available Data

The Copermittees' monitoring and inspection programs, along with the MS4 inventory, provide sufficient data to categorize the known or suspected sources of freshwater discharges, hydromodification, sediment, and bacteria within the Los Peñasquitos WMA. However, additional potential sources have been identified during the source identification that cannot be directly linked to freshwater discharges, hydromodification, sediment, and bacteria MS4 contributions on the basis of the data available. The contributions of these potential sources to freshwater discharges, sediment, and bacteria concentrations in the MS4 are unknown. Table 3-4 presents potential sources that require additional data to determine whether they are likely contributors to impairments within the Los Peñasquitos WMA.

Additionally, the following sources require further study to collect a larger data set to determine whether they may be contributing to the impairment of beneficial uses in the Los Peñasquitos WMA:

- ❖ Phase II MS4 contribution of freshwater discharge, hydromodification, sediment, and bacteria, as detailed in Section 3.1.2
- ❖ Non-point source contribution of freshwater discharge, hydromodification, sediment, and bacteria, as detailed in Section 3.1.2
- ❖ Locations and discharge characteristics of private outfalls
- ❖ Persistently flowing dry weather outfalls identified from the Responsible Agencies' transitional monitoring program (in progress)

Table 3-4
Potential Freshwater Discharge, Hydromodification, Sediment, and Bacteria Sources with Data Gaps

Pollutant or Stressor	Potential Source Where Magnitude of Impact Is Unknown	Potential Origin of the Source	Source of Data[1]
Freshwater Discharge	Groundwater infiltration into the MS4	Human activity and natural	County of Los Angeles, 2010
	Rising groundwater	Natural	Regional Board, 2010
Hydromodification	No sources with data gaps were identified.		
Sediment	Chemical and Allied Products	Human activity	WURMP
	Fabricated Metal	Human activity	WURMP
	General Industrial	Human activity	WURMP
	Institutional	Human activity	WURMP
	Aerial Deposition	Human activity and natural	CLRP[2]

Table 3-4 (continued)
Potential Freshwater Discharge, Hydromodification, Sediment, and Bacteria Sources with Data Gaps

Pollutant or Stressor	Potential Source Where Magnitude of Impact Is Unknown	Potential Origin of the Source	Source of Data[1]
Bacteria	Mobile Power Washing	Human activity	WURMP
	Motor Freight	Human activity	WURMP
	Offices	Human activity	WURMP
	Primary Metal	Human activity	WURMP
	Auto Parking Lots and Storage	Human activity	WURMP
	General Industrial	Human activity	WURMP
	Mobile Power Washing	Human activity	WURMP
	Motor Freight	Human activity	WURMP
	Offices	Human activity	WURMP
	Parks and Recreation (Including Golf Courses and Cemeteries)	Human activity, human body, and natural	WURMP
	Pest Control Services	Human activity	WURMP
	Reclaimed Water Use	Human activity	CLRP[2]
	Municipal	Human activity, human body, and natural	WURMP

1. Potential sources found in the WURMP are those classified as “unknown” by the LTEA; WURMP terminology for source names is used.
2. CLRP = Tecolote Watershed Comprehensive Load Reduction Plan (City of San Diego, 2012b).

3.2 Step 2: Prioritization of Freshwater Discharge, Hydromodification, Sediment, and Bacteria Sources

Based on the findings of Section 3.1, sources were prioritized according to two factors: (1) the ability of the Responsible Agencies to control the source, and (2) the level of human influence.

To determine whether a potential source is controllable, three factors were considered: (1) the locations of the MS4s and potential contributing land uses during wet weather, (2) known outlets with persistent dry weather flow, and (3) jurisdictional authority.

The relative level of human influence was evaluated on the basis of the origin of the bacteria and the relationship to urban development and human activity. The levels of fecal indicator bacteria (FIB) in a waterbody can be related to recreational health risks; a non-human-impacted waterbody with high FIB densities can pose less risk for water recreation than a human-impacted waterbody with low FIB densities (Soller et al., 2010; Schoen and Ashbolt, 2010). The three categories of source origin are the human body, human activity, and natural sources. For example, sewage spills and transient encampments contribute discharges of bacteria from human sources; pets and secondary wildlife (i.e., wildlife associated with human presence and habitation) contribute other forms of bacteria as a result of human activity; and wildlife contributes bacteria in open spaces independently of human activity. The prioritization of the known and suspected sources is described in the following subsections.

3.2.1 Source Controllability

Sources were ranked on the basis of the ability of the Responsible Agency to control the associated discharges. Controllable sources are controllable activities by humans, although in some instances (i.e., agricultural activities) Responsible Agencies have limited jurisdictional authority to regulate them. Most point sources were considered controllable, whereas many non-point sources were not. Controllable sources are those sources that are anthropogenic (i.e., influenced by humans) in origin (Regional Board, 2010). According to the Bacteria TMDL, controllable sources of stressors include:

- Discharges from municipal land uses
- Discharges from Caltrans
- Discharges from agricultural land uses that flow into the Responsible Agencies' MS4

Sources of stressors that are not controllable include:

- Discharges from open space and undeveloped land
- Wildlife (with the exception of secondary wildlife)
- Bacteria bound in soil and humic material
- Other natural sources not influenced by human activity

The Sediment TMDL (Regional Board, 2012) distinguishes controllable sources of sediment from non-controllable sources of sediment. Controllable sources of sediment include:

- Discharges from municipal land uses
- Discharges from Phase II land uses
- Discharges from Caltrans
- Discharges from the General Industrial and General Construction Storm Water permittees

Sources of sediment that are not controllable include:

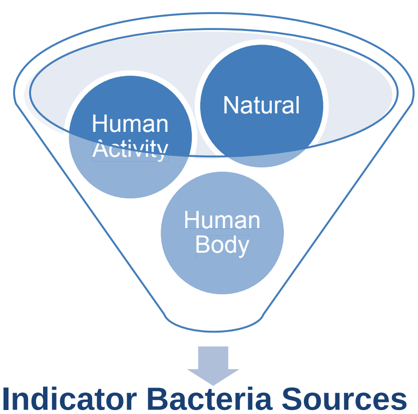
- Ocean sediment contributions

Sources that are outside the Responsible Agencies' jurisdictional boundaries, non-point sources that are not considered controllable, and sources over which the Responsible Agencies have no regulatory authority were considered to be non-controllable.

Based on this definition, sources in the Los Peñasquitos WMA were categorized as follows:

- Controllable:
  - Discharge is from a municipal land use, Caltrans, or an agricultural land use.
  - Identified land uses associated with the facility, area, or activity fall within the jurisdiction of the Responsible Agencies.
- Not controllable:
  - Discharge is not from a municipal land use, Caltrans, or an agricultural land use.
  - No identified land uses associated with the facility, area, or activity fall within the jurisdiction of the Responsible Agencies.

3.2.2 Level of Human Influence and Source Prioritization



Sources of freshwater discharge, hydromodification, sediment, and bacteria were prioritized on the basis of the level of human influence on the source. The Bacteria Conceptual Model that was developed for the San Diego County Municipal Copermittees' 2011–2012 Urban Runoff Monitoring Final Report (City of San Diego, 2012b) provides a methodology to characterize the sources of indicator bacteria (*Enterococcus*, fecal coliform, and total coliform) by the level of human influence. Freshwater discharge, hydromodification, and sediment source prioritization used the same methodology as that for bacteria, excluding sources from the human body that are not applicable.

The three categories of source origin are the human body, human activity, and natural sources, as follows:

- Human Body: Bacteria carried or shed by humans (e.g., bather shedding and sewage)

- Human Activity: Sources from non-human anthropogenic origins (the source is not from the human body, but may be increased by human influence or activities such as pet waste and secondary wildlife generation for bacteria, land-disturbing activities from construction for hydromodification and sediment, and irrigation of lawns for freshwater discharge)
- Natural: Sources from non-human non-anthropogenic origins (not increased by human influence), such as natural sources, including wildlife and natural plant decay for bacteria, naturally occurring erosion for sediment, and rising groundwater for freshwater discharge

Sources were ranked on the basis of the category of the stressor origin. Indicator bacteria sources from the human body were given the highest priority; sources associated with human activity, the second priority; and sources known or suspected to be natural in origin, the last priority. For sediment and freshwater discharges, sources associated with human activity were assigned high priority and sources identified with a potential natural origin were determined as low priority. For the Los Peñasquitos WMA, the final stressor prioritization was determined as follows:

- High:
  - Bacteria:
    - Source is controllable, and
    - Human body is identified as a potential origin.
  - Sediment, hydromodification, and freshwater discharge:
    - Source is controllable, and
    - Human activity is identified as a potential origin.
- Medium (bacteria only):
  - Source is controllable, and
  - Human activity is identified as a potential origin.
- Low (freshwater discharge, hydromodification, sediment, and bacteria):
  - Source is not controllable, or
  - Source is controllable and natural is identified as a potential origin.

Table 3-5 prioritizes the identified known and suspected sources of freshwater discharge, hydromodification, sediment, and indicator bacteria in the Los Peñasquitos WMA.

Table 3-5
Prioritized Sources

Known or Suspected Source	Controllability	Potential Origin of the Source
FRESHWATER DISCHARGE		
Facility–High		
Outfalls with Persistent Dry Weather Flow	Controllable	Human activity
Parks and Recreation (Including Golf Courses and Cemeteries)	Controllable	Human activity
Area–High		
Roads, Streets, Highways, and Parking	Controllable	Human activity
Residential Areas	Controllable	Human activity
Activity–High		
Irrigation runoff	Controllable	Human activity
Sanitary Sewer Overflows	Controllable	Human activity
HYDROMODIFICATION		
Facility–High		
Outfalls Discharging to Canyons/Bluffs	Controllable	Human activity
Flood Control Basins	Controllable	Human activity
Channel Drop Structures	Controllable	Human activity
Area–High		
Impervious Surfaces	Controllable	Human activity
Area–Low		
Open Space Areas	Not controllable	Natural
Activity–High		
Land Development	Controllable	Human activity
SEDIMENT		
Facility—High		
Aggregates/Mining	Controllable	Human activity
Animal Facilities	Controllable	Human activity
Building Materials Retail	Controllable	Human activity
Nurseries and Greenhouses	Controllable	Human activity
Health Services	Controllable	Human activity

**Table 3-5 (continued)
Prioritized Sources**

Known or Suspected Source	Controllability	Potential Origin of the Source
Recycling and Junk Yards	Controllable	Human activity
Stone/Glass Manufacturing	Controllable	Human activity
Storage/Warehousing	Controllable	Human activity
Area–High		
Agriculture	Controllable	Human activity
Auto Parking Lots or Storage	Controllable	Human activity
General Retail	Controllable	Human activity
Municipal	Controllable	Human activity
Residential Areas	Controllable	Human activity
Hydromodification	Controllable	Human activity
Area–Low		
Open Space Areas	Not controllable	Natural
Activity–High		
Concrete Manufacturing	Controllable	Human activity
Construction	Controllable	Human activity
General Contractors	Controllable	Human activity
Mobile Landscaping	Controllable	Human activity
Activity–Low		
Ocean Sediment Contribution	Not controllable	Natural
INDICATOR BACTERIA		
Facility–Medium		
Animal Facilities	Controllable	Human activity
Eating and Drinking Establishments	Controllable	Human activity
Nurseries and Greenhouses	Controllable	Human activity
Area–High		
Residential Areas	Controllable	Human activity
Area–Medium		
Agriculture	Controllable[1]	Human activity

**Table 3-5 (continued)
Prioritized Sources**

Known or Suspected Source	Controllability	Potential Origin of the Source
Area–Low		
Open Space Areas	Not controllable	Natural
Transient Encampments	Not controllable[2]	Human body and human activity
Activity–High		
Sanitary Sewer Overflows	Controllable	Human body
Activity–Medium		
Mobile landscaping	Controllable	Human activity
Wildlife (Secondary)[3]	Controllable	Human activity
Activity–Low		
Bacteria Regrowth and Biofilms	Controllable[4]	Natural
Wildlife	Not controllable	Natural

1. Per the Bacteria TMDL, discharges from agricultural lands are controllable; however, they are not in the Responsible Agencies' jurisdiction.
2. Transient encampments are temporarily located in both municipal and open space land uses. The issues raised by transient encampments are socio-economic by nature. To address the sources of homelessness requires coordination with law enforcement, social services, and the legal community. Therefore, it has been designated as an uncontrollable source.
3. Secondary wildlife comprises vermin and other wildlife species associated with human presence and habitation.
4. Bacteria regrowth is a natural phenomenon that is hard to track or predict. The regrowth of bacteria in pipes is influenced by multiple factors, some that are under the direct control of the MS4s and some that are not.

3.3 Summary of Priority Sources by Responsible Agency

JURMP Annual Reports were reviewed to identify whether priority sources could be found in the jurisdictions within the Los Peñasquitos WMA. These reports are unique to each jurisdiction, and did not consistently categorize the source information in the same manner as that presented below. Consequently, land use information provided in the JURMP Annual Reports was used to determine whether the following sources were found in the jurisdiction: agriculture; roads, streets, and parking; and residential. Because Caltrans is not subject to the MS4 Permit, it has not developed a JURMP Annual Report that presents the priority sources. Therefore, only sources for the jurisdictions are provided in this section.

Priority sources are summarized by Responsible Agency in Tables 3-6 through 3-9.

Table 3-6
Summary of Priority Freshwater Discharge Sources by Responsible Agency

Source Type	City of Del Mar	City of Poway	City of San Diego	County of San Diego
High Priority				
Irrigation Runoff[1]	✓	✓	✓	✓
Outfalls with Persistent Dry Weather Flow	—	—	✓	—
Parks and Recreation (Including Golf Courses and Cemeteries)	—	✓	✓	✓
Residential Areas	✓	✓	✓	✓
Roads, Streets, Highways, and Parking	✓	✓	✓	✓
Sanitary Sewer Overflows	—	✓	✓	—

1. Assumed to be present in all jurisdictions with MS4s.

Table 3-7
Summary of Priority Hydromodification Sources by Responsible Agency

Source Type	City of Del Mar	City of Poway	City of San Diego	County of San Diego
High Priority				
Outfalls Discharging to Canyons/Bluffs[1]	✓	✓	✓	✓
Flood Control Basins[1]	✓	✓	✓	✓
Channel Drop Structures[1]	✓	✓	✓	✓
Impervious Surfaces[2]	✓	✓	✓	✓
Land Development[2]	✓	✓	✓	✓
Low Priority				
Open Space Areas	✓	✓	✓	✓

1. Assumed to be present in all Copermittee jurisdictions; locations are subject to spatial verification.
2. Assumed to be present in all Copermittee jurisdictions.

Table 3-8
Summary of Priority Sediment Sources by Responsible Agency

Source Type	City of Del Mar	City of Poway	City of San Diego	County of San Diego
High Priority				
Aggregates/Mining	—	✓	✓	—
Agriculture	—	✓	✓	✓
Animal Facilities	—	✓	✓	✓
Auto Parking Lots and Storage	✓	✓	✓	—
Building Materials Retail	—	✓	✓	—
Concrete Manufacturing	—	✓	✓	—
Construction	✓	✓	✓	—
General Contractors	—	✓	✓	—
General Retail	—	✓	✓	—
Health Services	—	✓	✓	—
Hydromodification[1]	✓	✓	✓	✓
Mobile Landscaping	—	✓	✓	—
Municipal	✓	✓	✓	✓
Nurseries/Greenhouses	—	✓	✓	—
Recycling and Junk Yards	—	✓	✓	—
Residential Areas	✓	✓	✓	✓
Stone/Glass Manufacturing	—	✓	✓	—
Storage/Warehousing	—	✓	✓	—
Low Priority				
Ocean Sediment Contribution[2]	✓	—	✓	—
Open Space Areas	✓	✓	✓	✓

1. Assumed to be present in all Copermittee jurisdictions.
2. Assumed to be present in all Copermittee jurisdictions with a coastal boundary.

Table 3-9
Summary of Priority Indicator Bacteria Sources by Responsible Agency

Source Type	City of Del Mar	City of Poway	City of San Diego	County of San Diego
High Priority				
Residential Areas	✓	✓	✓	✓
Sanitary Sewer Overflows	—	✓	✓	—
Medium Priority				
Agriculture	—	✓	✓	✓
Animal Facilities	—	✓	✓	✓
Eating or Drinking Establishments	—	✓	✓	—
Mobile Landscaping	—	✓	✓	—
Nurseries/Greenhouses	—	✓	✓	—
Wildlife (Secondary)[1,2]	✓	✓	✓	✓
Low Priority				
Bacteria Regrowth and Biofilms[3]	✓	✓	✓	✓
Open Space Areas	✓	✓	✓	✓
Transient Encampments	NA[4]	NA[4]	NA[4]	NA[4]
Wildlife[2]	✓	✓	✓	✓

1. Assumed to be present in all Copermittee jurisdictions.
2. Secondary wildlife comprises vermin and other wildlife species associated with human presence and habitation.
3. Assumed to be present in all jurisdictions with MS4s.
4. NA = Not available; the number of transient encampments is not currently assessed by jurisdiction because of the challenges in obtaining an accurate count of encampments, which, by definition, are temporary. A point-in-time count is prepared annually by the Regional Task Force on the Homeless, and can be found on its website (http://www.rtfhsd.org/).

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4 Water Quality Goals, Strategies, and Schedules

Section 2 established two highest priority water quality conditions in the Los Peñasquitos WMA: (1) the impairment of EST and BIOL (e.g., salt marsh) beneficial uses in the Los Peñasquitos Lagoon (Lagoon), and (2) the potential impairment of REC-1 beneficial uses along the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar. The lagoon impairments are due to hydromodification, sedimentation, and siltation during wet weather and due to freshwater discharges during dry weather. Potential impairments along the Pacific Ocean Shoreline are due to indicator bacteria (*Enterococcus*, fecal coliform, and total coliform) during both wet and dry weather.

Section 3 identified and prioritized sources and stressors potentially contributing to the hydromodification, sediment, freshwater discharge, and bacteria impairments in the Los Peñasquitos WMA by jurisdiction.

Section 4 Highlights

- Goals for the highest priority water quality conditions (Section 4.1).
- Details on the planned strategies:
  - A description of the nonstructural and structural strategies to be implemented to achieve the goals (Section 4.2). Collaborative strategies will also be highlighted (Section 4.2.5).
  - Each Responsible Agency's strategies with an implementation schedule (Appendix I).
  - The basis for strategy selection and prioritization, along with implementation assumptions used to estimate strategy effectiveness with the BMP optimization model (Appendix J).
- Specifics of the compliance analysis modeling results (Section 4.3):
  - A percent load reduction for each BMP category to demonstrate that final goals will be met by implementing the strategies (Section 4.3.1).
  - The schedule for implementation to demonstrate that interim and final goals will be achieved by implementing the strategies (Section 4.3.2).
  - Detailed modeling results, including anticipated load reductions by each strategy type, subwatershed, jurisdiction, and pollutant (Appendix J).

As shown in the graphic below, the third step of Water Quality Improvement Plan development process is to identify the goals, strategies, and implementation schedules for the Los Peñasquitos WMA to address sources and stressors that are potentially contributing to the hydromodification, sediment, freshwater discharge, and bacteria impairment (Provision B.3).

The following sections present the goals (Section 4.1) and strategies (Section 4.2) selected by the Responsible Agencies to address the highest priority water quality conditions in the Los Peñasquitos WMA. A compliance analysis using a watershed model was completed to demonstrate the anticipated progress toward achieving these goals through the proposed strategies and their implementation schedules (Section 4.3). The modeling results are summarized in Section 4.3.

4.1 Goals

Numeric goals are developed in this section to support Water Quality Improvement Plan implementation, and will be used to measure progress toward addressing the highest priority water quality conditions. Numeric goals may take a variety of forms, but must be quantifiable so that progress toward and achievement of the goals are measurable. Each highest priority water quality condition may include multiple criteria or indicators. In accordance with the MS4 Permit and applicable regulatory drivers, final goals and reasonable interim goals have been developed. An interim goal is required for each five-year period from Water Quality Improvement Plan approval to the anticipated final goal compliance date (including an interim goal for this permit term).

Within the Los Peñasquitos WMA, the Sediment TMDL dictates the sediment goals that are applicable during wet weather. The Bacteria TMDL is the driver for bacteria goals, which are applicable during both dry and wet weather. Reduction of freshwater discharges during dry weather will assist in compliance with both TMDLs. Responsible Agencies must meet the wet weather Sediment TMDL targets within 20 years of TMDL adoption (FY35). Responsible Agencies must meet the wet weather Bacteria TMDL targets within 20 years of TMDL adoption (FY31) and dry weather targets within 10 years (FY21).

These TMDLs identify both receiving water and WMA targets. Appendix H describes the Sediment TMDL and Bacteria TMDL numeric targets, how the targets were derived, and how the targets were translated into numeric goals for the Water Quality Improvement Plan. Water Quality Improvement Plan numeric goals mirror TMDL targets and provide multiple compliance pathways that can be met within the receiving water or within the WMA. Water Quality Improvement Plan goals may be met (1) in the receiving water (restoring salt marsh habitat in the Lagoon or meeting applicable bacteria concentrations at the shoreline), (2) in MS4s discharges by demonstrating that the MS4 is not causing or contributing to receiving water exceedances, or (3) by implementing an approved Water Quality Improvement Plan that used a watershed model or other watershed analytical tools to identify BMPs required to achieve compliance with the final receiving water or effluent goals. Within the Los Peñasquitos WMA, a compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. Modeling described in the following sections demonstrates that the jurisdictional strategies presented in Section 4.2 will meet the jurisdictional goals, expressed as a load reduction from the jurisdiction's MS4. The Bacteria TMDL also allows compliance if final receiving water limitations are due to loads from natural sources and pollutant loads from the MS4s are not causing or contributing to the exceedances.

The Sediment TMDL was incorporated into the MS4 Permit in an amendment dated February 11, 2015. While the amended MS4 Permit was approved with language incorporating the Sediment TMDL in Attachment E, additional language is currently being reviewed by the Regional Board that would add consistency and clarification with the Sediment TMDL to the final compliance determination. It is anticipated that these revisions will be incorporated in a future amendment. This language has been incorporated into Responsible Agency goals as footnoted in the goals tables and provided in Appendix H.

The Sediment TMDL assigned a WMA-wide sediment load reduction to the Responsible Agencies. The proxy for assessing protection of the beneficial use of the Lagoon is salt marsh habitat. In the development of the Water Quality Improvement Plan, the TMDL model was updated and it calculated the sediment loads attributed to the Responsible Agencies (Appendix H). In addition to WMA sediment load reduction, the Sediment TMDL suggested two alternative measures that would contribute to an increase in salt marsh habitat: reduction of freshwater discharges and Lagoon restoration. The strategies selected in the Water Quality Improvement Plan will target both sediment and freshwater discharge reduction within individual jurisdictions. However, as stated in the TMDL, current sediment loading is not the only cause of the Lagoon impairment. Historical loading, including activities within the Lagoon, contributed to the impairment. Therefore, the Responsible Agencies are also investigating partnerships and opportunities for future restoration activities as described in Section 4.2.5.1. Lagoon restoration would involve a collaborative effort among the Responsible Agencies and other stakeholders in the WMA.

Responsible Agencies developed goals both collaboratively and individually to best address the sources and stressors within the WMA and individual jurisdictions. An individualized approach provides flexibility in selecting interim goals on the basis of jurisdiction-specific strategies and schedules, and provides the framework for a more accurate assessment of progress toward achieving goals within each jurisdiction. The final and interim numeric goals for the Los Peñasquitos WMA were derived from WQBELs identified in the Bacteria TMDL and incorporated into the MS4 Permit (currently being considered for adoption). Appendix H presents the Sediment TMDL and

Bacteria TMDL numeric targets and provides the basis for the Water Quality Improvement Plan numeric goals.

Performance-based goals are included to measure short-term jurisdictional progress toward achieving goals, given that sustained water quality improvement is typically demonstrated over a longer timeframe. Performance measures are intended to measure an outcome from a strategy or suite of strategies, and provide an interim link to demonstrate reasonable incremental progress in the quality of MS4 discharges and receiving waters by FY18. The strategies or suite of strategies presented have been selected as goals because they are measurable and provide a direct benefit in the short term. Section 4.2 and the associated appendices present the full suite of strategies that will be considered for implementation. Section 4.3 presents the anticipated schedule for implementation and the associated load reduction benefit estimated through implementation of the suite of strategies. The following sections present final and interim numeric goals by jurisdiction. Appendix H presents the Sediment TMDL and Bacteria TMDL numeric targets and provides the basis for the Water Quality Improvement Plan numeric goals. Appendix I presents the strategies selected by Responsible Agencies that will be implemented to meet the goals. Appendix J presents the details of the compliance analysis and modeling results.

4.1.1 City of Del Mar Goals

The City of Del Mar Water Quality Improvement Plan wet weather sediment interim and final goals are presented in Table 4-1 and Table 4-2, respectively. Wet weather bacteria interim and final goals are provided in Table 4-3. Dry weather interim and final goals are presented in Table 4-4. Water Quality Improvement Plan interim goals have been identified for each five-year assessment period and include TMDL targets. Where TMDL targets are not required, interim goals were estimated, considering the planning and implementation efforts described in the strategies and schedules discussion (Sections 4.2 and 4.3). Performance-based goals were selected to measure short-term jurisdictional progress toward achieving goals during the current permit cycle.

Strategies that the City of Del Mar will use to achieve the numeric goals are presented in Section 4.2 and include the programs specifically identified in the performance-based goals and associated metrics.

Table 4-1
Wet Weather Sediment Interim Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
SEDIMENT							
			FY18	FY20[1]	FY24[1]	FY28[1]	FY30[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]				
OR							
MS4 Discharges % Load Reduction		0% Load Reduction Year 2000 (Sediment TMDL Model)	3.0%[3]	7.0%[3]	13.9%[3]	20.9%[3]	27.8%[3]
OR							
MS4 Discharges Sediment Load Within Allowable Limits as Determined by Sediment Loading Model (tons/wet period)		1.6 tons/wet period 2010 (Sediment Water Quality Improvement Plan Model)	–	1.5	1.4	1.2	1.1
OR							

Table 4-1 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of Del Mar

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year				
		Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan	Submitting and fully implementing a Water Quality Improvement Plan, accepted by the Regional Board, which provides reasonable assurance[4] that the City's portion of the interim TMDL compliance requirements, described in Attachment A of Resolution No. R9-2010-0033 will be achieved. The compliance schedule in Attachment A provides two pathways to meet interim goals: (1) attain the specified percent load reduction, or (2) show progress in improving Lagoon conditions; see metrics below.					
	0% Load Reduction Year 2000 (Sediment TMDL Model)	3.0%[3]	7.0%[3]	13.9%[3]	20.9%[3]	27.8%[3]
	OR					
	1.6 tons/wet period 2010 (Sediment Water Quality Improvement Plan Model)	–	1.5	1.4	1.2	1.1
	OR					
	262 acres in 2010 (Sediment TMDL)	Increasing trend in the total area of salt marsh habitat				
OR						

Table 4-1 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
MS4 Discharges # of Direct or Indirect Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	0	0	0	0	0

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can mean either:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.
4. Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J. The metric used in the compliance analysis is percent load reduction.

All numeric goals are cumulative from the baseline assessment for each fiscal year.
% = percent; FY = fiscal year; WQO = Water Quality Objective

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Table 4-2
Wet Weather Sediment Final Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year
			FY31-36
SEDIMENT			
			FY35[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]
OR			
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan		Strategies presented in Appendix I	The Water Quality Improvement Plan must incorporate and the City must implement the BMPs or other implementation actions required to achieve the Lagoon restoration goal
		AND	
		Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J	Include a compliance analysis[3], accepted by the Regional Board, to demonstrate that implementation of the BMPs or other implementation actions will achieve the Lagoon restoration goal
		AND	
		262 acres in 2010 (Sediment TMDL)	Perform monitoring and assessments to demonstrated compliance with the Lagoon restoration goal of 346 acres[2]

Table 4-2 (continued)
Wet Weather Sediment Final Numeric Goals for the City of Del Mar

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can mean either:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of Del Mar's jurisdiction. Further analysis of loads specific to the City of Del Mar may be completed in the future.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

Table 4-3
Wet Weather Bacteria Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	FY 31-35
INDICATOR BACTERIA							
Compliance Pathways		Baseline	FY18	FY19	FY24[1]	FY29	FY31[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	30% Days Exceeding WQO (2002 TMDL Model)	See performance measures	30%[2]	26%	25%	22%
	Enterococcus	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
	Total coliform	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
OR							
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	0.3%	1.0%	1.4%	2.0%
	Enterococcus			0.3%	1.0%	1.3%	1.9%
	Total coliform			0.2%	0.8%	1.1%	1.6%
OR							

Table 4-3 (continued)
Wet Weather Bacteria Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	FY 31-35
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 wet weather data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	See performance measures	22%	22%	22%	22%
	Enterococcus			22%	22%	22%	22%
	Total coliform			22%	22%	22%	22%
OR							
# of Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	0	0	0	0	0
OR							
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%	100%	100%	100%	100%
	Enterococcus		100%	100%	100%	100%	100%
	Total coliform		100%	100%	100%	100%	100%
OR							
MS4 Discharges Implement Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule on the basis of analysis results (Appendix I). Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for modeling results.					

Table 4-3 (continued)
Wet Weather Bacteria Numeric Goals for the City of Del Mar

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year
		Current Permit Term
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Reduce anthropogenic surface dry weather flows[4] to address bacteria regrowth contributing during wet weather	Historical anthropogenic surface dry weather flow[4] data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	10% reduction in anthropogenic surface dry weather flows[4] that originate within the City's jurisdictional boundaries

1. Denotes TMDL interim and final target.
2. Denotes existing wet weather frequency as modeled in the Bacteria TMDL. With limited baseline monitoring data available, this goal reflects a reasonable estimate considering the difficulty in demonstrating progress within the receiving water during wet weather in a short amount of time. Furthermore, development and redevelopment of the urban environment has occurred since the Bacteria TMDL baseline loads were calculated in 2001. As such, this goal demonstrates that progress has been made by the Responsible Agencies by maintaining the existing wet weather exceeding frequency.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.
4. The term "dry weather flows" excludes groundwater, other exempt or permitted non-storm water flows, and sanitary sewer overflows.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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Table 4-4
Dry Weather Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
INDICATOR BACTERIA					
			FY18	FY19[1]	FY21[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	4% Days Exceeding WQO (2002[2])	See performance measures	2.0%[2]	0%
	Enterococcus	19% Days Exceeding WQO (2002[2])		9.5%[2]	0%
	Total coliform	1% Days Exceeding WQO (2002[2])		0.5%[2]	0%
OR					
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 dry weather data will be used to identify the baseline in the first annual report	See performance measures	0%	0%
	Enterococcus			0%	0%
	Total coliform			0%	0%
OR					
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	48.3%	96.6%
	Enterococcus			49.7%	99.4%
	Total coliform			48.3%	96.5%
OR					
# of Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of persistently flowing major MS4 outfalls provided in Section 5.1 of the Monitoring and Assessment Program Section of this Water Quality Improvement Plan	0		0

Table 4-4 (continued)
Dry Weather Numeric Goals for the City of Del Mar

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
OR					
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%		100%
	Enterococcus		100%		100%
	Total coliform		100%		100%
OR					
MS4 Discharges Implement Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule based on analysis results (Appendix I). Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for modeling results.			
FRESHWATER DISCHARGE					
			FY18	FY19[1]	FY21[1]
MS4 Discharges % Irrigation or Other Dry Weather Flow Reduction	Flow	Baseline to be evaluated and provided in first Water Quality Improvement Plan Annual Report	See performance measures	18%	25%
OR					
MS4 Discharges Implement Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule based on analysis results (Appendix I). Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for modeling results.			

Table 4-4 (continued)
Dry Weather Numeric Goals for the City of Del Mar

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year
		Current Permit Term
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Reduce anthropogenic surface dry weather water flows[4]	Historical anthropogenic surface dry weather flow[4] data will be used to identify the baseline in the final Water Quality Improvement Plan Annual Report	Reduce anthropogenic surface dry weather flows[4] that originate within the City's jurisdictional boundaries by 10%

1. Denotes TMDL interim and final target.
2. Calculated as a 50% reduction in the existing exceedance frequency presented in Appendix H.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.
4. The term "dry weather flow" excludes groundwater, other exempt or permitted non-storm water flows, and sanitary sewer overflows.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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4.1.2 City of Poway Wet and Dry Weather Goals

The City of Poway Water Quality Improvement Plan wet weather sediment interim and final goals are presented in Table 4-5 and Table 4-6, respectively. Wet weather bacteria interim and final goals are provided in Table 4-7. Dry weather interim and final goals are presented in Table 4-8. Water Quality Improvement Plan interim goals have been identified for each five-year assessment period and include TMDL targets. Where TMDL targets are not required, interim goals were estimated, considering the planning and implementation efforts described in the strategies and schedules discussion (Sections 4.2 and 4.3). Performance-based goals were selected to measure short-term jurisdictional progress toward achieving goals during the current permit cycle.

Strategies that the City of Poway will use to achieve the numeric goals are presented in Section 4.2 and include the programs specifically identified in the performance-based goals and associated metrics.

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Table 4-5
Wet Weather Sediment Interim Numeric Goals for the City of Poway

Compliance Pathway		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
SEDIMENT							
			FY18	FY20[1]	FY24[1]	FY28[1]	FY30[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]				
OR							
MS4 Discharges % Load Reductions		0% Load Reduction Year 2000 (Sediment TMDL Model)	See performance measures	9.4%[3]	18.9%[3]	28.3%[3]	37.8%[3]
OR							
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan		Submitting and fully implementing a Water Quality Improvement Plan, accepted by the Regional Board, which provides reasonable assurance[4] that the City's portion of the interim TMDL compliance requirements, described in Attachment A of Resolution No. R9-2010-0033, will be achieved. The compliance schedule in Attachment A provides two pathways to meet interim goals: (1) attain the specified percent load reduction, or (2) show progress in improving Lagoon conditions; see metrics below.					

Table 4-5 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of Poway

Compliance Pathway		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan (continued)		0% Load Reduction Year 2000 (Sediment TMDL Model)	See performance measures	9.4%[3]	18.9%[3]	28.3%[3]	37.8%[3]
		OR					
		262 acres in 2010 (Sediment TMDL)	See performance measures	Increasing trend in the total area of salt marsh habitat			
OR							
MS4 Discharges # of Direct or Indirect Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	0	0	0	0	0

Table 4-5 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of Poway

Compliance Pathway	Baseline	Goals by Assessment Period and Fiscal Year
		Current Permit Term (FY14 – FY18)
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Turf conversion	The baseline of the square footage of turf converted will be identified in the first Water Quality Improvement Plan Annual Report	5% increase from the baseline through turf conversion

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can either mean:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of Poway's jurisdiction. Further analysis of loads specific to the City of Poway may be completed in the future.
4. Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J. The metric used in the compliance analysis is percent load reduction.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

Table 4-6
Wet Weather Sediment Final Numeric Goals for the City of Poway

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year
			FY 31–36
SEDIMENT			
			FY35[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]
OR			
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan		Strategies presented in Appendix I	The Water Quality Improvement Plan must incorporate and the City must implement the BMPs or other implementation actions required to achieve the Lagoon restoration goal
		AND	
		Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J	Include a compliance analysis[3], accepted by the Regional Board, to demonstrate that implementation of the BMPs or other implementation actions will achieve the Lagoon restoration goal
		AND	
		262 acres in 2010 (Sediment TMDL)	Perform monitoring and assessments to demonstrated compliance with the Lagoon restoration goal of 346 acres[2]

Table 4-6 (continued)
Wet Weather Sediment Final Numeric Goals for the City of Poway

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can mean either:
    - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
    - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, as opposed to the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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Table 4-7
Wet Weather Bacteria Goals for the City of Poway

Compliance Pathway		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	FY 31–35
INDICATOR BACTERIA							
			FY18	FY19	FY24[1]	FY29	FY31[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	30% Days Exceeding WQO (2002 TMDL Model)	See performance measures	30%[2]	26%	25%	22%
	Enterococcus	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
	Total coliform	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
OR							
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	0.3%	1.0%	1.4%	2.0%
	Enterococcus			0.3%	1.0%	1.3%	1.9%
	Total coliform			0.2%	0.8%	1.1%	1.6%

Table 4-7 (continued)
Wet Weather Bacteria Goals for the City of Poway

Compliance Pathway		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	FY 31–35
OR							
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 wet weather data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	See performance measures	22%	22%	22%	22%
	Enterococcus			22%	22%	22%	22%
	Total coliform			22%	22%	22%	22%
OR							
# of Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	See performance measures	0	0	0	0
OR							
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%	100%	100%	100%	100%
	Enterococcus		100%	100%	100%	100%	100%
	Total coliform		100%	100%	100%	100%	100%
OR							
MS4 Discharges Implemented Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule based on analysis results (Appendix I). Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for modeling results.					

Table 4-7 (continued)
Wet Weather Bacteria Goals for the City of Poway

Compliance Pathway	Baseline	Goals by Assessment Period and Fiscal Year
		Current Permit Term (FY14 – FY18)
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Turf conversion	The baseline of the square footage of turf converted will be identified in the first Water Quality Improvement Plan Annual Report	5% increase from the baseline through turf conversion

1. Denotes TMDL interim and final target.
2. Denotes existing wet weather frequency as modeled in the Bacteria TMDL. With limited baseline monitoring data available, this goal reflects a reasonable estimate considering the difficulty in demonstrating progress within the receiving water during wet weather in a short amount of time. Furthermore, development and redevelopment of the urban environment has occurred since the Bacteria TMDL baseline loads were calculated in 2001. As such, this goal demonstrates that progress has been made by the Responsible Agencies by maintaining the existing wet weather exceeding frequency.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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Table 4-8
Dry Weather Numeric Goals for the City of Poway

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
INDICATOR BACTERIA					
			FY18	FY19[1]	FY21[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	4% Days Exceeding WQO (2002[2])	See performance measures	2.0%[2]	0%
	Enterococcus	19% Days Exceeding WQO (2002[2])		9.5%[2]	0%
	Total coliform	1% Days Exceeding WQO (2002[2])		0.5%[2]	0%
OR					
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 dry weather data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	See performance measures	0%	0%
	Enterococcus			0%	0%
	Total coliform			0%	0%
OR					
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	48.3%	96.6%
	Enterococcus			49.7%	99.4%
	Total coliform			48.3%	96.5%
OR					
# of Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of persistently flowing major MS4 outfalls provided in Section 5.1 of the Monitoring and Assessment Program Section of this Water Quality Improvement Plan	0	0	0

Table 4-8 (continued)
Dry Weather Numeric Goals for the City of Poway

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
OR					
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%	100%	100%
	Enterococcus		100%	100%	100%
	Total coliform		100%	100%	100%
FRESHWATER DISCHARGE					
			FY18	FY19[1]	FY21[1]
MS4 Discharges % Irrigation or other Dry Weather Flow Reduction	Flow	Baseline to be evaluated and provided in first Water Quality Improvement Plan Annual Report	See performance measures	18%	25%

Table 4-8 (continued)
Dry Weather Numeric Goals for the City of Poway

Compliance Pathway	Baseline	Goals by Assessment Period and Fiscal Year
		Current Permit Term (FY14 – FY18)
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Turf conversion	The baseline of the square footage of turf converted will be identified in the first Water Quality Improvement Plan Annual Report	5% increase from the baseline through turf conversion

1. Denotes TMDL interim and final target.
2. Calculated as a 50% reduction in the existing exceedance frequency presented in Appendix H.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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4.1.3 City of San Diego Wet and Dry Weather Goals

The City of San Diego Water Quality Improvement Plan wet weather sediment interim and final goals are presented in Table 4-9 and Table 4-10, respectively. Wet weather bacteria interim and final goals are provided in Table 4-11. Dry weather interim and final goals are presented in Table 4-12. Water Quality Improvement Plan interim goals have been identified for each five-year assessment period and include TMDL targets. Where TMDL targets are not required, interim goals were estimated, considering the planning and implementation efforts described in the strategies and schedules discussion (Sections 4.2 and 4.3). Performance-based goals were selected to measure short-term jurisdictional progress toward achieving goals during the current permit cycle.

Strategies that the City of San Diego will use to achieve the numeric goals are presented in Section 4.2 and include the programs specifically identified in the performance-based goals and associated metrics.

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Table 4-9
Wet Weather Sediment Interim Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
SEDIMENT							
			FY18	FY20[1]	FY24[1]	FY28[1]	FY30[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]				
OR							
MS4 Discharges % Load Reductions		0% Load Reduction Year 2000 (Sediment TMDL Model)	See performance measures	10.6%[3]	21.2%[3]	31.9%[3]	42.5%[3]
OR							

Table 4-9 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan		Submitting and fully implementing a Water Quality Improvement Plan, accepted by the Regional Board, which provides reasonable assurance[4] that the City's portion of the interim TMDL compliance requirements, described in Attachment A of Resolution No. R9-2010-0033, will be achieved. The compliance schedule in Attachment A provides two pathways to meet interim goals: (1) attain the specified percent load reduction, or (2) show progress in improving Lagoon conditions; see metrics below.					
		0% Load Reduction Year 2000 (Sediment TMDL Model)	See performance measures	10.6%[3]	21.2%[3]	31.9%[3]	42.5%[3]
		OR					
		262 acres in 2010 (Sediment TMDL)	See performance measures	Increasing trend in the total area of salt marsh habitat			
OR							
MS4 Discharges # of Direct or Indirect Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	0	0	0	0	0

Table 4-9 (continued)
Wet Weather Sediment Interim Numeric Goals for the City of San Diego

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year			
		Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30
PERFORMANCE MEASURES					
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18			
Develop a green infrastructure policy, attain City Council approval, and construct green infrastructure BMPs to improve water quality during wet and dry weather	0 acres treated in 2002, the year used as baseline in the Bacteria TMDL	36 acres of drainage area treated through construction of 9 green infrastructure BMPs[5]			

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can mean either:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.
4. Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J. The metric used in compliance analysis is percent load reduction.
5. The 36 acres of drainage area treated are associated with 9 green infrastructure projects that will be completed by FY18.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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Table 4-10
Wet Weather Sediment Final Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year FY31–36
SEDIMENT			
			FY35[1]
Lagoon Restoration Restoration of Salt Marsh Habitat	Acres of Salt Marsh Habitat	262 acres in 2010 (Sediment TMDL)	346 acres[2]
OR			
MS4 Discharges and Receiving Water Implement Accepted Water Quality Improvement Plan		Strategies presented in Appendix I	The Water Quality Improvement Plan must incorporate and the City must implement the BMPs or other implementation actions required to achieve the Lagoon restoration goal
		AND	
		Reasonable assurance is provided by the compliance analysis described in Section 4.3.2 and Appendix J	Include a compliance analysis[3], accepted by the Regional Board, to demonstrate that implementation of the BMPs or other implementation actions will achieve the Lagoon restoration goal
		AND	
		262 acres in 2010 (Sediment TMDL)	Perform monitoring and assessments to demonstrated compliance with the Lagoon restoration goal of 346 acres[2]

Table 4-10 (continued)
Wet Weather Sediment Final Numeric Goals for the City of San Diego

1. Denotes TMDL interim and final target.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can mean either:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

Table 4-11
Wet Weather Bacteria Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25	FY 26–30	FY 31–35
INDICATOR BACTERIA							
			FY18	FY19	FY24[1]	FY29	FY31[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	30% Days Exceeding WQO (2002 TMDL Model)	See performance measures	30%[2]	26%	25%	22%
	Enterococcus	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
	Total coliform	30% Days Exceeding WQO (2002 TMDL Model)		30%[2]	26%	25%	22%
OR							
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	0.3%	1.0%	1.4%	2.0%
	Enterococcus			0.3%	1.0%	1.3%	1.9%
	Total coliform			0.2%	0.8%	1.1%	1.6%
OR							
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 wet weather data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	See performance measures	22%	22%	22%	22%
	Enterococcus			22%	22%	22%	22%
	Total coliform			22%	22%	22%	22%
OR							

Table 4-11 (continued)
Wet Weather Bacteria Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year				
			Current Permit Term (FY14 – FY18)	FY 16-20	FY 21-25	FY 26-30	FY 31-35
# of Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of flowing major MS4 outfalls during wet weather monitoring (Section 5 of this Water Quality Improvement Plan)	See performance measures	0	0	0	0
OR							
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%	100%	100%	100%	100%
	Enterococcus		100%	100%	100%	100%	100%
	Total coliform		100%	100%	100%	100%	100%
OR							
MS4 Discharges Implemented Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule (presented in Appendix I) based on analysis results. Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for compliance analysis results.					

Table 4-11 (continued)
Wet Weather Bacteria Numeric Goals for the City of San Diego

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year				
		Current Permit Term (FY14 – FY18)	FY 16-20	FY 21-25	FY 26-30	FY 31-35
PERFORMANCE MEASURES						
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18				
Develop a green infrastructure policy, attain City Council approval, and construct green infrastructure BMPs to improve water quality during wet and dry weather	0 acres treated in 2002, the year used as baseline in the Bacteria TMDL	36 acres of drainage area treated through construction of 9 green infrastructure BMPs[4]				

1. Denotes TMDL interim and final target.
2. Denotes existing wet weather frequency as modeled in the Bacteria TMDL. With limited baseline monitoring data available, this goal reflects a reasonable estimate considering the difficulty in demonstrating progress within the receiving water during wet weather in a short amount of time. Furthermore, development and redevelopment of the urban environment has occurred since the Bacteria TMDL baseline loads were calculated in 2001. As such, this goal demonstrates that progress has been made by the Responsible Agencies by maintaining the existing wet weather exceeding frequency.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.
4. The 36 acres of drainage area treated are associated with 9 green infrastructure projects that will be completed by FY18.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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Table 4-12
Dry Weather Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
INDICATOR BACTERIA					
			FY18	FY19[1]	FY21[1]
Receiving Water % Days Exceeding WQO	Fecal coliform	4% Days Exceeding WQO (2002[2])	See performance measures	2.0%	0%
	Enterococcus	19% Days Exceeding WQO (2002[2])		9.5%	0%
	Total coliform	1% Days Exceeding WQO (2002[2])		0.5%	0%
OR					
MS4 Discharges % Days Exceeding WQO	Fecal coliform	Historical MS4 dry weather data will be used to identify the baseline in the first Water Quality Improvement Plan Annual Report	See performance measures	0%	0%
	Enterococcus			0%	0%
	Total coliform			0%	0%
OR					
MS4 Discharges % Load Reduction	Fecal coliform	0% Load Reduction (2002 TMDL Model)	See performance measures	48.3%	96.6%
	Enterococcus			49.7%	99.4%
	Total coliform			48.3%	96.5%
OR					
# Direct or Indirect MS4 Discharges to Receiving Water	Discharges	Number of persistently flowing major MS4 outfalls provided in Section 5.1 of the Monitoring and Assessment Program of this Water Quality Improvement Plan	0	0	0

Table 4-12 (continued)
Dry Weather Numeric Goals for the City of San Diego

Compliance Pathways		Baseline	Goals by Assessment Period and Fiscal Year		
			Current Permit Term (FY14 – FY18)	FY 16–20	FY 21–25
OR					
% of Exceedances of Final Receiving Water WQOs Due to Natural Sources[3]	Fecal coliform	Unknown at this time. A detailed source study that differentiates between human and non-human sources would be needed to establish the baseline.	100%	100%	100%
	Enterococcus		100%	100%	100%
	Total coliform		100%	100%	100%
OR					
MS4 Discharges Implement Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge percent load reduction (above). Interim compliance is implementation of strategies and schedule (presented in Appendix I) based on analysis results. Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for compliance analysis results.			
FRESHWATER DISCHARGE					
			FY18	FY19[1]	FY21[1]
MS4 Discharges % Irrigation or other Wet and Dry Weather Flow Reduction	Flow	Baseline will be evaluated and provided in the first Water Quality Improvement Plan Annual Report	See performance measures	18%	25%
OR					
MS4 Discharges Implement Accepted Water Quality Improvement Plan		Metric for compliance analysis is MS4 discharge % load reduction (above). Interim compliance is implementation of strategies and schedule (presented in Appendix I) based on analysis results. Final compliance is implementation of BMPs based on analysis results and demonstration of compliance with any of the compliance pathways through monitoring and assessment. See Section 4.3.2 and Appendix J for compliance analysis results.			

Table 4-12 (continued)
Dry Weather Numeric Goals for the City of San Diego

Compliance Pathways	Baseline	Goals by Assessment Period and Fiscal Year Current Permit Term (FY14 – FY18)
PERFORMANCE MEASURES		
Suite of Strategies to Measure Performance During First Permit Term	Baseline	FY18
Implement runoff reduction programs, including targeted education and outreach, enhanced inspections, rebates[4], and increased enforcement	Historical dry weather monitoring data will be used to establish a baseline in the first Water Quality Improvement Plan Annual Report	10% reduction in prohibited[5] dry weather flow from baseline measured at persistently flowing outfalls in the WMA
Develop a green infrastructure policy, attain City Council approval, and construct green infrastructure BMPs to improve water quality during wet and dry[6] weather	0 acres treated in 2002, the year used as baseline in the Bacteria TMDL.	36 acres of drainage area treated through construction of 9 green infrastructure BMPs[7]

1. Denotes TMDL interim and final target.
2. Calculated as a 50% reduction in the existing exceedance frequency presented in Appendix H.
3. Demonstration of exceedances due to natural sources includes demonstration that pollutant loads from MS4s are not causing or contributing to exceedances.
4. City of San Diego rebates include grass replacement, rainwater harvesting, downspout disconnect, and micro-irrigation.
5. Does not include allowable discharges as defined in Provision A and Provision E.2.a of the MS4 Permit.
6. Irrigation runoff reduction programs are the primary strategies for addressing dry weather, freshwater flows, and bacteria loading. However, green infrastructure will treat small storm events, in addition to unabated urban runoff in the short term. Green infrastructure also provides other benefits related to providing natural areas throughout urban development. See Section 4.2.3.1 for additional discussion.
7. The 36 acres of drainage area treated are associated with 9 green infrastructure projects that will be completed by FY18.

All numeric goals are cumulative from the baseline assessment for each fiscal year.

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4.1.4 County of San Diego Wet and Dry Weather Goals

The County of San Diego Water Quality Improvement Plan interim and final goals for wet and dry weather are presented in Table 4-13 and Table 4-14, respectively. The County has established wet weather goals to address the highest priority water quality conditions, including bacteria and sediment. Currently the County has identified one goal to address bacteria. One of the compliance options for the Bacteria TMDL requires a 2 percent reduction of the bacteria load from storm drain outfalls by 2031. Half of the load reduction, 1 percent, is required by the interim TMDL target date.

The implementation of the programmatic approaches of the storm water program is estimated to result in a 10 percent reduction of the bacteria loads and will be used to meet compliance. Baseline loads will be determined during FY15-16. The load reduction is anticipated to take place incrementally by permit term, with a 0.5 percent reduction during the second permit term, a 0.5 percent reduction during the third permit term, and a 1 percent reduction during the fourth permit term. If the anticipated reductions are not confirmed by monitoring, then program adjustments will be made according to the adaptive management process. This may require the incorporation of more effective strategies, changes in program design, or incorporation of additional structural BMPs if funding is available.

The County has also developed two wet weather goals for sediment consistent with the compliance pathways to meet the Sediment TMDL. The first compliance pathway requires a sediment load reduction of 47.6 percent from the current modeled baseline load of 83.6 tons per year for the County's jurisdiction in the Los Peñasquitos WMA. Programmatic approaches are estimated to reduce sediment loads by 10 percent. Because of the limited available area for structural BMPs or for significant redevelopment to occur within the County of San Diego, structural strategies are not currently being considered. However, the County will consider collaborations with watershed partners as necessary and as funding becomes available to address watershed sediment issues on a regional basis. The second compliance pathway requires restoration of the Los Peñasquitos Lagoon with an increasing trend toward 80 percent of the historical salt marsh habitat or 346 acres of tidal/non-tidal salt marsh habitat. The TMDL establishes monitoring protocols to evaluate trends in habitat within the Lagoon and will be utilized to determine the necessity to develop a restoration plan. If yearly monitoring warrants, the County will collaborate with the appropriate watershed parties to develop and implement this plan.

The County may also consider alternate approaches for compliance with the Sediment TMDL. For example, the current land uses are almost unchanged from the 1973 land uses in the unincorporated area. Quantitative modeling was conducted during development of the Sediment TMDL to reduce current sediment loads to the 1973 predicted levels. As outlined in Table 4-13, the County may choose to meet compliance by demonstrating that the sediment load is in compliance with the TMDL allowable loads modeled using 1973 land uses.

The County of San Diego has established dry weather numeric goals for the highest priority water quality conditions for bacteria in the Los Peñasquitos WMA, to comply with one of the compliance pathways for the Bacteria TMDL, to effectively eliminate anthropogenic dry weather discharges from storm drain outfalls to the receiving waters. This pathway will also address freshwater flows that were identified in this Water Quality Improvement Plan as a highest priority water quality condition.

The County of San Diego dry weather goal was established to reduce dry weather flow in storm drains to effectively eliminate anthropogenic discharges to zero, to reduce pollutant loading to waterbodies during dry weather. This goal will be accomplished through the implementation of numerous JRMP strategies to reduce dry weather runoff, as described in the County of San Diego JRMP. Throughout the implementation of the Water Quality Improvement Plan, adaptive management will be used to evaluate reasonable progress toward the numeric goals and to consider changes to program design and project implementation, as needed to meet goals and as funding becomes available. The adaptive management process is described in Section 6 of this Water Quality Improvement Plan. Efforts will be adaptively managed to mitigate dry weather flows and consider only small-scale structural controls if needed. Compliance with the TMDL goal, scheduled for April 2021, will be demonstrated through the storm drain outfall monitoring program.

Table 4-13
Wet Weather Numeric Goals for the County of San Diego

Wet Weather Numeric Goals for Highest Priority Water Quality Condition - Bacteria							
Title	Metric	Baseline	Outcome	1st Permit Term 2013 - 2018	2nd Permit Term 2018 - 2023	3rd Permit Term 2023 - 2028	4th Permit Term 2028 - 2033
						Meet TMDL Interim Compliance Date April 4, 2028 [1,2]	Meet TMDL Final Compliance Date April 4, 2031
Implement Water Quality Improvement Plan with focus on programmatic BMPs and use adaptive management to increase effectiveness	% bacterial load reduction	TBD in FY15-16 using TMDL model	Reduce baseline bacteria loads by 2% from storm drain outfalls to meet TMDL required load reductions	Implement programmatic (non-structural) BMPs to achieve source reduction of bacteria loads from the storm drain outfalls	Reduce bacteria loads by 0.5% from the storm drain outfalls through continued implementation of programmatic BMPs and, based on adaptive management, focus and enhance efforts where needed	Reduce bacteria loads by an additional 0.5% (total 1%) from the storm drain outfalls by continued implementation of programmatic BMPs	Reduce bacteria loads by an additional 1% (total 2%) from the storm drain outfalls by continued implementation of programmatic BMPs

1. Request moving Interim TMDL Compliance Date from April 4, 2021, (per MS4 Permit Attachment E, 6.c(1)) to April 4, 2028, to allow adequate time to monitor progress through the adaptive management process of the Water Quality Improvement Plan.
2. Progress toward final goals will be monitored and, if implemented programmatic BMPs are not enough to meet compliance, then through the adaptive management process of the Water Quality Improvement Plan, more effective and or additional BMPs, including structural controls, will be considered for implementation. The County of San Diego is concerned that a funding source to construct, operate, and maintain structural controls is not identified, if structural controls are needed to meet compliance.

TBD = to be determined

Table 4-13 (continued)
Wet Weather Numeric Goals for the County of San Diego

Wet Weather Numeric Goals for Highest Priority Water Quality Condition – Sediment									
Title	Metric	Baseline	Outcome	1st Permit Term 2013 - 2018	2nd Permit Term 2018 - 2023	3rd Permit Term 2023 - 2028		4th Permit Term 2028 - 2033	5th Permit Term 2033 - 2038
					Meet 20% Interim Compliance: December 2019	Meet 40% Interim Compliance: December 2023	Meet 60% Interim Compliance: December 2027	Meet 80% Interim Compliance: December 2031	Meet Final Compliance Date: December 2034
Implement Water Quality Improvement Plan with focus on programmatic BMPs and use adaptive management to increase effectiveness	% Sediment load reduction or verify allowable tons of sediment per year is met for the County's jurisdiction in the Los Peñasquitos WMA (Los Peñasquitos Creek and Carroll Canyon)	83.6 tons/ year using 2003 water year	43.9 tons/year 47.6% reduction of baseline loads or verify allowed loads of 39.7 tons/year is met in 2034	Implement programmatic (non-structural) BMPs to achieve reduction of sediment loads from the storm drain outfalls	Reduce sediment loads by 9.5% from the storm drain outfalls through implementation of programmatic BMPs and, based on adaptive management, focus and enhance efforts where needed	Reduce sediment loads by an additional 9.5% (cumulative total of 19.0%) from the storm drain outfalls by continued implementation of programmatic BMPs	Reduce sediment loads by an additional 9.6% (cumulative total 28.6%) from the storm drain outfalls by continued implementation of programmatic BMPs	Reduce sediment loads by an additional 9.5% (cumulative total 38.1%) from the storm drain outfalls by continued implementation of programmatic BMPs	Reduce sediment loads by an additional 9.5% (cumulative total 47.6%) from the storm drain outfalls by continued implementation of programmatic BMPs
AND									
Restoration of Lagoon (as needed and as funding is available)	Restoration of 346 acres of salt marsh	262 acres of tidal/non-tidal salt marsh	Restoration of 346 acres of tidal/non-tidal salt marsh	Coordinate with watershed partners to determine restoration goals and establish monitoring protocols, as applicable	Increasing trend toward 346 acres (Note: Compliance targets listed above are for sediment reduction only)				Successful restoration of 346 acres of tidal/non-tidal salt marsh

Table 4-14
Dry Weather Numeric Goals for the County of San Diego

Dry Weather Numeric Goals for Highest Priority Water Quality Condition – Bacteria and Freshwater Flow						
Title	Metric	Baseline	Outcome	1st Permit Term Numeric Goals 2013 – 2018	2nd Permit Term Numeric Goals 2018 – 2023	
					TMDL Interim Compliance Date April 4, 2020 [2]	TMDL Final Compliance Date April 4, 2021
Effectively eliminate anthropogenic dry weather flows [1] from storm drain outfalls	Make routine observations of storm drain outfalls to verify the absence of discharge to receiving water	Verify the absence of flow from storm drain outfalls in 2014 and 2015	Effectively eliminate anthropogenic dry weather flow from storm drain outfalls to receiving water	Verify the effective elimination of anthropogenic dry weather flow from storm drain outfalls and use programmatic approaches to maintain compliance	Verify the effective elimination of anthropogenic dry weather flow from storm drain outfalls and use programmatic approaches to maintain compliance	Verify the effective elimination of anthropogenic dry weather flow from storm drain outfalls and use programmatic approaches to maintain compliance

1. Here and throughout this table, the term "dry weather flows" excludes groundwater, other exempt or permitted non-storm water flows, and sanitary sewer overflows.
2. Request moving Interim TMDL Compliance Date from April 4, 2017, (per MS4 Permit Attachment E, 6.c(1)) to April 4, 2020, to allow adequate time to investigate and mitigate dry weather flows, if present through the adaptive management process of the Water Quality Improvement Plan.

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4.1.5 Caltrans Wet and Dry Weather Goals

Caltrans storm water flows are not included in the MS4 Permit; however, Caltrans is subject to similar requirements through its own MS4 Permit (State Board, 2012b). Caltrans has voluntarily contributed to the Water Quality Improvement Plan effort to provide a consistent and subwatershed-wide approach to meeting applicable TMDL requirements. The baseline strategies are continuously implemented and augmented as resources become available.

Attachment IV to the Caltrans MS4 Permit outlines a methodology for prioritizing stream segments included in TMDLs to which Caltrans is subject. The permit establishes BMP implementation requirements, evaluated in terms of compliance units. Caltrans is expected to achieve 1,650 compliance units per year through the implementation of retrofit BMPs, cooperative implementation, and post-construction treatment beyond permit requirements.

Impaired reaches throughout the state will be prioritized on the basis of several factors, including, but not limited to, percent reduction needed, Caltrans drainage area contributing to the reach, and proximity to receiving waters. Reaches with metals TMDLs will likely be prioritized. This prioritization list is currently under negotiation between Caltrans Headquarters and the State Board.

Caltrans' jurisdiction areas include roadways, land adjacent to roadways, and facilities. Caltrans' jurisdictional strategies specifically focus on BMP implementation to reduce known pollutants within these areas. Caltrans' strategies vary from those of other Responsible Agencies (in both type and name) to best address freeway characterization discharges from its right-of-way. Strategies include programs developed by Caltrans Headquarters for statewide execution and District 11 implementation. Caltrans' implementation of strategies with the WMA is dependent on legislative approval.

For Bacteria TMDLs, Caltrans is expected to eliminate dry weather flows by implementing control measures to ensure effective prohibition (Provision B.2 of the MS4 Permit). For wet weather flows, Caltrans is expected to implement control measures or BMPs to prevent discharge of bacteria from the right-of-way; this can be source control and preemptive activities such as street sweeping, cleanup of illegal dumping, and public education on littering. Implementation of these controls is per the TMDL prioritization list currently under development.

Caltrans Water Quality Improvement Plan interim and final goals for wet weather are presented in Table 4-15. Caltrans Water Quality Improvement Plan interim and final goals for dry weather are presented in Table 4-16.

Table 4-15
Wet Weather Goals for Caltrans

Goals	Unit of Measure	Assessment Metric
MS4 Discharges	Cooperative Implementation Agreement	Achieve compliance units by contributing funds to a cooperative implementation
OR		
MS4 Discharges	Implement Nonstructural BMPs	Continue to implement wet weather nonstructural BMP activities within the watershed
OR		
MS4 Discharges	Implement Structural BMPs	Continue to implement wet weather structural BMP activities for proposed projects within the watershed

Table 4-16
Dry Weather Goals for Caltrans

Goals	Unit of Measure	Assessment Metric
MS4 Discharges	Reduction in Dry Weather Flow	Eliminate dry weather flows by implementing control measures to ensure effective prohibition
OR		
MS4 Discharges	Implement Dry Weather BMPs	Implement drought-tolerant landscaping and conversion to smart irrigation controllers within the watershed

4.2 Strategies

The Responsible Agencies were tasked with identifying water quality improvement strategies to address the highest priority water quality conditions. The strategies were selected on the basis of their ability to effectively and efficiently eliminate non-storm water discharges to the MS4, reduce pollutants in storm water discharges from the MS4 to the MEP, and achieve the interim and final numeric goals identified in Section 4.1. A compliance analysis was completed using a watershed simulation and BMP optimization model developed for the Los Peñasquitos WMA to quantify load reductions to support evaluation of TMDL compliance and select the most cost-effective BMP strategy for implementation. The compliance analysis modeled the outcome of applying a set of strategies to the watershed in the most cost-effective order, and demonstrated that implementation of the strategies would result in achievement of interim and final goals.

A brief description of the strategy selection process is provided in Section 4.2.1. A general discussion of nonstructural strategies, such as MS4 maintenance and street sweeping, administrative policies, enforcement of municipal ordinances, education and outreach programs, rebate and incentive programs, and collaboration with WMA partners, is presented in Section 4.2.2. Structural strategies are those strategies that can improve water quality by removing pollutants through physical means such as filtration and infiltration and are introduced in Section 4.2.3. A description of selected nonstructural and structural strategies selected by each Responsible Agency to target the highest priority water quality conditions by jurisdiction is presented in Section 4.2.4. A comprehensive list of strategies, including the method for implementing each strategy, the cost, and WMA partners included in the effort, is presented in Appendix I. Strategies implemented on a WMA scale or through collaboration with WMA partners are discussed in more detail in Section 4.2.5. The modeling results, or outcome of the implementation of the strategies selected in terms of percent load reduction, is presented in Appendix J. Section 4.3 presents a summary of the compliance analysis results to demonstrate the anticipated progress toward achieving the interim and final goals.

4.2.1 Strategy Selection

A list of potential strategies (nonstructural and structural) was developed by the Responsible Agencies and includes JRMP activities and enhancements to JRMP activities, and augmented by public input and discussions with the Los Peñasquitos WMA Consultation Committee (Los Peñasquitos WMA Responsible Agencies, 2014). This list was used as a guide by Responsible Agencies to identify strategies appropriate for their jurisdictions.

Strategy selection considered the following:

- Emphasis was given to strategies that target highest priority water quality condition and provide multiple benefits.
- The Responsible Agencies considered the triple bottom line, evaluating the environmental, economic, and social components of the strategies.
- Strategies that improve and promote cooperation and collaboration between the Responsible Agencies and other governmental agencies (WMA groups, Caltrans, water districts, school districts) and other entities, such as private or non-profit organizations, were also given priority. Responsible Agencies also continually collaborate with internal jurisdictional departments, which are also presented in the jurisdictional strategies table.

The Responsible Agencies evaluated their existing JRMP programs, the potential for incorporating enhancements and new administrative programs, and, if warranted, the appropriate types of structural BMPs that may be needed to meet Water Quality Improvement Plan goals. The JRMP provided the necessary background for existing nonstructural solutions and informed potential enhancements in activities and programs.

Efficiency in pollutant reduction is based partly on identifying the known and suspected areas or sources likely contributing to the highest priority water quality conditions and targeting those sources. To assist in the geographical identification of sources, watershed modeling and GIS tools were used to estimate the relative sediment and bacteria loading within the Los Peñasquitos WMA, land ownership and availability of public land for implementation, and physical watershed characteristics such as slope and soil types for BMP selection. Appendix J provides additional details on strategy selection, including a description of the prioritization of drainage areas within the Los Peñasquitos WMA by sediment and bacteria loading, implementation assumptions used to estimate strategy effectiveness within the simulation models, and results of the modeling efforts, including anticipated load reductions by strategy, subwatershed, jurisdiction, and pollutant. The Water Quality Implementation Plan assessments and BMP optimization were based on results from watershed models (simulations) updated for TMDL development from the Bacteria TMDL to the Sediment TMDL. The Los Peñasquitos WMA baseline model calibration is presented in Appendix K.

4.2.2 Nonstructural Strategy Descriptions

Nonstructural reduction strategies are defined as those actions and activities that are intended to reduce storm water pollution that do not involve construction or implementation of a physical structure to filter and treat storm water. These strategies are also considered nonstructural by the nature of their programmatic implementation. Examples include MS4 maintenance and street sweeping, administrative policies, creation and enforcement of municipal ordinances, education and outreach programs, rebate and other incentive programs, and cooperation and collaboration with other WMA or regional partners. Jurisdictions across the region have implemented these types of programs for many years, either in response to MS4 Permit requirements or in response to jurisdiction- or WMA-specific needs (Regional Board, 2013).

The combination of existing efforts and new or enhanced efforts determines the final, expected load reduction (Figure 4-1). Fundamentally, strategies were chosen on the basis of their expected effectiveness in reducing pollutant sources and targeting pollutant-generating activities (PGAs) of concern in the Los Peñasquitos WMA, and their suitability and potential for implementation by the Responsible Agencies.

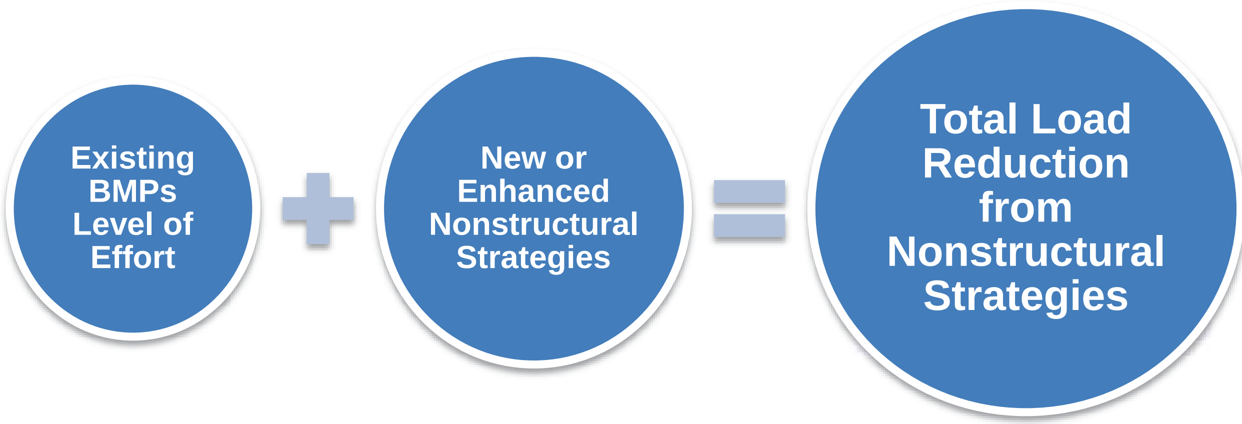

Figure 4-1
Determining Total Load Reduction from Nonstructural Strategies

The list of nonstructural strategies for each Responsible Agency is based on the following:

- ❖ Existing programs or actions that the Responsible Agencies are already implementing or must implement on the basis of MS4 Permit requirements
- ❖ Opportunities for enhancing and refining existing programs or actions
- ❖ Identification of new actions or initiatives that are effective or potentially effective in other areas or programs

It is challenging to accurately quantify most nonstructural strategy benefits in terms of pollutant load reductions because it generally requires extensive survey and monitoring information. In addition, nonstructural strategies may target pollutants, land uses, or populations, resulting in different load reductions depending on the implementation technique. Nevertheless, the modeling completed and discussed further in Appendix J estimated the effectiveness of current and future levels of implementation of selected nonstructural strategies, building on the previous modeling efforts in the region, such as Mission Bay CLRP I and II, and using best available information. The framework developed for other watersheds served as a foundation for modeling assumptions. Nonstructural strategies that cannot be effectively modeled to determine their quantifiable benefits are referred to as non-modeled nonstructural strategies (Section 4.2.2.1). The nonstructural strategies with sufficient supporting data to estimate associated load reductions through modeling are discussed in Section 4.2.2.2.

4.2.2.1 Non-modeled Nonstructural Strategies

The MS4 Permit requires Responsible Agencies to control the contribution of pollutants to the MS4 and the discharges from the MS4 within their jurisdictions through JRMPs (MS4 Permit Provision E). Most nonstructural strategies implemented by the Responsible Agencies are part of their JRMPs. The MS4 Permit requires the jurisdictions to identify the strategies being implemented by JRMP Provisions E.2 through E.7 as part of the Water Quality Improvement Plan for the highest priority water quality conditions. Caltrans is not subject to the requirements of the MS4 Permit; however, Caltrans is subject to similar requirements through its MS4 Permit (State Board, 2012b).

For those nonstructural strategies where sufficient data existed to support modeling of effectiveness, load reductions were quantified. Those strategies are covered in Section 4.2.2.2. The effectiveness of most nonstructural strategies, e.g., those non-modeled nonstructural strategies covered in this section, are difficult to quantify through modeling. However, the relative benefit associated with water chemistry, physical, and biological improvements for each of these non-modeled nonstructural strategies is shown in Table 4-18.

Nonstructural strategies may be broad, overarching administrative programs or activities targeting specific sources. The MS4 Permit provides guidelines for Responsible Agency implementation of each JRMP; however, they are implemented differently depending on the unique characteristics of each jurisdiction. In implementing the Water Quality Improvement Plan, the Responsible Agencies will implement strategies within their JRMPs with a specialized approach to best achieve the numeric goals and meet permit requirements within their jurisdictions. Because the MS4 Permit provides flexibility in selecting strategies, jurisdictions may prioritize different strategies within their JRMPs, to more effectively achieve pollutant reductions.

A description of the JRMP nonstructural strategy categories is presented in Table 4-17. The relative benefit associated with water chemistry, physical, and biological improvements achieved by strategy implementation is presented in Table 4-18. The assumptions represent best professional judgment based on literature reviews, practical experience, and stakeholder input. The BMP benefits outlined in Table 4-18 are dependent on site characteristics, implementation, and the target pollutant of the program or strategy. Although the benefits are variable, estimates of the relative pollutant reduction benefits are provided for comparative evaluation. A compilation of references used to estimate the overall, relative benefit is included in Appendix L. Table 4-18 identifies the primary benefits (●), the secondary benefits (◗), and the potential benefits that the strategy does not address (O). Estimated benefits assume typical design, land use, and geography, but can be modified to target pollutants or site-specific needs. For additional information on JRMP implementation, see each Responsible Agency's JRMP document (to be submitted in June 2015).

Table 4-17
Categories of JRMP Nonstructural Strategies

Strategy Category	Strategy Description
Development Planning	Uses Responsible Agencies' land use and planning authority to require implementation of BMPs to address effects from new development and redevelopment.
Construction Management	Addresses pollutant generation from construction activities associated with new development or redevelopment.
Existing Development	Addresses pollutant generation from existing development, including commercial, industrial, municipal, and residential land uses. Includes stream, channel, and habitat restoration and retrofitting in areas of existing development.
Illicit Discharge, Detection, and Elimination (IDDE) Program	Actively detects and eliminates illicit discharges and improper disposal of wastes into the MS4.
Public Education and Participation	Promotes and encourages behaviors to reduce pollutant discharges. Describes opportunities for public participation in water quality improvement planning.
Enforcement Response Plan	Describes escalating enforcement measures for each JRMP component.

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Table 4-18
JRMP Nonstructural Strategy Benefits

JRMP STRATEGY	Average Water Chemistry Benefit[1]									Physical and Biological Benefit			
	Sediment[2]	Bacteria[2]	Metals	Organics	Pesticides	Nutrients	Oil and Grease	Dissolved Solids	Trash	Flow Rate	Volume Reduction[3]	Habitat/ Wildlife	Aquatic Life
Development Planning													
All Development Projects	*Benefit varies by source control or low-impact development (LID) BMP type: Refer to Table 4-20 for a discussion of structural benefits.*												
Priority Development Projects (PDPs)	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Construction Management	●	○	○	○	○	○	◗	○	◗	●	●	○	●
Existing Development													
Commercial, Industrial, Municipal, and Residential Minimum BMP Requirements and Facility and Area Inspections	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
MS4 Infrastructure Maintenance (including Catch Basin Cleaning)	●	◗	●	○	◗	◗	○	○	●	○	○	○	◗

Table 4-18 (continued)
JRMP Strategy Benefits

JRMP STRATEGY	Average Water Chemistry Benefit[1]									Physical and Biological Benefit			
	Sediment[2]	Bacteria[2]	Metals	Organics	Pesticides	Nutrients	Oil and Grease	Dissolved Solids	Trash	Flow Rate	Volume Reduction[3]	Habitat/ Wildlife	Aquatic Life
Roads, Streets, and Parking Lots Maintenance (including Street Sweeping)	●	◗	●	◗	○	●	○	◗	●	○	○	○	◗
Pesticide, Herbicides, and Fertilizer Program	○	○	○	●	●	●	○	○	○	○	○	◗	●
Retrofit and Rehabilitation in Areas of Existing Development	*Varies by development area; potential benefit for all conditions.*												
IDDE Program	***Benefit varies; potential benefit for all conditions.***												
Public Education and Participation	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Enforcement Response Plan	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

1. For references for the water chemistry benefits for each strategy, refer to Appendix L.
2. Orange-shaded cells indicate highest priority water quality condition for the WMA.
3. Volume reductions address the freshwater discharge goals.

Responsible Agencies have also identified additional strategies that fall outside a JRMP category. These additional strategies are not required by MS4 Permit Provision E, but some Responsible Agencies have identified them as potentially effective in addressing priority water quality conditions within their jurisdictions. They may not be appropriate or effective within all jurisdictions.

The effectiveness of non-modeled, nonstructural strategies is difficult to quantify. Therefore, assigning a load reduction to each strategy or a suite of strategies is difficult. For the BMPs that are not represented in the model, a conservative load reduction of 10 percent is allocated. A 10 percent load reduction for nonstructural activities was estimated by averaging the range of measured and anticipated pollutant removal from the list of City of San Diego nonstructural strategies. Strategies were categorized as "high" percent removal, those with greater City control (operation and maintenance of MS4 infrastructure), or "low" percent removal, those requiring public behavior changes. The range of pollutant load reduction was as low as approximately 2 percent and as high as 72 percent. The overall average percent removal for all constituents and all activities is 10.1 percent. The average bacteria removal from the list of strategies was 11.7 percent (HDR, 2014).

4.2.2.2 Modeled Nonstructural Strategies

While the effectiveness of most nonstructural strategies is difficult to quantify, the pollutant and flow reduction benefits from rain barrels, downspout disconnections, and irrigation runoff reduction practices were estimated using quantitative methods, as described in Table 4-19 and Appendix J. The general effectiveness of each strategy was identified. The implementation assumptions, such as the number of rain barrels implemented per year, were then modeled independently from other nonstructural strategies because of their quantifiable properties. Appendix J describes the modeling process for the nonstructural strategies for each Responsible Agency. Because Caltrans' jurisdiction primarily consists of roadways, rain barrels and other incentive programs are not applicable.

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Table 4-19
Modeled Nonstructural Strategies

Modeled Nonstructural Strategy[1]	Strategy Description	Example Photograph
Catch Basin Cleaning	Enhanced catch basin cleaning activities will contribute to watershed-scale pollutant load reductions. The City of San Diego Catch Basin Cleaning Pilot Study findings suggested that catch basins tend to fill up with debris quickly during storm events and remain at their capacity for debris storage until they are cleaned. Because current catch basin cleaning activities are typically performed only once annually, there is ample opportunity to substantially increase pollutant load removal by increasing the number of cleanings per basin in areas targeting sediment high priority water quality conditions, as appropriate. Note that while enhanced catch basin cleaning can significantly reduce pollutant loads, this BMP is not associated with runoff volume reduction.	
Downspout Disconnection Incentive Program	Implementing a downspout disconnection incentive program can promote load reductions by routing rooftop runoff over pervious surfaces, such as landscaped or grassed areas, rather than directly to hardscaped areas or storm drains. Downspout disconnections provide a similar watershed impact as rain barrels and are modeled similarly.	
Irrigation Runoff Reduction and Grass Replacement	This nonstructural strategy is a suite of measures that target water conservation and landscaping practices to reduce and eliminate irrigation runoff. Measures that contribute to this modeled strategy include the implementation of grass replacement projects, micro-irrigation system installations, downspout disconnections, education and outreach, and enforcement of regulations that prohibit runoff.	

**Table 4-19 (continued)
Modeled Nonstructural Strategies**

Modeled Nonstructural Strategy[1]	Strategy Description	Example Photograph
Rain Barrels Incentive Program	Capturing storm water from rooftops in residential rain barrels is a simple method to reduce demand on the potable water system and help prevent pollution by reducing the amount of runoff entering municipal storm drain systems. Retained runoff can be reused for irrigation, or when reuse is not possible, the retained flows can be slowly released after a period of storage. Any released flows can be routed through landscaped areas, where runoff load reduction can be attained through the processes of infiltration and evapotranspiration, or to bioretention BMPs as part of a treatment train. Through its residential BMP rebate program, the City of San Diego offers residential customers a cash-back rebate of $1.00 for every gallon of rain barrel storage capacity up to 400 gallons. Other rebate programs offered by regional water agencies and promoted by Responsible Agencies are also available.	
Street Sweeping	Improved street and median sweeping technology enhances the potential for wet weather pollutant load reductions for bacteria, metals, non-metal toxics, and nutrients. Increasing the sweeping frequency, increasing the area of impervious cover swept, or upgrading the sweeping equipment can result in an increase in pollutant load removal. Recommendations for program enhancement could affect the selection of mechanical (broom) and enhanced (vacuum) sweeping of commercial and residential roads and medians at frequencies ranging from bimonthly to twice per week. Note that while street sweeping can significantly reduce pollutant loads, the practice is not associated with runoff volume reduction.	

1. Assumptions about the modeling process and the extent of implementation are presented in Appendix K.

4.2.3 Structural Strategy Descriptions

Structural strategies can be used strategically throughout the contributing watershed to improve water quality by removing pollutants through a variety of chemical, physical, and biological processes, including filtration and infiltration. The effectiveness and feasibility of implementing different types of BMPs should be carefully considered in regard to the BMP impact and cost to implement and maintain. Long-term structural BMP effectiveness is often dependent on the successful construction and routine maintenance of each BMP. Note that there are many areas in the Los Peñasquitos WMA that contain low-infiltrating soil types. In addition, the impacts of infiltration BMPs on the highest priority water quality condition of freshwater discharges to the Lagoon is a concern. The Responsible Agencies acknowledged these factors by considering non-infiltrating BMPs in these areas, such as detention ponds, wetlands, and bioretention and permeable pavement with underdrains. The Responsible Agencies also considered channel restoration projects and source control strategies. Before implementing structural strategies, Responsible Agencies will consult with appropriate resource agencies (e.g., California Coastal Commission, California Department of Fish and Wildlife, Fish and Wildlife Service, National Marine Fisheries Service, etc.) and will obtain required permits as necessary. Further, Responsible Agencies will identify and apply “lessons learned” during project development and post-development monitoring. Feasibility of maintenance and inspection will be incorporated in the design and site selection stages to ensure that structural BMPs meet engineered specifications and can be maintained for the life of the BMP without difficulty.

Similar to nonstructural strategies, structural BMPs were carefully evaluated and chosen. Factors include their expected effectiveness in reducing pollutant sources, targeting PGAs of concern in the Los Peñasquitos WMA, and their suitability and potential for implementation by the Responsible Agencies.

Potential structural BMPs were broken into three categories on the basis of scale and overall function: (1) green infrastructure, (2) multiuse treatment areas, and (3) water quality improvement BMPs (Figure 4-2). These categories and their respective levels of implementation in the Los Peñasquitos WMA are discussed in detail in the following sections.

Modeling was used to estimate the effectiveness of already-implemented structural BMPs and future levels of implementation of select structural BMPs, using best available information. Modeling assumptions and results are further detailed in Appendix K.

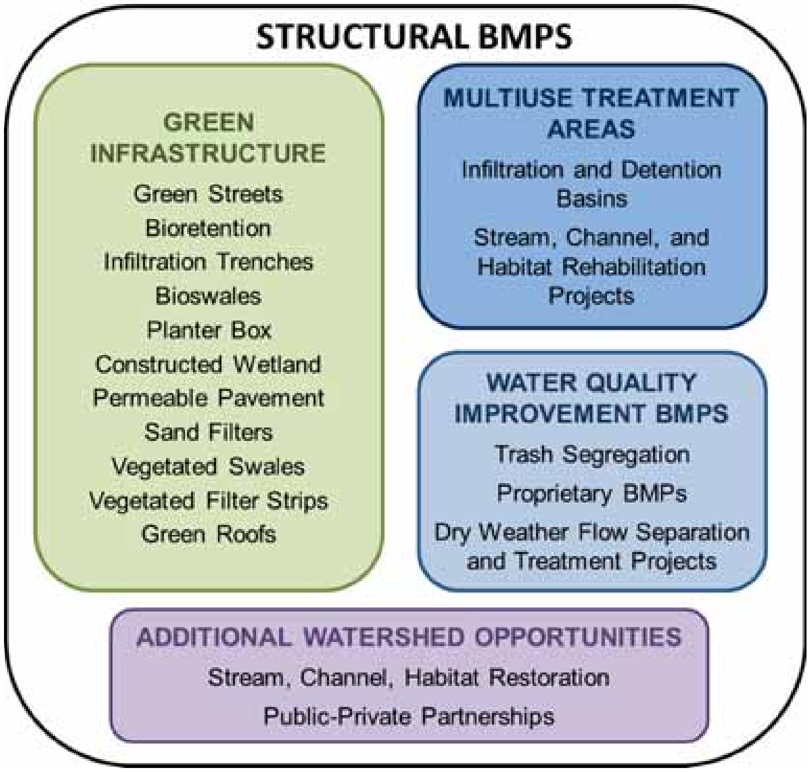

Figure 4-2
Summary of Structural Strategy Categories

Table 4-20 provides the relative benefit to water quality improvement by structural BMP type. Although variable, estimates of the relative pollutant reduction benefits are provided for comparative reference. These estimates are based on best professional judgment from literature reviews, practical experience, and stakeholder input. The site characteristics, BMP implementation, and pollutant of concern all influence the potential benefits. Routine maintenance of these structural strategies also significantly impacts the benefits of the BMPs. References used to estimate the overall, relative benefit are included in Appendix L. Table 4-20 identifies the primary benefits (●), the secondary benefits (◗), and the potential benefits that the strategy does not address (○). Estimated benefits assume typical design, land use, and geography, but can be modified to target pollutants or site-specific needs.

Table 4-20
Structural Strategy Benefits

STRUCTURAL BMP	Water Chemistry Benefit[1]									Physical and Biological Benefit			
	Sediment [2]	Bacteria[2]	Metals	Organics	Pesticides	Nutrients	Oil and Grease	Dissolved Solids	Trash	Flow Rate	Volume Reduction[3]	Habitat/ Wildlife	Aquatic Life
Green Infrastructure													
Green Infrastructure Outside the Right-of-Way													
Bioretention	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Infiltration Trenches	●	●	●	●	●	●	●	●	●	●	●	○	●
Bioswales	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Planter Boxes	●	●	●	●	●	◗	●	◗	●	◗	◗	○	◗
Permeable Pavement	●	◗	●	◗	●	◗	◗	◗	◗	●	●	○	◗
Constructed Wetlands	●	●	●	◗	●	●	◗	◗	●	●	◗	●	◗
Sand Filters	●	●	●	●	●	◗	●	○	●	◗	◗	○	◗
Vegetated Swales	●	◗	◗	◗	◗	◗	◗	○	●	◗	◗	○	◗
Vegetated Filter Strips	●	◗	◗	◗	◗	◗	◗	○	●	◗	◗	○	◗
Green Roofs	●	◗	◗	○	○	○	○	○	○	●	◗	○	◗
Green Streets													
Green Streets	●	●	●	●	●	◗	●	◗	●	●	●	○	◗

Table 4-20 (continued)
Structural Strategy Benefits

STRUCTURAL BMP	Water Chemistry Benefit[1]									Physical and Biological Benefit			
	Sediment [2]	Bacteria[2]	Metals	Organics	Pesticides	Nutrients	Oil and Grease	Dissolved Solids	Trash	Flow Rate	Volume Reduction[3]	Habitat/ Wildlife	Aquatic Life
Multiuse Treatment Areas													
Infiltration and Detention Basins	●	◗	●	◗	●	◗	◗	◗	◗	●	●	○	◗
Stream, Channel, and Habitat Rehabilitation Projects	Varies by project												
Water Quality Improvement BMPs													
Trash Segregation, Proprietary BMPs, and Dry Weather Flow Separation and Treatment Projects	Varies by project												

1. For references for the water chemistry benefits for each strategy, refer to Appendix L.
2. Orange-shaded cells indicate the highest priority water quality condition for the WMA.
3. Volume reductions address the freshwater discharge goals.

4.2.3.1 Green Infrastructure

A critical consideration in selecting and evaluating structural BMPs is scale. Green infrastructure refers to structural BMPs that are built within the landscape at the site scale, which often require retrofit of site designs to accommodate the rerouting and positioning of BMPs onsite. Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provide habitat, flood protection, cleaner water, and potentially through cleaner air. At the scale of a neighborhood or individual site, green infrastructure includes storm water management systems such as bioretention areas, permeable pavements, and green roofs that use natural processes to soak up, store, and treat water.

Green infrastructure typically incorporates multiple BMPs using the natural features of the site in conjunction with the goal of the site development. Multiple BMPs can be incorporated into the site development to complement and enhance the proposed layout, while also providing water quality treatment and runoff volume reduction. Green infrastructure practices provide control and treatment of storm water runoff on or near locations where the runoff originates. The most common and effective green infrastructure BMPs implemented by the Responsible Agencies are listed in Table 4-21. Rain barrels are covered programmatically as a nonstructural strategy, but are also commonly incorporated as multi-benefit components of green infrastructure systems.

Table 4-21
Common Green Infrastructure BMPs

Green Infrastructure BMP	BMP Description	Example Photograph
Bioretention	Shallow vegetated features constructed in green spaces alongside roads, sidewalks, and other paved surfaces. Bioretention includes an engineered soil media designed to encourage pollutant treatment and water storage.	
Infiltration Trenches	Narrow, linear BMPs that have functions similar to those of bioretention areas with variable surface materials, including rock or decorative stone, designed to allow storm water to infiltrate into subsurface soils.	

Table 4-21 (continued)
Common Green Infrastructure BMPs

Green Infrastructure BMP	BMP Description	Example Photograph
Bioswales	Shallow, open channels designed to reduce runoff volume through infiltration and pollutant removal by filtering water through vegetation within the channel and infiltration into bioretention soil media. Bioswales can serve as a storm water conveyance, but the primary objective is water quality enhancement (often referred to as linear bioretention).	
Planter Box	Fully contained system containing soil media and vegetation that functions similarly to a small biofiltration BMP, but including an impermeable liner and underdrain.	
Constructed Wetland	Engineered, shallow marsh system designed to control and treat storm water runoff. Particle-bound pollutants are removed through settling and other pollutants are removed through biogeochemical activity.	
Permeable Pavement	Material that allows streets, parking lots, sidewalks, and other impervious covers to increase or enhance their infiltration capacity while maintaining the structural and functional features of the materials they replace. Roads such as highways can include permeable friction course (PFC) overlays that provide water quality benefits when traditional permeable pavement is not suitable. This BMP can also include underdrains in areas with low-infiltration soil types.	
Sand Filters	Treatment systems that remove particulates and solids from storm water runoff by facilitating physical filtration.	

Table 4-21 (continued)
Common Green Infrastructure BMPs

Green Infrastructure BMP	BMP Description	Example Photograph
Vegetated Swales	Shallow, open channels that are designed primarily for storm water conveyance. Pollutants such as trash and debris are removed by physically straining/filtering water through vegetation in the channel.	
Vegetated Filter Strips	Bands of dense, permanent vegetation with a uniform slope, designed to provide pretreatment of runoff generated from impervious areas before it flows into another BMP as part of a treatment train.	
Green Roofs	Roofing systems that layer a soil/vegetative cover over a waterproofing membrane and can reduce runoff through interception and evapotranspiration.	

Green infrastructure can provide water quality and community benefits at the site scale outside of the right-of-way or within the public street right-of-way (green streets). The following subsections discuss implementation of green infrastructure in these two settings.

Green Infrastructure Outside the Right-of-Way

Any single BMP or a combination of the BMPs listed in Table 4-21 can be applied at the site scale to capture and treat storm water runoff at the source. These potential small-scale projects are important to the WMA as a whole when incorporated near the top of the watershed. Collectively they can provide an effective means toward pollutant load reduction, while also attenuating peak flow, reducing discharge volume, and providing aesthetic value and improved habitat quality. These potential small-scale BMPs can be implemented on public parcels by municipalities or incorporated into Priority Development Projects (PDPs) and redevelopment activities on private parcels. Examples of potential existing development retrofits for green infrastructure BMPs outside the right-of-way include converting parking lot medians into planter boxes and asphalt into permeable pavements.

Much of the impervious area on most parcels, regardless of land use type, consists of a combination of parking lots and roof tops. Those areas can often be treated using a system of green infrastructure implemented in landscape areas and replacing hardscape with comparable permeable materials (see examples in Figure 4-3 and Figure 4-4). Other options for treatment to be considered for areas outside the right-of-way are green roofs, infiltration trenches, sand filters, vegetated filter strips, and vegetated swales.

Figure 4-3
Bioretention Areas in Parking Lots and Adjacent to Buildings Provide Multiple Benefits by Treating Runoff While Also Serving as Landscape Features and Habitat

Figure 4-4
Permeable Pavement Functions as a Parking and Driving Surface While Capturing and Treating Storm Water

Example Green Infrastructure Project Outside the Right-of-Way

The parking lot of the Mira Mesa Library, which is located in the Los Peñasquitos Creek subwatershed, has been identified as a suitable site for green infrastructure. The green lot proposed for the parking lot will implement several surface and subsurface low-impact development (LID) BMP components to manage flows from the parking lot. Figure 4-5 is a rendering that shows how green infrastructure could enhance the parking lot. Installing treatment planters in the landscaped areas and pervious pavement in the parking areas can reduce runoff volumes, bacteria, heavy metals, nutrients, pesticides, and sediment loadings in the Los Peñasquitos WMA. Additionally, green infrastructure at Mira Mesa Library could enhance community enjoyment and environmental awareness by calming traffic, reducing heat island effects, improving aesthetics, providing bird and butterfly habitat, and offering public outreach opportunities.

Figure 4-5
Rendering of Proposed Green Parking Lot at Mira Mesa Library

Green Infrastructure in the Right-of-Way (Green Streets)

Green streets can consist of multiple BMP types implemented in a linear manner within the road right-of-way. Placing BMPs within the right-of-way provides an additional opportunity to treat urban storm water runoff, attenuate peak flow, and reduce discharge volume while improving community pride, land value, and habitat quality. Given that green streets are in the right-of-way, they have no land acquisition costs and are more conveniently accessed for maintenance activities. Green streets also provide the added benefit of treating runoff from both the roadway and contributing parcel.

The most common approaches for green streets include bioretention areas located between the edge of the pavement and the edge of the right-of-way and permeable pavement installed in the parking lanes. The configuration of the street, particularly the presence of curb and gutter, locations of underground utilities, road classifications, and sidewalk, parking, and right-of-way widths, often dictates the configuration of green streets. Options are presented below for streets with and without curb and gutter.

Streets with Curb and Gutter

Curb and gutter is often used to provide a clear delineation between the travel lanes and the parkway area of the right-of-way. With this configuration, storm water is often treated through permeable pavement in the parking lanes and bioretention areas in the space between the back of the curb and the sidewalk. Figure 4-6 provides examples of green infrastructure in the parking area and parkway within the right-of-way.

Figure 4-6
Examples of Bioretention and Permeable Pavement in the Right-of-Way with Curb and Gutter

Streets Without Curb and Gutter

Streets without curb and gutter provide direct connection for diffused runoff to be treated within the right-of-way. Often, without the delineation provided by curb and gutter, the right-of-way at the edge of the travel lane can become compacted and eventually cause erosion concerns. Implementing green street concepts can provide an opportunity to stabilize those areas using permeable pavers, as shown in Figure 4-7, or bioretention areas.

Figure 4-7
Permeable Pavers in the Right-of-Way Without Curb and Gutter

Implementation in Los Peñasquitos WMA

The pollutant and flow reduction benefits attributed to the implementation of potential green infrastructure BMPs in the Los Peñasquitos WMA were estimated using quantitative methods and are summarized in Appendix K. These benefits were then applied to the areas that were identified for potential green infrastructure opportunities (some of which have already been constructed) throughout the Los Peñasquitos WMA to meet numeric targets. The resulting total level of implementation of potential green infrastructure BMPs is outlined in Section 4.2.4 and further discussed in Section 4.3.

4.2.3.2 Multiuse Treatment Areas

Large structural treatment control BMPs, referred to as multiuse treatment areas, are regional facilities that receive flows from neighborhoods or larger areas and often serve dual purposes for flood control and groundwater recharge. These BMPs are often located in public spaces and can be co-located within parks or green spaces to provide excellent ecosystem services and aesthetic value. Bioretention areas can enhance biodiversity and beautify the urban environment with native vegetation. Large-scale facilities, such as infiltration basins or dry extended detention basis, can provide dual use as athletic fields or open spaces.

The following components can be incorporated into multiuse treatment areas to promote multiuse benefits:

- Simple signage or information kiosks can be used to raise public awareness of storm water issues, educate the public, and provide a guide for native plant and wildlife identification.
- Volunteer groups can be organized to perform basic maintenance such as trash removal as an opportunity to raise public awareness.
- Public-private partnerships can be pursued where property owners are supportive of water quality improvement measures and parcels are identified for ideal multiuse treatment area locations.
- Larger BMPs can be equipped with pedestrian cross-paths or benches for wildlife viewing.
- Sculptures and other art can be installed within the BMP and outlet structures and cisterns can incorporate aesthetically pleasing colors, murals, or facades.
- Vegetation with canopy cover can provide shade, localized cooling, and noise dissipation.
- Bird and butterfly feeders can be used to attract wildlife to the BMPs.
- Ornamental plants can be cultivated along the perimeter and in the bed of vegetated BMPs (invasive plants should be avoided).

Infiltration and Detention Basins

Large multiuse BMPs considered in this Water Quality Improvement Plan focus on surface BMPs (on public parcels) that provide treatment through the detention and infiltration of runoff. Examples include infiltration and dry extended detention basins, an example of which is shown in Figure 4-8. These BMPs are designed to hold runoff for an extended period of time to allow water to evaporate into the atmosphere, infiltrate into native soils, or be transpired by vegetation, while accommodating for overflow and bypass during large storm events. These BMPs are well suited to public spaces such as active (soccer fields) and passive (parks) recreation areas and they raise public

Figure 4-8
Example of an Athletic Field Designed to Function as an Infiltration Basin

awareness of storm water management. The example in Figure 4-8 is a park designed to function as a multiuse treatment area.

Example Potential Multiuse Treatment Area Project

Figure 4-9
Ashley Falls Catchment Open Space with Potential for Conversion to Infiltration or Detention Basins

The Ashley Falls catchment is located in the northwestern portion of the Los Peñasquitos WMA, north of the intersection of Carmel Knolls Drive and Pearlman Way. The drainage area spans approximately 30 acres and includes a large school site, approximately 4 acres of medium-density residential area, and a large area of park and open space preserve. Pending a geotechnical investigation by a licensed geotechnical engineer, an infiltration or detention basin would be appropriate to treat the large drainage area. Figure 4-9 shows the open space along Carmel Knolls Drive that could be converted to infiltration or detention basins in the Ashley Falls catchment area.

Based on regional monitoring in residential areas and the drainage area characteristics, nutrients, TSS, and bacteria are expected to be prevalent in the storm water runoff. Relative to similarly sized drainage areas, the site is anticipated to have higher levels of bacteria, due to the dense housing configuration and potential for pet waste from the area.

The infiltration or detention basin could treat storm water by diverting flow from the drainage pipe flowing along Carmel Knolls Drive just north of the intersection of Carmel Knolls Drive and Seagrove Street into the open space along Carmel Knolls Drive. Locating the basin in the open space would provide an educational opportunity for children and adults through educational signage.

Stream, Channel, and Habitat Rehabilitation Projects

Natural streams, channels, and habitats serve hydrologic and ecological functions that can be compromised when these natural systems are degraded or altered. Natural systems can be degraded or altered by increased runoff volumes and velocities which can cause bank erosion of streams and channels. Erosion can result in large quantities of sediment and sediment-binding pollutants entering the water column and traveling downstream, where potentially critical coastal habitats such as salt marshes, lagoons, and wetlands can be affected.

In the Los Peñasquitos WMA, erosion of creek banks has led to sediment loading. According to the Preliminary Assessment of Sediment Reduction Measures (ESA, 2011), increased peak flows and changes in creek morphology from hydromodification, quarry activities, and other creek modifications have led to the erosion of creek banks along Carroll Canyon and subsequent sediment loading. Sediment transport due to erosion of unlined canyon walls, drainages, channels, and/or stream banks can be reduced through stream stabilization methods as well as habitat rehabilitation projects. Stabilization projects can include grading; construction of check dam structures, drop structures, and channel bed and bank protection measures; vegetation planting to protect channel areas; and modified channel cross-sections to promote hydrologic connectivity. Alternatively, habitat rehabilitation projects can improve a biological and ecological system that has been degraded as a result of sediment loading, erosion, or other causes. To ensure adaptive management, methods and metrics to measure the effectiveness of these stabilization and rehabilitation measures should also be developed to provide feedback on the level of sediment reduction achieved. These rehabilitation projects can results in sediment load reduction and restoration of aquatic life and vegetation. Rehabilitation projects can also include educational opportunities which can lead to greater public understanding of water quality.

Implementation in Los Peñasquitos WMA

The pollutant and flow reduction benefits attributed to the implementation of potential multiuse treatment areas (specifically infiltration and detention basins) in the Los Peñasquitos WMA were estimated using quantitative methods and are summarized in Appendix K. These benefits were then applied to the areas that were identified for potential multiuse treatment area opportunities throughout the Los Peñasquitos WMA to meet numeric targets. The resulting total level of implementation of multiuse treatment areas is outlined in Sections 4.2.4 and 4.3 for the Responsible Agencies. The load reduction benefits of stream and habitat rehabilitation projects have not been explicitly modeled, but are further discussed in Section 4.2.3.4.

4.2.3.3 Water Quality Improvement BMPs

The Responsible Agencies will implement green infrastructure as permitted and when feasible, but site constraints preclude use of green infrastructure in some areas. In such cases, water quality improvement BMPs may be required to protect water resources. Water quality improvement BMPs include trash segregation, proprietary BMPs, and dry weather flow separation and treatment projects. Maintenance of these BMPs is covered separately under nonstructural strategies as part of each Responsible Agency's MS4 infrastructure maintenance programs, where applicable.

Trash segregation includes inlet devices, such as trash guards or trash racks, which are installed to capture trash and debris before conveyance into receiving waters. Proprietary BMPs are prefabricated commercial products such as hydrodynamic separators or catch basin filter inserts that typically provide storm water treatment in space-limited areas, often using patented and innovative technologies.

Proprietary BMPs typically use settling, filtration, absorptive/adsorptive materials, vortex separation, and sometimes vegetative components to remove pollutants from runoff.

Dry weather flow separation and treatment projects are those identified and planned by each respective Responsible Agency to target non-storm water dry season flows and to divert these flows for treatment either onsite or to sanitary sewer systems and ultimately wastewater treatment plants.

Implementation in Los Peñasquitos WMA

Because of the relative scale of their pollutant-reduction benefits, as well as the lack of published supporting data, trash segregation and proprietary BMPs were not modeled for the Los Peñasquitos WMA. However, the level of implementation of these BMPs is outlined in Sections 4.2.4 and 4.3.

4.2.3.4 Additional Opportunities

In the event that the combination of structural and nonstructural BMPs discussed above is not sufficient to meet reduction goals, additional strategies exist that can be identified and implemented through adaptive management to achieve interim and final numeric goals. In general, additional opportunities may include the creation of additional sediment detention basins, stream and canyon restoration, Lagoon restoration, new strategies not yet identified, phased implementation, operation, and maintenance of the additional required acreage of multiuse treatment area projects, or increased implementation of nonstructural and/or green infrastructure BMPs that would be equivalent to the storage volume required for treatment. Some strategies, such as Lagoon restoration, will require Responsible Agencies to engage in collaborative efforts collectively and, as needed, with other institutional entities. Activities particularly relevant within the Los Peñasquitos WMA that target water quality improvement include upgrades to existing MS4 outfalls to reduce scouring, low-impact development measures in the developed mesas, restoration or enhanced sediment management of reaches affected by mining operations, and stabilization of various sections of Carroll Canyon. Restoration of the Los Peñasquitos Lagoon, further discussed in Sections 4.2.5.1 and 4.2.5.2, is a significant regional effort and potential additional watershed opportunity that will rely on key WMA partnerships and funding. The success of this restoration effort can result in significant sediment load reduction while restoring the Lagoon's beneficial uses (see Section 4.2.5.1), and therefore, the Los Peñasquitos Lagoon Restoration Project is recognized as a priority additional opportunity.

Implementation in Los Peñasquitos WMA

Load reductions for additional opportunities were estimated either as an equivalent load to additional multiuse treatment areas in non-public land or as restoration, depending on the Responsible Agency and opportunities available. Because of limited restoration component details currently available, load reductions for additional opportunities were estimated because of the implementation of two additional sediment detention basins, similar to the existing basin in the Los Peñasquitos Creek subwatershed, restoration of five creek segments, including repair or replacement of MS4 outfalls, and restoration of the Lagoon, as discussed further in Section 4.2.5.1. Detailed modeling or technical analyses will need to be performed to quantitatively assess the water quality benefits as a result of the restoration and to identify other regional structural BMPs, if needed, to meet the Water Quality Improvement Plan numeric goals.

4.2.4 Jurisdictional Strategy Selection by Responsible Agency

Strategy selection within the Los Peñasquitos WMA is discussed in Section 4.2.1 and Appendix J. Sections 4.2.4.1 through 4.2.4.5 provide examples of recommended strategies for each Responsible Agency and jurisdiction-specific selection methodologies, if different from watershed-wide selection methodologies. The recommended strategies are those that are intended to specifically target the highest priority water quality conditions to achieve the numeric goals identified in Section 4.1. These strategies are a subset of each Responsible Agency's JRMP. A complete list of strategies by Responsible Agency, including the implementation approach, implementation year, and level of effort required, is presented in Appendix I.

As discussed in Sections 4.2.2 and 4.2.3, typically most nonstructural and structural strategies address multiple pollutants. For example, maintenance activities for catch basins and roads primarily target sediment, metals, and trash. In addition, bacteria and organics can be removed. Green infrastructure strategies such as bioretention and bioswales primarily target bacteria, sediment, and metals; however, they can provide dissolved solids and organics reductions as well. Permeable pavement primarily targets sediment, oil and grease, and metals, but can provide secondary benefits toward bacteria and organics reductions as well.

4.2.4.1 Caltrans Strategies

Caltrans' jurisdiction areas include roadways, land adjacent to roadways, and facilities; Caltrans' jurisdictional strategies specifically focus on BMP implementation to reduce known pollutants within these areas. Caltrans is not subject to the requirements of the MS4 Permit; however, Caltrans is subject to TMDL requirements through its MS4 Permit (State Board, 2012b). Caltrans' strategies vary from those of other Responsible Agencies (in both type and name) to best address typical discharges from its jurisdictions. Strategies include programs being implemented by Caltrans Headquarters for statewide execution and by District 11 for local implementation. Caltrans' implementation of strategies within the WMA is dependent on state funding. A complete list of strategies and their anticipated implementation schedule are provided in Appendix I. The strategies and schedules are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed.

4.2.4.2 City of Del Mar Example Strategies

The City of Del Mar (Del Mar) has selected jurisdictional strategies that best suit the topography and characteristics of its jurisdiction to comply with MS4 Permit requirements. Del Mar's land use primarily consists of low-density residential and commercial areas, so the strategies address problematic areas associated with these characteristics. The following example strategies have been identified to address the highest priority water quality conditions in Del Mar's jurisdiction within the Los

Peñasquitos WMA. A complete list of strategies and their anticipated implementation schedule are provided in Appendix I. The strategies and schedules are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed. Any applicable projects which incorporate or implement this Plan will require its own environmental review, as required by the California Environmental Quality Act by the City of Del Mar as appropriate.

Development Planning – Greater Pervious Area Requirement

Del Mar has a stringent planning requirement that requires a conservative ratio of impervious area footprint to lot size, which assists in reducing the amount of directly connected impervious areas within its jurisdiction. Despite stringent planning requirements, the jurisdiction is highly developed, and many roads have not only limited right-of-way, but also limited physical space for green street implementation. While green streets will be considered, options may be limited due to right-of-way constraints and bluff stabilization concerns in many parts of the City of Del Mar.

Existing Development – Enhanced Patrol Program

A key strategy to address dry and wet weather bacteria loads from existing development, which includes commercial, industrial, municipal, and residential land uses, is a patrol-based program throughout the jurisdiction. Del Mar's size facilitates a hands-on approach to inspections, including mobile businesses. Frequent patrols, a minimum of six per year, allow for increased opportunities to identify potential illicit discharges and outreach to business owners and residents. Del Mar also has an irrigation control program in place to specifically address runoff associated with residential and commercial properties.

In addition to the patrol-based program, Del Mar performs street sweeping, catch basin cleaning, and other JRMP activities detailed further in Appendix I.

Public Education and Participation

Implementation of a public education and participation program is a key strategy to promote and encourage development programs, management practices, and behaviors that reduce the discharge of pollutants in storm water. Del Mar plans to continue and to expand several of its current outreach programs. Outreach program efforts include distributing informational material on irrigation runoff through the patrol program, conducting trash cleanup events through community-based organizations, and collaborating with other regional education and outreach efforts. Del Mar also plans to review the City storm water website and to identify and implement appropriate updates to reflect Water Quality Improvement Plan and JRMP revisions.

4.2.4.3 City of Poway Example Strategies

The City of Poway (Poway), located in the middle of the Los Peñasquitos WMA, tends to have larger lot sizes and more pervious surfaces. In addition to administrative JRMP strategies, strategies focus on source control, such as open trash enclosures, and monitoring and reducing of the pollutant source exposure and storm water runoff at a public waste yard. The following example strategies have been identified to address the highest priority water quality conditions in Poway's jurisdiction within Los Peñasquitos WMA. A complete list of strategies and their anticipated implementation schedule are provided in Appendix I. The strategies and schedules are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed.

Existing Development – Promote Water Conservation Programs that Improve Water Quality

Poway plans to promote and collaborate with water agencies and other groups to encourage implementation of water conservation programs that improve water quality by reducing irrigation runoff with smart products or turf replacement and capturing rain water in residential areas. Poway plans to promote and encourage implementation of designated BMPs in residential areas through collaboration with the Metropolitan Water District (MWD) and San Diego County Water Authority (SDCWA) to promote SoCal Water$mart rebates and products. Products intended to conserve water include Water$mart irrigation systems, weather-based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor systems, rain barrels, and turf removal.

Existing Development – Program to Address Illegal Grading on Private Property

Poway plans to address illegal grading on private property through a program dedicated to investigating reports and maintaining records of reported illegal grading. Through this program, violations of grading or storm water regulations would be issued "Stop Work" notices so that permits can be obtained and violations can be corrected.

Existing Development – MS4 Infrastructure Maintenance

Poway plans to continue to improve the MS4 infrastructure as well as roads, streets, and parking lots. Strategies to improve the MS4 infrastructure include optimizing catch basin cleaning to maximize pollutant removal, proactively repairing and replacing MS4 components to provide source control, increasing the frequency of open-channel cleaning and scour pond repair to reduce pollutant loads, and implementing controls to prevent sewage infiltration into the MS4. Strategies to enhance the street sweeping program include equipment upgrades and route optimization, sweeping of medians, and outreach of sweeping enhancement in targeted areas.

Structural BMPs – Green Infrastructure

Poway currently maintains five infiltration basins within the Los Peñasquitos WMA. In addition, a creek stabilization project in Rattlesnake Creek is scheduled to begin in FY16. This project is intended to stabilize a segment of the ephemeral tributary to Los Peñasquitos Creek. As required to meet numeric goals, green infrastructure and additional multiuse treatment area projects have been identified and are being investigated for potential future implementation.

4.2.4.4 City of San Diego Example Strategies

The City of San Diego (City) has identified administrative policies, urban development management programs, and innovative pilot projects as strategies to achieve its goals, and is investing in research for site locations for green infrastructure and other treatment BMPs throughout its jurisdiction in multiple WMAs. Furthermore, the City is currently developing a framework to evaluate other potential benefits that the recommended strategies may provide beyond those associated with water quality. These other benefits may be financial, environmental, or societal. Other benefits refer to additional outcomes of a strategy beyond water quality improvements. Other benefits can include reduced air pollution, increased water conservation, aesthetics-induced property value increases, and increased business investments. The recommended strategies will be scored on the basis of the number of other benefits they provide, and may guide future updates to the Water Quality Improvement Plan (Appendix M).

The following strategies are examples of those selected by the City and planned for implementation. A complete list of strategies planned for implementation and a description of the strategy selection process are provided in Appendix I.4. Appendix I.4 also presents the City's projected funding needs (total and annual) to implement the strategies. These strategies will be implemented by the City of San Diego; they are not intended to be implemented by private entities (e.g., development, business, industry, etc.); however, some of the City's strategies, such as development planning, may have implications for private entities. In the Los Peñasquitos WMA, an analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The strategies and implementation schedules identified in Appendix I demonstrate that numeric goals will be met on the basis of that analysis. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies, if necessary. If strategies are modified, the analysis will be updated as needed to provide assurance that numeric goals will be met. The strategies and schedules are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed.

The City of San Diego will address discharges of bacteria, sediment, and other pollutants through activities on public land across its jurisdiction in the Los Peñasquitos WMA. The following example strategies provide multiple benefits by addressing bacteria and sediment, as well as other water quality pollutants such as trash. They are targeted at reducing wet weather discharges, but may also assist the City in meeting dry weather numeric goals.

Development Planning – Development and Implementation of a Green Infrastructure Policy and Program

In FY16, the City will develop a policy that will require the inclusion of green infrastructure features on all suitable City projects, including non-SUSMP (Standard Urban Storm Water Mitigation Plan) projects. This policy will be coordinated with ongoing efforts to update City design manuals and LID design standards for public LID

BMPs. To guide implementation of the new policy, a green infrastructure program will be initiated in parallel. The program will begin with research and recommendation of ideal methods for green infrastructure project siting and prioritization within the City. By FY18, the City will initiate design of proposed green infrastructure and green streets projects to capture and treat approximately 36 acres of drainage area pending environmental permitting as necessary in the Los Peñasquitos WMA.

Construction Management – Explore Enhanced Inspections for Construction Sites

In FY16, the City plans to establish storm water standards and guidelines for construction sites. These standards and guidelines will include inspections at appropriate frequencies and will identify enforcements that can take place.

Existing Development – Enhanced Property-Based Inspection Program

In FY16, the City plans to administer a program that will require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs. This program would increase the number of discharges identified compared to those identified using standard inspections. This program will also include the inspection of existing development at appropriate frequencies and methods, such as property-based inspections in lieu of traditional individual business inspections. The City conducted an extensive multi-year pilot study of its business inspection program and found that additional discharges could be found and abated by inspecting large properties rather than individual businesses.

Existing Development – Increased Enforcement

The City intends to enhance enforcement responses by increasing the number of Code Compliance staff. Between FY16 and FY19, the City is planning to gradually hire additional Code Compliance Officers and support staff to increase compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development as detailed in the City's Enforcement Response Plan. This effort will target increased enforcement of irrigation runoff regulations and water-using mobile businesses.

Existing Development – Residential and Commercial Rebate Programs Targeting Water Quality

The City plans to continue and expand its landscape-based rebate program to target water quality impacts from residential and commercial areas in FY16 and beyond. Expansion of this program can occur through distribution of promotional and information material and brochures to community groups, libraries, and recreation centers. Educational material would emphasize watershed stewardship and encourage the implementation of designated BMPs through rebates for rain barrels, grass replacement, downspout disconnection, and micro-irrigation.

Existing Development – MS4 Infrastructure Improvements and Flood Risk Management

In FY16, the City plans to continue to improve the MS4 infrastructure as well as the City's roads, streets, and parking lots. The City strives for water quality improvement and flood control risk management through proper and effective operation and maintenance activities (inspections and cleanings) for MS4 and related structures (catch basins, storm drain inlets, detention basins, channels etc.). Strategies to improve the MS4 infrastructure include optimizing catch basin cleaning to maximize pollutant removal, proactively repairing and replacing MS4 components to provide source control from MS4 infrastructure, and implementing controls to prevent sewage infiltration into the MS4. Strategies to enhance the street sweeping program include equipment upgrades and route optimization, sweeping of medians, and outreach of sweeping enhancement in targeted areas.

The City has adopted a Master Storm Water System Maintenance Program (MSWSMP) for flood control facilities. Each fiscal year, the City identifies channels requiring maintenance to restore flood control capacity. The list of identified channels is available at the City of San Diego's Storm Water Division website.

The City has identified a need to assess canyon areas where MS4 asset structural or configuration issues have the potential to cause or contribute to downstream water quality problems, such as sediment loads. Accordingly, the City has developed and implemented a prioritized assessment strategy for canyon outfall assets to identify areas where assets may need to be rehabilitated, replaced, or relocated to prevent structural damage, reduce or eliminate potential erosion issues, and/or improve water quality in downstream receiving waters. The City is currently implementing the fourth phase of this work, which will exclusively focus on the Los Peñasquitos WMA and will identify priority locations and sediment load reductions associated with outfall repair/relocation.

In FY16, the City plans to request resources to increase identification and enforcement of actionable erosion and slope stabilization issues on private and municipal property and require stabilization and repair. This strategy would be performed through an inventory and assessment of eroding areas and their risk to surface waters, followed by development of a schedule for ongoing inspection and stabilization.

The City continues to collaborate with watershed stakeholders to plan and implement projects that will further Los Peñasquitos Lagoon restoration efforts and reduce flooding in the lower watershed. Efforts may include (1) dredging of tidal channels and inlet area to restore and maintain tidal circulation and facilitate draw down times of floodwater in the Lagoon, and (2) modeling and/or studies to analyze sediment transport and flood control options.

Increased Public Education and Participation

The City of San Diego conducts an extensive public education and outreach program through its Think Blue program. Examples include the following:

- ❖ The City will continue and expand several of its current outreach programs. Outreach programs would be widely implemented but targeted to home owners associations (HOAs), business owners associations (BOAs), maintenance districts, various community groups through organized community trash cleanup events, and water-used mobile businesses.
- ❖ Workshops will be held, community events will be organized, and informational material and brochures will be disbursed to reach community members and advise them of incentives, regulations, and training, and provide general information they need for implementation of good watershed stewardship practices or BMPs.

Structural Strategies – Green Infrastructure

Green infrastructure projects in the Los Peñasquitos WMA will be implemented in a phased approach. Nine projects (in the form of bioretention and/or permeable pavement) on public parcels or on the public right-of-way are currently planned to be built by FY18 to treat approximately 36 acres of drainage area. Approximately 240 acres of potential green streets are anticipated for implementation throughout Los Peñasquitos WMA by FY35.

4.2.4.5 County of San Diego Example Strategies

The County of San Diego comprises only 3 percent (1,875 acres) of the Los Peñasquitos WMA. This area includes 73 percent undeveloped vacant land/natural open space, 20 percent rural residential areas, and 7 percent agricultural and roadway areas. Therefore, during the interim permit cycles, the County will focus on implementing its programmatic programs to meet its goals. However, if it is determined through assessments that the County is unable to meet its interim goals, the County will work toward a solution through adaptations of the programmatic program and through collaboration with watershed partners. Specific dry and wet weather goals are further discussed below.

Dry Weather Strategies

The County's dry weather goal to effectively eliminate anthropogenic discharges will be accomplished through the implementation of numerous JRMP strategies to reduce dry weather runoff, as described in the County of San Diego JRMP. In particular, the County has shifted to a more active field program to better locate and abate dry weather flows. County storm water staff members spend a greater frequency of time present in unincorporated communities identifying nuisance anthropogenic flows and addressing them through appropriate education and enforcement strategies. All County staff members have been trained to identify and report illicit discharges and illicit connections during required annual storm water training; this training has been updated to reflect recent MS4 Permit changes.

In addition to the increase in County staff field surveillance, the County is also implementing a focused program to reduce flow at targeted MS4 outfalls that have demonstrated persistent dry weather flow. The County understands that there are no reported persistent dry weather flows in the unincorporated area, but will confirm whether this is the case through field surveys. Regular monitoring will be conducted to determine the conditions of all outfalls. If dry weather flows are detected, staff will initiate a field investigation to seek out and abate the source of flow.

Using the strategy above, the County will strive to effectively eliminate dry weather flow from outfalls in the Los Peñasquitos WMA. Throughout the implementation of the Water Quality Improvement Plan, adaptive management will be used to evaluate reasonable progress toward the numeric goals and to consider changes to program design and project implementation, as needed to meet goals and as funding becomes available. This adaptive management process will be further described in the final Water Quality Improvement Plan. Efforts will be adaptively managed to mitigate dry weather flows and consider only small-scale structural controls if needed. Compliance with the Bacteria TMDL goal, scheduled for April 2021, will be demonstrated through the storm drain outfall monitoring program.

Wet Weather Strategies

The County will address wet weather bacteria and sediment load reductions primarily through a programmatic approach. The implementation of the programmatic approaches of the storm water program is estimated to result in a 10 percent reduction of the bacteria loads and will be used to meet compliance. Baseline loads will be determined during FY15–FY16. The load reduction is anticipated to take place incrementally by permit term, with a 0.5 percent reduction during the second permit term, a 0.5 percent reduction during the third permit term, and a 1 percent reduction during the fourth permit term. If the anticipated reductions are not confirmed by monitoring, then program adjustments will be made according to the adaptive management process. This may require the incorporation of more effective strategies, changes in program design, or incorporation of additional structural BMPs if funding is available.

Additionally, the County of San Diego will assess during the second permit term whether or not predicted bacteria reductions are being met through the programmatic approaches. If this assessment indicates that a final load reduction of 2 percent cannot be reached through changes to the programmatic approach, then structural BMPs may be considered. A county-wide program may be implemented, if determined to be feasible, that encourages small-scale structural BMPs through a public-private partnership. The BMPs may include roof downspout disconnects to landscaped areas, rainwater use through rain barrel capture, rain gardens, and bioswales. This is in addition to the anticipated BMPs required to be constructed during redevelopment. If determined to be feasible, the public-private partnership small-scale BMP program is an optional strategy to be implemented only as needed and as funding becomes available.

The County has also developed two wet weather goals to address sediment to address the two compliance pathways that are anticipated to be required to meet the Sediment TMDL. The first compliance pathway requires a sediment load reduction of 47.7 percent from the current modeled baseline load of 76 tons per year for the Los Peñasquitos Creek subwatershed and 48.2 percent current modeled baseline load of 7.6 tons per year within the Carroll Canyon subwatershed. Programmatic approaches are estimated to reduce sediment loads by 10 percent. Because of the limited available area for structural BMPs or for significant redevelopment to occur within the County of San Diego, structural strategies are not currently being considered. However, the County will consider collaborations with watershed partners as necessary and as funding becomes available to address watershed sediment issues on a regional basis.

The County may also consider alternate approaches for compliance with the Sediment TMDL. For example, the current land uses are almost unchanged from the 1973 land uses in the unincorporated area. Quantitative modeling was conducted during development of the Sediment TMDL to reduce current sediment loads to the 1973 predicted levels. As outlined in the Table 4-13, the County may choose to meet compliance in one or more subwatersheds by demonstrating that the sediment load is in compliance with the TMDL allowable loads modeled using 1973 land uses.

The second compliance pathway requires that the Los Peñasquitos Lagoon be restored, to include an increasing trend toward 80 percent of the historical salt marsh habitat or 346 acres of tidal/non-tidal salt marsh habitat. The TMDL establishes monitoring protocols to evaluate trends in habitat within the Lagoon and will be utilized to determine the necessity to develop a restoration plan. If yearly monitoring warrants, the County will collaborate with the appropriate watershed parties to develop and implement this plan.

4.2.5 Collaborative WMA Strategies

In addition to implementing strategies on a jurisdictional basis, Responsible Agencies may collaboratively implement projects within the WMA that improve water quality. Two restoration opportunities are being explored. The first is in response to the Sediment TMDL (Section 4.2.5.1) and the second is an existing effort through the North Coast Corridor (NCC) Program (Section 4.2.5.2). Other watershed-wide efforts include encouraging water conservation efforts to meet dry weather goals, collaborating on the potential for alternative compliance and the WMAA, and collaborating with the Regional Board.

4.2.5.1 Watershed Collaboration for Los Peñasquitos Lagoon Restoration

This strategy will identify opportunities for stakeholder collaboration to promote the restoration of salt marsh areas and overall improvements in estuarine and other beneficial uses within the Los Peñasquitos Lagoon. Benefits of this strategy include more efficient targeting and prioritization of lagoon restoration activities, increased cost-effectiveness of selected BMP strategies in the watershed, and development of partnerships across the MS4 jurisdictions and other TMDL responsible parties. These efforts will be coordinated with the Lagoon Enhancement Program currently being updated by the Los Peñasquitos Lagoon Foundation and will require that (1) funding to address MS4 discharges and dry weather input of freshwater is identified and secured, (2) staff resources are identified and secured, (3) partners are identified and formal memoranda of understanding (MOUs) are developed and executed, (4) permits required by regulatory agencies are secured, and (5) consensus and community support are achieved. In addition, the need for collaboration will depend on progress toward achieving interim and final numeric goals on the basis of the MS4 jurisdiction-specific strategies.

Planning will include evaluation of potential short- and long-term restoration activities using a phased approach and will assess their effectiveness in restoring salt marsh habitat in critical areas, their ability to maintain restored areas over time, and their capacity to mitigate current and future impacts on Lagoon beneficial uses. Of particular interest will be identifying restoration activities designed to increase the resiliency of the lagoon to sedimentation (from watershed and ocean inputs), freshwater flows, and other impacts during initial years until the necessary sediment load reduction and other actions can be achieved that will to support the lagoon's long-term viability (especially salt marsh areas). Such an approach may facilitate the success of nonstructural BMPs that target direct sources of constituents of concern and result in more efficient use of funds, while minimizing impacts and costs related to implementation and maintenance of structural BMPs that may not be needed through in the long term. For example, efforts to increase the tidal prism and water circulation in the Lagoon may allow for a shift in resources toward lagoon restoration versus building structural BMPs throughout the watershed. In addition, regional BMPs, such as the Los Peñasquitos Creek sedimentation basin, have proven to be more effective at removing sediment compared with WMA BMPs. It's important to note that collaboration and participation of all key stakeholders will be crucial to successfully implement any restoration activities identified.

To achieve Water Quality Improvement Plan numeric goals, it will be necessary to incorporate elements of the Lagoon Enhancement Program along with lagoon modeling/analysis. The first step would be to identify the appropriate combination of regional BMPs and lagoon restoration efforts that are likely to provide significant increases in salt marsh habitat over time, and will help offset the need for the most costly structural BMPs that are programmed to be built throughout the watershed at the end of the compliance schedule. The second step will be to perform modeling/technical analysis to quantitatively assess the appropriate combination of sediment reduction and lagoon restoration activities needed to help increase the Lagoon's resiliency to sedimentation and other impacts (as described above). The modeling/technical analysis performed would also be used to identify more effective regional structural BMPs in conjunction with the lagoon restoration strategy. In addition, other strategies that are particularly relevant within the Los Peñasquitos WMA will be quantified as part of this analysis. For example, stream channel restoration, relocation of storm water outfalls, and other activities can potentially reduce the need more expensive BMP implementation efforts within the WMA, as described in Section 4.3.

Based on current plans for the Lagoon Enhancement Program and future refinements to watershed BMP strategies, it is estimated that approximately 15 percent of the sediment load reduction required could be offset or accomplished through more efficient measures. This estimate conservatively assumes that approximately 5 percent of the sediment load reduction may not necessarily be due to future restoration efforts and improvements in lagoon function and sediment transport characteristics. Regional BMPs, similar to the existing Los Peñasquitos Creek sedimentation basin, would be able to provide more efficient sediment trapping and removal. A preliminary modeling analysis indicates that 5 percent of the sediment load reduction could be reasonably achieved through the development of sedimentation basins in the lower portion of the watershed. Finally, other more efficient watershed strategies such as outfall repair and relocation, slope stabilization, and stream restoration could conservatively achieve 5 percent of the load reduction at a much lower cost. These potential benefits and cost savings were incorporated into the overall Water Quality Improvement Plan strategy. These estimates will be updated when the lagoon modeling/analysis (described above) and future BMP special studies are completed. It is anticipated that these two steps would occur over the next one to two years, depending on momentum in establishing WMA partnerships and funding. Key to the success of the Water Quality Improvement Plan will be an effective adaptive management program that will track progress in restoring the Lagoon's beneficial uses and adjust strategies, as needed.

4.2.5.2 Los Peñasquitos Wetland Restoration Project

The NCC Program is a region-wide effort led by Caltrans and SANDAG that is intended to improve coastal transportation (including Interstate 5 and the coastal rail and transit system) while protecting and restoring coastal habitats throughout the corridor (Figure 4-10). The 27-mile-long project stretches across the cities of Oceanside, Carlsbad, Encinitas, Solana Beach, Del Mar, and San Diego, and provides improvements for six coastal lagoons, including the Los Peñasquitos Lagoon.

Figure 4-10
Los Peñasquitos Lagoon (LPLF, 2014)

In the Los Peñasquitos WMA, SANDAG and Caltrans acquired the Pardee Carmel Valley property, known as Deer Canyon, to restore native upland habitat. The Deer Canyon habitat restoration project will provide 12.6 acres of wetlands creation, 30.9 acres of upland habitat creation, and 0.25 acre of upland habitat enhancement. The project will remove non-native vegetation and revitalize coastal sage shrub that is native to the area, preserving the habitat of the California Gnatcatcher. Bioswales are planned to be implemented along the freeway to prevent runoff from entering into the Lagoon. The NCC Program is implementing construction in phases from 2010 through 2040. The program is a $6.5-billion investment in the region that will be paid for through a combination of federal, state, and local funds. The NCC Program is part of TransNet, the voter-approved, half-cent sales tax initiative that helps fund transportation projects in the region (TransNet, 2014).

4.2.5.3 Collaborative Approach to Irrigation Reduction

Responsible Agencies of the Los Peñasquitos WMA are collaborating with water agencies to encourage implementation of water conservation efforts. In a Mediterranean climate such as that of southern California, water conservation efforts ensure a reliable water supply while keeping the region naturally beautiful. Water conservation that attempts to reduce irrigation and minimize storm water runoff can also improve water quality of receiving waterbodies, including reducing anthropogenic freshwater flows into the Los Peñasquitos Lagoon. The MWD and SDCWA are primary water providers in southern California that lead regional and multijurisdictional programs that incentivize water conservation efforts.

MWD's SoCal Water$mart Program and SDCWA's WaterSmart Program support conservation efforts by offering incentives in the form of rebates for rain barrels, rotating sprinkler nozzles, weather-based irrigation controllers, soil moisture sensor systems, and turf replacement (MWD, 2014; SDCWA, 2014). The San Diego County Water Authority's WaterSmart program also offers landscape training classes and plant fairs to educate and engage the community on water conservation efforts. Several Responsible Agencies and local municipal water districts promote and express interest in collaborating with MWD and SDCWA to support their water conservation incentive programs (Table 4-22). Funding and resources to support these region-wide water conservation efforts for each Responsible Agency are presented in Table 4-22. There is also potential to collaborate with retail water suppliers who have more direct contact with water users and who can more effectively monitor water consumption to identify possible sources of system leaks and over-irrigation.

Table 4-22
Responsible Agency Collaboration with Regional and WMA Water Conservation Programs

Responsible Agency	Responsible Departmental Agency	Metropolitan Water District (MWD)	San Diego County Water Authority (SDCWA)	Source of Funding
City of San Diego	Transportation and Storm Water Department (T&SW); Public Utilities Department (PUD)	✓	—	Residential BMP Rebate program is intended to promote rebates for rain barrels, irrigation controls (grass replacement), and downspout disconnections.
City of Del Mar	Clean Water Program (CWP)	✓	✓	Costs to be confirmed upon budget approval.
City of Poway	Development Services Department (DSD)	✓	✓	City to provide cost
County of San Diego	Watershed Protection Program (WPP)/Other County Department	✓	✓	General Fund

Water conservation efforts through residential and/or commercial rebates are not applicable to Caltrans.

Modeling within the San Diego region, including in the Los Peñasquitos WMA, indicates that a 25 percent reduction in irrigation (modeled as a reduction in irrigated land by 25 percent and the reduction of overspray) results in an average 99 percent reduction in fecal coliform. The 25 percent reduction in irrigation is in line with and slightly more aggressive than California's statewide 20x2020 Water Conservation Plan (20x2020 Plan), which aims to reduce the urban water demand by 20 percent per capita by 2020. In California, outdoor water consumption exceeds 40 percent of overall urban water use (DWR, 2010). The reduction of irrigation (or outdoor water) demand not only benefits receiving water conditions, including the restoration of salt marsh habitat, but also reduces costs of new water infrastructure and reduces water-related energy among other benefits discussed in the 20x2020 Plan.

The collaborative strategies implemented through the Responsible Agencies and water agencies to reduce and eliminate dry weather flows will be encouraged and implemented throughout the watershed, reducing freshwater discharges not only directly to the lagoon through MS4 outfalls, but also to tributaries upstream through MS4 discharges, surface runoff, and percolation through groundwater seeps. By targeting a reduction in irrigation, both irrigation runoff and overall anthropogenic contributions to a rising groundwater table will be addressed.

4.2.5.4 Offsite Alternative Compliance Option (WMAA)

The MS4 Permit allows for the implementation of offsite alternative compliance methods in lieu of meeting structural BMP design standards and/or hydromodification management criteria on the project site. To implement an alternative compliance program, a jurisdiction must first complete an optional WMAA as detailed in MS4 Permit Provision B.3.b(4). The San Diego County Copermittees have collectively funded and provided guidance for development of a regional WMAA. Findings of the draft regional WMAA, specific to the Los Peñasquitos WMA, are provided in Appendix N. The WMAA characterizes important processes of the watershed through creation of GIS layers that include the following information:

- A description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates
- A description of existing streams in the watershed, including bed material and composition, and whether they are perennial or intermittent
- Current and anticipated future land uses
- Potential coarse sediment yield areas
- Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins

Information from the WMAA can be used for the following purposes:

- To identify candidate projects that could potentially be used as offsite alternative compliance options in lieu of satisfying full onsite retention, biofiltration, and hydromodification runoff requirements
- To identify and/or prioritize areas where it is appropriate to allow certain exemptions from onsite hydromodification management BMPs

Alternative compliance methods can be implemented at the subwatershed scale (e.g., multiuse treatment area BMPs) or as green infrastructure BMPs (e.g., green streets). Regardless of scale, offsite alternative compliance BMPs mitigate for pollutants not reliably retained on the project site or hydromodification impacts not reliably mitigated onsite per requirements detailed in MS4 Permit Provisions E.3.c(1) and E.3.c(2). Note that onsite treatment control BMPs will still be required, although such BMPs would not be required to meet the onsite retention requirements. In addition to meeting site-specific structural BMP and hydromodification management requirements, alternative compliance methods can provide enhanced benefits for the WMA.

In addition to allowing for offsite alternative compliance program development, the WMAA findings can also assist in determining the feasibility of candidate projects for offsite alternative compliance implementation (MS4 Permit Provision B.3.b(4)(b)). The Responsible Agencies compiled a list of candidate projects that consider the numeric goals of the Los Peñasquitos WMA as well as projects previously identified in JRMPs and other regulatory documents. Candidate project lists currently available are provided in Appendix N. The Water Quality Improvement Plan will be updated to include the final candidate project list, as that list is made available.

The WMAA documents were developed as part of a regional Copermittee effort and followed criteria set forth in the MS4 Permit. The effort included a call for data and information to be included in the analysis. Data included in the documents are intended for guidance purposes. Where more site specific information is available, then the more detailed information should be used.

The WMAA also provides an assessment of applicable exemptions to hydromodification management requirements, in addition to the MS4 Permit's allowed exemptions regarding direct discharges to exempt receiving waters including the Pacific Ocean, lakes, or reservoirs (or direct discharges to underground storm drains or concrete-lined channels directly discharging to the Pacific Ocean). For the Los Peñasquitos WMA, no additional potential exemptions are recommended with regard to exempt river reaches, stabilized conveyances, highly impervious watersheds, or tidally influenced lagoons.

4.2.5.5 Collaboration with the Regional Board

The Responsible Agencies will work with the Regional Board to identify solutions and address sources of potential water quality impairments within the Los Peñasquitos WMA. Descriptions of the current priorities are provided below and will be updated as implementation, monitoring, and assessment continues.

Enforcement of the Industrial General Permit

As discussed in Section 1, the MS4 Permit requires the Responsible Agencies to control pollutants originating from Non-MS4 or non-municipal lands if those pollutants ultimately discharge into the MS4. Therefore, the Responsible Agencies recognize the need to collaborate with and improve communication between non-municipal entities within the WMA and the appropriate regulatory agencies to ensure that discharges are appropriately regulated before entering the MS4, and to improve water quality throughout the Los Peñasquitos WMA.

In the Los Peñasquitos WMA, a strategy to address sediment, bacteria, and freshwater discharge impairments is to ensure that industrial dischargers are fulfilling their requirements under the Industrial General Permit (IGP). The Responsible Agencies and the Regional Board have dual permitting and oversight responsibilities over land use where industrial activities occur. The Responsible Agencies conduct inspections within their jurisdictions and inform the Regional Board when industries have the potential to be regulated under the IGP, but are not permitted (non-filers), or when non-compliance with the IGP is suspected. The Responsible Agencies will continue to work with the Regional Board to identify priority areas or facilities that need additional follow-up. Follow-up may take place in the form of additional inspections by the Regional Board on facilities with exceedances of monitored constituents and verification that facilities are monitoring for all appropriate constituents. Additional collaborations between the Responsible Agencies and the Regional Board are detailed in Section 4.2.5.6, and Section 4.4 discusses the alternative analysis to identify MS4 and Non-MS4 responsibilities.

Enforcement of Other Non-MS4 Dischargers

The Responsible Agencies will work with the Regional Board to identify and address other sources of potential water quality impairment within the WMA. These sources may include working with Phase II MS4 dischargers, transportation agencies, school districts, nurseries and agricultural dischargers, or non-compliant construction dischargers, as the need arises. In addition, the Regional Board should work with the MS4s to identify potential updates to TMDLs, the MS4 Permit, and other responsible parties' NPDES permits, as appropriate, to more accurately and fairly assign load responsibilities among all the responsible parties in the watershed.

Bacteria TMDL Updates

The Pacific Ocean Shoreline segment at the Los Peñasquitos River mouth was removed from the 303(d) list for REC-1 impairment in 2010. However, calculation of the Bacteria TMDL had already begun and the segment remained in the Bacteria TMDL through Bacteria TMDL adoption in 2011. The Los Peñasquitos WMA Pacific Ocean Shoreline segment was then incorporated into the Bacteria TMDL requirements within the MS4 Permit in 2013. The Responsible Agencies will pursue removal of the beach segment from the Bacteria TMDL and Attachment E of the MS4 Permit.

In February 2010, the Regional Board adopted Resolution No. R9-2010-0001, *Resolution Amending the Water Quality Control Plan for the San Diego Basin (9) to Incorporate Revised Total Maximum Daily Loads for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region (Including Tecolote Creek),* referred to as the Bacteria TMDL. As part of the Bacteria TMDL Implementation Plan, the Regional Board included a planned milestone to consider revisions to the Bacteria TMDL on the basis of new technical information provided by the dischargers or other entities within five years after the effective date of the TMDL (April 4, 2016). The Counties of San Diego and Orange and the City of San Diego are coordinating with the Regional Board to assess the scope of a third-party TMDL reopener process.

4.2.5.6 Refinement of Water Quality Regulations

A goal for Responsible Agencies is to protect human health and improve water quality in an effective and efficient manner. To achieve this goal, the Water Quality Improvement Plan will be used as a tool to plan and cost the BMPs needed to protect human health and improve water quality for the highest priority water quality conditions in the Los Peñasquitos WMA. The MS4 Permit clearly states that the "Copermittees need only comply with permit conditions relating from discharges from the MS4s for which they are operators." This objective is reflected in the discussion presented in Section 1.1 and Figure 1-1. The resolution adopting the Los Peñasquitos Sediment TMDL (R9-2012-0033) and recently updated MS4 Permit provide a list of the dischargers that are subject to the TMDL. The listed dischargers include Phase I MS4s, Phase II MS4s, Caltrans, industrial facilities, and permitted construction activities in the WMA. By contrast, the Bacteria TMDL assigns wasteload allocations only to the Phase I MS4s, although bacteria loads are also contributed by Non-MS4 areas within the WMA. As such, the Responsible Agencies will collaborate with the Regional Board to refine the accuracy of regulations to ensure that Non-MS4 dischargers are regulated appropriately. The Water Quality Improvement Plan provides an opportunity to present a scenario where discharges associated with areas within the Copermittees' jurisdictions covered by other NPDES permits or regulatory procedures, or owned by federal or state agencies or Indian tribes, are removed from the Copermittees' responsibility. In short, the goal of this exercise is to begin a dialog with the Regional Board that may lead to the following outcomes:

(1) Removal of Non-MS4 discharges and the associated BMPs needed to treat those discharges from the Responsible Agencies' burden.

(2) Amendment of current TMDLs and the MS4 Permit to correctly assign responsibilities for Non-MS4 discharges to the appropriate entities.

(3) Strengthening of Non-MS4 NPDES permits that are directly tied to the requirements of existing and future TMDLs. For example, the City of San Diego and USEPA Region 9 are currently collaborating on a modeling study to evaluate the relative pollutant loads from various commercial, industrial, institutional, and MS4 Phase II sources and the costs to reduce loads from each source. Results of this analysis will inform the USEPA of the ability of the MS4 Permit to address these sources, potentially resulting in new specific requirements for the Industrial General Permit and General Phase II Permit to address TMDL discharges.

Note that the Copermittees would continue to implement programs to inspect, enforce, and oversee some of these dischargers because the MS4 Permit requires that "each Copermittee must implement a program to actively detect and eliminate illicit discharges and improper disposal into the MS4, or otherwise require the discharge to apply for and obtain a separate NPDES permit."

Other NPDES Permits

There are several active NPDES permits for dischargers within the Los Peñasquitos WMA that are not addressed by the MS4 Permit, including:

- NPDES No. CAS000003 – Statewide Storm Water Permit, Waste Discharge Requirements for State of California Department of Transportation (Caltrans Permit)
- NPDES NO. CAS000002 – General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (General Construction Permit)
- NPDES General Permit No. CAS000001 – Waste Discharge Requirements for Dischargers of Storm Water Associated with Industrial Activities Excluding Construction Activities (Industrial General Permit)
- NPDES General Permit No. CAS000004 – Waste Discharge Requirements for Storm Water Discharges from Small MS4s (General Phase II Permit)

Caltrans is voluntarily participating in the Water Quality Improvement Plan, and is proposing BMPs within its jurisdiction to meet jurisdictional numeric goals. The General Construction Permit is difficult to assess because areas are never constant, and oversight of these areas by both the Copermittees and the Regional Board is addressed through separate processes. However, areas addressed by the Industrial General Permit and the General Phase II Permit are clear and their responsibilities can be considered in the Water Quality Improvement Plan. The Industrial General Permit states that "discharges addressed by this General Permit are considered to be point source discharges, and therefore must comply with effluent limitations that are consistent with the assumptions and requirements of any available waste load allocation for the discharge prepared by the state and approved by USEPA." Similarly, the General Phase II Permit states that "discharges from Small MS4s are point source discharges subject to TMDLs," and further states that "this Order requires Permittees to comply with all applicable TMDLs." With TMDL pollutants representing the highest priority water quality conditions, it is logical to assume that the Industrial General Permit and General Phase II Permit are independently responsible for meeting associated wasteload allocations, and therefore can be separated from the Copermittees responsibility in the Water Quality Improvement Plan.

In addition to these NPDES permits, the Regional Board allows a Conditional Waiver of Discharges from Agricultural and Nursery Operations (Ag Waiver) that applies to discharges of storm water runoff and irrigation return water. Ag Waiver enrollment is accomplished in one of three ways. Operations can (1) join an established Monitoring Group; (2) submit a Notice of Intent (NOI) and form a new Monitoring Group; or

(3) enroll as an individual by submitting a NOI. However, there is little data available to identify those areas in the Los Peñasquitos WMA covered by the Ag Waiver.

Land owned by federal and state agencies or Indian tribes can also be considered in terms of removing responsibility of the Copermittees in the Water Quality Improvement Plan. Copermittees do not have authority to require BMPs to be placed within these lands, nor do they have authority to regulate discharges from these lands.

As a result of these considerations, the following land use categories were assessed for potential removal from the responsibility of the Copermittees within the Water Quality Improvement Plan:

- Industrial Areas
- General Phase II Permittees
- Agricultural Areas
- Federal, State, and Indian Land

An alternative scenario was developed to estimate the load contribution and associated BMP implementation implications for MS4s and Non-MS4 entities in the Los Peñasquitos WMA. The results of this analysis are summarized in Section 4.4 and provide important context for collaborative discussions with the Regional Board and Non-MS4 entities in the future. The following sections describe how the land areas for the four categories listed above are being selected for the alternative scenario.

Industrial Areas

The Industrial General Permit addresses a range of industrial facilities and operations; however, the inclusion of specific industry owners within the permit is contingent on their registration within the permit. To date, the Industrial General Permit addresses only a limited number of registrants as identified in California’s Stormwater Multiple Application and Report Tracking System (SMARTS). Industrial permit locations were geocoded on the basis of address information provided in SMARTS (if available) and the associated parcels were identified on the basis of SANDAG parcel ownership GIS data.

An additional consideration for assessing the impact of industrial areas on pollutant loadings, particularly those not currently registered in the Industrial General Permit, is the use of land use GIS to establish industrial areas. Assessment of industrial land use can provide an indication of the impact that additional registrants in the Industrial General Permit can have on reducing the responsibility of the Copermittees, should those areas be fully registered in the permit. Currently, the USEPA is providing similar analyses of the impact of industrial land uses (as well as commercial and institutional areas) in watersheds in the San Diego and Los Angeles regions to evaluate the effectiveness of the NPDES program to regulate these areas. The intent of this study is to inform future discussions regarding revisions of the Industrial General Permit, including increased registration of all applicable industrial dischargers and stricter requirements to directly address TMDL requirements and other water quality impairments. Further analysis of industrial areas in the Water Quality Improvement Plan will provide additional assessment of the balance between responsibilities of the Copermittees and the role of all industrial areas in the Industrial General Permit should full registration of industrial areas take place.

General Phase II Permit

Several small MS4s that are regulated under the Phase II General Permit are located within the Los Peñasquitos WMA. As with the Industrial General Permits, further analysis is necessary to identify Phase II permit responsibilities to facilitate meeting the Water Quality Improvement Plan numeric goals. Existing Phase II Permits were spatially identified on the basis of information gathered from permit documentation on the Regional Board's website. In addition, it is understood that some school districts and other facilities that qualify will be incorporated into the General Phase II Permit program in the near future. These potential Phase II Permits were not spatially located, but could be included in future analyses.

Agriculture

Without specific information regarding agricultural areas enrolled in the Ag Waiver, SANDAG land use data were used to identify agricultural lands within the Los Peñasquitos WMA to help with estimating the contribution from these areas.

Federal, State, and Indian Land

Multiple areas in the Los Peñasquitos WMA are owned by federal or state governments, or Indian tribes. These lands were identified on the basis of SANDAG parcel ownership GIS data to help estimate the contribution from these areas.

4.3 Implementation Schedule to Meet Final Goals

Responsible Agencies must identify reasonable schedules that demonstrate progress toward achieving the interim and final numeric goals presented in Section 4.1. Compliance analysis results presented in Appendix J and summarized in Section 4.3.1 dictate the schedule for implementation, which is presented graphically in Section 4.3.2. This Water Quality Improvement Plan incorporates the 20-year Sediment TMDL and 20-year Bacteria TMDL compliance schedules to attain wet weather goals and the 10-year Bacteria TMDL compliance schedule to attain dry weather goals. Strategy development and planning include an assessment of relative cost-effectiveness of each strategy and was one of the key drivers in phasing strategy implementation. Nonstructural BMPs are effective in reducing pollutant loads before they enter the storm drain system and are generally cost-effective and require a shorter planning period. Therefore, most nonstructural strategies are planned for implementation before or upon approval of the Water Quality Improvement Plan. Structural BMPs can be cost-effective when greater load reductions are needed and treatment must occur after the pollutants enter the storm drain system, particularly when benefits other than water quality improvements are considered. However, planning for structural BMPs requires additional time to secure resources, design BMPs, and obtain permits. Most of the potential structural BMPs are planned for later in the compliance period to allow more time to ensure that the implementation is necessary to meet numeric goals and is designed to achieve the load reductions required, and that alternatives to construction have been evaluated.

In the Los Peñasquitos WMA, a compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. BMP optimization models were used to simulate associated pollutant reductions over the entire compliance period. A summary of the level of effort anticipated for each modeled strategy, the associated load reductions predicted for the highest priority water quality conditions, and the predicted benefit to other water quality parameters for wet and dry weather conditions are presented in Section 4.3.1.

The Los Peñasquitos watershed model has been continuously updated since development of the bacteria and sediment TMDLs on the basis of recent studies that provided additional information and insight on pollutant sources in the watershed (especially within Carroll Canyon), fate and transport processes, and existing water quality conditions. This information was used to improve the accuracy of the model and provide a sound foundation for the evaluation of the various Water Quality Improvement Plan strategies. Long-term sediment transport modeling at the watershed scale is particularly complex because of changing weather patterns and instream dynamics that constantly vary temporally and spatially. Because of these challenges, the model provides the best possible representation of pollutant fate and transport and loads contributed by the watershed and stream network, based on available data. Likewise, substantial efforts were made to identify and quantify the broader BMP strategies (structural and nonstructural) that may be needed to meet the Water Quality Improvement Plan numeric goals. These strategies, including multiuse treatment areas, green infrastructure, and green streets, represent a range of BMP types proven effective at removing pollutants and reducing dry weather flows, in some cases.

The suite of nonstructural and structural strategies were selected in the order described in Section 4.3.1 based on efficient targeting of the highest priority water quality condition as well as consideration of multiple benefits, taking into account the environmental, economic, and social components of each strategy. Following nonstructural strategies, structural strategies were proposed in the model in order of efficiency. Accordingly, following nonstructural strategies, all identified potential multiuse treatment areas on public parcels and green infrastructure opportunities were proposed, with implementation phased to meet interim and final goals. Green streets were then proposed to the optimal extent of implementation (30 percent based on the modeled point of diminishing return). Green streets, when sited and designed appropriately, as described in detail in Appendix J, are highly effective at pollutant removal through filtration and sedimentation. Even in areas with higher erodibility and sediment loading, green streets can be located upstream to reduce volume and peak flow.

Significant research was conducted to quantitatively represent these BMPs in the modeling analysis to demonstrate their relative effectiveness and identify the level of implementation needed to meet the numeric goals. Although this analysis focused on these broader BMP categories, which have widespread application and sufficient data available for model representation, additional strategies exist that are particularly relevant within the Los Peñasquitos WMA. For example, scouring of canyon walls due to storm water outfalls has been a historical problem within the WMA. Also, historical and current sediment loading from mining operations (quarries) within the Carroll Canyon area represent an important data gap. Stream channel restoration, in addition to the planned restoration projects, may also be beneficial and feasible in other areas of the watershed. For Carroll Canyon, the most cost-effective sediment reduction measures will likely consist of a combination of upgrades to existing MS4 outfalls along canyon slopes, low-impact development measures in the developed mesas, restoration or enhanced sediment management of the reaches passing through the two quarries, and stabilization of sections of Carroll Canyon Creek and its drainages. These strategies are discussed in Section 4.2.3.4 and will be further explored and quantified in the near future. In addition, development of a comprehensive Los Peñasquitos Lagoon Restoration strategy (as outlined in Section 4.2.5.1) will provide an opportunity to reassess the watershed sediment load reduction needs and further refine the overall direction of the Water Quality Improvement Plan. Potential permitting challenges and local data necessary to incorporate these strategies into the modeling analysis will be addressed.

In summary, the current modeling analysis incorporates the best use of available data and an effective suite of proposed structural and nonstructural strategies that were prioritized and selected as outlined in Section 4.3.1. Continued improvement of the compliance/modeling analysis is anticipated through the following steps:

- ❖ Quantification of the load reduction benefits associated with lagoon restoration, as discussed in Section 4.2.5.1
- ❖ Completion of an Outfall Assessment/Special Study quantifying benefits associated with storm water outfall repairs (in particular, those that may be causing significant canyon scouring)
- ❖ Incorporation of other Special Studies that further quantify sediment transport dynamics throughout Carroll Canyon, including a study currently underway with locations upstream and downstream of mining areas and a Flanders Canyon Study (completed by AMEC in 2013)
- ❖ Coordination with resource agencies on permitting of outfall extensions/repairs for overall benefit to the WMA
- ❖ Evaluation of additional opportunities and data collection necessary for model representation and compliance analysis

Additionally, collaborative efforts with the Regional Board and potential refinement of the water quality regulations covered in Sections 4.2.5.5 and 4.2.5.6, respectively, will provide further opportunities for an improved compliance analysis.

The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met. Section 4.3.1 presents the modeling analysis that demonstrates that planned strategies will reach the required load reductions for sediment, bacteria, and freshwater discharge (flow). The modeling results also include benefits to pollutants other than the highest priority water quality conditions, demonstrating the multiple benefits of nonstructural and structural strategies. Section 4.3.2 presents the schedule for achieving interim and final goals by identifying the load reductions from nonstructural and structural strategies over the compliance time frame.

4.3.1 Jurisdictional Implementation (Compliance Analysis)

A summary of the implementation year and duration of each jurisdictional strategy is presented in Appendix I within each jurisdictional strategy table. If a jurisdictional strategy is not initiated upon approval of the Water Quality Improvement Plan, the expected implementation year is provided. The implementation description within the strategy tables for optional strategies provides the circumstances for implementation and the resources needed. Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals. The schedules and resources required to implement the WMA strategies are presented in Section 4.2.5, as well as within each jurisdictional strategy for those jurisdictions participating in the WMA strategy. This section describes the schedule for implementation, the benefits expected from the strategies, and the dates that the final and interim goals will be met by the Responsible Agency.

Jurisdictional schedules demonstrate that phased implementation of the nonstructural and structural strategies by jurisdiction, listed in Section 4.2.4, achieves both Bacteria and Sediment TMDL wet weather numeric goal compliance over 20 years and dry weather numeric goal compliance over 10 years. To demonstrate this progress and select and schedule the most cost-effective strategies, the following steps were taken (graphically depicted in Figure 4-11):

1. The combination of programmatic nonstructural strategies that could not be explicitly modeled was assumed to result in a combined pollutant load reduction of 10 percent for wet and dry weather (Section 4.2.2.1). These are the most cost-effective strategies and were, accordingly, scheduled first.
2. Pollutant reduction benefits realized by nonstructural strategies that could be explicitly represented in the model were then quantified, as described further in Appendix K. These strategies were scheduled along with the non-modeled nonstructural strategies (item 1 above).

3. Potential structural strategies were then individually evaluated by category for the most cost-effective solution toward TMDL numeric goal compliance. Because multiuse treatment areas on public land are the most cost-effective strategy toward pollutant load reduction (Figure 4-11) and provide additional community benefits, this category of structural strategies was maximized and scheduled first.

4. Potential green infrastructure BMPs were the next most cost-effective option and can be implemented, monitored, and maintained on prioritized locations within the Responsible Agencies' jurisdictions. To leverage these efficiencies, potential green infrastructure followed next in the jurisdictional schedules.

5. The public right-of-way collects storm water runoff (and associated pollutants) from roadway surfaces, and can be easily accessed for maintenance. Because of these factors, and because projects can be scheduled to coincide with other road improvement projects, potential green street BMPs were scheduled as the next strategy after green infrastructure.

6. Any additional loads that could not be reduced by the preceding combination of strategies were assumed to be addressed by additional opportunities. To serve as a foundation for future analyses, additional opportunities were estimated as the implementation of two additional sediment detention basins, similar to the existing basin in the Los Peñasquitos Creek subwatershed, restoration of five creek segments, including repair or replacement of MS4 outfalls, and restoration of the Lagoon, as discussed further in Section 4.2.5.1. Further collaboration between Responsible Agencies will identify the preferred strategies to attain the jurisdictional goals. Responsible Agencies may consider potential stream, channel, and habitat rehabilitation projects, such as the Los Peñasquitos Lagoon Restoration Project, and other public-private partnerships, as needed, that most effectively target the final numeric goal.

The resulting jurisdictional load reductions from the strategies listed in Section 4.2.4 and Appendix J are outlined for the Responsible Agencies in Sections 4.3.1.1 through 4.3.1.5. A detailed breakdown of load reductions is provided in Appendix J.

The dry weather results present the percent bacteria load reduction through implementation of two primary strategy types: (1) non-modeled nonstructural strategies, and (2) irrigation runoff reduction strategies. Irrigation reduction strategies include the implementation of grass replacement projects, micro-irrigation system conversions, weather-based irrigation controllers, education and outreach, and enforcement of regulations that prohibit runoff. Modeling simulations of 25 percent irrigation reduction and elimination of overspray have projected on average 99 percent bacteria load reduction across all Los Peñasquitos subwatersheds. Complete elimination of dry weather runoff is the goal; however, there is also an anticipated load reduction from treatment of dry weather flows through structural BMPs as they are built. Infiltration and detention basins built to treat wet weather flows can also be designed to infiltrate or detain dry weather runoff, thus providing multi-season benefits. Thus, implementing these programs is anticipated to meet or exceed the required dry weather load reduction goals. If monitoring and assessment demonstrate that compliance is not occurring, the Responsible Agencies will adapt their programs and assess the incorporation of optional strategies or amendments to ongoing strategies.

Figure 4-11
Conceptual Diagram Illustrating BMP Implementation (not to scale)

4.3.1.1 Caltrans

Caltrans will voluntarily implement the strategies outlined in Section 4.2, as resources are available, per the schedule provided in Appendix I. Attachment IV to the Caltrans MS4 Permit outlines a methodology for prioritizing stream segments included in TMDLs to which Caltrans is subject. The permit establishes BMP implementation requirements evaluated in terms of compliance units, as opposed to load reduction targets. Caltrans is expected to achieve 1,650 compliance units per year through the implementation of retrofit BMPs, cooperative implementation, and post-construction treatment beyond permit requirements.

For Bacteria TMDLs, Caltrans is expected to eliminate dry weather flows by implementing control measures to ensure effective prohibition (Provision B.2 of the MS4 Permit). For wet weather flows, Caltrans is expected to implement control measures/BMPs to prevent discharge of bacteria from the right-of-way; this can be source control and preemptive activities such as street sweeping, cleanup of illegal dumping, and public education on littering. Implementation of these controls is per the TMDL prioritization list currently under development. The Sediment TMDL has not been incorporated into the Caltrans MS4 Permit.

4.3.1.2 City of Del Mar

The City of Del Mar currently plans to implement the strategies outlined in Section 4.2 per the schedule provided in Appendix I. A combination of nonstructural strategies, potential multiuse treatment areas, and potential green infrastructure may be used to meet the interim and final numeric goals. Implementation of most of the nonstructural strategies is planned to occur prior to or upon approval of the Water Quality Improvement Plan.

To demonstrate that the final goals will be met, BMP optimization models were used to simulate associated pollutant reductions over the entire compliance period. Table 4-23 provides an overall summary for these load reductions for wet and dry weather for Del Mar. A summary of the level of effort anticipated for each modeled strategy, the associated load reductions predicted for the highest priority water quality condition, and the predicted benefit to other water quality parameters for wet and dry weather conditions is presented in Appendix K. Monitoring and adaptive management will verify implementation will need to be adjusted over time.

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Table 4-23
Water Quality Improvement Plan Load Reductions for the City of Del Mar

Strategy and Level of Implementation[2]	City of Del Mar – Percentage Load Reductions[1]									
	Total Sediment[3]	Fecal Coliform[3]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	*Entero-coccus*	Total Coliform
Wet Weather										
Los Peñasquitos Lagoon Subwatershed										
Nonstructural Subtotal[4]	13.2%	10.1%	14.4%	10.6%	11.4%	10.2%	12.3%	14.0%	10.0%	10.0%
Structural Subtotal[5]	7.0%	9.4%	5.5%	11.6%	9.4%	11.8%	8.1%	6.1%	9.2%	8.8%
Additional Opportunities	14.6%	21.2%	18.3%	17.6%	16.5%	17.6%	19.7%	17.4%	21.3%	21.1%
Total	34.8% Goal = 34.8%	40.7% Goal = 2.0%	38.3%	39.8%	37.3%	39.7%	40.1%	37.4%	40.5% Goal = 1.9%	39.9% Goal = 1.6%
Dry Weather										
Los Peñasquitos Lagoon Subwatershed										
Nonstructural Subtotal[4,6]	42%	100%	42%	36%	47%	69%	75%	96%	100%	100%
Total	42%	100% Goal = 96.6%	42%	36%	47%	69%	75%	96%	100% Goal = 99.4%	100% Goal = 96.5%

1. Load reductions are subject to change as new information and data are collected for this specific drainage area.
2. Note that these numbers are planning-level values calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
3. Orange-shaded cells indicate highest priority water quality condition for the WMA.
4. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
5. Structural subtotals include green infrastructure and green street opportunities on public land.
6. Nonstructural subtotals include non-modeled nonstructural strategies and irrigation reduction strategies such as the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, education and outreach, and enforcement of regulations that prohibit runoff. These are the primary dry weather strategies to eliminate dry weather flow. As structural wet weather strategies are implemented and designed to treat dry-weather flows (e.g., multiuse treatment areas), additional load reductions may be achieved.

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4.3.1.3 City of Poway

The City of Poway currently plans to implement the strategies outlined in Section 4.2 per the schedule provided in Appendix I. A combination of nonstructural strategies, potential multiuse treatment areas, and potential green infrastructure may be used to meet the interim and final numeric goals. Implementation of most of the nonstructural strategies is planned to occur prior to or upon approval of the Water Quality Improvement Plan.

To demonstrate that the final goals will be met, BMP optimization models were used to simulate associated pollutant reductions over the entire compliance period. Table 4-24 provides an overall summary for these load reductions for wet and dry weather for Poway. A summary of the level of effort anticipated for each modeled strategy, the associated load reductions predicted for the highest priority water quality condition, and the predicted benefit to other water quality parameters for wet and dry weather conditions is presented in Appendix K. Monitoring and adaptive management will verify implementation will need to be adjusted over time.

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Table 4-24
Water Quality Improvement Plan Load Reductions for City of Poway

Strategy and Level of Implementation[1]	City of Poway – Percentage Load Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	*Entero-coccus*	Total Coliform
Wet Weather										
Los Peñasquitos Creek Subwatershed										
Nonstructural Subtotal[3]	17.4%	10.1%	13.5%	20.4%	17.2%	18.6%	12.0%	12.5%	10.0%	10.0%
Structural Subtotal[4]	27.1%	35.2%	17.1%	41.4%	30.2%	41.2%	26.9%	23.9%	37.3%	34.9%
Additional Opportunities[5]	7.5%	Load Reductions from pollutants are not assessed, but are anticipated.								
Total	51.9% Goal = 47.2%	45.3% Goal = 2%	30.6%	61.8%	47.3%	59.8%	38.9%	36.4%	47.3% Goal = 1.9%	44.9% Goal = 1.6%
Dry Weather										
Los Peñasquitos Creek Subwatershed										
Nonstructural Subtotal[3,6]	47%	100%	43%	42%	53%	67%	74%	85%	100%	100%
Total	47%	100% Goal = 96.6%	43%	42%	53%	67%	74%	85%	100% Goal = 99.4%	100% Goal = 96.5%

1. Note that these numbers are planning-level values calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality condition for the WMA.
3. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
4. Structural subtotals include green infrastructure and green street opportunities on public land.
5. Additional opportunities include participation in lagoon restoration, stream restoration, construction of sedimentation basins, and other BMP. See Section 4.2.3.4 and Appendix J for additional details.
6. Nonstructural subtotals include non-modeled nonstructural strategies and irrigation reduction strategies such as the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, education and outreach, and enforcement of regulations that prohibit runoff. These are the primary dry weather strategies to eliminate dry weather flow. As structural wet weather strategies are implemented and designed to treat dry-weather flows (e.g., multiuse treatment areas), additional load reductions may be achieved.

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4.3.1.4 City of San Diego

The City of San Diego currently plans to implement the strategies outlined in Section 4.2 per the schedule provided in Appendix I. A combination of nonstructural strategies, potential multiuse treatment areas, and potential green infrastructure may be used to meet the interim and final numeric goals. Implementation of most of the nonstructural strategies is planned to occur prior to or upon approval of the Water Quality Improvement Plan.

To demonstrate that the final goals will be met, BMP optimization models were used to simulate associated pollutant reductions over the entire compliance period. Table 4-25 provides an overall summary for these load reductions for wet and dry weather for the City of San Diego. A summary of the level of effort anticipated for each modeled strategy, the associated load reductions predicted for the highest priority water quality condition, and the predicted benefit to other water quality parameters for wet and dry weather conditions is presented in Appendix K. Monitoring and adaptive management will verify implementation will need to be adjusted over time.

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Table 4-25
Water Quality Improvement Plan Load Reductions for City of San Diego

Strategy and Level of Implementation[1]	City of San Diego – Percentage Load Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	*Entero-coccus*	Total Coliform
Wet Weather										
Los Peñasquitos Watershed										
Nonstructural Subtotal[3]	22.5%	10.3%	13.3%	25.5%	20.0%	22.4%	12.4%	13.4%	10.3%	10.2%
Structural Subtotal[4]	24.8%	37.3%	9.6%	31.8%	24.7%	32.8%	24.1%	23.7%	40.2%	34.9%
Additional Opportunities[5]	8.6%	Load Reductions from pollutants not assessed, but are anticipated.								
Total	55.8% Goal = 53.1%	47.6% Goal = 2.0%	22.9%	57.2%	44.8%	55.1%	36.6%	37.1%	50.5% Goal = 1.9%	45.0% Goal = 1.6%
Dry Weather										
Los Peñasquitos Watershed										
Nonstructural Subtotal[3,6]	57%	100%	49%	51%	64%	90%	78%	96%	100%	100%
Total	57%	100% Goal = 96.6%	49%	51%	64%	90%	78%	96%	100% Goal = 99.4%	100% Goal = 96.5%

1. Note that these numbers are planning-level values calculated at a watershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality condition for the WMA.
3. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
4. Structural subtotals include green infrastructure and green street opportunities on public land.
5. Additional opportunities include participation in lagoon restoration, stream restoration, construction of sedimentation basins, and other BMP. See Section 4.2.3.4 and Appendix J for additional details.
6. Nonstructural subtotals include non-modeled nonstructural strategies and irrigation reduction strategies such as the implementation of grass replacement projects, micro-irrigation system conversions, weather-based irrigation controllers, education and outreach, and enforcement of regulations that prohibit runoff. These are the primary dry weather strategies to eliminate dry weather flow. As structural wet weather strategies are implemented and designed to treat dry-weather flows (e.g., multiuse treatment areas), additional load reductions may be achieved.

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4.3.1.5 County of San Diego

The County of San Diego currently plans to implement the strategies outlined in Section 4.2 per the schedule provided in Appendix I. A combination of nonstructural strategies, potential multiuse treatment areas, and potential green infrastructure may be used to meet the interim and final numeric goals. Implementation of most of the nonstructural strategies is planned to occur prior to or upon approval of the Water Quality Improvement Plan.

To demonstrate that the final goals will be met, BMP optimization models were used to simulate associated pollutant reductions over the entire compliance period. Table 4-26 provides an overall summary for these load reductions for wet and dry weather for the County of San Diego. A summary of the level of effort anticipated for each modeled strategy, the associated load reductions predicted for the highest priority water quality condition, and the predicted benefit to other water quality parameters for wet and dry weather conditions is presented in Appendix K. Monitoring and adaptive management will verify implementation will need to be adjusted over time.

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Table 4-26
Water Quality Improvement Plan Load Reductions for the County of San Diego

Strategy and Level of Implementation[1]	County of San Diego – Percentage Load Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	*Entero-coccus*	Total Coliform
Wet Weather										
Los Peñasquitos Watershed										
Nonstructural Subtotal[3]	14.6%	10.3%	12.2%	30.9%	21.4%	35.5%	12.3%	11.0%	10.4%	10.2%
Structural Subtotal[4]	3.2%	9.3%	1.4%	5.1%	4.7%	6.1%	3.1%	2.6%	13.6%	7.0%
Additional Opportunities[5]	29.5%	33.3%	22.9%	18.8%	19.4%	32.0%	22.4%	19.1%	33.6%	32.4%
Total	47.3% Goal = 47.3%	52.9% Goal = 2.0%	36.5%	54.8%	45.5%	73.5%	37.7%	32.6%	57.6% Goal = 1.9%	49.7% Goal = 1.6%
Dry Weather										
Los Peñasquitos Watershed										
Nonstructural Subtotal[3,6]	53%	100%	43%	48%	60%	89%	76%	97%	100%	100%
Total	53%	100% Goal = 96.6%	43%	48%	60%	89%	76%	97%	100% Goal = 99.4%	100% Goal = 96.5%

1. Note that these numbers are planning-level values calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality condition for the WMA.
3. Nonstructural load reductions include both the modeled and non-modeled load reductions. Non-modeled load reductions are assumed to be 10% for all pollutants (HDR, 2014) and modeled load reductions vary by strategy and pollutant.
4. Structural subtotals include green infrastructure and green street opportunities on public land.
5. Additional opportunities include participation in lagoon restoration, stream restoration, construction of sedimentation basins, and other BMP. See Section 4.2.3.4 and Appendix J for additional details.
6. Nonstructural subtotals include non-modeled nonstructural strategies and irrigation reduction strategies such as the implementation of turf conversion projects, micro-irrigation system conversions, weather-based irrigation controllers, education and outreach, and enforcement of regulations that prohibit runoff. These are the primary dry weather strategies to eliminate dry weather flow. As structural wet weather strategies are implemented and designed to treat dry-weather flows (e.g., multiuse treatment areas), additional load reductions may be achieved.

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4.3.2 Progress Toward Achieving Numeric Goals

As resources are available, the Responsible Agencies will implement the strategies in Section 4.2 per the schedules in Appendix I to achieve the subwatershed load reductions in Section 4.3.1. Phasing of the implementation is necessary to properly plan, assess, and select strategies that will be the most efficient and effective in addressing the highest priority water quality conditions.

Compliance with Water Quality Improvement Plan goals is met by achieving one of the compliance pathways for each highest priority water quality conditions during each assessment period (Section 4.1). One of the compliance pathways is implementing a Water Quality Improvement Plan that demonstrates that the selected strategies will meet the goals. Within the Los Peñasquitos WMA, the compliance analysis described in the previous sections provides assurance that the jurisdictional strategies presented in Section 4.2 will meet the jurisdictional goals, expressed as a load reduction from the jurisdiction's MS4. The Responsible Agencies within the Los Peñasquitos WMA will implement water quality monitoring and assess programmatic results to guide the iterative process of adapting strategies and direct the level of effort needed for implementation to meet the required load reductions. The iterative adaptive management process may include coordination with WMA stakeholders as the Responsible Agencies continue to pursue the necessary sustainable, effective, and efficient strategies to address the highest priority water quality conditions.

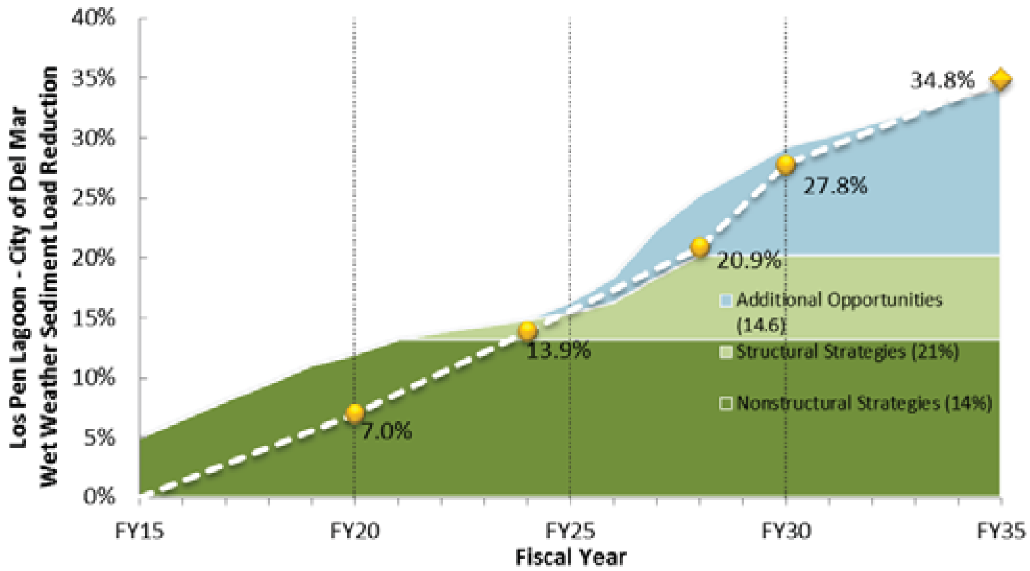
4.3.2.1 Caltrans

Although Caltrans is not permitted under this MS4 Permit, nor is it required to meet numeric goals, Caltrans has voluntarily demonstrated progress toward meeting watershed goals by planning and implementing nonstructural and green infrastructure projects within the Los Peñasquitos WMA.

Caltrans has voluntarily contributed to the Water Quality Improvement Plan effort to provide a consistent and subwatershed-wide approach to meeting applicable TMDL requirements. The strategies developed will be implemented as resources are available.

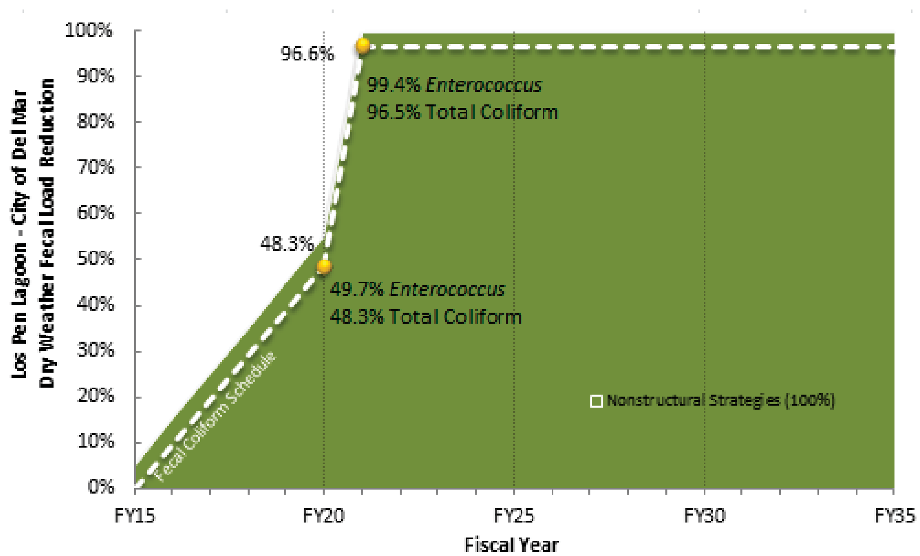
4.3.2.2 City of Del Mar

The City of Del Mar has already demonstrated progress toward meeting the numeric goals by implementing a number of nonstructural strategies within the WMA. The City of Del Mar's expected progress toward meeting interim and final numeric goals is presented for the Los Peñasquitos Lagoon subwatershed in Figure 4-12 for wet weather and in Figure 4-13 for dry weather. As strategies are implemented over time (x-axis), the anticipated load reduction increases (y-axis).



Note: The load reductions are subject to change as new information and data are collected for this specific drainage area.

Figure 4-12
Wet Weather Compliance Schedule for the City of Del Mar in the Los Peñasquitos Lagoon Subwatershed



Note: The load reductions are subject to change as new information and data are collected for this specific drainage area.

Figure 4-13
Dry Weather Compliance Schedule for the City of Del Mar in the Los Peñasquitos Lagoon Subwatershed

4.3.2.3 City of Poway

The City of Poway has already demonstrated progress toward meeting the numeric goals by implementing a number of nonstructural and structural projects within the WMA, including five multiuse treatment areas that were represented explicitly in the baseline model. BMPs included in the baseline model do not represent specific load reductions reported in the Water Quality Improvement Plan, but rather they reduce the baseline loads to be addressed by other strategies. In other words, the five multiuse treatment areas that have been implemented in the City of Poway demonstrate progress toward attaining the numeric goals by reducing the baseline amount of sediment that must be captured by the strategies listed in Section 4.2.4 The City of Poway's expected progress toward meeting interim and final numeric goals in the Los Peñasquitos Creek subwatershed is presented in Figure 4-14 for wet weather and in Figure 4-15 for dry weather. As strategies are implemented over time (x-axis), the anticipated load reduction increases (y-axis).

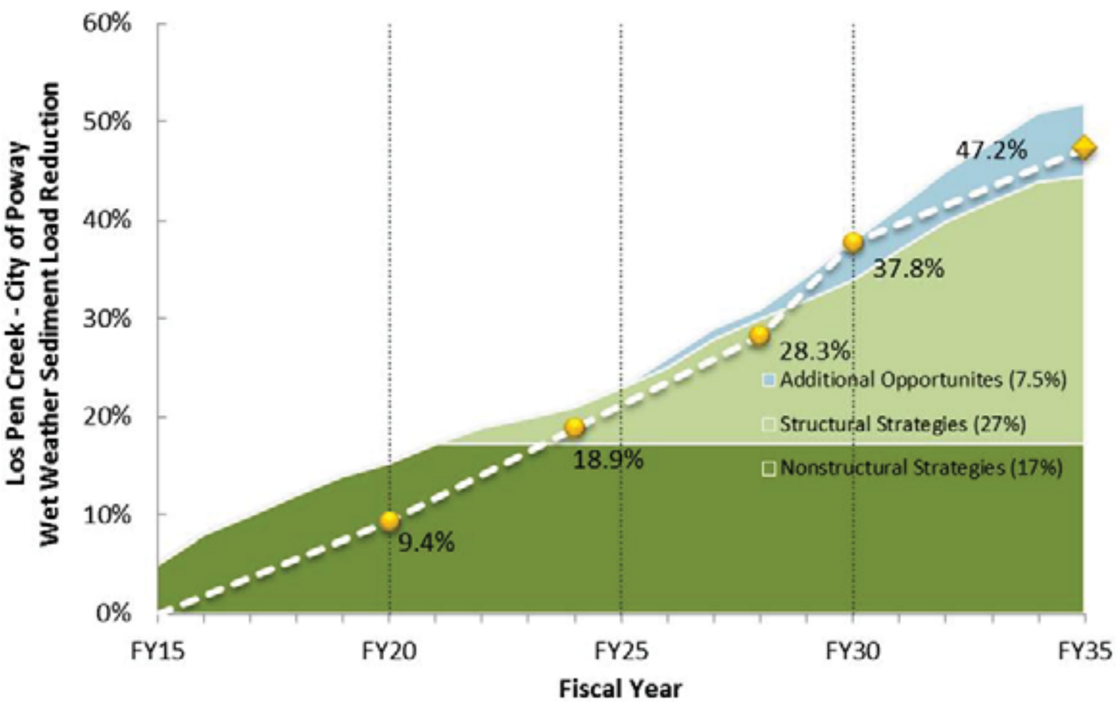


Figure 4-14
Wet Weather Compliance Schedule for the City of Poway in the Los Peñasquitos Creek Subwatershed

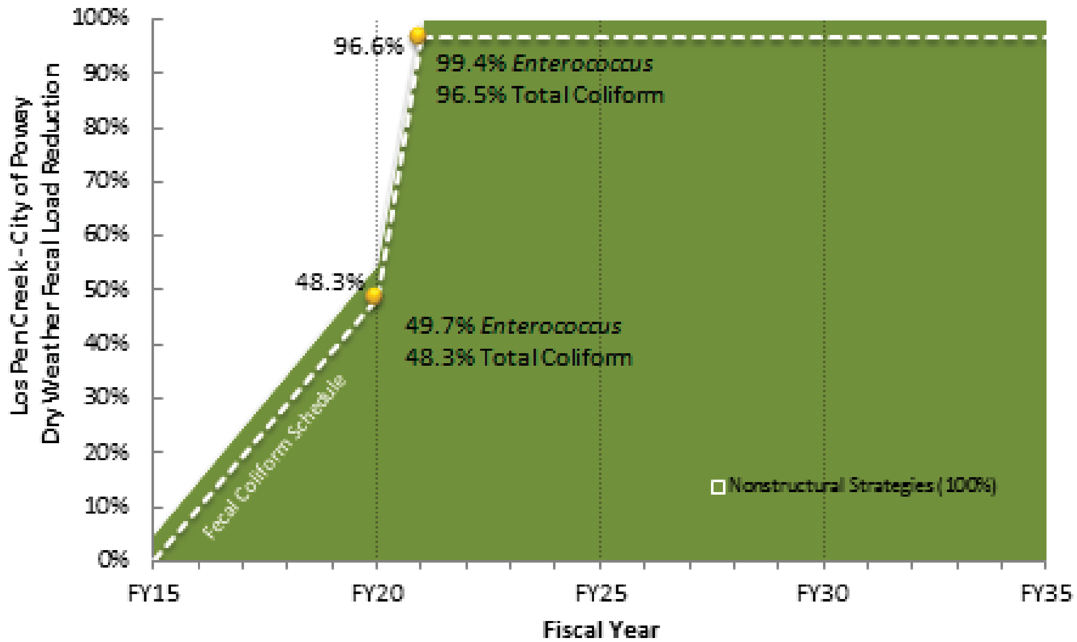


Figure 4-15
Dry Weather Compliance Schedule for the City of Poway in the Los Peñasquitos Creek Subwatershed

4.3.2.4 City of San Diego

The City of San Diego has already demonstrated progress toward meeting the numeric goals by planning and implementing a number of nonstructural and structural projects within the WMA, including at least nine green infrastructure projects and four multiuse treatment areas. The City of San Diego's expected progress toward meeting interim and final numeric goals is presented for the Carmel Valley Creek, Carroll Canyon, Los Peñasquitos Creek, and Los Peñasquitos Lagoon subwatersheds in Figure 4-16 for wet weather and in Figure 4-17 for dry weather. As strategies are implemented over time (x-axis), the anticipated load reduction increases (y-axis).

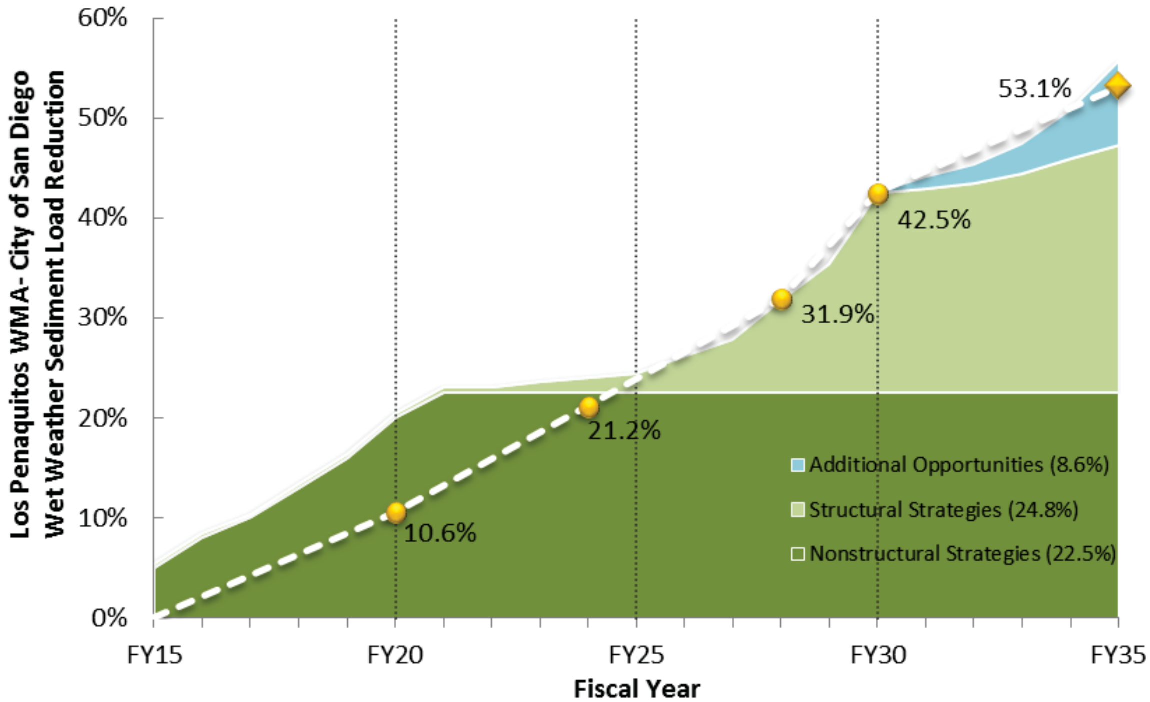


Figure 4-16
Wet Weather Compliance Schedule for City of San Diego

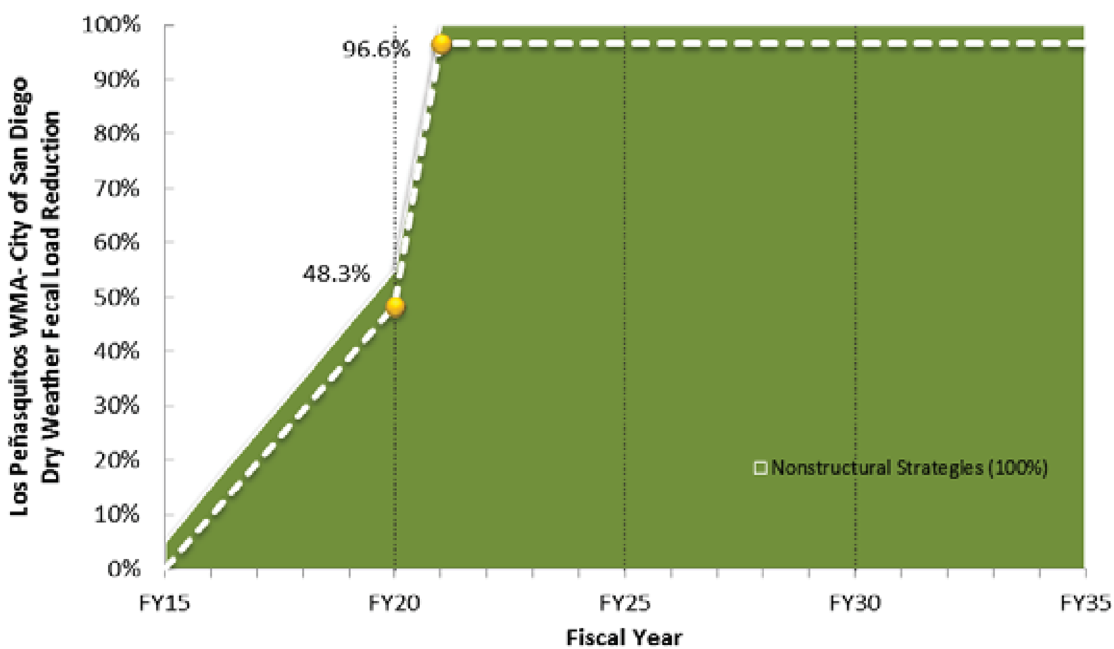


Figure 4-17
Dry Weather Compliance Schedule for City of San Diego

4.3.2.5 County of San Diego

The County of San Diego has already demonstrated progress toward meeting the numeric goals by implementing a number of nonstructural strategies within the WMA. The County of San Diego's expected progress toward meeting interim and final numeric goals in the Carroll Canyon and Los Peñasquitos Creek subwatersheds is shown in Figure 4-18 for wet weather and Figure 4-19 for dry weather. As strategies are implemented over time (x-axis), the anticipated load reduction increases (y-axis).

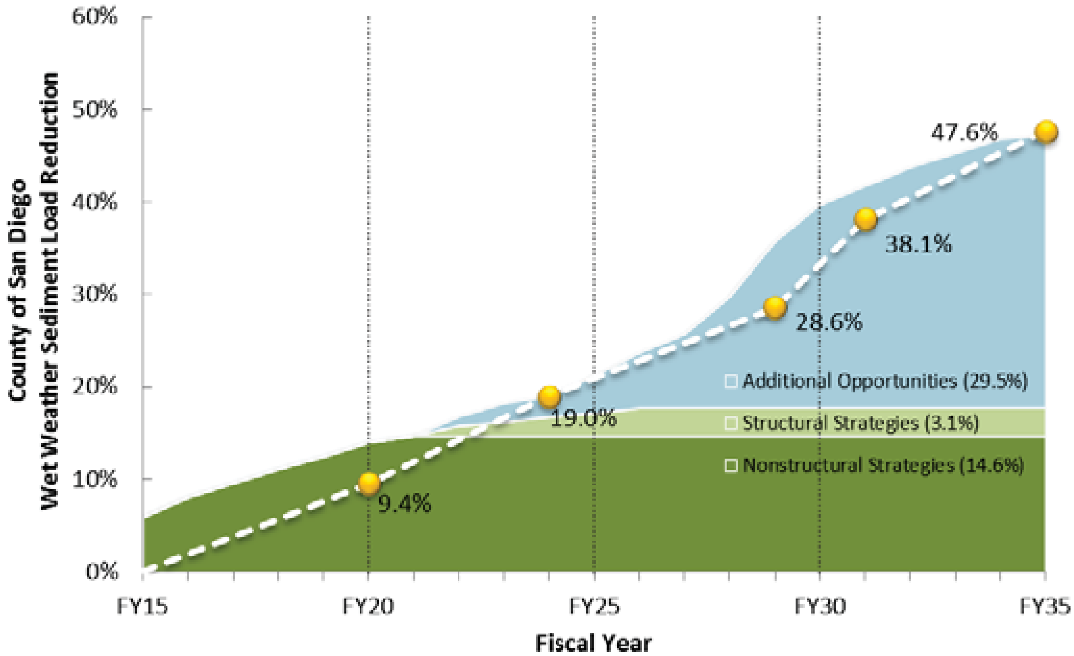


Figure 4-18
Wet Weather Compliance Schedule for County of San Diego in Carroll Canyon and Los Peñasquitos Creek Subwatersheds

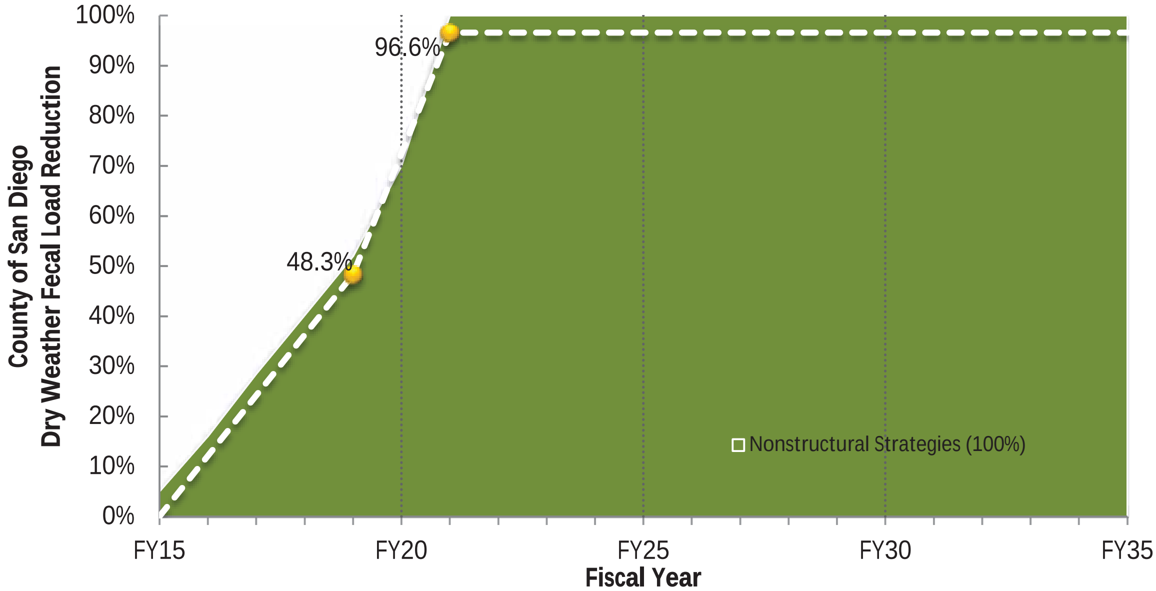


Figure 4-19
Dry Weather Compliance Schedule for County of San Diego in Carroll Canyon and Los Peñasquitos Creek Subwatersheds

4.4 Alternative BMP Implementation Scenario for Refinement of Water Quality Regulations

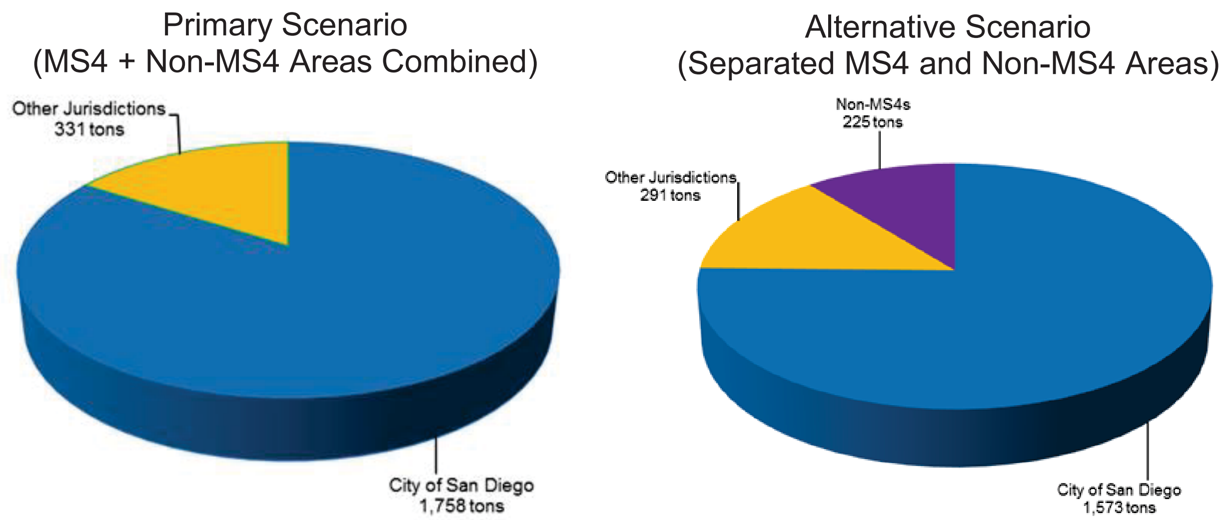
As discussed in Section 1 and Section 4.2.5.6, the pollutant loads from Non-MS4s can be differentiated from MS4s' loads to more accurately and fairly assess load reduction responsibilities within the watershed. Load reduction responsibilities are assigned to responsible dischargers in a TMDL and are enforceable when adopted in a NPDES Permit. The Los Peñasquitos Sediment TMDL (R9-2012-0033) and the recently updated MS4 Permit (R9-2015-0001) identify responsible dischargers subject to the Sediment TMDL. The responsible dischargers include Phase I MS4s, Phase II MS4s, Caltrans, industrial facilities, and permitted construction activities in the WMA. By contrast, the Bacteria TMDL (R9-2010-0001) only assigns load reduction responsibility to the MS4s, although Non-MS4 areas are present within the watershed and contribute to bacteria loads. It is worth noting that pollutant loads from Non-MS4 areas may discharge directly to a receiving water body or enter a MS4 before ultimately discharging to a receiving water body.

Given these inconsistencies and the lack of clarity on how responsible dischargers are identified in the TMDLs, the primary scenario included in this Water Quality Improvement Plan currently does not differentiate between MS4 loads and Non-MS4 loads. To separate Non-MS4 loads from MS4 loads, a preliminary alternative modeling analysis was performed and is presented in this section. The purpose of this analysis is to foster future discussions about accurate and fair apportionment of pollutant reduction responsibilities in the watershed to ensure that Non-MS4 discharges are regulated before they enter a MS4 to improve water quality throughout the WMA. It is important to note that under the Alternative Scenario the MS4s would continue to implement programs to inspect and provide oversight of industrial discharges and detect illicit discharges, as discussed in Section 4.2.5.6.

The first step of the analysis was to update the watershed model to remove areas associated with the following Non-MS4s: registered industrial permits, Phase II permits, federal and state lands (and Indian lands, if present), and agricultural lands. Federal, state, and Indian lands, and agricultural lands, were removed because these areas are also subject to separate regulatory requirements. Land areas involving pollutant loading from construction activities and groundwater extraction were not considered because of the limited timeframe associated with construction permits and groundwater extraction impacts were assumed to be negligible. The second step was to optimize the proposed structural strategies in the remaining MS4 areas to achieve the required MS4 load reductions to meet the Water Quality Improvement Plan numeric goals while maintaining cost efficiencies.

The overall watershed load reduction goal would be met through reductions by both the MS4s and Non-MS4s within each subwatershed, thereby maintaining equity among all dischargers within each subwatershed. Estimated load reductions were based on the relative loading from each responsible discharger in the watershed. Additional details and the data and assumptions used in the analysis are provided in Appendix O.

Figure 4-20 summarizes the current Water Quality Improvement Plan load reduction tonnage requirements (primary scenario) and the alternative scenario results that separate MS4 and Non-MS4 loads. The Alternative Scenario allows cost efficiencies to be achieved while still meeting the watershed's overall load reduction goals. Although the MS4 load reduction difference between the primary and alternative scenarios is small, the total cost savings to the MS4s are significant. This is because of structural BMP optimization within MS4 areas and a greater proportion of the required load reduction being addressed by nonstructural programs, which are less costly. Note that BMP optimization refers to the modeling analysis that was conducted to identify the "optimal" structural BMP opportunities (considering BMP size, type, and location in the watershed) that would achieve the load reduction with the lowest cost. BMP optimization was conducted for both scenarios; however, additional cost savings are provided in the alternative scenario because only MS4 areas are considered. Results of this analysis are shown for the City of San Diego in Table 4-27, as an example.



Note: Load reduction targets were calculated on the basis of individual subwatershed results.

Figure 4-20
Summary of Primary and Alternative Scenarios Results (Load Reduction Shown)

Table 4-27
Example Cost and Load Reduction Summary for the City of San Diego

Cost Comparison between Primary and Alternative Scenario	Primary Scenario (MS4 + Non-MS4 Areas Combined[1]; $ Million)	Alternative Scenario (MS4 Only[2]; $ Million)	Cost Savings from Primary Scenario ($ Million)
	$1,107	$743	$364 (33%)
MS4 Load Reduction Summary for Alternative Scenario	Primary Scenario (MS4 + Non-MS4) Existing Load for Sediment (ton)	Alternative Scenario (MS4 Only) Load Reduction Target for Sediment (ton)	Load Reduction Target for Sediment (%)[3]
	2,972.9	1,572.8	53.1%

1. MS4 treats loads from other regulated sources.
2. MS4 treats loads within its jurisdiction.
3. The City of San Diego is located in all subwatersheds; therefore, the percent load reduction target was based on the aggregate subwatershed results.

The MS4s assert that the Regional Board is ultimately responsible for regulating storm water discharges from Non-MS4s to more accurately and fairly assign pollutant reduction responsibilities in the watershed. The MS4s support this regulatory approach as an effective tool for improving water quality, and are commented to participating in efforts to incorporate Non-MS4s into current water quality regulations. To that end, the MS4s will continue to refine and update the alternative scenario analysis, and will engage stakeholders in a dialogue about how all the responsible parties within the watershed can work together to achieve the numeric goals in the Water Quality Improvement Plan. For example, the current list of IGP non-filers could be added to the analysis to more accurately estimate load reduction responsibilities for industrial dischargers within the WMA.

In addition, the Regional Board should work with the MS4s to identify potential updates to TMDLs, the MS4 Permit, and other responsible parties' NPDES permits, as appropriate, to more accurately and fairly assign load responsibilities among all the responsible parties in the watershed. The MS4s will provide the Regional Board with additional analysis and information necessary to facilitate future determinations by the Regional Board on load reduction responsibilities within the WMA. The Water Quality Improvement Plan may be revised in a future update to remove the Non-MS4 loads.

5 Water Quality Improvement Plan Monitoring and Assessment Program

This section of the Water Quality Improvement Plan describes the development of the Monitoring and Assessment Program for the Los Peñasquitos WMA. The Monitoring Program includes three major components: (1) the receiving water monitoring program measures the long-term health of the watershed; (2) the MS4 outfall monitoring program investigates the elimination of dry weather flows from MS4 outfalls and improvement to the quality of the flows the exit the MS4 outfalls during rain events; and (3) special studies take a further look into the highest priority water quality conditions presented in Section 2. The Assessment Program includes an annual analysis of the monitoring data and an integrated analysis that combines all previously performed analyses at the end of the MS4 permit term.

Section 5 Highlights

- Develops the Monitoring and Assessment Program for the Los Peñasquitos WMA Water Quality Improvement Plan
- Monitoring Program includes the following components:
  - Receiving Water Monitoring
    - Includes 14 total locations for 1 to 5 years of monitoring per location
    - Measures long-term health and attainment of beneficial uses
  - MS4 Outfall Monitoring
    - Includes 16 total locations
    - Dry weather: Includes inspections and inventory development with the goal of eliminating non-storm flow
    - Wet weather: Investigates whether there is a reduction in flow volumes and an improvement in discharge quality
  - Special Studies
- Assessment Program includes:
  - Annual assessments, including a review of the receiving water, MS4 outfall, and special studies data
  - A permit term assessment, combining all previous assessments into an integrated assessment.

As shown in the graphic below, the fourth step of the Water Quality Improvement Plan (Monitoring & Assessment) is the development of an integrated Monitoring and Assessment Program for the Los Peñasquitos WMA (Provision B.4, Provision D, Provision E, Provision F and Attachment E). The Monitoring and Assessment Program moves into the second phase of the Water Quality Improvement Plan process.

The first three steps of the Water Quality Improvement Plan drive the Copermittees' program planning and budgeting processes:

(1) Determining the priority water quality conditions

(2) Identifying the sources

(3) Defining goals, strategies, and schedules in relation to the highest priority water quality conditions

The last three steps of the Water Quality Improvement Plan are designed to evaluate the progress in addressing the priority water quality conditions through monitoring and assessment, updating the Water Quality Improvement Plan where needed (Adaptive Management Process, Section 6 of the Water Quality Improvement Plan), and reporting the findings of the assessments along with any necessary changes. Annual Reporting is described under both Section 5 and Section 6 of this Water Quality Improvement Plan, as it draws on both the Monitoring and Assessment Program and the Adaptive Management Process. Caltrans is not participating in the Water Quality Improvement Plan Monitoring and Assessment Program because its monitoring program is regulated under its own MS4 permit.

Based on the requirements of the MS4 Permit and Water Quality Improvement Plan process, the Copermittees in the Los Peñasquitos WMA have developed an integrated Monitoring and Assessment Program that:

(1) Assesses the progress toward achieving the numeric goals and schedules provided in Section 4

(2) Measures the progress toward addressing the highest priority water quality conditions established in Section 2

(3) Evaluates each Copermittee's overall efforts to implement the Water Quality Improvement Plan

Water Quality Improvement Plan Monitoring includes sampling and analysis, inspection, and data collection at beaches, creeks, lakes, estuaries, and storm drain outfalls to observe conditions, improve understanding, and inform the management within the WMA to improve water quality conditions.

The Monitoring and Assessment Program incorporates requirements of Provision B and Provision D of the MS4 Permit, along with the specific monitoring and assessment requirements for the Bacteria TMDL and Sediment TMDL listed in Attachment E of the MS4 Permit. Table 5-1 presents an overview of planned monitoring activities for the Los Peñasquitos WMA, including key monitoring elements and an implementation schedule by program. The program is designed to characterize the pollutant levels associated with the highest priority water quality conditions in the discharges from the MS4 outfalls, identify sources of the highest priority water quality condition pollutants, and assess the effectiveness of strategies designed to address the highest priority water quality conditions. Additionally, these programs will generate data to track priority water quality conditions and general health and condition within the WMA. As stated in Provision D of the MS4 Permit:

> *"The purpose of this provision is for the Copermittees to monitor and assess the impact on the conditions of receiving waters caused by discharges from the Copermittees' MS4s under wet weather and dry weather conditions. The goal of the Monitoring and Assessment Program is to inform the Copermittees about the nexus between the health of receiving waters and the water quality condition of the discharges from their MS4s. This goal will be accomplished through monitoring and assessing the conditions of the receiving waters, discharges from the MS4s, pollutant sources and/or stressors, and effectiveness of the water quality improvement strategies implemented as part of the Water Quality Improvement Plans."*

Translated into the Water Quality Improvement Plan process, the Monitoring and Assessment Program will provide the tools necessary to evaluate the main components presented in Sections 2 through 4 of the Water Quality Improvement Plan. In particular, the assessment focuses on the compliance pathways in Section 4. To do this, Section 5 is divided into two main components, Monitoring and Assessment. Figure 5-1 summarizes the main components of the Los Peñasquitos WMA Monitoring and Assessment Program.

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Table 5-1
Water Quality Improvement Plan Monitoring Overview

MS4 Permit Monitoring Programs			Monitoring Elements	MS4 Permit Schedule[1]				
				2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Monitoring to Assess Goals and Schedules		Dry and Wet	Varies by goal and jurisdiction	–	–	●	●	●
Receiving Water Monitoring	Long-term Receiving Water	Dry	Conventionals[2], FIB nutrients, metals, pesticides, toxicity (chronic), possible TIE/TREs, visual observations, field measurements	–	●[3]	–	–	–
			Hydromodification (channel conditions, discharge points, habitat integrity, evidence and estimate of erosion and habitat impacts)	–	●[3]	–	–	–
			Bioassessment (BMI taxonomy, algae taxonomy, physical habitat characteristics)	–	●[3]	–	–	–
		Wet	Conventionals[2], FIB nutrients, metals, pesticides, toxicity (chronic), field measurements	–	●[3]	–	–	–

Table 5-1 (continued)
Water Quality Improvement Plan Monitoring Overview

MS4 Permit Monitoring Programs				Monitoring Elements	MS4 Permit Schedule[1]				
					2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Receiving Water Monitoring (continued)	Regional Monitoring Participation	Bight	Dry	Chemistry, toxicity, benthic infauna	●	–	–	–	●[4]
		SMC	Dry	Bioassessment	●	●	●	●	●
		AB411[5]	Dry	FIB	●	●	●	●	●
		2011 Hydromod-ification Monitoring Program (HMP)	Wet	Channel assessments; flow monitoring; sediment transport monitoring	●	●	●	–	–
	Sediment Quality Monitoring	Sediment Quality Monitoring	Dry	Chemistry, toxicity, benthic infauna	●[6]	●[3]	–	–	–
	TMDL Monitoring	Sediment TMDL for Los Peñas-quitos Lagoon	Dry	Particle size distribution, suspended sediment concentration[2], pebble count, extended flow monitoring; vegetation mapping	●	●[8]	●[8]	●[8]	●[8]
		Bacteria TMDL for Pacific Ocean Shoreline at Torrey Pines State Beach, Del Mar	Dry	FIB, visual observations, optional field measurements	●[7]	●[7]	●	●	●
			Wet	FIB, visual observations, optional field measurements	●[7]	●[7]	●	●	●

Table 5-1 (continued)
Water Quality Improvement Plan Monitoring Overview

MS4 Permit Monitoring Programs			Monitoring Elements	MS4 Permit Schedule[1] 2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
MS4 Monitoring	MS4 Field Screening	Dry	Visual: flow condition, presence and assessment of trash in and around the station, IC/IDs, descriptions	●[3]	●[3]	●	●	●
	MS4 Outfall	Dry	Field parameters, conventionals[2], nutrients, metals, FIB,	–	–	●	●	●
		Wet	Field parameters, conventionals[2], nutrients, metals, FIB,	●[7]	●[7]	●	●	●
Special Studies	San Diego Regional Reference Streams and Beaches	Dry	Field parameters, conventionals[2], FIB, instantaneous flow	2012-2014	●[8]	–	–	–
			Streams only: nutrients, metals, bioassessment (including physical habitat and chlorophyll a)	2012-2014	–	–	–	–
		Wet	Field parameters, conventionals[1], FIB	2012-2014	●	–	–	–
			Streams only: nutrients, metals, toxicity, flow, and precipitation (duration of storm)	2012-2014	●	–	–	–

Table 5-1 (continued)
Water Quality Improvement Plan Monitoring Overview

MS4 Permit Monitoring Programs			Monitoring Elements	MS4 Permit Schedule[1]				
				2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Special Studies (continued)	Los Peñasquitos Lagoon TMDL Upper Watershed Sediment Load Monitoring Plan	Dry/Wet	Particle size distribution, suspended sediment concentration, streambed and bedload sampling, pebble count, extended flow monitoring	–	●	●[9]	●[9]	–
		Dry	Air particle monitoring	–	●	●[10]	●[10]	–
	Stream Gauge Study	Dry/Wet	Temperature, water level, conductivity (location dependent)	–	●	●	–	–
	Outfall Repair and Relocation Study	Dry/Wet	Priority locations for outfall repair and relocation	–	–	●	–	–

BMI = benthic macroinvertebrates; BOD = biological oxygen demand; IC/ID = illicit connection and/or illicit discharge;
LPC-MLS = Los Peñasquitos Mass Loading Station; MST = microbial source tracking; NA = not applicable;
O&G = oil and grease; SMC = Southern California Stormwater Monitoring Coalition; TBD = to be determined;
TIE = toxicity identification evaluation; TRE = toxicity reduction evaluation

1. The MS4 Permit was adopted on May 8, 2013; the MS4 Permit became effective on June 27, 2013. Note that the implementation of the programs will depend on the approval date of the Water Quality Improvement Plan and the fiscal year of implementation may be modified.
2. Definition of conventionals (conventional parameters) is based on SWMP guidelines.
3. Completed under the Transitional Monitoring Program according to MS4 Permit Provisions D.1.a and D.2.a. Note that the second dry weather monitoring event is planned for May 2015. Given the extreme drought conditions, there is the potential that the selected site may not have enough flow to allow for monitoring to occur. The dry weather long-term receiving water monitoring may then be extended.
4. The 2018 Southern California Bight Regional Monitoring will occur during the summer of 2018 or 2019.
5. The AB 411 program is not required by the MS4 Permit. Responsible Agencies are using the data to track beach water quality conditions related to the highest priority water quality condition for the WMA.
6. Sediment quality monitoring was completed under the 2013 Southern California Bight Regional Monitoring Program.
7. Completed under the Transitional Monitoring Program in accordance with MS4 Permit Provisions D.1.a and D.2.a.
8. Dry weather monitoring at reference streams was completed in spring 2014. Dry weather monitoring at reference beaches began in fall 2014.
9. Only the three WMA sites will be monitored until the Water Quality Improvement Plan is approved.
10. Phase II of Los Peñasquitos Lagoon TMDL Upper Watershed Sediment Load Monitoring Plan will be implemented in either FY16 or FY17, depending on the approval date of the Water Quality Improvement Plan.

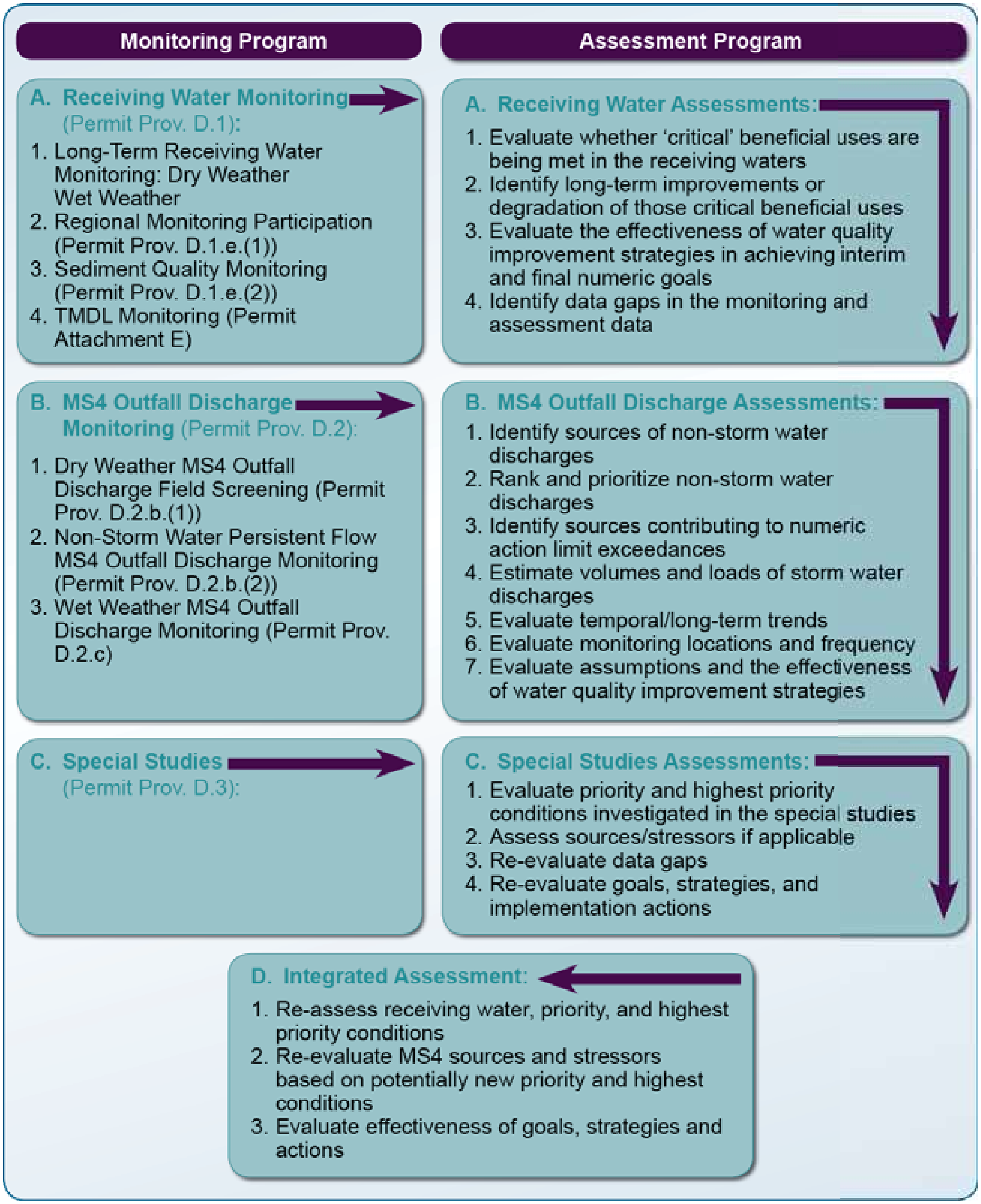

Figure 5-1
Monitoring and Assessment Program Components for the Los Peñasquitos WMA

5.1 Water Quality Improvement Plan Monitoring Program

The Water Quality Improvement Plan Monitoring Program has three major components:

- Receiving water monitoring
- MS4 outfall discharge monitoring
- Special studies

- Wet weather is defined as >0.1 inch of rainfall within a 24-hour period and the following 72 hours after the end of rainfall.
- Dry weather is defined as all other days where rainfall is <0.1 inch of rainfall within a given 24-hour period.

Those three components, together with other information gathered from jurisdictional sources are used to assess progress toward achieving short-term goals and schedules, as described in Section 5.1.1 below.

A summary of the Water Quality Improvement Plan Monitoring Program (including detailed information required to complete the monitoring tasks) is in Appendix P. The associated monitoring plans for each of the various elements described in Sections 5.1.1 through 5.1.4 will be available on the Project Clean Water Website, http://www.projectcleanwater.org/index.php, by June 2015. The methods and procedures described in these plans may be modified on the basis of site-specific environmental conditions and updated analytical methodologies.

5.1.1 Monitoring to Assess Progress Toward Achieving Goals and Schedules

This section summarizes monitoring designed to assess progress toward achieving goals related to the highest priority water quality conditions, which are bacteria, sediment, and fresh water discharge for the Los Peñasquitos WMA, as described in Chapter 2 of the Water Quality Improvement Plan. As outlined in Chapter 4 of the Water Quality Improvement Plan, bacteria and sediment goals are based on multiple compliance pathways set forth for the Bacteria TMDL in Attachment E.6 of the MS4 Permit and in the future incorporation of the Sediment TMDL into the MS4 Permit. Compliance with the TMDLs may be demonstrated via one of the compliance pathways. The proposed compliance dates for both the TMDL's interim goals and final goals are set outside of this MS4 Permit cycle, as presented in Water Quality Improvement Plan Chapter B.3. Tables 5-2 through 5-5 present the interim and final Bacteria TMDL, Sediment TMDL, and interim freshwater discharge goals, as well as monitoring that may be used to track progress toward achieving the goals.

Each Responsible Agency has established jurisdictional goals for bacteria, sediment, and freshwater discharge during this MS4 Permit term to demonstrate progress toward compliance with the TMDL requirements. Generally, Responsible Agencies have identified near-term goals to address potential bacteria and sediment sources and/or to reduce anthropogenic dry weather flow in MS4 outfalls. Data collection or monitoring elements that go beyond the prescribed MS4 Permit activities are tailored to measure progress toward meeting each goal. These elements, which are further detailed in the following subsections, may include visual surveys, inspections, sampling and analysis, or field measurements, and development of new outreach and source control programs related to bacteria reduction.

Table 5-2
Monitoring Related to Bacteria TMDL Interim and Final Goals[1]

Compliance Pathway		TMDL Goal	Monitoring Elements
1 OR	Receiving Water Conditions	Meet allowable exceedance frequency of the interim or final Receiving Water Limitations (RWLs) in the receiving water	Bacteria data collected at compliance points as described in Section 5.1.2, TMDL Monitoring Program
2 OR	MS4 Outfall Discharges	Meet allowable exceedance frequency in MS4 outfall discharges	Visual observation of flow from outfalls to receiving waters as described in Section 5.1.3, MS4 Outfall Monitoring Program
3 OR	MS4 Outfall Discharges	Pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls greater than or equal to the final load reductions	Bacteria and flow data collected at outfalls as described in as described in Section 5.1.3, MS4 Outfall Monitoring Program
4 OR	MS4 Outfall Discharges	No direct or indirect discharge from the Responsible Agencies' MS4 outfalls to the receiving water[2]	Data from Sections 5.1.1, 5.1.2, 5.1.4, and Jurisdictional Runoff Management Programs.
5 OR	Receiving Water Conditions	Exceedances of the final receiving water limitations in the receiving waters due to loads from natural sources	Bacteria data collected at compliance points as described in Section 5.1.2, TMDL Monitoring Program

Table 5-2 (continued)
Monitoring Related to Bacteria TMDL Interim and Final Goals[1]

Compliance Pathway		TMDL Goal	Monitoring Elements
6	Water Quality Improvement Plan	Implementation of Water Quality Improvement Plan and use of adaptive management (Interim Goal)	Data from Jurisdictional Runoff Management Programs
		OR	
		Implementation of Water Quality Improvement Plan and use of adaptive management (Final Goal)	Data from monitoring and Jurisdictional Runoff Management Programs

1. The County of San Diego proposed schedule to meet the TMDL interim goals in Attachment E.6 of the MS4 Permit is 2021 for dry weather and 2028 for wet weather. All other Copermittees propose to meet the TMDL interim goals by 2019 for dry weather and 2024 for wet weather.
2. Does not include allowable discharges as defined in MS4 Permit Provision A and Provision E.2.a.

Table 5-3
Monitoring Related to Interim Sediment TMDL Goals[1]

Compliance Pathway		Interim TMDL Goal	Monitoring Elements
1 OR	Receiving Water Conditions	Restoration of salt marsh habitat[2]	Data from Section 5.1.2, TMDL Monitoring Program
2 OR	MS4 Outfall Discharges	Pollutant load from discharges from the Responsible Agencies' MS4 outfalls less than or equal to allowable limits determined by sediment loading model	Sediment and flow data collected at outfalls as described in as described in Section 5.1.3, MS4 Outfall Monitoring Program

Table 5-3 (continued)
Monitoring Related to Interim Sediment TMDL Goals[1]

Compliance Pathway		Interim TMDL Goal	Monitoring Elements
3 OR	Water Quality Improvement Plan	Fully implementing a Water Quality Improvement Plan, accepted by the San Diego Water Board that includes reasonable assurance[3] The compliance schedule in Attachment A of Resolution No. R9-2010-0033 provides two pathways to meet interim goals: (1) attain the specified percent load reduction, or (2) show progress in improving Lagoon conditions; see metrics below.	
		MS4 Outfall Discharges: Pollutant load from discharges from the Responsible Agencies' MS4 outfalls less than or equal to allowable limits determined by sediment loading model	Sediment and flow data collected at outfalls as described in as described in Section 5.1.3, MS4 Outfall Monitoring Program
		OR	
		Receiving Water Conditions: Restoration of salt marsh habitat with increasing trend toward final restoration goal	Data from Section 5.1.2, TMDL Monitoring Program
4	MS4 Outfall Discharges	No direct or indirect discharge from the Responsible Agencies' MS4 outfalls to the receiving water	Visual observation of flow from outfalls to receiving waters as described in Section 5.1.3, MS4 Outfall Monitoring Program

1. First interim Sediment TMDL goal to be assessed in 2020.
2. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can either mean:
   - Successful restoration of 80% of the 1973 acreage of lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
3. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.

Table 5-4
Monitoring Related to Final Sediment TMDL Goals

Compliance Pathway		Interim TMDL Goal	Monitoring Elements
1 OR	Receiving Water Conditions	Restoration of salt marsh habitat[1]	Data from Section 5.1.2, TMDL Monitoring Program
2	Water Quality Improvement Plan	Implementation BMP and strategies described in Appendix I of Water Quality Improvement Plan	Data from monitoring and Jurisdictional Runoff Management Programs
		AND	
		Reasonable assurance provided by compliance analysis[2]	Acceptance of compliance analysis by Regional Board.
		AND	
		Restoration of salt marsh habitat with increasing trend toward final restoration goal	Data from Section 5.1.2, TMDL Monitoring Program

1. As defined by the Sediment TMDL and Attachment A to Resolution No. R9-2010-0033, this can either mean:
   - Successful restoration of 80% of the 1973 acreage of Lagoon salt marsh habitat (346 acres); or
   - Demonstration that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.
2. The percent load reduction is based on Sediment TMDL model updates completed during the development of the Water Quality Improvement Plan. The interim goals were calculated on the basis of the required percent reductions in the compliance schedule (Attachment A to Resolution No. R9-2010-0033). Percent load reduction, rather than the mass (or tonnage) of load reduction, was selected as the Water Quality Improvement Plan numeric goal because the mass of sediment reduction is, in part, related to rainfall, which varies year by year. Percent load reduction provides a relative metric that is unaffected by wet or dry water years. Calculation of the percent load reduction includes loading from Phase II MS4s, general construction, and general industrial permittees within the City of San Diego's jurisdiction. Further analysis of loads specific to the City of San Diego may be completed in the future.

Table 5-5
Monitoring Related to Interim and Final Freshwater Discharge Goals

Compliance Pathway		Interim TMDL Goal	Monitoring Elements
1 OR	MS4 Outfall Discharges	Irrigation and other dry weather flow reductions greater than or equal to final irrigation reductions	Flow data collected at outfalls as described in as described in Section 5.1.3, MS4 Outfall Monitoring Program
2	Water Quality Improvement Plan	Implementation of Water Quality Improvement Plan and adaptive management	Data from monitoring and Jurisdictional Runoff Management Programs

Wet Weather Monitoring Related to Performance Measures

Copermittees have established wet weather goals for the 2013–2018 MS4 Permit term. Table 5-6 summarizes the data that will be collected to assess these goals by jurisdiction.

Table 5-6
Wet Weather Monitoring Related to Jurisdictional Goals

Jurisdiction	First MS4 Permit Term Numeric Goals 2013-2018	Assessment Metric	Monitoring Elements
City of Del Mar	Reduce by 10% anthropogenic surface dry weather flows[1] that originate within the City's jurisdictional boundaries to address bacteria regrowth contributing during wet weather	Percent anthropogenic surface dry weather flow reduction at MS4 outfalls	Collect flow measurements at selected MS4 outfalls during dry weather
City of Poway	Achieve a 5% increase in turf conversion from baseline	Percent increase in turf conversion	Specify City programs tracking the implementation of turf conversion, including turf conversion increase
City of San Diego	Develop a green infrastructure policy, attain City Council approval, and construct green infrastructure BMPs to improve water quality from 36 acres of drainage area	Acres of drainage area treated by construction of green infrastructure BMPs	Detail the completion of BMPs, including acres treated

Table 5-6 (continued)
Wet Weather Monitoring Related to Jurisdictional Goals

Jurisdiction	First MS4 Permit Term Numeric Goals 2013-2018	Assessment Metric	Monitoring Elements
County of San Diego	Implement programmatic (non-structural) BMPs to achieve source reduction of bacteria loads from the MS4 outfalls	Anticipated percent bacteria load reduction	Detail programmatic BMPs implemented
	Implement programmatic (non-structural) BMPs to achieve source reduction of sediment loads from the MS4 outfalls	Anticipated percent sediment load reduction or verify allowable tons of sediment per year is met for Los Peñasquitos Creek and Carroll Canyon	Detail programmatic BMPs implemented
	AND		
	Coordinate with watershed partners to determine restoration goals and establish monitoring protocols, as applicable	Goals for restoration of 346 acres of salt marsh habitat	Detail restoration goals and monitoring protocols

1. The term “dry weather flow” excludes groundwater, other exempt or permitted non-storm water flows and sanitary sewer overflows.

Dry Weather Monitoring Related to Performance Measures

Copermittees have established dry weather goals for the 2013–2018 MS4 Permit term. Table 5-7 summarizes the data that will be collected to assess these goals by jurisdiction.

Table 5-7
Dry Weather Monitoring Related to Jurisdictional Goals

Jurisdiction	Performance Measures	Assessment Metric	Monitoring Elements
City of Del Mar	Reduce by 10% anthropogenic surface dry weather flows[1] that originate within the City's jurisdictional boundaries	Percent anthropogenic surface dry weather flow reduction at MS4 outfalls	Collect flow measurements at selected MS4 outfalls
City of Poway	Achieve a 5% increase in turf conversion from baseline	Percent increase in turf conversion	Specify City programs tracking the implementation of turf conversion including turf conversion increase
City of San Diego	Develop a green infrastructure policy, attain City Council approval, and construct green infrastructure BMPs to improve water quality from 36 acres of drainage area	Acres of drainage area treated by construction of green infrastructure BMPs	Detail the completion of BMPs including acres treated
	Reduce by 10% the prohibited[2] dry weather flow from baseline measured at persistently flowing outfalls during dry weather	Percent reduction in prohibited[2] dry weather flow	Collect flow measurements at persistently flowing outfalls
County of San Diego	Verify the effective elimination of anthropogenic dry weather flow from MS4 outfalls and use programmatic approaches to maintain compliance	Number of routine inspections of MS4 outfalls to verify absence of discharge to receiving water	Detail the elimination of anthropogenic dry weather flows from MS4 outfalls

1. The term "dry weather flow" excludes groundwater, other exempt or permitted non-storm water flows, and sanitary sewer overflows.
2. Does not include allowable discharges as defined in MS4 Permit Provision A and Provision E.2.a.

5.1.2 Receiving Water Monitoring

The purpose of the receiving water monitoring program is to characterize trends in the chemical, physical, and biological conditions of a receiving water to determine whether beneficial uses are protected, maintained, or enhanced. This program is designed to meet requirements set forth in Provision D.1 of the MS4 Permit. Long-term monitoring occurs during both wet and dry conditions for water quality and physical and biological integrity, along with sediment quality monitoring and participation in regional monitoring. The MS4 Permit also stipulates how TMDL monitoring requirements are to be incorporated into the receiving water monitoring program as described in Attachment E of the MS4 Permit.

Receiving waters monitoring comprises the following programs:

- Long-term receiving water monitoring
- Regional monitoring participation
- Sediment quality monitoring
- TMDL monitoring

Long-Term Receiving Water Monitoring

Long-term receiving water monitoring will track the overall health of the receiving waters and is designed to answer the following questions:

- Are conditions in the receiving water protective, or likely protective, of beneficial uses?
- What are the extent and magnitude of the current or potential receiving water problems?
- Are the conditions in the receiving water getting better or worse?

Dry and wet weather monitoring will continue at the historical mass loading station (LPC-MLS) located on Los Peñasquitos Creek prior to its discharge to the Los Peñasquitos Lagoon. Copermittees have monitored LPC-MLS since 2001 to meet requirements of previous MS4 Permits. The MLS is depicted on Figure 5-2. This site will be monitored three times during wet weather and three times during dry weather per permit cycle. This monitoring program is designed to monitor the highest priority water quality conditions in the receiving water, along with a comprehensive list of constituents on the basis of the 303(d) list impairments, CLRP, non-storm water action levels (NALs) or storm water action levels (SALs), and Table D-3 of the MS4 Permit. During both dry and wet weather, water samples will be analyzed for conventional constituents, nutrients, metals, pesticides, bacteria, field parameters, and toxicity, when applicable. Toxicity identification evaluations (TIEs), if necessary, will be conducted in compliance with Provisions D.1.c(4)(f) and D.1.d(4) of the MS4 Permit and used to determine the causative agent(s) of toxicity. Once per term during dry weather, a bioassessment will be conducted to evaluate chemical, physical, and biological data, and hydromodification monitoring will be conducted to record the stream conditions and habitat integrity and impacts. These data can be used to re-evaluate priorities via the iterative approach described in Section 6.

The 2013 and 2014 Transitional Monitoring Programs satisfied long-term receiving water monitoring requirements, including dry and wet weather water quality sampling, bioassessments, and hydromodification monitoring for this MS4 Permit term. For details of this monitoring program, refer to Appendix P. The methods and procedures provided in Appendix P may be modified on the basis of site-specific environmental conditions and updated analytical methodologies.

Regional Monitoring Participation

Regional monitoring includes separate studies that will evaluate various aspects of receiving water health at a regional scale. The data may be used by Responsible Agencies to answer the following questions:

- ❖ Are conditions in the receiving water protective, or likely protective, of beneficial uses?
- ❖ What is the extent and magnitude of the current or potential receiving water problems?

The Responsible Agencies participated in the following regional programs:

- ❖ Bight

  The Bight regional monitoring program is a multi-agency collaborative effort developed to assess the ecological condition of the Southern California Bight from a regional perspective. The core monitoring program consists of sediment chemistry, sediment toxicity, benthic infauna, demersal fish, and epibenthic invertebrates. The goals of past Bight programs were to answer three primary questions:

  - ➢ What are the extent and magnitude of direct impact from sediment contaminants?
  - ➢ How does the extent and magnitude of the environmental impact vary by habitat?
  - ➢ What is the trend in extent and magnitude of direct impacts from sediment contaminants?

  Sediment quality monitoring was conducted during the summer of 2013 at a total of 22 sites in 9 estuaries and lagoons in the San Diego region including the Los Peñasquitos Lagoon under the Southern California Bight 2013 Regional Monitoring Survey (Bight '13) (San Diego County Municipal Copermittees, 2014c). As described in Section 4.1.1.3, sediment monitoring data from Bight '13 will be used to fulfill part or all of the sediment monitoring requirements of the

MS4 Permit. During this MS4 Permit term, Responsible Agencies will participate in planning Bight ’18 monitoring programs.

- SMC Regional Monitoring

Since 2001, Copermittees have partnered with regulated storm water municipalities in southern California, the Regional Boards of Southern California, and the SCCWRP to form the Southern California SMC. The goals of the SMC are to standardize monitoring, improve understanding of storm water mechanics, and identify receiving water impacts from storm water (SCCWRP, 2002). According to its 2014 Research Agenda, the SMC has identified 21 projects for the next 5-year term and is in the process of prioritizing its efforts on the basis of need and available funding (SMC, 2014a). The Los Peñasquitos WMA Responsible Agencies will continue participation in the SMC Regional Freshwater Stream Bioassessment Monitoring Program (SMC Regional Bioassessment Program) that began as a five year program in 2008-2013 and will be implemented for another five years (2015-2019).

The 2009–2013 SMC Regional Bioassessment Program was designed to address the following monitoring questions (SMC, 2014b):

- What is the extent of impact in streams of southern California?
- What are the stressors that impact southern California streams?
- Is the extent of stream impacts changing over time?

A final monitoring report was prepared on the basis of 2009–2013 results to identify lessons learned, data gaps, and recommendations to guide the design of the 2015–2019 program. In 2015, a new five-year SMC program will extend the initial survey to answer key management questions about the impacts of storm water on stream conditions. The program will have an added emphasis on detecting trends, including non-perennial streams and sampling sediment chemistry and toxicity.

The non-perennial stream monitoring was initiated in April 2014, with site revisits in May and June 2014. Sampling included benthic macroinvertebrates (BMI), algae, physical habitat, and California Rapid Assessment Method (CRAM). The trend site monitoring was conducted during the standard index period (i.e., from mid-May through July). Sampling for trend site monitoring included all of the parameters and constituents of the original SMC Regional Bioassessment Program (San Diego County Municipal Copermittees, 2014b). The bioassessment monitoring was conducted at a total of 64 bioassessment stations; 30 stations were compliance stations; 28 stations were randomly placed SMC stations; and 6 stations were San Diego County reference stations (San Diego County Municipal Copermittees, 2014b). The California Assembly Bill (AB) 411 (Beach Safety Act) monitoring program is not required by the MS4 Permit. Responsible Agencies are using the AB 411 data to track beach water quality conditions related to the Highest Priority Water Quality Condition for the watershed.

- Hydromodification Regional Monitoring Program

  Copermittees have developed a regional Hydromodification Management Plan (HMP) to address impacts on beneficial uses and stream habitat from increased erosive force potentially caused by an increase in runoff discharge rates and duration from all Priority Development Projects (County of San Diego, 2011). The HMP was initially developed to meet the requirements of the 2007 MS4 Permit. The Monitoring Plan is defined in Chapter 8 of the HMP, and was updated by the San Diego County Regional Copermittees and accepted by the Regional Board in February 2014. The HMP requires monitoring with a final report due to the Regional Board in December 2016. Monitoring consists of channel sediment transport assessments, and continuous flow monitoring of pre-project, post-project, and reference conditions per MS4 Permit Provisions D.1.a and D.1.c(6). Additional monitoring is required per MS4 Permit Provision D.1.a(2).

- San Diego County Beach Water Quality (AB 411) Monitoring

  San Diego County Department of Environmental Health (DEH) implements the Beach and Bay Water Quality Monitoring Program to support the statewide program funded by AB 411. This program is commonly referred to as AB 411 monitoring. The purpose of this monitoring program is to advise the public of potential health risks that could occur with water contact recreation at local beaches. DEH will post a health advisory notice or close a beach when FIB results are above REC-1 water quality standards. There is one AB 411 beach monitoring station in the Los Peñasquitos WMA. This station is monitored twice weekly year-round.

Sediment Quality Monitoring

Sediment quality monitoring is designed to assess compliance with receiving water limits applicable to MS4 discharges to enclosed bays and estuaries in accordance with the State Water Board's Water Quality Control Plan for Enclosed Bays and Estuaries of California – Part I Sediment Quality (Sediment Control Plan). Part I of the State Board’s Sediment Quality Control Plan provides sediment quality objectives for enclosed bays and estuaries and does not apply to ocean waters or inland surface waters (State Board 2009). Sediment quality monitoring will be performed in compliance with Permit Provision D.1.e(2), which requires preparation of a Sediment Quality Monitoring Plan that satisfies the requirements of the Sediment Control Plan. As described in the Sediment Control Plan, assessment of receiving water quality with respect to the California Sediment Quality Objectives (SQOs) involves use of a multiple-line-of-evidence approach.

The data generated will be used to answer the following question:

- ❖ What is the condition of sediments in enclosed bays or estuaries with respect to the statewide sediment quality objectives?

The Sediment Quality Monitoring Plan and Quality Assurance Project Plan describe detailed proposed monitoring procedures and analytical methods that are illustrative and may change on the basis of site environmental conditions. These plans will be available on the Project Clean Water Website, http://www.projectcleanwater.org/index.php, by June 2015. As indicated in Table 5-1, sediment quality monitoring of the Los Peñasquitos Lagoon was conducted in the summers of 2013 and 2014.

The participating agencies propose to conduct one round of sediment sampling each MS4 Permit term. The second required round of sampling will be satisfied by conducting additional follow up sampling in the vicinity of potentially impacted sites identified in the first round. Sediment quality monitoring will employ the following general approach to meet the requirements of the MS4 Permit:

(1) Conduct initial monitoring within each qualifying water body per the requirements of the state's Sediment Control Plan. These data will be used to assess the degree of potential impact at each site using the California SQO multiple-line-of-evidence approach in accordance with the assessment criteria specified in Sediment Control Plan Section V. These scores are derived using multiple metrics from three key lines of evidence: (1) sediment chemistry data, (2) toxicity data, and (3) benthic community data. Sites are then categorized as un-impacted, likely un-impacted, possibly impacted, likely impacted, or clearly impacted.

(2) Confirm and characterize pollutant-related impacts for any sites that are considered possibly impacted, likely impacted, or clearly impacted, following an integration of all lines of evidence. In accordance with Sediment Control Plan criteria, the data assessment in this phase is required to determine whether the score(s) indicate potential impacts due to toxic pollutants (e.g., freshwater-related contaminant sources from the MS4), or non-toxic pollutants (e.g., physical habitat, freshwater inundation, legacy contaminants, or other potential factors). This phase would be considered the first phase of the stressor/source identification (SSID) investigation based on existing data. The requirements of this phase are dependent on the site characterization as follows:

   a. Sites deemed to be possibly, likely, or clearly impacted based on initial monitoring for which the impact or impairment is determined to likely not be caused or contributed to by MS4 discharges will be monitored once more in the current MS4 Permit term. Follow-up monitoring is required to verify the findings from the first round of monitoring.

i. If results from the follow-up monitoring are consistent (possibly impacted), or unimpacted, no additional follow-up will be required during the current MS4 Permit term.

ii. If the second round of sampling reclassifies the station as likely or clearly impacted, an additional follow-up investigation may be needed or suspended pending future routine SQO monitoring. In this circumstance, results of the analytical assessments will be discussed with the Regional Board staff to determine whether/where any SSID studies should be undertaken, and to identify major elements of the approach for any identified studies. Prior to additional investigation, a site-specific Sediment Assessment Work Plan would be prepared that would outline specific steps and methodologies to be taken.

b. Stations deemed by assessment to be likely or clearly impacted by MS4 discharges will require additional follow-up investigation and this is deemed the first phase of SSID. A site-specific Sediment Assessment Work Plan will be prepared that will outline specific steps and methodologies to be taken. Per the Sediment Control Plan, SSID comprises three steps: (1) confirmation and characterization of pollutant impacts, (2) pollutant identification, and (3) source identification and management actions.

(3) In the annual Sediment Monitoring Report, describe the planned follow-up monitoring, including any planned SSID studies, and revisions to the Sediment Monitoring Plan, accordingly.

During the transitional (pre-Water Quality Improvement Plan) monitoring phase, the Southern California Regional Bight ’13 Monitoring Program (Bight ’13) satisfied the initial monitoring requirements of the state's Sediment Control Plan. As presented in Table 5-8, up to two sites were monitored in the Los Peñasquitos Lagoon in 2013 for the initial screening of sediment quality. Because both sites were found to be likely unimpacted during the initial screening, no follow-up monitoring was conducted. Based on the monitoring and assessment completed, sediment conditions in the Los Peñasquitos Lagoon are generally protective of the beneficial uses (San Diego County Municipal Copermittees, 2014c). The Sediment Monitoring Report was provided in the 2014 Transitional Monitoring and Assessment Report in accordance with the permit reporting requirements.

Table 5-8
Bight '13 Sample IDs, Site Locations, Dates Sampled, and Sample Depths

Lagoon/ Estuary	# of Sites	Site ID	Sediment Sampling			Monitored Events
			Latitude	Longitude	Depth (meters)	Date Sampled
Los Peñasquitos Lagoon	2	8169	32.9317	-117.2521	1.7	8/1/2013
		8176	32.9336	-117.2567	0.9	8/1/2013

Source: Transitional Monitoring and Assessment Report Appendix H Sediment Monitoring Report (San Diego County Municipal Copermittees, 2014c).

TMDL Monitoring

TMDL provisions, schedules, and monitoring requirements are provided in Attachment E of the MS4 Permit. The purpose of TMDL monitoring programs is to track progress toward achieving compliance with interim and final numeric targets. There are two TMDLs in the Los Peñasquitos WMA: the Bacteria TMDL and the Sediment TMDL. Compliance monitoring is designed to meet the receiving water monitoring requirements of the Bacteria and Sediment TMDLs.

For the Bacteria TMDL, compliance monitoring, including wet and dry weather sampling, will be conducted each year at the compliance monitoring location. The data generated will be used to address the following questions:

- Are TMDL numeric targets for bacteria indicators being met at the compliance monitoring locations?
- Are bacteria levels improving at the compliance monitoring locations?

The scope of compliance monitoring considers the frequency and type of sampling activities of the existing Health and Safety Code Section 115880 of the AB 411 Monitoring Program to facilitate overlap of monitoring efforts and resources when feasible. Dry weather monitoring will be conducted weekly during the recreation season (five times monthly, April 1 through October 31) to be consistent with AB 411 monitoring and a monthly (at a minimum) during the wet season per the MS4 Permit requirements. Samples are to be collected on dry weather days, after an antecedent dry period of 72 hours with less than 0.1 inch of rainfall. Wet weather monitoring will be conducted at the monitoring locations during a minimum of one and up to three storm events each wet season (October 1 through April 30). Per the MS4 Permit Attachment E.6, a minimum of one storm is required to be monitored. Storms resulting in greater than 0.2 inch of precipitation will be targeted for analysis. FIB are the target constituents for the Pacific Ocean Shoreline segment within the Los Peñasquitos WMA, as indicated by the MS4 Permit. Grab samples will be collected in a manner consistent with requirements of the AB 411 program and analyzed for total coliform, fecal coliform, and *Enterococcus*.

For details of this monitoring program, refer to Appendix P. The methods and procedures described in Appendix P may be modified on the basis of site-specific environmental conditions and updated analytical methodologies.

The Sediment TMDL compliance monitoring program monitors suspended sediment concentrations (SSC), collect sediment core samples in each of the creeks to assess sediment age, and estimate wet weather sediment loads in each of the WMA's three major tributary creeks during wet weather. The program also includes a vegetation monitoring in Los Peñasquitos Lagoon. This monitoring program is designed to answer the following questions:

- What is the ecological health of the Lagoon?
- How is the Lagoon's health changing with time?
- What is the progress toward ultimate restoration of the Lagoon?
  - What is the sediment concentration at discrete times throughout a storm event hydrograph at the base of each major creek tributary?
  - What are the age and particle-size distribution of sediment accumulated near the mouth of each major creek?
  - What are current sediment load estimates from the three major creeks that discharge to the Lagoon?
  - How do the sediment delivery potentials of the three creeks compare during wet weather?
- What additional regulatory and implementation actions are needed to restore the Lagoon?

This information will allow comparisons of current load estimates with the WLA designated in the Sediment TMDL, and will assist the Reponsible Agencies in evaluating potential management measures, including BMPs and low-impact development. The sediment core dating data will contribute to an understanding the rate of accumulation at the base of each creek, prior to the creeks entering the Lagoon.

5.1.3 MS4 Outfall Monitoring

The purpose of the MS4 outfall monitoring program is to evaluate the potential contribution from MS4 discharges to the receiving water quality. This program is designed to meet requirements set forth in Provision D.2 of the MS4 Permit. The MS4 outfall monitoring program has both dry and wet weather monitoring components. The outfall monitoring seeks to answer the question:

- Do non-storm water or storm water discharges from the MS4 contribute to receiving water quality problems?

This program is composed of the following two components:

- Dry Weather

  - Field screening
  - MS4 outfall dry weather monitoring
- Wet Weather
  - MS4 outfall wet weather monitoring

Table 5-9 provides the number of major outfalls to be monitored under each component of the MS4 Outfall Monitoring Program by Responsible Agency. The number of major outfalls monitored per year as shown in Table 5-9 are subject to change on the basis of new information, updates to the Copermittee's MS4 outfall inventories, changes in transient or persistent flow classifications, and/or changes or updates to the priority water quality conditions over the life of the Water Quality Improvement Plan. Detailed proposed monitoring methods and procedures will be presented in the MS4 Outfall Monitoring Plan (the Plan will be available on the project Clean Water website, http://www.projectcleanwater.org/index.php, by June 2015). These methods and procedures may be modified on the basis of site-specific environmental conditions and updated analytical methodologies.

Table 5-9
Number of Major MS4 Outfalls per Jurisdiction

Jurisdiction	Number of Major Outfalls Per Year		
	Field Screening[1]	Dry Weather Monitoring	Wet Weather Monitoring
City of Del Mar	2 (1)[2]	1	1
City of Poway	30 (37)[2]	5	3
City of San Diego	198 (198)[3]	5	1
County of San Diego	0[4]	0[4]	0[4]

1. Total number of major outfalls within each jurisdiction in the WMA is provided in parentheses.
2. For Copermittees with fewer than 125 major outfalls in the WMA, 80% of major outfalls must be screened twice per year.
3. For Copermittees with portions of their jurisdictions in more than one WMA and more than 500 major MS4 outfalls in its jurisdiction, at least 500 major outfalls must be inspected once per year.
4. No major outfalls have been identified in the Los Peñasquitos WMA.

MS4 Outfall Dry Weather Monitoring

The purpose of the MS4 Outfall Dry Weather Monitoring Program is to evaluate the potential contribution from MS4 discharges to the receiving water quality during dry conditions and to assess the ability of programs to effectively eliminate non-storm water discharges to waterbodies or waterways. Each Copermittee has established a number of major MS4 outfalls that are prioritized on the basis of non-storm water flow status and threat to receiving water quality, and these outfalls will be screened once or twice annually on the basis of this prioritization. Additionally, the highest priority major MS4 outfalls have been selected for further water quality testing to facilitate source investigations of these outfalls with persistent dry weather flows.

Dry Weather Field Screening

Field screening is visual monitoring of all major MS4 outfalls to identify and eliminate sources of persistently flowing non-storm water discharges. Dry weather MS4 outfall discharge field screening is designed to answer the following questions:

- Which non-storm water discharges are transient and which are persistent?
- Which discharges should be investigated as potential illicit connection/illicit discharges?

The frequency of field screening is determined on a jurisdictional basis and is dependent on the number of major outfalls. Provision D.2.b(1) of the MS4 Permit outlines three categories as the basis for frequency as described below:

- 0-125 major outfalls, 80% of major outfalls 2 times per year
- 125-500 major outfalls, all major outfalls 1 time per year
- 500+ major outfalls, at least 500 major outfalls 1 time per year

Field screening activities will be conducted during dry weather with an antecedent dry period of at least 72 hours with less than 0.1 inch of rainfall. Field observations will include flow condition (pooled, ponded, flowing, or no flow), estimate of flow, characteristics of flow and water, likely source(s), presence of trash, or evidence or signs of illicit connections or illegal dumping. Follow-up investigations will be employed based on jurisdictional illicit connection and/or illicit discharge (IC/ID) programs.

Prioritization of Non-Storm Water Persistently Flowing Outfalls

Each jurisdiction ranked its major outfalls independently on the basis of their highest priority conditions, PGAs, and specific site considerations. Responsible Agencies considered the following factors to prioritize persistently flowing outfalls:

- Potential to contribute to a highest or priority water quality condition
- Historical monitoring or inspection data
- Controllability
- Surrounding land uses/potential sources
- Flow rate
- Selected focus areas

Highest Priority MS4 Outfall Dry Weather Monitoring

The purpose of this program is to determine which major persistent flow MS4 outfalls impact receiving water quality during dry weather. MS4 outfall dry weather monitoring is designed to answer the following questions:

- Do dry weather discharge concentrations at MS4 outfalls meet MS4 Permit action levels?
- What is the relative contribution of MS4 outfalls to priority water quality conditions during dry weather?
- What are the sources of persistent non-storm water flows?

Responsible Agencies will monitor a minimum of five major MS4 outfalls during dry weather (if a Responsible Agency has fewer than five major MS4 outfalls, then all of them will be monitored). Each outfall will be monitored semi-annually during dry weather conditions. During each event, field observations will be recorded, and when measureable flow is present, in-situ field measurements and analytical data will be collected. Analytical constituents will include constituents contributing to the highest priority water quality conditions, 303(d) list impairments, TMDLs, NALs, and Table D-7 of the MS4 Permit as described in the MS4 Outfall Monitoring Plan (the Plan will be available on the Project Clean Water Website, http://www.projectcleanwater.org/index.php, by June 2015). When historical data demonstrated or justified that analysis of a constituent is not necessary for a particular waterbody or outfall, then it has been removed and its removal notated in the analytical table provided in the Water Quality Improvement Plan Annual Report. The methods and procedures described in the MS4 Outfall Monitoring Plan may be modified on the basis of site-specific environmental conditions and updated analytical methodologies.

Based on the data collected at the MS4 outfalls per jurisdiction as shown in Table 5-9, monitoring at these outfalls may be reprioritized to eliminate monitoring entirely or to reduce it to field screening activities only to address higher priority non-storm water persistent flows. Reprioritization of outfalls may occur if one of the following conditions is met:

- Non-storm water discharges have been effectively eliminated for three consecutive monitoring events; or
- Source(s) of the persistent flows have been identified as not an illicit or a source of pollutants; or
- Pollutants in the persistent flow do not exceed NALs; or
- The threat to water quality has been reduced by the Participating Agency.

Wet Weather MS4 Outfall Monitoring

The purpose of this program is to identify pollutants in storm water discharges from the MS4s, guide pollutant source identification efforts, and track progress in achieving the goals set forth in Section 4. The Responsible Agencies' five monitoring locations for the wet weather MS4 outfall discharge monitoring component are chosen to be representative of the residential, commercial, industrial, and mixed-use land uses within the Los Peñasquitos WMA. These five locations will be monitored during one storm event annually. Wet weather MS4 outfall discharge monitoring is designed to answer the following questions:

- Do wet weather discharge concentrations at MS4 outfalls meet MS4 Permit action levels?
- What is the relative contribution of MS4 outfalls to priority water quality conditions during wet weather?
- How do representative MS4 outfalls discharge concentrations, loads, and flows change over time?

The MS4 Permit (Provision D.2.c) requires that a minimum of five outfalls will be monitored once per year within the WMA, during a storm event with greater than 0.1 inch of rainfall. During each event, observational and hydrologic data will be recorded, including duration of the storm, rainfall estimates, and estimated or measured flow rates and volumes. Grab samples will be collected to analyze for pH, temperature, specific conductivity, dissolved oxygen, turbidity, hardness, and indicator bacteria. When feasible, a composite sample must be collected and analyzed for constituents contributing to the highest priority conditions, 303(d) list impairments, TMDLs, and SALs. When historical data demonstrated or justified that analysis of a constituent is not necessary for a particular water body or outfall, then it was removed and its removal notated in the analytical table provided in the MS4 Outfall Monitoring Plan (the Plan will be available on the Project Clean Water Website, http://www.projectcleanwater.org/index.php, by June 2015). The methods and procedures described in the MS4 Outfall Monitoring Plan may be modified on the basis of site-specific environmental conditions and updated analytical methodologies. If historical data demonstrate or justify that analysis of a constituent is not necessary for a particular waterbody or outfall, then it will be removed and its removal noted in the Water Quality Improvement Plan Annual Report.

The 2013 Transitional Monitoring Programs began implementation of the wet weather MS4 outfall monitoring requirements at five Los Peñasquitos WMA outfall monitoring locations. Some of the locations selected for the Water Quality Improvement Plan Monitoring Program are different the Transitional Monitoring Program monitoring locations.

5.1.4 Special Studies

Special studies have been selected to further investigate the highest priority water quality conditions set forth in Section 2 and to meet requirements of MS4 Permit Provision D.3. The special studies will include a regional special study and a special study specific to the Los Peñasquitos WMA.

San Diego Regional Reference Streams and Beaches Studies

The regional special studies selected in the Los Peñasquitos WMA are the San Diego Regional Reference Streams and Beaches Studies currently being conducted by the San Diego and Orange County Copermittees. The studies will develop numeric targets that account for "natural sources" to establish the concentrations or loads from streams in a minimally disturbed by anthropogenic activities or "reference" condition. The Reference Stream Study also collected nutrients, metals, and toxicity data as secondary constituents, with a goal of collecting the data necessary to derive reasonable and accurate numeric targets for bacteria, nutrients, and heavy metals on the basis of a reference approach. This study will provide a scientific basis for evaluating bacteria compliance levels in the Bacteria TMDL. The results of the studies will be used to support the forthcoming reopener of the recently adopted Bacteria TMDL and to support numeric targets in future TMDLs for bacteria, nutrients, and metals.

The San Diego Regional Stream Reference Study will address the following questions (SCCWRP, 2013):

- How does the Water Quality Objective (WQO) exceedance frequency vary between summer dry weather, winter dry weather, and wet weather?
- How does the WQO exceedance frequency vary by hydrologic factors, including:
  - Size of storm (wet weather only)?
  - Discharge flow rate and volume (wet and dry weather)?
  - Beginning versus end of storm season (wet weather only)?
- How does the WQO exceedance frequency vary by input factors such as:
  - Size of catchment?
  - Geology?
- How does the WQO exceedance frequency vary by biotic and abiotic factors, including:
  - Algal cover and/or biofilms?
  - Water quality (temperature, pH, conductivity, dissolved oxygen, total suspended solids concentration)?

The San Diego Regional Reference Beaches Study will address the following questions (SCCWRP, 2013) in beaches minimally influenced by anthropogenic activities:

- How does the WQO exceedance frequency vary between summer dry weather, winter dry weather, and wet weather?
- How does the WQO exceedance frequency vary by hydrologic factors, including:
  - Discharge flow rate (wet and dry weather)
  - Status of estuary mouth (open/closed; dry weather only)
- What are the wet and dry weather exceedance frequencies of fecal indicator bacteria in estuaries?

A total of 6 locations were selected for wet weather monitoring and up to 10 locations were selected for dry weather monitoring throughout the San Diego region. Sites were selected to represent 95 percent undeveloped land uses (reference conditions), two major geologic settings, and the target catchment sizes. Wet weather sampling frequency at the six locations consists of three targeted events throughout the wet season (October 1 through April 30). Dry weather sampling frequency consists of weekly sampling for up to 40 weeks at flowing locations during winter and summer dry weather periods. Dry weather sampling occurs if there has been no measurable rainfall for at least 72 hours.

Water samples will be analyzed for a combination of conventional constituents, nutrients, metals, fecal indicator bacteria, microbial source testing, and algae. Of these constituents, *Enterococcus*, *E. coli*, fecal coliform, total coliform, *Bacteroides*, and *in-situ* parameters are of primary importance; all other analytes are considered secondary. During dry weather sampling, reference stream sites will be assessed for algal percent cover, algal biomass, ash-free biomass, and factors that control the growth of algae (stream bankful dimensions, canopy cover, and pebble count). Flow discharge rates were estimated for seven reference streams using recorded continuous water level data during both wet and dry weather conditions and measured velocity and flow during sampled wet weather events.

Los Peñasquitos Lagoon TMDL Upper Watershed Sediment Load Monitoring Plan

The special study selected to represent the Los Peñasquitos WMA is the Los Peñasquitos Lagoon TMDL Upper Watershed Sediment Load Monitoring Plan (the Plan will be available on the Project Clean Water Website, http://www.projectcleanwater.org/index.php, by June 2015). This study will assess sediment loads in the watersheds upstream of the Draft Sediment TMDL compliance monitoring locations. The study seeks to answer the following question:

- What are the watershed sources of sediment affecting the health of the Los Peñasquitos Lagoon?

The Los Peñasquitos TMDL Upper Watershed Sediment Load Monitoring Study will include analysis of sediment water column loads and stream bedload, and air monitoring. The special study will be implemented in a phased approach. Monitoring will occur first in the Carroll Canyon subwatershed, because previous modeling has indicated that most of the sediment in the Los Peñasquitos Lagoon is coming from this subwatershed. The Los Peñasquitos Creek and Carmel Valley Creek subwatersheds will be monitored in subsequent phases.

5.1.5 Other Special Studies

Responsible Agencies have planned projects and studies to fill data gaps, further investigate priority and highest priority water quality conditions, or evaluate the MS4 discharges and potential impacts. These projects exceed the monitoring requirements of the MS4 Permit. These studies will be implemented on the basis of available resources.

Stream Gauge Study

Many waterbodies in the San Diego region have not been subject to regular flow monitoring. Knowledge of water level is essential for programs, including TMDL implementation, bio-objectives, and bioassessment. The stream gauge study attempts to fill in some of the gaps in the information regarding the level of flow at two stream locations in Los Peñasquitos WMA. Monitoring will answer the questions:

- What is the level of flow in local streams?
- Which streams are perennial and which are ephemeral?

The study, which began in spring of 2014 and will continue until spring 2015, includes installation of two datalogger units. Dataloggers will gather water level, temperature, and conductivity data at 5-minute intervals.

Outfall Repair and Relocation Study

The City of San Diego is currently developing a study to prioritize storm water outfalls for repair or relocation throughout the Los Peñasquitos WMA. The study will look a number of factors to determine the impact of outfall repair or relocation may impact sediment load reductions.

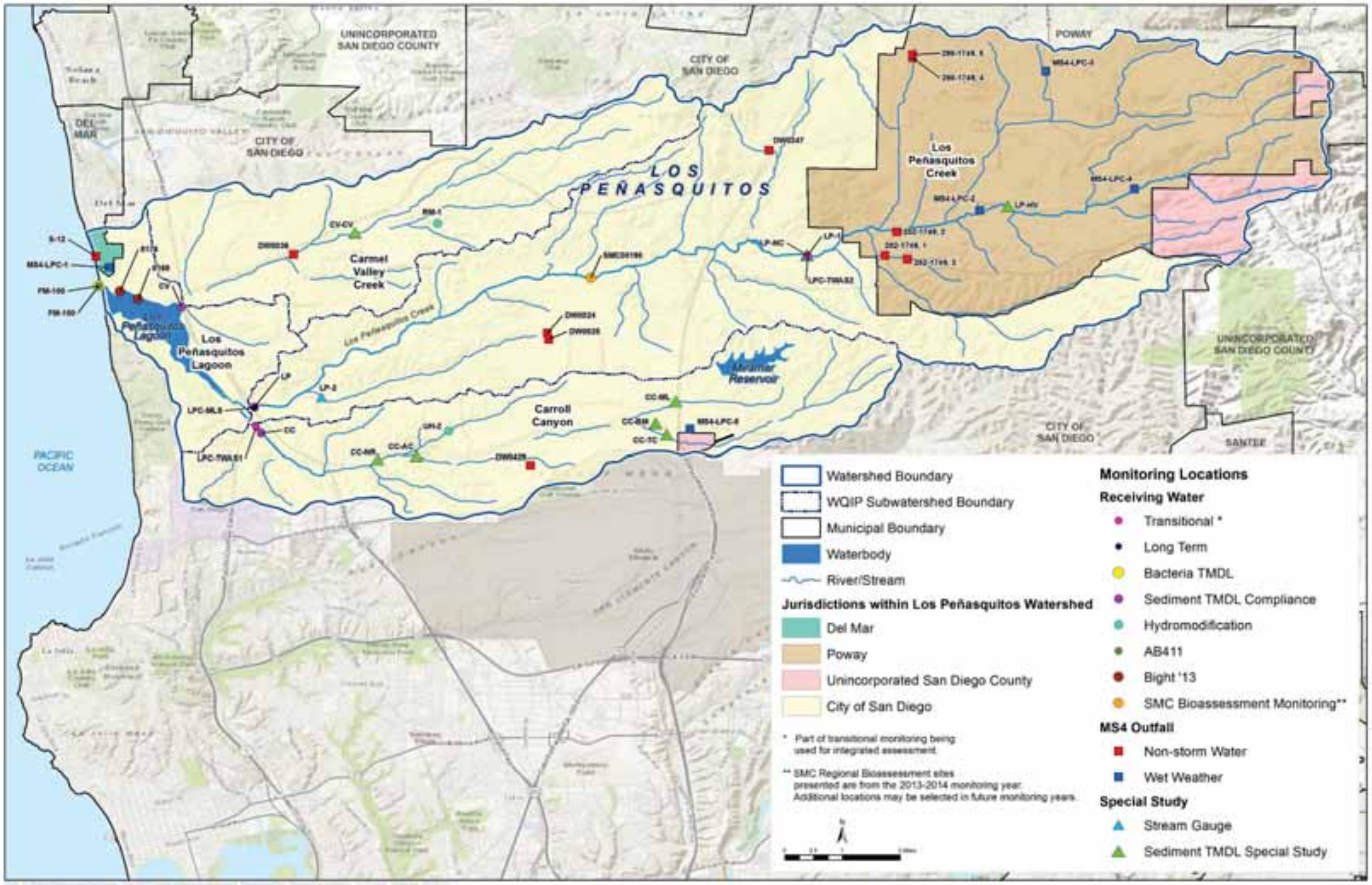

Figure 5-2
MAP Monitoring Locations for the Los Peñasquitos WMA

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5.1.6 Remaining Data Gaps

The data gaps discussed in Section 2 were compared with each of the monitoring program components described in the previous subsections. Most of the data gaps will be addressed by the Monitoring and Assessment Program. The long-term monitoring locations include a larger suite of pollutants than previously monitored on the basis of the new MS4 Permit requirements and provide more detail on hydromodification. In addition, because the MS4 outfall monitoring locations for dry and wet weather are prioritized on the basis of the priority water quality conditions identified in Section 2, over time there will be more MS4 data near the waterbodies included in the priority water quality conditions. It is expected to take a few years of monitoring to potentially assess the MS4 contribution to the priority water quality conditions because of the typical high variability of constituent concentrations in storm water. MS4 monitoring locations may also need to change because it is unlikely that MS4 locations will be monitored near each priority water quality condition during one monitoring season.

Some data gaps remain because the present state of science does not allow for the full characterization of the cause of the priority water quality condition. The impairment caused by nutrients is impacted by the physical and biological conditions of the receiving water. The link between these factors and the concentration of nutrients in the priority water quality condition waterbodies will not be determined as part of this iteration of the Monitoring and Assessment Program. Similarly, for receiving waters impaired by toxicity, factors other than runoff from the MS4 contribute to toxicity levels. The Monitoring and Assessment Program does not currently include analyses of Non-MS4 contributions to toxicity in receiving water. For pollutants such as selenium and nutrients, groundwater may be a contributing source, as noted throughout the San Diego Region (City of San Diego, 2011).

5.1.7 Regional Clearinghouse

The Responsible Agencies will use existing data-sharing templates to facilitate compilation of watershed-wide data sets for assessment and reporting purposes. To support reporting under previous MS4 Permit cycles, regional data-sharing templates were developed for receiving water monitoring, MS4 outfall monitoring, field screening, and illicit connection/illicit discharge (IC/ID) reporting. The Responsible Agencies will make the following data and documentation available to the public on the Project Clean Water website:

- Los Peñasquitos WMA Water Quality Improvement Plan and all updated versions with date of update
- Annual Reports for the WMA

> Project Clean Water is a web-based portal for San Diego County watersheds. It is used as a centralized point of access to share educational materials, water quality information, and MS4 Permit-required reports with the public.
>
> www.projectcleanwater.org

- JRMP documents for each Responsible Agency within the WMA and all updated versions with date of update
- BMP Design Manual for each Responsible Agency within the WMA and all updated versions with date of update
- Reports from special studies conducted in the WMA
- Monitoring data uploaded to the California Environmental Data Exchange Network (CEDEN) with links to the uploaded data
- Available GIS data, layers, and/or shape files used to develop the maps to support the Water Quality Improvement Plan, Annual Reports, and Jurisdictional Runoff Management Programs

5.2 Water Quality Improvement Plan Assessment Program

The assessment portion of the Monitoring and Assessment Program will evaluate the data collected under the monitoring programs described in Section 5.1, as well as the information collected as part of the JRMPs. The data collected from these two programs will be used to assess the progress toward achieving the Water Quality Improvement Plan numeric goals and schedules and to measure the progress toward addressing the highest priority water quality conditions.

This section summarizes the requirements of the four primary assessments listed in Figure 5-1. Depending on permit requirements, some assessments will be reported annually, as part of the Water Quality Improvement Plan Annual Report, while others will be included in the Report of Waste Discharge that the Responsible Agencies must submit prior to the issuance of the next MS4 Permit.

The timeframe for each of the assessments is as follows:

- Annual Reporting
  - Receiving Water Assessment
  - MS4 Outfall Discharge Assessment
  - Special Studies Assessment
- MS4 Permit Reporting (Report of Waste Discharge at end of MS4 Permit Cycle)
  - Integrated Assessment

The Monitoring and Assessment Program will be evaluated and adapted in the context of the Annual Reporting and the Report of Waste Discharge. The re-evaluation will consider data gaps and the results of all monitoring program elements. Required elements of the Water Quality Improvement Plan Annual Report are provided in Table 5-10.

Modifications may be made to the Monitoring and Assessment Program, but the core elements required by the MS4 Permit and described in Section 5.1 must be maintained. This limits the amount of adaptation that is possible. Potential changes could be to change the frequency of sampling, add a new analyte of concern, or move a monitoring location.

Table 5-10
Annual Reporting Components

Assessment and Documentation	Detailed Data and Information
Summary of data collected, findings, interpretations, and conclusions from the assessments required per MS4 Permit Provisions F.3.b.(3)(a)-(c)	❖ Receiving Water Assessments per Provision D.4.a. ❖ Sediment Quality Assessments per Provision D.1.e(2) ❖ TMDL Assessments per Provision E.6 ❖ MS4 Outfall Discharger Assessments D.4.b ❖ IDDE relevant information and findings per Provision E.2 ❖ Special studies: findings and progress per Provision D.4.c ❖ Re-evaluation of the priority water quality conditions, numeric goals, strategies, schedules, and/or monitoring and assessment, as needed per Provision D.4.d[1]
Progress of implementing the Water Quality Improvement Plan per Provision F.3.b.(3)(d)	❖ Progress toward interim and final numeric goals for the highest priority water quality conditions for the WMA ❖ Status of water quality improvement strategies by each Responsible Agency ❖ Proposed modifications to water quality improvement strategies and supporting rationale ❖ Water quality improvement strategies planned for implementation during the next reporting period

Table 5-10 (continued)
Annual Reporting Components

Assessment and Documentation	Detailed Data and Information
Progress of implementing the Water Quality Improvement Plan per Provision F.3.b.(3)(d) (continued)	❖ Proposed modifications to Water Quality Improvement Plan and/or each Copermittee's jurisdictional runoff management program document ❖ Previous modifications or updates incorporated into the Water Quality Improvement Plan and/or each Copermittee's jurisdictional runoff management program document
A completed Jurisdictional Runoff Management Program Annual Report Form for each Copermittee in the WMA, certified by a Principal Executive Officer, Ranking Elected Official, or Duly Authorized Representative per Provision F.3.b.(3)(e)	❖ City of Del Mar ❖ City of Poway ❖ City of San Diego ❖ County of San Diego
Any data or documentation utilized in developing the Water Quality Improvement Plan Annual Report for each Responsible Agency, upon request by the Regional Board. Monitoring data must be uploaded to CEDEN and available for access on the Regional Clearinghouse per Provision F.3.b.(3)(f)	❖ Receiving water and data collected per Provision D.1 ❖ MS4 outfall discharge monitoring data collected per Provision D.2 ❖ Special Study data ❖ IC/ID investigation data

1. This re-evaluation is not required annually; at minimum, it must be completed as part of the Report of Waste Discharge.

5.2.1 Integrated Assessment

The integrated assessment builds on the receiving water assessment, MS4 outfall discharge assessment, and special studies assessment described in Sections 5.2.2 through 5.2.4. Additionally, the integrated assessment will evaluate the data collected as part of the transitional monitoring program implemented after the approval of the 2013 MS4 Permit and before the implementation of the monitoring program detailed in Section 5.1.

Transitional monitoring components from the 2007 Permit consisted of:

- Continuation of the receiving water monitoring programs performed under the previous MS4 Permits(including monitoring at the upstream TWAS locations described in Section 2.1)
- Continuation of the Hydromodification Management Plans monitoring program
- Continued participation in regional receiving water monitoring programs
- Continuation of the dry weather MS4 outfall field screening program
- Continuation of wet weather MS4 outfall discharge monitoring

The Responsible Agencies will integrate the data collected as part of the Monitoring and Assessment Program, along with information collected during implementation of the JRMP. The integrated assessment will evaluate the main components of the Water Quality Improvement Plan and will follow the assessment process outlined in the MS4 Permit, as summarized in Table 5-11. The priority water quality conditions will be re-evaluated using the receiving water and MS4 outfall discharge assessments on the basis of the methodology presented in Appendix A. The compliance pathways that comprise the goals and schedules in Section 4 will be reviewed on the basis of the results of the receiving water and MS4 outfall discharge assessments, along with data collected as part of the JRMP. This evaluation will characterize progress in achieving the compliance goals. Finally, both water quality monitoring data and maintenance/observational data related to BMP effectiveness will be used to assess the strategies implemented by the Responsible Agencies. Table 5-11 summarizes the assessment program components.

The integrated assessment for all three Water Quality Improvement Plan components will be performed during the development of the Report of Waste Discharge. Strategies will be evaluated in the Water Quality Improvement Plan Annual Report on the basis of the data collected as part of the JRMPs and any new relevant BMP effectiveness data collected by the Responsible Agencies.

Table 5-11
Integrated Assessment Components

Water Quality Improvement Plan Components	MS4 Permit Assessment Methodology	Evaluation Assessment
Priority Water Quality Conditions	<u>Re-assess receiving water, priority, and highest priority water quality conditions.</u> (1) Re-evaluate the receiving water conditions per methodology and any new methodology provided in Appendix A. (2) Re-evaluate the impacts of MS4 discharges on receiving waters per methodology provided in Appendix A. (3) Identify beneficial uses in receiving waters that must be protected per Receiving Water Assessment (Section 5.2.2). <u>Re-evaluate MS4 sources and stressors based on potentially new priority and highest priority water quality conditions.</u> (4) Re-evaluate the identification of MS4 sources and/or stressors performed in Section 3.	❖ Receiving Water Assessments ❖ MS4 Outfall Discharge Assessments
Goals and Schedules (Compliance Pathways)	<u>Evaluate effectiveness of goals.</u> (1) Evaluate the progress toward achieving interim and final numeric goals for protecting impacted beneficial uses in receiving waters.	❖ Receiving Water Assessments ❖ MS4 Outfall Discharge Assessments ❖ JRMP Assessments
Strategies	<u>Evaluate effectiveness of strategies and actions.</u> (1) Identify the non-storm water and storm water pollutant loads from the MS4 outfalls based on the MS4 Outfall Discharge Assessment (Section 5.2.3). (2) Identify the non-storm water and storm water pollutant load reductions, or other improvements that are necessary to attain the interim and final numeric goals.	❖ MS4 Outfall Discharge Assessments ➢ Special Studies Assessments for BMP Effectiveness ➢ JRMP Assessments

Table 5-11 (continued)
Integrated Assessment Components

Water Quality Improvement Plan Components	MS4 Permit Assessment Methodology	Evaluation Assessment
Strategies (continued)	(3) Identify the non-storm water and storm water pollutant load reductions, or other improvements, that are necessary to demonstrate that non-storm water and storm water discharges are not causing or contributing to exceedances of receiving water limitations. (4) Evaluate the progress of the strategies toward achieving interim and final numeric goals for protecting beneficial uses in receiving waters.	❖ MS4 Outfall Discharge Assessments ➢ Special Studies Assessments for BMP Effectiveness ➢ JRMP Assessments

Performance-Based Goals Assessment

Of particular interest for the integrated assessment to be performed during this MS4 permit cycle is a review of the performance-based goals in Section 4. These goals will be reviewed during the development the Report of Waste Discharge. Sections 5.1.1 and 6.3.2 summarize the jurisdictional goals put forth by each Responsible Agency and the measures that will be used to assess the goals.

5.2.2 Receiving Water Assessments

The assessment of receiving waters involves evaluating the physical, chemical, and biological conditions of the receiving waters and the condition of the sediment. The Responsible Agencies must assess the status and trends of receiving water quality conditions in coastal waters, lagoons, and streams in the Los Peñasquitos WMA. This assessment includes evaluation of both dry weather and wet weather conditions. The receiving water assessment may be presented in the Water Quality Improvement Plan Annual Report or will be in the Report of Waste Discharge and will:

- ❖ Assess whether or not the conditions of the receiving waters are meeting the numeric goals established in Section 4.
- ❖ Identify the most critical beneficial uses that must be protected to ensure the overall health of the receiving water.
- ❖ Evaluate whether or not those critical beneficial uses are being protected.
- ❖ Identify short-term and/or long-term improvements or degradation of those critical beneficial uses.

- Consider whether or not the strategies established in the Water Quality Improvement Plan contribute toward progress in achieving the interim and final numeric goals of the Water Quality Improvement Plan.
- Identify gaps in the monitoring data needed to assess the above provision.

5.2.3 MS4 Outfall Discharge Assessments

The MS4 outfall discharge assessments include evaluating both the dry weather monitoring data associated with the IDDE program and the wet weather monitoring data collected by the Responsible Agencies. Details of these two separate assessments are provided below. Each Responsible Agency will assess its MS4 programs individually and will compile the reports as part of the Los Peñasquitos WMA Water Quality Improvement Plan Annual Report. The key elements of the MS4 Outfall Discharge Assessments are summarized in Table 5-12.

Table 5-12
Key Elements of the MS4 Discharge Assessments

Dry Weather Outfall Assessment	Illicit Discharge	Wet Weather Outfall Assessment
❖ Identify sources of non-storm water discharges on the basis of field screening data or IDDE activities ❖ Rank and prioritize non-storm water discharges ❖ Identify sources contributing to numeric action limit exceedances ❖ Estimate volumes and loads of non-storm water discharges ❖ Evaluate non-storm water discharge monitoring locations ❖ Evaluate the effectiveness of the water quality improvement strategies	❖ All IC/ID investigations ❖ IC/IDs eliminated within the jurisdiction	❖ Estimate volumes and loads of storm water discharges ❖ Evaluate temporal trends ❖ Evaluate storm water discharge monitoring locations and frequency ❖ Evaluate Water Quality Improvement Plan analysis ❖ Evaluate the effectiveness of water quality improvement strategies

Dry Weather Outfall Assessments and Illicit Discharges

Each Responsible Agency must assess and report the progress of its IDDE program (required pursuant to MS4 Permit Provision E.2) toward effectively prohibiting non-storm water and illicit discharges into the MS4s within its jurisdiction, including the following elements:

❖ **Identify sources of non-storm water discharges.**

Based on the dry weather MS4 outfall discharge field screening monitoring described in Appendix P, each Responsible Agency must assess and report as follows (Provision D.4.b(1)(b)):

- Identify the known and suspected controllable sources (e.g., facilities, areas, land uses, and pollutant-generating activities) of transient and persistent flows within the Responsible Agency’s jurisdiction in the Los Peñasquitos WMA.
- Identify sources of transient and persistent flows within the Responsible Agency’s jurisdiction in the Los Peñasquitos WMA that have been reduced or eliminated.
- Identify modifications of the field screening monitoring locations and frequencies for the MS4 outfalls in the Responsible Agency’s inventory necessary to identify and eliminate sources of persistent flow non-storm water discharges (Provision D.2.b).

The JRMP Annual Report will be used to guide this assessment in the Water Quality Improvement Plan Annual Report. The known and suspected sources will be identified during implementation of JRMP activities. These activities include the facility inspections that complement the IDDE program and information gathered by the storm water hotline or other public complaints. The JRMP Annual Report now consists of a two-page form that summarizes the JRMP activities provided in Attachment D of the MS4 Permit, along with supporting information. Section IV of the JRMP Annual Report Form summarizes the findings of the IDDE Program.

The back-up information that may be provided with the form may include the following information to help identify sources:

- Subwatershed of the source or complaint
- Potential receiving water of the source or complaint
- Potential pollutant or pollutant category that could be contributed by the source or complaint

Those Copermittees that do not provide this optional back-up will make this information available for collaborative watershed assessments.

- **Rank and prioritize non-storm water discharges.**

  Based on the data collected and applicable numeric action levels described in Section 2 and detailed in Appendix P, the Responsible Agencies must rank the MS4 outfalls in their jurisdictions according to the potential threat to receiving water quality and produce a prioritized list of persistently flowing major MS4 outfalls. The Water Quality Improvement Plan will be updated as described in Section 6 on the basis of these findings and with the goal of implementing (in the order of the ranked priority list) targeted programmatic actions and source investigations to eliminate persistent non-storm water discharges and/or pollutant loads.

- **Identify sources contributing to numeric action limit exceedances.**

  For the highest priority major MS4 outfalls with persistent flows that exceed NALs (Provision C.1), each Responsible Agency must identify the known and suspected sources within its jurisdiction in the Los Peñasquitos WMA that may cause or contribute to the numeric action limit exceedances.

- **Estimate volumes and loads of non-storm water discharges.**

  Annually, each Responsible Agency must (1) analyze the data collected as part of the Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring Program from the highest priority major MS4 outfalls and (2) use a model or another method to calculate or estimate the non-storm water volumes and pollutant loads collectively discharged from all the major MS4s outfalls in its jurisdiction that have persistent dry weather flows during the monitoring year. These calculations or estimates must include:

  - The percent contribution from each known source for each MS4 outfall
  - The annual non-storm water volumes and pollutant loads collectively discharged from the Responsible Agency's major MS4 outfalls to receiving waters within the Responsible Agency's jurisdiction
  - The annual volumes and pollutant loads for sources of non-storm water not subject to the Responsible Agency's legal authority that are discharged from the Responsible Agency's major MS4 outfalls to downstream receiving waters

- **Evaluate non-storm water discharge monitoring locations.**

  Based on an evaluation of the data collected from the highest priority non-storm water persistent flow MS4 outfall monitoring locations, the outfall monitoring locations may be reviewed and the list reprioritized according to one or more of the following criteria (Provision D.2.b(2)(b)(ii)):

  - The non-storm water discharges have been effectively eliminated (i.e., there is no flowing, pooled, or ponded water) for three consecutive dry weather monitoring events

- The sources of the persistent flows have been identified as a category of non-storm water discharges that do not require an NPDES permit and do not have to be addressed as an illicit discharge because they were not identified as sources of pollutants (i.e., the constituents in the non-storm water discharge do not exceed numeric action level) and the persistent flow can be reprioritized to a lower priority
- The constituents in the persistent flow non-storm water discharge do not exceed NALs (Provision C.1)
- The source(s) of the persistent flows has (have) been identified as a non-storm water discharge authorized by a separate NPDES permit

Where these criteria have not been met but the threat to water quality has been reduced by the Responsible Agency, the highest priority persistent flow MS4 outfall monitoring stations may be reprioritized accordingly for continued dry weather MS4 outfall discharge field screening monitoring as part of the Dry Weather MS4 Outfall Discharge Field Screening Program.

Each Responsible Agency must document removal or reprioritization of the highest priority persistent flow MS4 outfall monitoring stations identified under the Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring Program in the Water Quality Improvement Plan Annual Report. When a Responsible Agency removes a persistent flow MS4 outfall monitoring station, it will be replaced with the next highest prioritized major MS4 outfall designated by that jurisdiction in the Los Peñasquitos WMA. If there are no remaining qualifying major MS4 outfalls within its jurisdiction, the number of major MS4 outfalls monitored will be reduced.

❖ **Evaluate the effectiveness of the water quality improvement strategies.**

As part of the Report of Waste Discharge, each Responsible Agency will review the data collected as part of the Dry Weather MS4 Outfall Discharge Monitoring Program and findings from annual dry weather MS4 discharge monitoring assessments described above (Provisions D.4.b(1)(c)(v)[a]-[c] and Provision D.4.b(1)(c)(vi)). The evaluation will incorporate the following:

- Identification of reductions and progress in achieving reductions in non-storm water and illicit discharges to the Responsible Agency's MS4s in the Los Peñasquitos WMA
- Assessment of the effectiveness of the water quality improvement strategies being implemented by the Responsible Agencies within their jurisdictions in the Los Peñasquitos WMA toward reducing or eliminating non-storm water and pollutant loads discharging from the MS4s to receiving waters, and, if possible, estimation of the non-storm water volume and/or pollutant load reductions attributable to specific water quality strategies in the Responsible Agency's jurisdictions

- Identification of modifications necessary to increase the effectiveness of the water quality improvement strategies implemented by the Responsible Agency toward reducing or eliminating non-storm water and pollutant loads discharging from the MS4s to receiving waters within its jurisdiction, including a comparison with NALs as appropriate
- Identification of data gaps in the monitoring data necessary to develop the assessments above (Provisions D.4.b(1)(c)(i)-(v))

Wet Weather Outfall Assessments and Illicit Discharges

The Responsible Agencies must assess and report the progress of the water quality improvement strategies implemented as part of the Water Quality Improvement Plan and the JRMP toward reducing pollutants in storm water discharges from the MS4s. This is designated as the Wet Weather MS4 Outfall Discharge Monitoring Program. The assessment of this program will:

- **Estimate volumes and loads of storm water discharges.**

  As part of the Water Quality Improvement Plan Annual Report, the Responsible Agencies must analyze the monitoring data collected as part of the Wet Weather MS4 Outfall Discharge Monitoring Program. This includes using a watershed model or another method to calculate or estimate the following for each monitoring year:

  - The average storm water runoff coefficient for each land use type within the Los Peñasquitos WMA
  - For storm events with measurable rainfall greater than 0.1 inch, the volume of storm water and pollutant loads discharged from the monitored MS4 outfalls to receiving waters within the Los Peñasquitos WMA
  - The total flow volume and pollutant loadings discharged from each Responsible Agency's jurisdiction within the Los Peñasquitos WMA over the course of the wet season, extrapolated from the data produced from the monitored MS4 outfalls
  - For storm event with measurable rainfall greater than 0.1 inch, the percent contribution of storm water volumes and pollutant loads discharged from land use type within (1) each hydrologic subarea with a major MS4 outfall to receiving waters, or (2) each major MS4 outfall to receiving waters

- **Evaluate temporal trends.**

  To evaluate all the data collected as part of the Wet Weather MS4 Outfall Discharge Monitoring Program, the Responsible Agencies must:

  - Incorporate new outfall monitoring data into time series plots for each long-term monitoring constituent for the Los Peñasquitos WMA.
  - Analyze statistical trends on the cumulative long-term wet weather MS4 outfall discharge water quality data set. This will include a comparison with SALs (Provision C.2).

- **Evaluate storm water discharge monitoring locations and frequency.**

  The Responsible Agencies may identify modifications to the wet weather MS4 outfall discharge monitoring locations and frequencies necessary to identify pollutants in storm water discharges from the MS4s in the Los Peñasquitos WMA (Provision D.2.c(1)). Two methods are available per the MS4 Permit to modify the Wet Weather MS4 Discharge Outfall Program are the following:

  - The Responsible Agencies may adjust the wet weather MS4 outfall discharge monitoring locations in the Los Peñasquitos WMA, as needed, to (1) identify pollutants in storm water discharges from MS4s, (2) guide pollutant source identification, and (3) determine compliance with the WQBELs associated with the applicable TMDLs in Attachment E of the MS4 Permit on the basis of the highest priority water quality conditions identified in Section 2. The number of stations should be, at a minimum, equivalent to the number of stations required under the MS4 Permit (Provision D.2.a(3)(a)). Additional outfall monitoring locations (above the minimum per jurisdiction) may be required to demonstrate compliance with the WQBELs associated with the Bacteria TMDL and the Draft Sediment TMDL.
  - The Responsible Agencies may adjust the analytical monitoring required for the Los Peñasquitos WMA if historical data or other supporting information demonstrate or justify that analysis of a constituent is not necessary.

- **Evaluate Water Quality Improvement Plan analysis.**

  The Responsible Agencies will evaluate the Water Quality Improvement Plan analysis on the basis of the wet weather MS4 outfall monitoring data collected and the applicable numeric storm water action levels (Provision C.2). This evaluation will include analyzing and comparing the monitoring data used to develop the Water Quality Improvement Plan, particularly the strategies presented in Section 4. Additionally, the Responsible Agencies will evaluate whether those analyses should be updated as a component of the adaptive management process described in Section 6.

- **Evaluate the effectiveness of water quality improvement strategies.**

  As part of the Report of Waste Discharge, the Responsible Agencies will review the data collected pursuant to the Wet Weather MS4 Outfall Discharge Monitoring Program and findings from the annual wet weather MS4 discharge monitoring assessments described above (Provisions D.4.b(2)(c)(i)-(ii)). The evaluation will:

  - Identify progress in achieving reductions in pollutant concentrations and/or pollutant loads from different land uses or drainage areas discharging from the Responsible Agencies' MS4s in the Los Peñasquitos WMA.
  - Assess the effectiveness of water quality improvement strategies being implemented by the Responsible Agencies within the Los Peñasquitos WMA toward reducing pollutants in storm water discharges from the MS4s to receiving waters within the WMA to the maximum extent practicable. If possible, include an estimate of the pollutant load reductions attributable to specific water quality strategies implemented by the Responsible Agencies.
  - Identify modifications necessary to increase the effectiveness of the water quality improvement strategies implemented by the Responsible Agencies in the Los Peñasquitos WMA toward reducing pollutants in storm water discharges from the MS4s to receiving waters in the WMA to the maximum extent practicable.
  - Annually identify data gaps in the monitoring data necessary to assess the provisions above.

5.2.4 Special Studies Assessments

As part of the Water Quality Improvement Plan Annual Report, the Los Peñasquitos WMA Responsible Agencies will evaluate the results and findings from the special studies described in Appendix P. They will use the resulting data to (1) assess their relevance to the Responsible Agencies' characterization of receiving water conditions, (2) understand sources of pollutants and/or stressors, and (3) control and reduce the discharges of pollutants from the MS4 outfalls to receiving waters. As with the other monitoring programs, the results of the special studies assessment may warrant modifications of or updates to the Water Quality Improvement Plan.

The Los Peñasquitos WMA special studies will seek to answer questions concerning the natural "reference" concentration of bacteria and other pollutants in the region and potential upper watershed sediment loads. The special studies will help guide the implementation of the strategies for the highest priority water quality conditions.

Future special studies related to BMP effectiveness that are implemented by the Responsible Agencies in the Los Peñasquitos WMA will be included in this assessment. Responsible Agencies may elect to report the results of BMP effectiveness studies that are being performed in other WMAs if they relate to the highest priority water quality conditions and results are expected to be transferrable to strategies planned for the Los Peñasquitos WMA.

5.2.5 Regional Monitoring Report

The regional monitoring and reporting requirement from Provision F.3.c of the MS4 Permit requires integration of all data on a regional scale to recommend modifications to the implementation or assessment of the Water Quality Improvement Plan and jurisdictional runoff management programs. The report may be included in the Report of Waste Discharge submitted 180 days prior to the expiration of the MS4 Permit, and must assess the following:

- The beneficial uses of the receiving waters within the San Diego region that are supported and not adversely affected by the Responsible Agency's MS4 discharges.
- The beneficial uses of the receiving waters within the San Diego region that are adversely affected by the Responsible Agency's MS4 discharges.
- The progress toward protecting beneficial uses of the receiving waters within the San Diego Region from Responsible Agency's MS4 discharges.
- Pollutants or conditions of emerging concern that may impact beneficial uses of the receiving waters within the San Diego region.

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6 Iterative Approach and Adaptive Management Process

The iterative approach that facilitates the adaptive management process for the Los Peñasquitos WMA is presented in this section. The iterative approach re-evaluates the water quality conditions and priorities, goals, and strategies on the basis of the MS4 Permit requirements. The adaptive management process details how the Water Quality Improvement Plan (including the Monitoring and Assessment Plan) is revised when new priorities and/or highest priorities are added, how goals will be adjusted or new goals are added, and how the strategies will be modified to meet the latest goals.

As shown in the graphic below, the fifth step of the Water Quality Improvement Plan (adaptive management process) is to develop the iterative approach that facilitates the adaptive management process for the Los Peñasquitos WMA (per MS4 Permit Provisions A.4, B.5, D.4.d, and F.2.c). The sixth step of the Water Quality Improvement Plan (annual reporting) is to compile and analyze the information collected as part of the MS4 Permit implementation. Annual reporting is described in both Sections 5 and 6 of this Water Quality Improvement Plan, as it draws on both the Monitoring and Assessment Program and the adaptive management process.

Section 6 Highlights

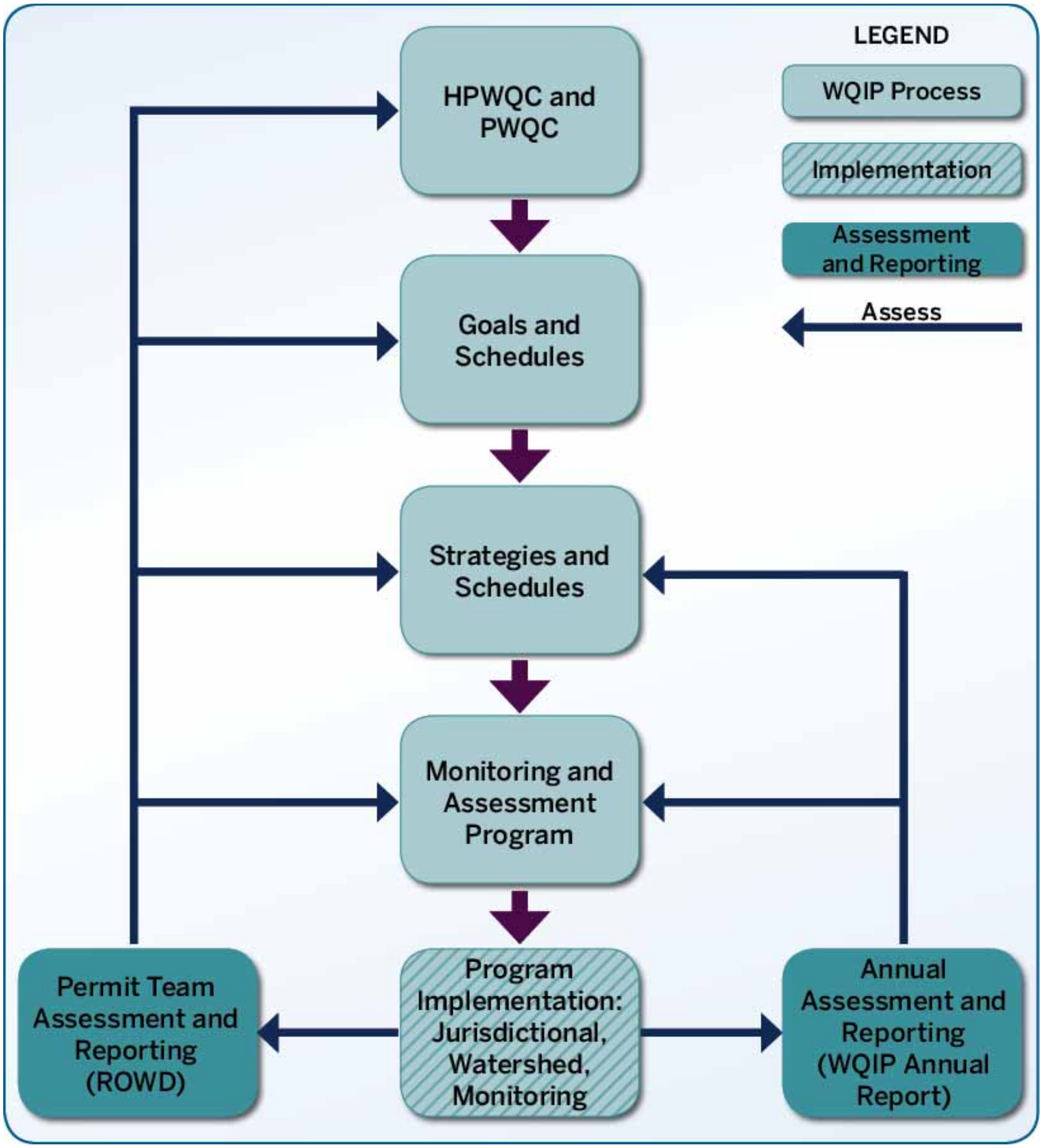
- Develop the iterative approach to facilitate the adaptive management process for the Los Peñasquitos WMA.
- Iterative approach re-evaluates the following on the basis of the requirements of the MS4 Permit:
  - Conditions and priorities
  - Goals
  - Strategies
- Adaptive management process explains how the Water Quality Improvement Plan will be revised when:
  - New priorities and/or highest priorities are developed
  - Goals are adjusted or new goals are added
  - Strategies are modified to meet the latest goals

The MS4 Permit describes various triggers that may require program adaptation, including exceedances of water quality standards in receiving waters, new information, Regional Board recommendations, and public participation.

The results of effectiveness assessments of JRMP programs and strategies may also trigger adaptations of the Water Quality Improvement Plan. Each trigger will result in specific adaptive management processes or actions within the timeframes specified in the MS4 Permit. The timing of the adaptive management requirements is typically either annually or at the end of the MS4 Permit term. Other adaptations, especially those driven by TMDLs, will likely occur outside of the MS4 Permit term. For example, the Draft Sediment TMDL outlines specific adaptive management requirements that include long-term monitoring and special studies timelines.

The adaptive management process provides the framework to evaluate progress toward meeting the requirements in the compliance pathways of the Bacteria and Sediment TMDLs that are reflected in the goals presented in Section 4. The adaptive management process will be used in conjunction with the data collected as part of the Monitoring and Assessment Program to evaluate whether modifications to goals, schedules, and/or strategies are necessary to achieve compliance with the interim and final TMDL compliance options provided in Attachment E of the MS4 Permit. Figure 6-1 provides an overview of the adaptive management process.

MS4 Permit requirements, annual assessments and adaptation, and Report of Waste Discharge assessments and adaptations, including triggers and resulting actions, are described in Sections 6.1 through 6.3. The adaptive management requirements of the Draft Sediment TMDL are in Section 6.4.



HPWQC= Highest Priority Water Quality Condition; PWQC = Priority Water Quality Condition; ROWD = Report of Waste Discharge; WQIP = Water Quality Improvement Plan.

Figure 6-1
Water Quality Improvement Plan Assessment and Adaptive Management Process

6.1 MS4 Permit Requirements: Iterative Approach and Adaptive Management

The MS4 Permit includes the requirements for adaptive management in multiple provisions. Provisions A.4, B.5, D.4.d, and F.2.c each contain requirements related to adaptive management, as summarized below:

- Provision A.4 requires the Water Quality Improvement Plan to be designed and adapted to ultimately comply with the discharge prohibitions (Provisions A.1.a and A.1.c) and receiving water limitations (Provision A.2.a) specified in the MS4 Permit. The provision addresses the adaptive management process that may be triggered when exceedances of water quality standards persist in receiving waters.

- Provision B.5 contains specific considerations that must be included in the adaptive management process, whether performed as part of the Water Quality Improvement Plan Annual Report or as part of the Report of Waste Discharge. This includes the re-evaluation of priority water quality conditions; adaptation of goals, strategies, and schedules; and adaptation of the Monitoring and Assessment Program.

- Provision D.4.d contains the processes for the assessments and adaptive management that must occur in preparation of the Report of Waste Discharge.

- Provision F.2.c describes the requirements for updates to the Water Quality Improvement Plan that could result from implementation of the adaptive management requirements.

The following sections elaborate on the adaptive management processes, including the frequencies of adaptation required by the MS4 Permit (annual versus MS4 Permit term), triggers, and resulting actions.

Figure 6-2 provides a tentative timeline for the adaptive management process.

The first Water Quality Improvement Plan Annual Report is scheduled to be submitted by the Responsible Agencies in January 2017. It will include an abbreviated monitoring and JRMP implementation period, because the Monitoring and Assessment Program and JRMP will not be effective until after the approval of the Water Quality Improvement Plan. The timeline below assumes that the Water Quality Improvement Plan will be accepted by the Regional Board during fall 2015, with the earliest implementation beginning in October 2015.

The second Annual Report for the current MS4 Permit cycle will be submitted in January 2018. This submittal would be after the submittal of the Report of Waste Discharge that is due to the Regional Board in December 2017.

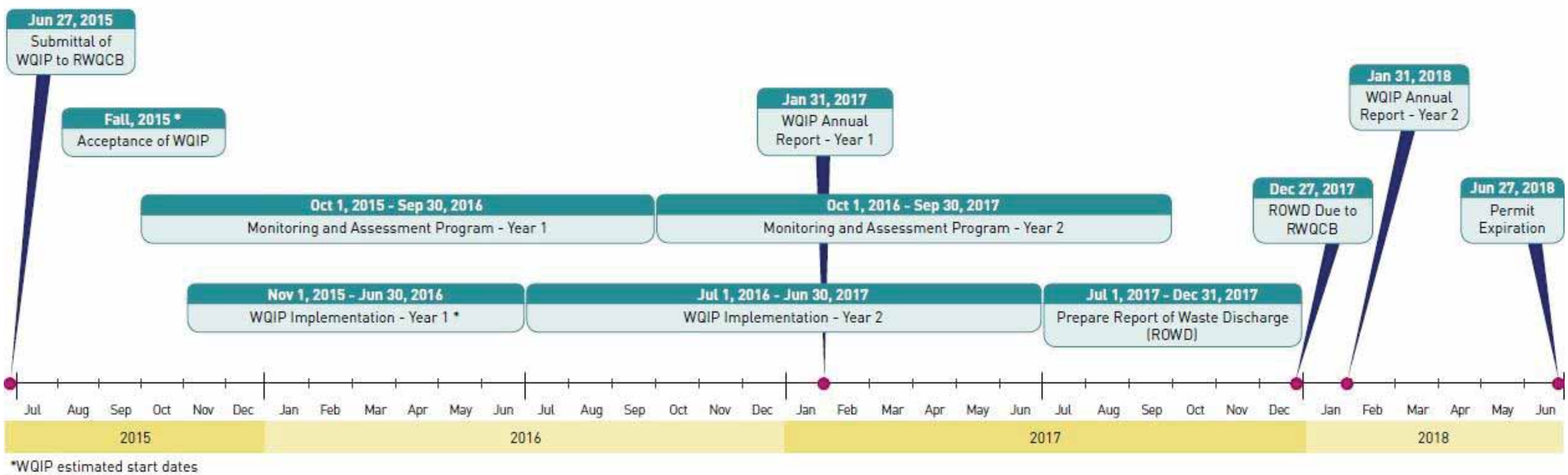


Figure 6-2
Water Quality Improvement Plan
Assessment and Reporting Timeline

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6.2 Annual Assessments and Adaptive Management

The MS4 Permit contains two conditions that may trigger adaptation annually:

(1) Exceedance of water quality standards in receiving waters

(2) New information

In either case, modifications may be appropriate for the water quality goals, strategies, schedules, and/or Monitoring and Assessment Program. The priority water quality conditions may be modified as needed during the MS4 Permit term, but would likely be modified only as a result of assessments conducted for the Report of Waste Discharge. A summary of the triggers that must be assessed annually and the corresponding adaptive management processes is presented in Table 6-1.

Table 6-1
Adaptive Management on an Annual Basis (Annual Report)

Plan Element	Trigger[1]	Adaptive Management Process Considerations
Water Quality Strategies and Schedules	Persistent Exceedances Not Addressed (A.4.a(2))	*Provision A.4.a(2), Integrated Assessment Considerations (Summarized in Figure 6-3)*[2] ❖ Water quality standard exceedances for pollutants that are addressed by the Water Quality Improvement Plan; continuing implementation of the accepted plan and updating as necessary= ❖ If MS4 discharges are causing or contributing to a new exceedance of an applicable water quality standard for pollutants that are not addressed by the Water Quality Improvement Plan, updating of the plan as part of the Water Quality Improvement Plan Annual Report (unless directed by the Regional Board to update it earlier ❖ Following Regional Board approval of modifications to the Water Quality Improvement Plan, update of the JRMP accordingly by the affected Responsible Agency

Table 6-1 (continued)
Adaptive Management on an Annual Basis (Annual Report)

Plan Element	Trigger[1]	Adaptive Management Process Considerations
Water Quality Strategies and Schedules (continued)	New Information (B.5.b)	*Provision B.5.b, Iterative Approach and Adaptive Management Considerations* ❖ Modifications to the priority water quality conditions based on Provision B.5.a ❖ Progress toward achieving numeric goals for the highest priority water quality conditions ❖ Progress in meeting established schedules ❖ New policies or regulations that may affect goals ❖ Reductions of non-storm water discharges ❖ Reductions of pollutants in storm water discharges from MS4s to the MEP ❖ New information resulting from the re-evaluation of impacts from MS4 discharges and/or pollutants and stressors ❖ Efficiency in implementing the Water Quality Improvement Plan ❖ Recommendations of the Regional Board ❖ Recommendations received through a public participation process
Monitoring and Assessment Program	Persistent Exceedances Not Addressed (A.4.a(2))	*Provision A.4.a(2), Integrated Assessment Considerations (Summarized in Figure 6-3)*[2] ❖ Following the process as described in Figure 6-3, which might include revising the monitoring program to fill data gaps with modifications such as moving monitoring locations, adding additional sample collection, or changing type of sample collected.
	New Information (B.5.c)	*Provision B.5.c, Iterative Approach and Adaptive Management Considerations* ❖ Re-evaluation based on new information such as modified priority water quality conditions, goals, strategies, or schedules ❖ New information that might include new regulations ❖ Inclusion in the Monitoring and Assessment Program of the monitoring required by the MS4 Permit

1. Following approval of a TMDL with wasteload allocations by the OAL and the USEPA, Responsible Agencies must initiate an update of the Water Quality Improvement Plan within six months.
2. This procedure does not have to be repeated for continuing or recurring exceedances of the same water quality standard(s) once scheduled strategies are implemented unless Responsible Agencies are directed to do so by the Regional Board.

6.2.1 Receiving Water Assessments

Evaluation of receiving water and MS4 outfall discharge data will be performed annually as part of the Water Quality Improvement Plan Annual Report (Provision F.3.b(3)(a)) as described in Section 5. More comprehensive evaluations of receiving water data will be performed for the Transitional Monitoring and Assessment Program Report and for the Report of Waste Discharge (Provision D.4.a(1)). These evaluations will summarize receiving water data collected within the Los Peñasquitos WMA and will provide information with the potential to trigger the adaptive management process described under Provision A.4.

Provision A.4 describes adaptive management procedures that the Responsible Agencies must implement "if exceedance(s) of water quality standards persist in receiving waters." Thus, the trigger for the adaptive management process under this provision is indication of exceedances of water quality standards that persist in receiving waters. If the adaptive management process is triggered under this provision, the process will assess two key questions:

- ❖ Is the MS4 a source of a pollutant causing the exceedances to persist in the receiving waters?
- ❖ Are the exceedances addressed by the Water Quality Improvement Plan?

If the MS4 is determined to be a source of pollutants causing the receiving water exceedance(s) and the receiving water exceedances are addressed under the Water Quality Improvement Plan, the Responsible Agencies will continue to implement the Water Quality Improvement Plan. If the MS4 is determined to be a source of pollutants causing the receiving water exceedance(s) and the receiving water exceedances are not addressed, the Responsible Agencies will update the plan to address the exceedances as described in Provision A.4.a(2) and submit the updates with the Water Quality Improvement Plan Annual Report. The updates will include, as applicable:

- ❖ A description of strategies that are currently being implemented, are effective, and will continue
- ❖ A description of strategies that will be implemented to reduce or eliminate pollutants or conditions that are a source of the receiving water exceedances
- ❖ Updates to the implementation schedules for existing, revised, or additional strategies
- ❖ Updates to the Monitoring and Assessment Program to track progress toward achieving compliance with Provisions A.1.a, A.1.c, and A.2.a

The adaptive management process as required under Provision A.4 is illustrated in Figure 6-3.

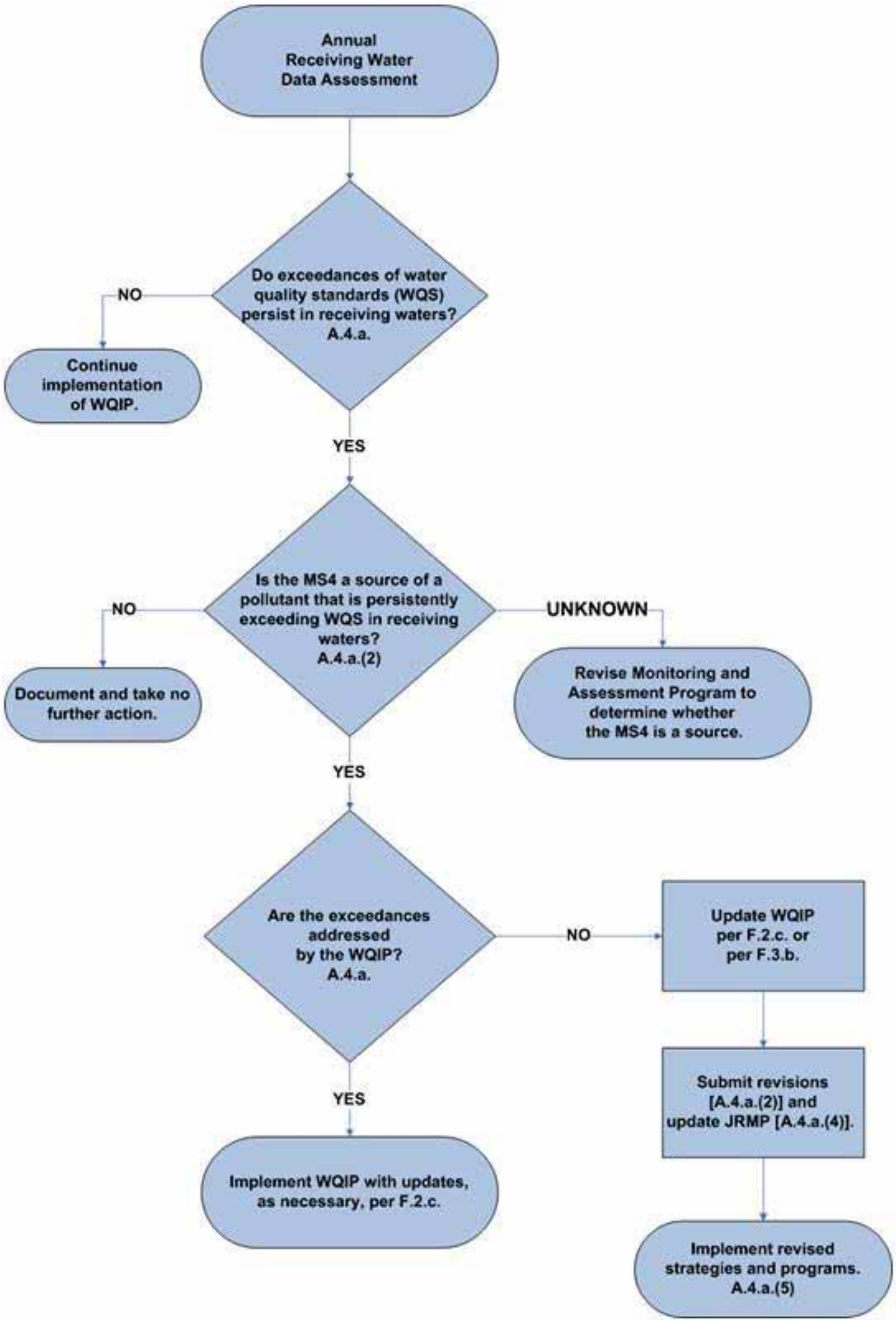

Figure 6-3
Receiving Water Exceedance Process (Provision A.4)

6.2.2 Annual Evaluation of New Information

The adaptive management process may also be triggered as new information becomes available (Provision B.5.b). Where appropriate, modifications may be made to goals, strategies, schedules, and/or the Monitoring and Assessment Program, and reported in the Water Quality Improvement Plan Annual Report. Types of new information that may trigger the adaptive management process as part of the annual assessment process are discussed below, including the potential trigger(s) for modification(s) and the resulting adaptive management process to be used.

Regulatory Drivers

Where new regulations or policies are adopted that impact Los Peñasquitos WMA planning and implementation processes in the near term, modifications to the Water Quality Improvement Plan goals, strategies, schedules, and/or Monitoring and Assessment Plan may be warranted and (in some cases) required. For example, an update to the Water Quality Improvement Plan will be initiated no later than six months following approval of a TMDL Basin Plan Amendment by the OAL and the USEPA. The trigger applies to TMDLs containing WLAs assigned to Responsible Agencies within the WMA during the term of the MS4 Permit (Provision F.2.c(2)). Other examples of regulatory drivers that may trigger modifications to the Water Quality Improvement Plan include new state policies (e.g., those related to trash, toxicity, biological objectives, and bacteria) and changes resulting from modifications to existing MS4 Permit requirements (e.g., as a result of a re-opener).

Special Study Results

As part of the Monitoring and Assessment Program, Responsible Agencies will perform special studies related to the highest priority water quality conditions for the Los Peñasquitos WMA. The special studies are designed to provide information that is related to sources of the highest priority water quality conditions within the Los Peñasquitos WMA, will be implemented during the MS4 Permit term, and are typically performed over multiple years. As relevant data, conclusions, and lessons learned become available from these studies, the Water Quality Improvement Plan may be modified. The study results may impact the goals, strategies, schedules, and monitoring and assessment plans. Additionally, lessons learned and study results from outside the Los Peñasquitos WMA, especially those related to sediment and bacteria impairments, may also be incorporated into the Water Quality Improvement Plan.

Program Effectiveness Assessments

Strategies developed within the Water Quality Improvement Plan will be incorporated into individual Responsible Agency programs through implementation of the JRMPs or the Stormwater Management Plan (SWMP), as applicable. Each Responsible Agency is implementing programs that focus on addressing the highest priority water quality conditions within the Los Peñasquitos WMA. While implementation of these programs has been ongoing in many cases, refinements to the programs provide additional focus on the particular water quality issues identified in the Water Quality Improvement Plan. Over time, Responsible Agencies will use various assessment methods to determine which program refinements are effective and which are not. In some cases, the program effectiveness assessment results may provide useful information leading to adaption of elements of the Water Quality Improvement Plan. As new information is applicable, it may be used to modify goals, strategies, schedules, and the Monitoring and Assessment Program.

Regional Board Recommendations

Adaptation of the Water Quality Improvement Plan may also be required on the basis of recommendations from the Regional Board. Recommendations may be from the public participation process, the Consultation Committee, review of submitted reports, or other Regional Board interests.

6.3 MS4 Permit Term Assessments and Adaptive Management

The MS4 Permit also contains specific assessments to be performed during the preparation of the Report of Waste Discharge. The assessments are longer-term, occurring only once during the MS4 Permit cycle. Because the updates to the Water Quality Improvement Plan are required to undergo a full public participation process per Provision F.2.c, including reconvening the Consultation Committee, modifications will consider input from the public and the Regional Board. Adaptation of Water Quality Improvement Plan elements will also consider new regulations or policies as appropriate. In the Report of Waste Discharge preparation, all elements of the Water Quality Improvement Plan are eligible for modifications through the required adaptive management processes. Elements that will be evaluated include the water quality conditions (i.e., priorities), goals and accompanying schedules, strategies and accompanying schedules, and the Monitoring and Assessment Program. Table 6-2 summarizes the triggers and adaptive management processes that are required as part of the Report of Waste Discharge.

Table 6-2
Adaptive Management on a Permit Term Basis (Report of Waste Discharge)

Plan Element	Adaptive Management Process Considerations
Priority Water Quality Conditions (B.5.a, D.4.d(1))	***Provision B.5.a, Iterative Approach and Adaptive Management Considerations*** ❖ Achievement of the outcome of improved water quality through the implementation of strategies identified in the Water Quality Improvement Plan ❖ New information developed in the re-assessment of receiving water conditions, impacts from MS4 discharges, and subsequent re-evaluation of priorities ❖ Spatial and temporal accuracy of monitoring data ❖ Availability of new information and data from sources outside the JRMP programs that inform the effectiveness of implementation strategies and actions ❖ Recommendations of the Regional Board ❖ Recommendations received through a public participation process
	Provision D.4.d(1), Integrated Assessment Considerations ❖ Re-evaluation of the receiving water conditions and the impacts of MS4 discharges on receiving waters per the process developed in Section 2 of the Water Quality Improvement Plan and included in Appendix A, including the identification of beneficial uses in receiving waters that are protected per the Monitoring and Assessment Program ❖ Re-evaluation of the identification of MS4 sources and/or stressors that correspond to elevation of a new highest priority

Table 6-2 (continued)
Adaptive Management on a Permit Term Basis (Report of Waste Discharge)

Plan Element	Adaptive Management Process Considerations
Water Quality Goals and Schedules (B.5.b, D.4.d(1))	***Provision B.5.b, Iterative Approach and Adaptive Management Considerations*** ❖ Modifications to the priority water quality conditions based on Provision B.5.a ❖ Progress toward achieving numeric goals for the highest priority water quality conditions ❖ Progress in meeting established schedules ❖ New policies or regulations that may affect goals ❖ Reductions of non-storm water discharges ❖ Reductions of pollutants in storm water discharges from MS4s to the MEP ❖ New information resulting from re-evaluating impacts from MS4 discharges and/or pollutants and stressors ❖ Efficiency in implementing the Water Quality Improvement Plan ❖ Recommendations of the Regional Board ❖ Recommendations received through a public participation process
	Provision D.4.d(1), Integrated Assessment Considerations ❖ Evaluation of the progress toward achieving interim and final numeric goals for protecting impacted beneficial uses in receiving waters
	Provision D.4.d(2), Integrated Assessment Considerations ❖ Identification of the non-storm water and storm water pollutant loads from the MS4 outfalls per Provision D.4.b ❖ Identification of the non-storm water and storm water pollutant load reductions, or other improvements that are necessary to attain the interim and final numeric goals ❖ Identification of the non-storm water and storm water pollutant load reductions, or other improvements, that are necessary to demonstrate that non-storm water and storm water discharges are not causing or contributing to exceedances of receiving water limitations ❖ Evaluation of the progress of the strategies toward achieving interim and final numeric goals for protecting beneficial uses in receiving waters

Table 6-2 (continued)
Adaptive Management on a Permit Term Basis (Report of Waste Discharge)

Plan Element	Adaptive Management Process Considerations
Monitoring and Assessment Program (B.5.c)	***Provision B.5.c, Iterative Approach and Adaptive Management Considerations*** ❖ Review of Monitoring and Assessment Programs based on the requirements in Provision D ❖ Adjustment of the monitoring program to determine whether discharges from the MS4 are causing/contributing to exceedances in the receiving water when new exceedances persist; identification and addressing of data gaps via re-assessment of monitoring locations and frequencies; adjustment of the monitoring program to address results of special studies

6.3.1 Priority Water Quality Conditions

The process for selecting the highest priority water quality condition(s) is documented in Section 2. Given the relatively short duration of the remainder of this MS4 Permit term after expected approval of the Water Quality Improvement Plan, the priority water quality conditions selected during the development of the Water Quality Improvement Plan will remain for the duration of the current term. They will be modified only on the basis of new information assessed as part of the Report of Waste Discharge. Data collected during the MS4 Permit term will be used to update the analysis of the priority water quality conditions based on the methodology described in Appendix A and implemented in Section 2.

6.3.2 Progress Toward Achieving Goals

As part of the preparation of the Report of Waste Discharge, the Responsible Agencies will evaluate the progress toward achieving the interim and final numeric goals established in Section 4.1. The Water Quality Improvement Plan interim goals identified for the current permit term are provided in Tables 6-3 through 6-6 along with the related assessment metric for each.

Table 6-3
City of Del Mar Jurisdictional Goals, FY14 – FY18

Numeric Goal	Unit of Measure	Assessment Period and Fiscal Year Current Permit Term (FY14–FY18)	Assessment Method
Wet Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria Reduction	Reduction in anthropogenic surface dry weather flows[1] that originate within the City's jurisdictional boundaries to address bacteria regrowth contributing during wet weather	Achieve a 10% reduction in anthropogenic surface dry weather flows[1] that originate within the City's jurisdictional boundaries from historical baseline	Summarize reduction in dry weather flow observed through MS4 Outfall monitoring program in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.
Dry Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria and Dry Weather Flow Reduction	Reduction in anthropogenic surface dry weather flows[1]	Achieve a 10% reduction in anthropogenic surface dry weather flows[1] from historical baseline	Summarize reduction in dry weather flow observed through MS4 Outfall monitoring program in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.

1. The term "dry weather flow" excludes groundwater, other exempt or permitted non-storm water flows, and sanitary sewer overflows.

Table 6-4
City of Poway Jurisdictional Goals, FY14 – FY18

Numeric Goal	Unit of Measure	Assessment Period and Fiscal Year Current Permit Term (FY14–FY18)	Assessment Method
Wet Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria and Sediment Reduction	Turf conversion	Achieve a 5% increase in turf conversion from baseline	Summarize percent increase in turf conversion in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.
Dry Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria and Dry Weather Flow Reduction	Turf conversion	Achieve a 5% increase in turf conversion from baseline	Summarize percent increase in turf conversion in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.

Table 6-5
City of San Diego Jurisdictional Goals, FY14 – FY18

Numeric Goal	Unit of Measure	Assessment Period and Fiscal Year Current Permit Term (FY14–FY18)	Assessment Method
Wet Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria and Sediment Reduction	Green Infrastructure Policy	Construct 9 green infrastructure BMPs to treat 36 acres of drainage area	Summarize the completed projects that capture and treat drainage from 36 acres in the January 2018 Water Quality Improvement Plan Annual Report.
Dry Weather Performance Measures			
MS4 Discharges Dry Weather Flow, Bacteria, and Sediment Reduction	Green Infrastructure Policy	Construct 9 green infrastructure BMPs to treat 36 acres of drainage area	Summarize the completed projects that capture and treat drainage from 36 acres in the January 2018 Water Quality Improvement Plan Annual Report.
OR			
MS4 Discharges Reduce Pollutants in Dry Weather Discharges	Dry weather flow reduction from baseline	Achieve a 10% reduction in flow[1] from historical baseline measured at persistently flowing outfalls in the WMA	Summarize the dry weather flow reduction observed through MS4 outfall monitoring program in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.

1. Does not include allowable discharges as defined in MS4 Permit Provision A and Provision E.2.a.

Table 6-6
County of San Diego Jurisdictional Goals, FY14 – FY18

Numeric Goal	Unit of Measure	Assessment Period and Fiscal Year Current Permit Term (FY14–FY18)	Assessment Method
Wet Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Bacteria Reduction	% bacterial load reduction	Implement programmatic (non-structural) BMPs to achieve source reduction of bacteria loads from the MS4 outfalls	Provide a summary of BMPs implemented in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.
MS4 Discharges Sediment Reduction	% sediment load reduction or verify allowable tons of sediment per year is met for Los Peñasquitos Creek and Carroll Canyon	Implement programmatic (non-structural) BMPs to achieve reduction of sediment loads from the MS4 outfalls	Provide a summary of BMPs implemented in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.
AND			
Lagoon Restoration	Goals for the restoration of 346 acres of salt marsh	Coordinate with watershed partners to determine restoration goals and establish monitoring protocols, as applicable	Summarize restoration goals and monitoring protocols in January 2018 Water Quality Improvement Plan Annual Report.

Table 6-6 (continued)
County of San Diego Jurisdictional Goals, FY14 – FY18

Numeric Goal	Unit of Measure	Assessment Period and Fiscal Year Current Permit Term (FY14–FY18)	Assessment Method
Dry Weather Performance Measures			
Performance Metrics		FY18	
MS4 Discharges Dry Weather Flow, Bacteria, and Sediment Reduction	Routine observations of MS4 outfalls to verify the absence of discharge to receiving water	Verify the effective elimination of anthropogenic dry weather flow from MS4 outfalls and use programmatic approaches to maintain compliance	Verify elimination of anthropogenic dry weather flows from MS4 outfalls in the Los Peñasquitos WMA in the January 2018 Water Quality Improvement Plan Annual Report.

The goals and compliance pathways will be assessed using data collected per the Monitoring and Assessment Program and JRMPs, along with the schedules developed in conjunction with each goal. Depending on the results of the assessment, it may be appropriate to adjust either or both of the numeric goals and/or the schedules associated with each goal. The exception is when the interim and/or final numeric goals and schedules are based on approved Bacteria TMDL compliance schedules; in this case, interim schedules may be modified. However, numeric targets (interim and final) and final schedules cannot be modified without changes to the Bacteria TMDL.

6.3.3 Strategies and Schedules

The strategies and implementation schedules developed to address the highest priority water quality conditions in the Los Peñasquitos WMA will be re-evaluated as part of the preparation of the Report of Waste Discharge. Ultimately, the effectiveness of the strategies will be based on the progress toward achieving the interim and final numeric goals. However, an evaluation of strategies based on the achievement of the interim and final numeric goals may take many years of implementation and monitoring to assess. To supplement the "goal-based" assessments, water quality and programmatic data collected over the MS4 Permit term will be incorporated into the assessment and adaptive management process to modify strategies and implementation schedules as appropriate.

Water Quality Data Evaluation of Strategies

Receiving water data will be assessed as described in Section 5.2.2. The assessment will indicate progress toward goals and protection of beneficial uses. These data may be used to evaluate the collective effectiveness of the Water Quality Improvement Plan strategies. This information will provide a "big picture" assessment of the success of the strategies over the long term.

MS4 outfall data and special studies results may provide information that is more directly linked to the implementation of individual strategies. Where possible, this information will be used to modify, eliminate, and/or develop new strategies to address the highest priority water quality conditions in the Los Peñasquitos WMA. Where appropriate, these assessments will include a comparison of the data with the NALs and SALs, as required by MS4 Permit Provision C. These data will provide the foundation for the MS4 outfall discharge assessments described in Section 5.2.3, which will examine the results of the Responsible Agencies' IDDE and MS4 outfall discharge monitoring programs. Where strategies can be linked to measurable or demonstrable reductions of non-storm water discharges or of pollutants in storm water, appropriate modifications will be made.

Program Assessments

Where available, the results of program effectiveness assessments performed on the jurisdictional or WMA scale may also drive the adaptation of specific strategies. The level of information will vary by jurisdiction and by program, because these types of assessments are not explicitly required under the MS4 Permit. However, in many cases, the jurisdictions are performing programmatic assessments to ensure the most effective use of limited resources. These assessments have the potential to provide information to determine the effectiveness of specific strategies that is more relevant than water quality data collected at outfalls or in receiving waters, and the assessments may be a key driver in adapting strategies. In some cases, modifications to strategies may also be the result of internal jurisdictional opportunities or constraints, such as increases or decreases in available funding or staffing.

6.3.4 Monitoring and Assessment Program

As part of the Report of Waste Discharge, the Responsible Agencies will consider modifications to the Monitoring and Assessment Program, consistent with the requirements in Provision D.4.d(3). During the MS4 Permit term, modifications must be consistent with the requirements of Provisions D.1, D.2, and D.3 (receiving water, MS4 outfall, and special study monitoring requirements, respectively), which limit the amount of adaptation that is possible. However, recommendations in the Report of Waste Discharge provide an opportunity to propose more meaningful modifications to the Monitoring and Assessment Program. Examples of potential modifications include adjustments to:

- Determine whether discharges from the MS4 are linked to exceedances in the receiving water
- Address data gaps via re-assessment of monitoring locations and frequencies
- Address results of special studies

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APPENDIX A

Priority and Highest Priority Water Quality Condition Selection Methodology

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APPENDIX A – Methodology for Selecting Priority and Highest Priority Water Quality Conditions

The methodology to select the priority and highest priority water quality conditions follows four steps.

Step 1: Determine Receiving Water Conditions (Permit B.2.a). The goal of the receiving water assessment is to determine the receiving water conditions in the watershed. Some receiving water conditions may be selected as priority water quality conditions if there is sufficient data showing that the MS4 is causing and contributing to the receiving water condition or if it is suspected that the MS4 may be causing and contributing but there is a gap in the data.

a. Information and data to evaluate receiving waters conditions includes:
    i. TMDLs;
    ii. 303(d) listings to determine impaired beneficial uses;
    iii. Sources that are provided as part of the 303(d) listing. (This is important if the 303(d) listing has called out the MS4 as a source);
    iv. RW limits for appropriate segments;
    v. Historic and current data from the LTEA and WURMP. (Associate a NPDES monitoring location with each watershed when available. The priorities listed by these documents exceed water quality benchmarks.); and
    vi. 3rd party data submitted in response to public data call.
b. Determine a receiving water condition based on the following criteria:
    i. TMDLs in the watershed applied upstream where appropriate;
    ii. All 303(d) listings;
    iii. All additional receiving water conditions identified by reviewing historic and current monitoring data; and
    iv. 3rd party data submitted in response to public data call.

Step 2: Determine Potential Receiving Water Impacts from MS4 Discharges (Permit B.2.b). Review MS4 Monitoring Data to determine potential receiving water impacts associated with MS4 discharges by assessing the following:

a. Outfall monitoring data provided in the WURMP and LTEA. (It is important to note that often only one MS4 wet weather outfall location is associated with each NPDES monitoring location, meaning that the analysis is done at the subwatershed level and not in the receiving water);
b. WQBELs where appropriate;
c. The 303(d) listing identifies the MS4 as a source; and
d. 3rd party data.

Step 3: Determine Priority Water Quality Conditions (Permit B.2.c.(1)). The goal of this step is to select the priority water quality conditions by analyzing the receiving water conditions based on the potential for the MS4 to cause and contribute to the condition. Priority water quality conditions may be identified based on the following criteria:

a. MS4 subwatershed outfall data compared to the receiving water condition. If the subwatershed level outfall data shows that MS4 is causing and contributing to the receiving water condition then it may be considered a priority water quality condition;
b. If there is no outfall monitoring data associated with the receiving water condition, the 303(d) listing will be referenced to determine if the MS4 is included as a source. If the MS4 is listed as a source, this receiving water condition may be considered a priority water quality condition with a data gap; and
c. Consider 3rd party input submitted in response to public data call.

Step 4: Determine Highest Priority Water Quality Condition(s) (Permit B.2.c.(2)). The MS4 Permit requires the Copermittees to identify the highest priority water quality conditions to be addressed by the Water Quality Improvement Plan, and provide a rationale for selecting a subset of the priority water quality conditions identified in Step 3. Because the MS4 Permit requires the development and identification of numeric goals, strategies, and schedules for the highest priority water quality conditions, a scientifically-based screening analysis of priority water quality conditions was applied. Conditions already subject to an approved TMDL, ASBS or other water quality regulation will be elevated to highest priority water quality condition.

The Responsible Agencies will identify priority water quality conditions not subject to an approved water quality regulation as a highest priority based on the following factors:

a. The supporting data set is sufficient to adequately characterize the degree to which the priority water quality condition changes seasonally, and over geographic area, to support its consideration as a highest priority water quality condition.
b. Storm water/ non-storm water runoff is a predominant source for the priority water quality condition.
c. The priority water quality condition is controllable by the Responsible Agencies.
d. The priority water quality condition would not be addressed by strategies identified for other highest priority water quality conditions in this Water Quality Improvement Plan.

APPENDIX B

Los Peñasquitos WMA Maps

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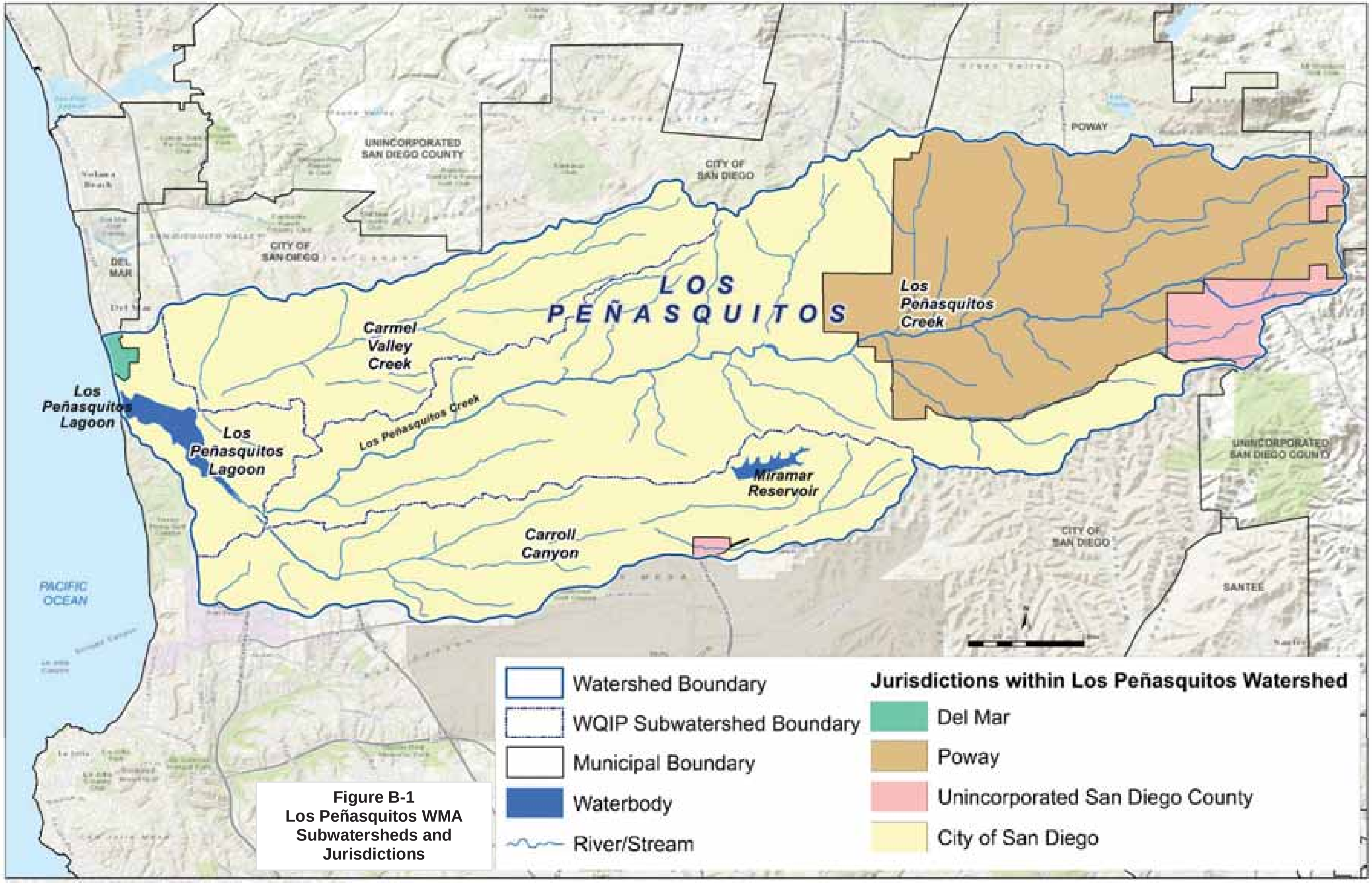

Figure B-1
Los Peñasquitos WMA Subwatersheds and Jurisdictions

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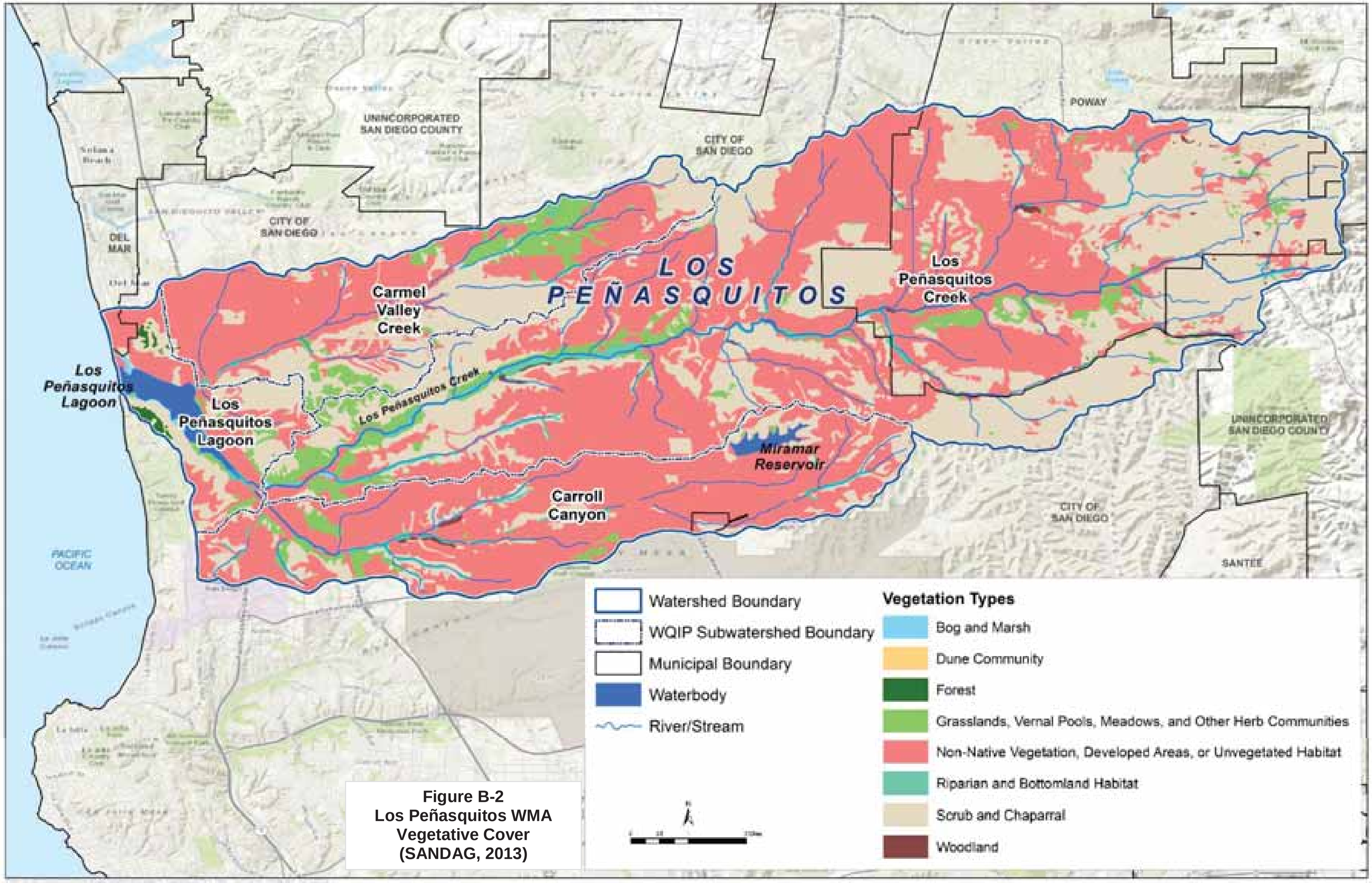

Figure B-2
Los Peñasquitos WMA
Vegetative Cover
(SANDAG, 2013)

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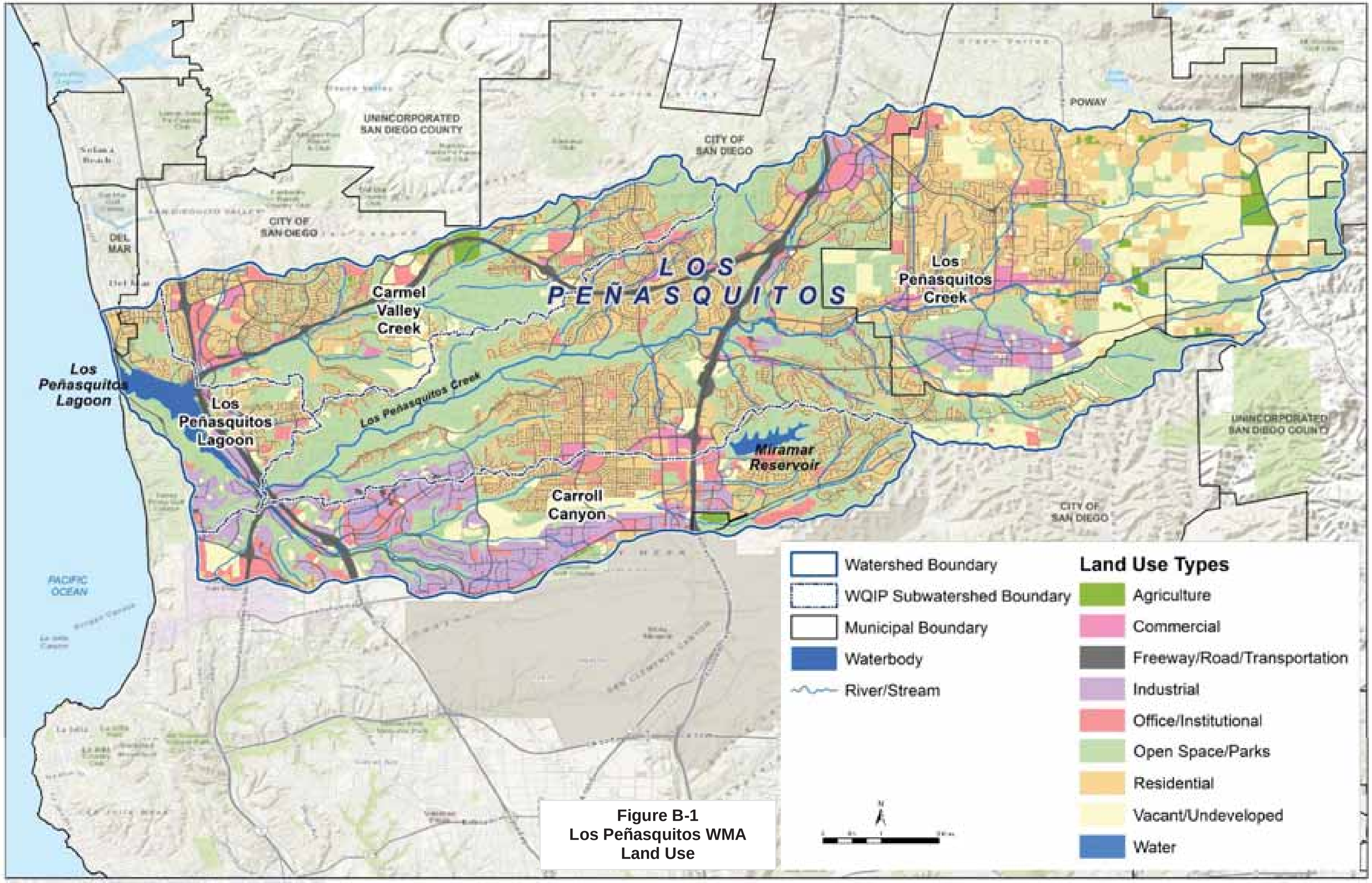

Figure B-1
Los Peñasquitos WMA
Land Use

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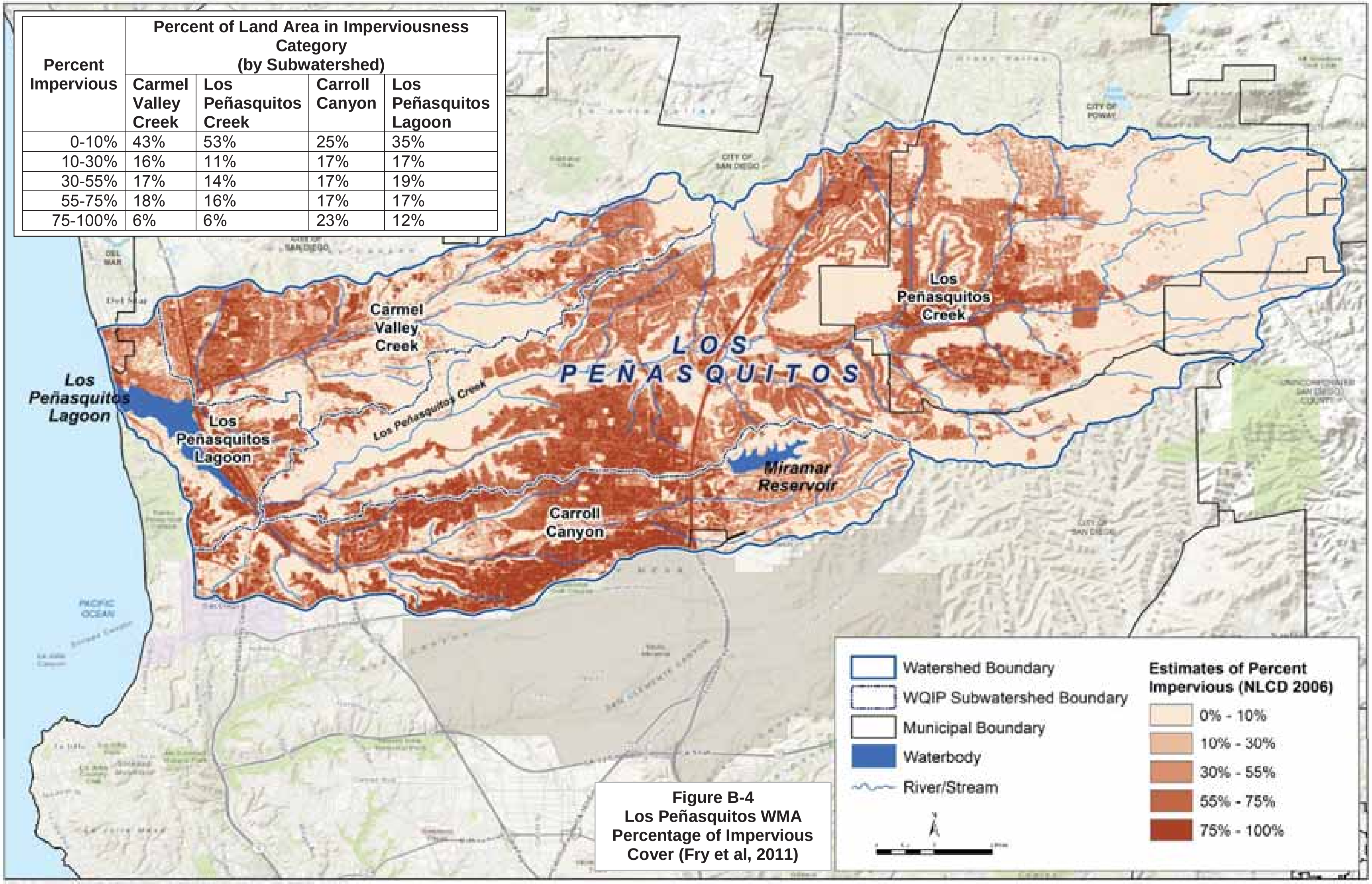

Percent Impervious	Percent of Land Area in Imperviousness Category (by Subwatershed)			
	Carmel Valley Creek	Los Peñasquitos Creek	Carroll Canyon	Los Peñasquitos Lagoon
0-10%	43%	53%	25%	35%
10-30%	16%	11%	17%	17%
30-55%	17%	14%	17%	19%
55-75%	18%	16%	17%	17%
75-100%	6%	6%	23%	12%

Figure B-4
Los Peñasquitos WMA Percentage of Impervious Cover (Fry et al, 2011)

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APPENDIX C

Beneficial Uses of 303(d) Listed Waterbodies in the Los Peñasquitos WMA

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Table C-1 presents the beneficial use designations of the 303(d) listed waterbodies in the Los Peñasquitos WMA. Beneficial uses specifically identified as impaired by the 2010 303(d) list are shaded blue. This table does not present waterbodies that were not identified as impaired on the 303(d) list. Approximately 92% of the waterbodies in the Los Peñasquitos WMA are not impaired or have not been assessed. Of those waterbodies that are listed as having impairments, most beneficial uses are attained.

Table C-1
Beneficial Uses of the 2010 303(d) Listed Waterbodies in the Los Peñasquitos WMA

303(d) Listed Waterbody Name	Beneficial Use																		
	MUN	AGR	IND	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN	NAV	COMM	EST	MAR	AQUA	MIGR	SHELL
Miramar Reservoir (in Los Peñasquitos Creek Subwatershed) (906.10)	●		●	●	●	●		● (impaired)		●									
Soledad Canyon (Carroll Canyon Creek) (906.10)	+	●	●		○	●		● (impaired)		●	●								
Poway Creek (906.20)	+	●	○		●	●		● (impaired)		●									
Los Peñasquitos Creek (906.20 and 906.10)	+	● (impaired)	●		●	●	●	● (impaired)	●	●									
Los Peñasquitos Lagoon (906.10)					●	●	● (impaired)			●	●	●			● (impaired)	●		●	●
Pacific Ocean Shoreline (906.10)			●		●	●	●			●	●	●	●	●		●	●	●	● (impaired)

Beneficial use is impaired based on the 2010 303(d) list (blue shading)
○ Potential beneficial use
● Existing beneficial use
+ Excepted from Municipal and Domestic Supply (MUN)

The definitions of beneficial uses that are impaired based on the 303(d) list in the Los Peñasquitos WMA are defined in the Basin Plan as follows:

- **Agricultural Supply (AGR)** includes uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
- **Preservation of Biological Habitats of Special Significance (BIOL)** includes uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.

- **Estuarine Habitat (EST)** includes uses of water that support estuarine ecosystems, including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).
- **Shellfish Harvesting (SHELL)** includes uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes.
- **Warm Freshwater Habitat (WARM)** includes uses of water that support warm water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

The beneficial uses in the Los Peñasquitos WMA which are not listed as impaired are defined in the Basin Plan as follows:

- **Aquaculture (AQUA)** includes the uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.
- **Cold Freshwater Habitat (COLD)** includes uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.
- **Commercial and Sport Fishing (COMM)** includes the uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
- **Industrial Service Supply (IND)** includes uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.
- **Marine Habitat (MAR)** includes uses of water that support marine ecosystems including, but not limited to, preservation or enhancement or marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).
- **Migration of Aquatic Organisms (MIGR)** includes uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.
- **Municipal and Domestic Supply (MUN)** includes uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
- **Navigation (NAV)** includes uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

- **Hydropower Generation (POW)** includes uses of water for hydropower generation.
- **Rare, Threatened, or Endangered Species (RARE)** includes uses of water that support habitats necessary, at least in part, for the survival and successful maintenance or plant or animal species established under state or federal law as rare, threatened, or endangered.
- **Contact Water Recreation (REC-1)** includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs.
- **Non-contact Water Recreation (REC-2)** includes the uses of water for recreational activities involving proximity to water but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
- **Shellfish Harvesting (SHELL)** includes uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters and mussels) for human consumption, commercial, or sport purposes.
- **Spawning, Reproduction, and/or Early Development (SPWN)** includes uses of water that support high quality habitats suitable for reproduction, early development and sustenance of marine fish and/or cold freshwater fish.
- **Wildlife Habitat (WILD)** includes uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

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APPENDIX D

Additional Data Sources

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APPENDIX D.1

Primary and Secondary Data Sources

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Primary and Secondary Data Sources

Primary References

2011 Long-Term Effectiveness Assessment. San Diego County Municipal Copermittees Urban Runoff Management Programs. Final Report
2011-2012 San Diego County Copermittee Receiving Waters and Urban Runoff Monitoring Report
2010-2011 San Diego County Copermittee Receiving Waters and Urban Runoff Monitoring Report
2008 City of Del Mar Jurisdictional Urban Runoff Management Plan (JURMP) (Including FY10 Annual Report)
2008 City of Poway JURMP (Including FY12 Annual Report)
2008 City of San Diego JURMP (Including FY11 and FY12 Annual Report)
2008 County of San Diego JURMP (Including FY11 and FY12 Annual Report)
Los Peñasquitos WURMP (Including FY11 and FY12 Annual Report)
Los Peñasquitos Watershed Comprehensive Load Reduction Plan (CLRP) Phase I

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APPENDIX D.2

Third Party Data Sources Summary

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Document:
San Diego Coastkeeper Data for Los Peñasquitos Watershed

Locations within watershed:
LPQ-020, LPQ -030, LPQ -040 (Los Peñasquitos Creek just upstream of the lagoon)

Conditions:
• Healthy levels of dissolved oxygen, pH, and temperature (basic water indicators of health). Most sites had elevated levels of electrical conductivity, especially during the dry season.
• Very low concentrations of dissolved metals. Only one sample slightly exceeded basin plan standards (cadmium in Carmel Creek). 99.2% of samples were below Basin Plan standards.
• Slightly elevated ammonia and phosphorus concentrations. Almost every sample showed ammonia and phosphorus levels at or slightly above Basin Plan thresholds.
• Generally low *E. coli* concentrations. 100% of samples met regulatory thresholds during the dry season. Compared to most of the region, the wet season had few samples that exceeded the threshold.
• Moderate levels of *Enterococcus*. Unlike E. coli, these results are not heavily tied to the wet or dry season; exceedances are spread through the whole year.

Sources:
No Data

Strategies:
No Data

Document:
Interstate 5/State Route 56 Interchange Project Water Quality Report, 2010

Locations within watershed:
Project drains to Carmel Valley Creek, Los Peñasquitos Creek, Los Peñasquitos Lagoon

Conditions:
• Los Peñasquitos Creek was 303(d) listed for phosphate and TDS, Los Peñasquitos Lagoon was listed for sedimentation/siltation
• Pollutants potentially added due to construction and/or operation = sediment, vehicle fluids, various chemical compounds, rubble/litter, nutrients from tree leaves, nitrite from exhaust, pesticides, metals, etc
• Hydromodification due to impervious surface addition

Sources:
Document identified construction activities as having short term impact on storm water runoff

Strategies:
• Temporary impacts will be avoided or minimized by the use of construction site best management practices (BMPs) such as fiber rolls, hydraulic mulch, drainage inlet protection, check dams, concrete washouts, construction entrances, and street sweeping.
• Phosphate and sediment will be targeted for treatment.

Document:
Public Input Form – Paula Roberts

Locations within watershed:
No data

Conditions:
No data

Sources:
No data

Strategies:
• Potential to use historical data from (illegible name) Creek Watershed District.
• Suggests leveraging satellite photos for longitudinal studies of water quality as well as data collected by local classrooms as part of global project.

Document:
Email from Jeff Carr of Poway to TSW Think Blue

Locations within watershed:
No Data

Conditions:
No Data

Sources:
• Residential runoff
• Swimming pools
• Parking lots and roads

Strategies:
• Swimming pool draining: suggests draining swimming pools into sewer, since pool water can be source of chemicals, algae, and debris as well as deteriorating streets and picking up additional debris when flowing into storm drains. Mr. Carr also suggests that this would not increase sewer charges for homeowners/cities because of how residential sewer charges are calculated: the homeowner with the pool is paying sewer fees for that water whether it's put in the sewer or not.
• Property drainage: suggests replacement of concrete gutter drains with swale or bioswale to reduce year round flows into storm drains. Mr. Carr also suggests updates to building codes to promote alternatives to standard concrete gutter drains.
• Parking lots and roads: suggests that in addition to contaminants from cars, road material can deteriorate due to surface damage and end up in storm drains via runoff. Mr. Carr suggests requiring municipalities/private property owners to properly maintain roads and parking lots to prevent deterioration that will end up in storm drains. Additionally, Mr. Carr notes there are many private and/or gated communities with access to city storm drains that do not receive City street sweeping (though residents pay for it via taxes). Mr. Carr suggests that HOAs should be required to perform similar maintenance activities or allow City street sweeping services to be extended into these private communities in an effort to maintain clean storm drains.

Document:
City of San Diego Strategic Plan for Watershed Activity Implementation, input from Consultation Committee

Locations within watershed:
Not specified

Conditions:
The following priority conditions were identified:
- Bacteria
- Nutrients
- Sediments
- Total Dissolved Solids
- Benthic Alterations

Sources:
Potential Sources include:
- Eating and Drinking Establishments
- Residential Areas and Activities
- Commercial Landscaping
- Animal Related Facilities
- Golf Courses, Parks, and Recreational Activities
- Municipal Facilities and Activities
- Auto Related Facilities
- Roads, Streets, Highways, and Parking Facilities
- Construction Activities

Strategies:
No data (Strategies identified through 2011 only)

Document:
Download SWAMP data from CEDEN website using the following search parameters – San Diego County and SWAMP RWB 9 Monitoring

http://ceden.waterboards.ca.gov/AdvancedQueryTool

Locations within watershed:
See red highlighted waterbodies in the table on Page C-9.

Conditions:
SWAMP monitoring data available from CEDEN for Region 9 was reviewed to determine if the data provide additional priority water quality conditions. Many of the programs included 1 -4 sampling events and measured a range of parameters. A majority of the monitoring occurred before the 2005 and 2011 LTEAs that incorporated the most recent regional monitoring data for the region. No additional conditions were selected based on a review of the data.

Sources:
No Data

Strategies:
No Data

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Project Name from CEDEN	Years	Station Name(s)	Temporal	No. of Sampling Events	Matrix	Summary of General Analyses
Statewide Project Urban Pyrethroid Status Monitoring		Peñasquitos Creek @ Springbrook	dry weather	1	sediment	TOC, % fines, moisture, and pyrethroids
RWB9 Status Sampling 2008	2008	Campo Creek 1, Ironside Creek, Los Peñasquitos Creek 6, Rose Canyon Creek 4	dry weather	1	water, benthic	field measurements, comments noted, velocity, algae, and conventional chemistry
RWB9 Rotational BA Monitoring 2005	2005	Santa Ysabel Creek ~2mi E Hwy 79	dry weather	1	physical	field measurements, velocity, and slope profile
RWB9 Rotational Monitoring 2002	2002	Los Peñasquitos Creek 6, Poway Creek 2, Rose Canyon Creek 4, Soledad Canyon Creek 2, and Soledad Canyon Creek 4	dry weather	1-4	water, sediment	field measurements, conventional chemistry, metals, herbicides, pesticides, and velocity. % fines
RWB9 Rotational Monitoring 2003	2003	Green Valley Creek 2, San Dieguito River 9, Santa Ysabel Creek 1	dry weather	2-4	water, sediment	Field measurements, conventional chemistry, metals, herbicides, pesticides, and velocity. % fines
San Diego Regional Board Fire Study	2005, 2007, 2008, 2009	Black Mountain Creek Upstream of Santa Ysabel Creek, Boden Canyon Creek (BOD), Boden Canyon Creek ~0.5 mile upstream of Santa Ysabel Creek , Chicarita Creek downstream of Evening Creek Road, Green Valley Creek 2, Kit Carson Creek Sunset Drive crossing	dry weather	1-3	water	field measurements and velocity
Statewide Perennial Streams Assessment 2008	2008	Encinitas Creek, Arroyo Trabuco 57, Santa Ysabel Creek	dry weather	1	water, benthic	field measurements, comments noted, velocity, algae, and conventional chemistry
CMAP Wadeable Streams 2004	2004	Santa Ysabel Creek below Witch Creek	dry weather	2	water	field measurements and velocity

continued on next page

Project Name from CEDEN	Years	Station Name(s)	Temporal	No. of Sampling Events	Matrix	Summary of General Analyses
Statewide Ref Condition Management Plan 2009	2009	Noble Canyon Creek ~0.8mi above Pine Valley Cr.	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2010	2010	Cedar Creek 2, Japacha Creek above Hwy 79, Spring Canyon Creek ~2.3mi above Hwy 74	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2008	2008	Arroyo Trabuco	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Management Plan 2011	2011	Cold Spring Canyon above Devil Cyn Creek, Devils Canyon Creek above San Mateo Cyn. Creek, Juaquapin Creek above Sweetwater River, Kitchen Creek at Kitchen Creek Road, Troy Canyon Creek (TCC2), Wilson Creek 3	dry weather	1	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Mgmt Plan Index Study 2009	2009	Noble Canyon Creek ~0.8mi above Pine Valley Cr.	dry weather	2	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Ref Condition Mgmt Plan Index Study 2010	2010	Cedar Creek 2	dry weather	4	water, benthic	field measurements, conventional chemistry, algae and velocity
Statewide Stream Pollution Trends Study 2008	2008, 2009, 2010	Agua Hedionda Creek 6, Escondido Creek at Camino del Norte, Forrester Creek 2, Los Peñasquitos Creek 6, San Diego River at Ward Road, San Dieguito River 9, San Juan Creek 9, Santa Margarita at Basilone Rd, Soledad Canyon Creek 4, Tijuana River at Hollister Rd	dry weather	1	sediment	Organics, PCBs, Pyrethroids, Pesticides, Semi-volatile Organic Carbons, metals

APPENDIX D.3

Persistent Flow Outfall Summary

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Potential Persistent Flow Outfalls[1]

Jurisdiction[2]	Subwatershed	Site ID	Latitude	Longitude	Land Use
City of San Diego[3]	Carmel Valley Creek	DW0017	32.96954	-117.13830	Residential
		DW0034	32.94366	-117.24016	Commercial
		DW0036	32.94300	-117.21310	Residential
		DW0037	32.94293	-117.21227	Residential/Commercial
		DW0281	32.94786	-117.20860	Residential
		DW0402	32.95021	-117.19780	Residential
		DW0422	32.93138	-117.20519	Residential
	Carroll Canyon	DW0027	32.90409	-117.15680	Residential
		DW0030	32.89081	-117.19461	Commercial/Industrial
		DW0031	32.89174	-117.18453	Industrial
		DW0064	32.88284	-117.17248	Industrial
		DW0266	32.90228	-117.16409	Residential
		DW0353	32.91149	-117.10614	Residential
		DW0429	32.89021	-117.15368	Industrial/Open Space
		DW0478	32.90555	-117.10285	Residential
		DW0481	32.90559	-117.09524	Residential/Open Space
		DW0643	32.88952	-117.16110	Industrial
		DW0692	32.88822	-117.22084	Industrial/Open Space
		DW0839	32.89915	-117.11371	Industrial
	Los Peñasquitos Creek	DW0024	32.92319	-117.14947	Residential
		DW0025	32.92164	-117.14905	Residential
		DW0247	32.96909	-117.09382	Residential
		DW0290	32.94188	-117.11442	Residential
		DW0302	32.91386	-117.17438	Industrial
		DW0308	32.91070	-117.18990	Industrial
		DW0375	32.92349	-117.21081	Residential
		DW0435	32.91739	-117.15250	Residential/Commercial
		DW0638	32.90833	-117.18039	Industrial
City of Del Mar	Los Peñasquitos Lagoon	S-12	32.94241	-117.26268	Open Space & Residential
City of Poway	Los Peñasquitos Creek	282-1749, 1	32.94269	-117.065	Residential
		282-1749, 3 (DW Site 2)	32.94177	-117.059	Open Space/Parks & Recreation
		282-1749, 2	32.9486	-117.062	Vacant/Undeveloped
		298-1749, 4 (123)	32.99228	-117.058	Road
		298-1749, 5	32.99311	-117.058	Freeway

1. This list of persistent flow outfalls is current based on 2014 dry weather monitoring data.
2. No outfalls with persistent dry weather flow have been identified in Caltrans or County of San Diego jurisdictions.
3. Identified land uses for the City of San Diego include all land uses comprising more than 30% of upstream drainage area.

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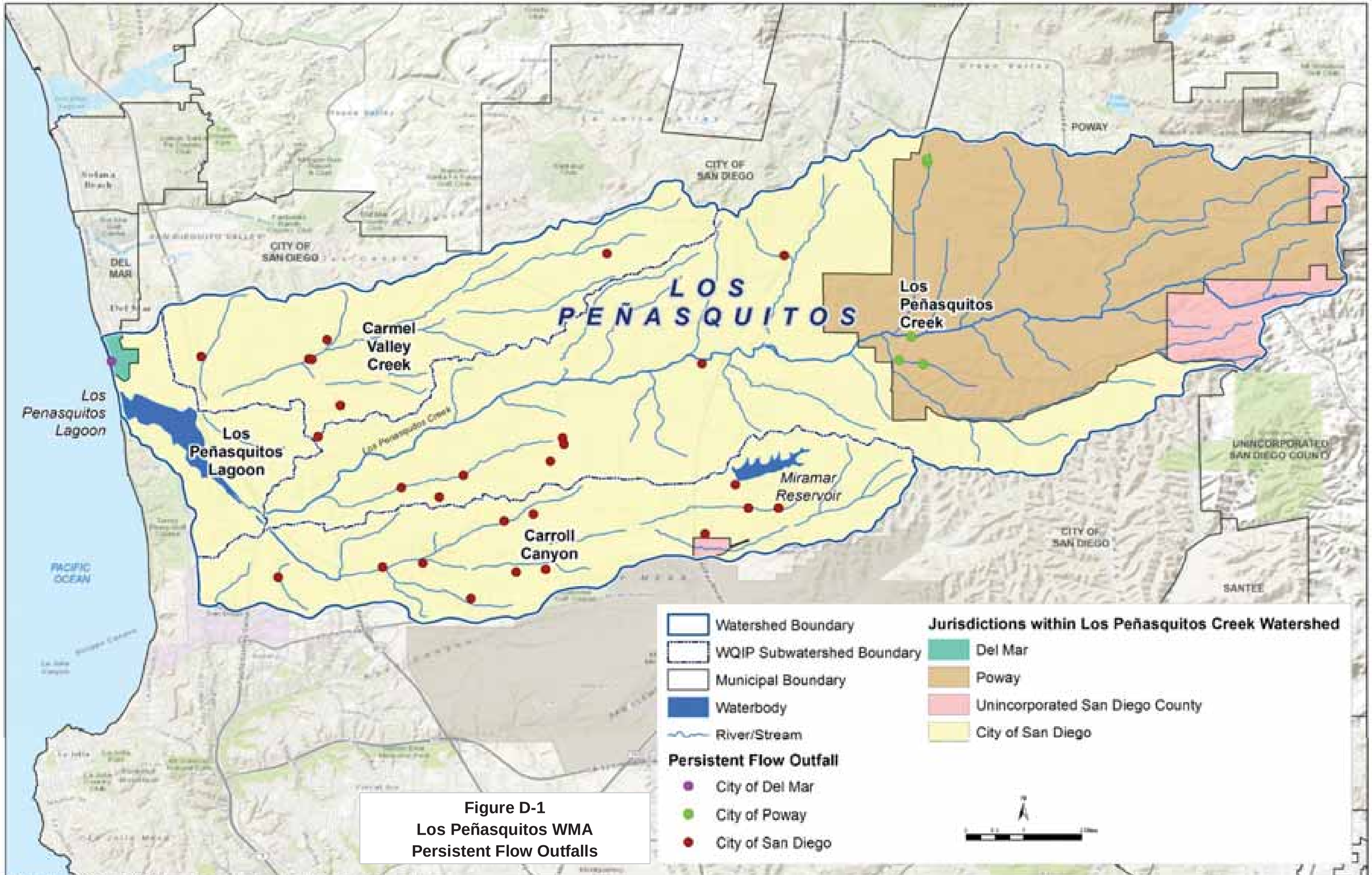

Figure D-1
Los Peñasquitos WMA
Persistent Flow Outfalls

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APPENDIX D.4

Public Input from Water Quality Improvement Plan Workshop

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Public Input

Priority Water Quality Conditions

- Erosion
- Velocity
- Sedimentation/Siltration
- Freshwater input – dry weather flows
- Nutrients
- Bacteria

Sources

- Industrial activities (sand and gravel) cause sediment issues
- Primarily non-point sources located along the watershed lagoon boundaries
- Deteriorating road materials

Potential Water Quality Strategies

- Curb cuts – retrofits
- Fungus (mycelium) that removes contaminants in soil and slow moving waterways as researched by Paul Stamets
- Targeted street sweeping
- Traffic slowing – no braking – such as roundabouts
- Stopping sediment closer to the source by improving maintenance to access roads and trails
- Man-made wetlands
- Return concrete channels back to natural state
- Day-lighting underground channels
- Build detention basins in recreational facilities
- Continue coordination with the Los Peñasquitos Lagoon Foundation and California State Parks with regard to planning efforts and activities within the Los Peñasquitos Watershed and Lagoon

- Address existing TMDL constituents of concern for Los Peñasquitos Lagoon (i.e. sediment/siltation and bacteria) and its tributaries (e.g. phosphorus, TDS).
- Consider approaches for reducing loading of other 303(d) constituents of concern (e.g. nutrients) and/or conditions (e.g. habitat conversion) to avoid additional TMDLs for Los Peñasquitos Lagoon and tributaries in the future
- Consider approaches for managing water input into the watershed and Lagoon from storm events and dry weather flows that can contribute to pollutant loading, habitat conversion and breeding habitat for *Culex tasalis* (freshwater species of mosquito known to transmit West Nile virus)
- Review swimming pool draining policies – fast moving water can contaminate storm water even if it is de-chlorinated
- Adjust building codes to promote alternatives to concrete gutter drains such as bioswales or swales.
- Require municipalities and private land owners to properly maintain roads and parking lots to prevent deterioration
- Require communities such as HOAs in Poway to sweep their streets on a regular basis

Data

- SMARTS database from the Regional Board
- Construction permits
- Locational data
- Historical data
- 1st water data from 1914 USGS
- Caltrans data
- Hydro geo morphological – erosion – Prescott 1975 and 1982
- CVREP Sediment transport study
- Developers studies – check with DSD
- Review Minnehaha Creek Watershed District in Minneapolis/St. Paul – they have longitudinal studies of satellite photos for water quality data

APPENDIX E

Receiving Water Condition and Urban Runoff Assessment

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Appendix E –Receiving Water Condition and Urban Runoff Assessment

Appendices E.1 and E.2 present an assessment of receiving water conditions and the impact of urban discharges in Los Peñasquitos WMA during wet and dry weather, respectively. The list of receiving water conditions was developed on the basis of the 2010 303(d) list, applicable TMDLs, waterbodies with special biological significance, public input, and the priority pollutants or stressors identified from current and historical receiving water monitoring data. MS4 monitoring data compiled from the LTEA and WURMP Annual Reports, as well as any applicable TMDL WQBELs, are also evaluated in relation to the receiving water conditions to determine if a priority water quality condition existed.

The tables in Appendices E.1 and E.2 are presented by WQIP Subwatershed and 303(d) listed waterbody. In order to mirror the process used by the Responsible Agencies to assess the potential receiving water conditions for each waterbody, the data are presented in the order they were evaluated. The following is an illustration of how the reader might follow the process used to assess receiving water conditions in an example waterbody (Example Waterbody A):

- **303(d) Listings (Page E-5, reading left to right)** identifies the WQIP subwatershed, applicable TMDLs, and 303(d) listed waterbody (Example Waterbody A), and then presents the associated pollutants, impaired beneficial uses, and potential sources of impairment for Example Waterbody A as identified under the 2010 303(d) list.
- **Receiving Water Assessment and Conditions (Page E-6, reading left to right)**
  - **Receiving Water Assessment** identifies the WQIP subwatershed, applicable TMDLs, and 303(d) listed waterbody (Example Waterbody A), and then presents public input submitted in response to the public data call and NPDES receiving water monitoring station data for Example Waterbody A. The receiving water priorities identified were noted as exceeding water quality benchmarks in the 2005-2010 LTEA, the FY 11 & 12 WURMP, or both.
  - **Receiving Water Conditions** summarizes the receiving water conditions identified through the 303(d) listings and receiving water assessment, and states the applicable lines of evidence.
- **Urban Runoff Monitoring Assessment (Page E-7, reading left to right)** identifies the WQIP subwatershed and 303(d) listed waterbody (Example Waterbody A), and then presents the priority pollutants at the MS4 outfall, based on the Urban Runoff Monitoring Program and identified in the 2005-2010 LTEA and FY 11&12 WURMP Annual Reports, for Example Waterbody A. as well as the applicable WQBELs where appropriate.

Page E-8 then restarts the assessment with an evaluation of 303(d) listings for the next waterbody.

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APPENDIX E.1

Wet Weather Receiving Water Condition Assessment

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WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	Selenium	Warm Freshwater Habitat	Source Unknown, Unknown Non-point Source, Urban Runoff/Storm Sewers
			Sediment Toxicity	Warm Freshwater Habitat	Unknown Point Source, Unknown Non-point Source
		Miramar Reservoir	Total Nitrogen as N	Warm Freshwater Habitat	Source Unknown

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Condition(s)	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP		
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	Erosion, velocity, sedimentation/siltation, freshwater input, nutrients, bacteria	LPC-TWAS-1	Turbidity, TSS, Bifenthrin, Fecal Coliform, TDS	TSS, Turbidity, Bifenthrin, pH, Very Poor IBI ***Based on one sample in analysis***, Fecal Coliform, TDS	Impairment of WARM from selenium in Soledad Canyon during wet weather.	303(d)
							Impairment of WARM due to sediment toxicity in Soledad Canyon during wet weather.	303(d)
							Elevated fecal coliform near NPDES monitoring locations during wet weather.	RW monitoring data (historic & current)
							TDS not included because impact to WARM during wet weather is unknown. TDS will be listed as contributing to impairment of WARM during dry weather.	
							Elevated bifenthrin near NPDES monitoring locations during wet weather.	RW monitoring data (historic & current)
							Elevated TSS and turbidity near NPDES monitoring locations during wet weather.	RW monitoring data (historic & current)
		Miramar Reservoir		NA	NA	NA	Eutrophic conditions (total nitrogen) not included because impact to WARM during wet weather is unknown. Eutrophic conditions (total nitrogren) will be listed as contributing to impairment of WARM during dry weather.	

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL(s)
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	Fecal Coliform	Fecal Coliform	Sediment Load, Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Miramar Reservoir	NA	NA	

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	*Enterococcus*	Warm Freshwater Habitat	Source Unknown
			Fecal Coliform	Warm Freshwater Habitat	Source Unknown
			Selenium	Warm Freshwater Habitat	Source Unknown
			Total Nitrogen as N	Warm Freshwater Habitat	Source Unknown
			TDS	Agricultural Supply	Source Unknown
			Toxicity	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
		Poway Creek	Selenium	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
			Toxicity	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Condition(s)	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP		
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	Same as above	LPC-MLS, LPC-TWAS-2	TDS, TSS, Turbidity, Bifenthrin, Diazinon, Toxicity (*H. azteca* acute survival), Fecal Coliform	Toxicity (*H. azteca* acute), Very Poor IBI ***Based on one sample in analysis***, Fecal Coliform, TDS, TSS, Turbidity, Bifenthrin	Impairment of WARM due to *Enterococcus* in Los Peñasquitos Creek during wet weather.	303(d)
							Impairment of WARM due to fecal coliform in Los Peñasquitos Creek during wet weather	303(d) and RW monitoring data
							Impairment of WARM due to selenium in Los Peñasquitos Creek during wet weather.	303(d)
							Eutrophic conditions (total nitrogen) not included because impact to WARM during wet weather is unknown. Eutrophic conditions (total nitrogren) will be listed as contributing to impairment of WARM during dry weather.	
							Impairment of AGR due to TDS in Los Peñasquitos Creek during wet weather	303(d) and RW monitoring data
							Impairment of WARM due to toxicity in Los Peñasquitos Creek during wet weather.	303(d) and RW monitoring data
							Elevated bifenthrin near NPDES monitoring locations in Los Peñasquitos Creek during wet weather.	RW monitoring data (historic & current)
							Elevated TSS and turbidity near NPDES monitoring locations in in Los Peñasquitos Creek during wet weather.	RW monitoring data (historic & current)
		Poway Creek					Impairment of WARM due to selenium in Poway Creek during wet weather.	303(d)
							Impairment of WARM due to toxicity in Poway Creek during wet weather.	303(d) and RW monitoring data

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL(s)
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	Fecal Coliform, TDS	Fecal Coliform	Sediment Load, Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Poway Creek			

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listing(s)		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	NA	NA	NA
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	Sedimentation/ Siltation	Estuarine Habitat	Non-point Source, Point Source
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar	Indicator Bacteria	Water Contact Recreation	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth	Total Coliform	Shellfish Harvesting	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment				Receiving Water Conditions	
			Public Input	NPDES Receiving Water			Receiving Water Condition(s)	Line(s) of Evidence
				Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP		
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	Same as above	NA	NA	NA	NA	NA
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	Same as above	LPC-TWAS-1, LPC-MLS	Turbidity, TSS, Bifenthrin, Fecal Coliform, TDS	TSS, Turbidity, Bifenthrin, pH, Very Poor IBI ***Based on one sample in analysis***, Fecal Coliform, TDS	Impairment of BIOL and EST due to sedimentation in Los Peñasquitos Lagoon during wet weather.	303(d), Draft Sediment TMDL, RW monitoring data (historic & current; Turbidity and TSS)
							Elevated bacteria near NPDES monitoring locations in Los Peñasquitos Lagoon during wet weather.	RW monitoring data (historic & current)
							Elevated bifenthrin near NPDES monitoring locations in Los Peñasquitos Lagoon during wet weather.	RW monitoring data (historic & current)
							Elevated TDS near NPDES monitoring locations in Los Peñasquitos Lagoon during wet weather.	RW monitoring data (historic & current)
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar					Impairment of REC-1 due to indicator bacteria of the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar during wet weather.	Bacteria TMDL
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth					Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Los Peñasquitos River Mouth during wet weather.	303(d)

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL(s)
			2005-2010 LTEA	FY 11 & 12 WURMP	WQBELs
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	NA	NA	Sediment Load, Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	Fecal Coliform, TDS	Fecal Coliform	Sediment Load, Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar	No coastal outfall data	No coastal outfall data	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth	No coastal outfall data	No coastal outfall data	NA

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APPENDIX E.2

Dry Weather Receiving Water Condition Assessment

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WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	Selenium	Warm Freshwater Habitat	Source Unknown, Unknown Non-point Source, Urban Runoff/Storm Sewers
			Sediment Toxicity	Warm Freshwater Habitat	Unknown Point Source, Unknown Non-point Source
		Miramar Reservoir	Total Nitrogen as N	Warm Freshwater Habitat	Source Unknown

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment					Receiving Water Conditions	
			NPDES Receiving Water			SMC Program			
			Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP	Receiving Water Conditions	Line(s) of Evidence
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	LPC-TWAS-1	Toxicity (*C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, *Enterococcus* , TDS	Toxicity (*S. capricornutum* acute), Very Poor IBI ***Based on one sample in analysis***, TDS, *Enterococcus* (Coastkeeper)	NA	NA	Impairment of WARM from selenium in Soledad Canyon during dry weather.	303(d)
								Impairment of WARM due to sediment toxicity in Soledad Canyon during dry weather.	303(d)
								Elevated *Enterococcus* near NPDES monitoring locations during dry weather.	RW monitoring data (historic & current)
								Elevated TDS near NPDES monitoring locations during dry weather.	RW monitoring data (historic & current)
								Poor -Very Poor IBI scores near NPDES monitoring locations during dry weather.	RW monitoring data (historic & current)
		Miramar Reservoir	NA	NA	NA	NA	NA	Impairment of WARM due to eutrophic conditions (total nitrogen) in Miramar Reservoir during dry weather.	303(d)

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			FY 11 & 12 WURMP	2005-2010 LTEA	WQBELs
Carroll Canyon Creek	Draft Sediment TMDL and Bacteria TMDL	Soledad Canyon	*Enterococcus* , Fecal Coliform, Total N, Total P, TDS	Dissolved Copper, *Enterococcus* , TDS, Total N, Total P	Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Miramar Reservoir			

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	*Enterococcus*	Warm Freshwater Habitat	Source Unknown
			Fecal Coliform	Warm Freshwater Habitat	Source Unknown
			Selenium	Warm Freshwater Habitat	Source Unknown
			Total Nitrogen as N	Warm Freshwater Habitat	Source Unknown
			TDS	Agricultural Supply	Source Unknown
			Toxicity	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
		Poway Creek	Selenium	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
			Toxicity	Warm Freshwater Habitat	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment					Receiving Water Conditions	
			NPDES Receiving Water			SMC Program		Receiving Water Conditions	Line(s) of Evidence
			Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP		
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	LPC-MLS, LPC-TWAS-2	Toxicity (*C. dubia* reproduction), Poor IBI, O/E, *Enterococcus* , Benthic Algae, Total N, Total P, TDS	Toxicity (*S. capricornutum* acute), Very Poor IBI ***Based on one sample in analysis*** *Enterococcus* , Total P, Dissolved P, TDS	Chloride, Sulfates, Very Poor IBI, O/E, Total P, TDS	DO, Chloride, Sulfates, Poor IBI, Total N, Total P, TDS	Impairment of WARM due to *Enterococcus* in Los Peñasquitos Creek during dry weather.	303(d)
								Impairment of WARM due to fecal coliform in Los Peñasquitos Creek during dry weather.	303(d) and RW monitoring data
								Impairment of WARM due to selenium in Los Peñasquitos Creek during dry weather.	303(d)
								Impairment of WARM due to eutrophication (total nitrogen) in Los Peñasquitos Creek during dry weather.	303(d) and RW monitoring data
								Impairment of AGR due to TDS in Los Peñasquitos Creek during dry weather.	303(d) and RW monitoring data
								Impairment of WARM due to toxicity in Los Peñasquitos Creek during dry weather.	303(d) and RW monitoring data
								Poor -Very Poor IBI scores near NPDES monitoring locations in Los Peñasquitos Creek during dry weather.	RW monitoring data (historic & current)
								Elevated chloride near the SMC monitoring location in Los Peñasquitos Creek during dry weather.	SMC RW monitoring data
								Elevated sulfates near the SMC monitoring location in Los Peñasquitos Creek during dry weather.	SMC RW monitoring data
		Poway Creek						Impairment of WARM due to selenium in Poway Creek during dry weather.	303(d)
								Impairment of WARM due to toxicity in Poway Creek during dry weather.	303(d) and RW monitoring data

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			FY 11 & 12 WURMP	2005-2010 LTEA	WQBELs
Los Peñasquitos Creek	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Creek	*Enterococcus* , Fecal Coliform, Total N, Total P, TDS	*Enterococcus* , Fecal Coliform, Total N, Total P, TDS	Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
		Poway Creek			

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	303(d) Listings		
			Pollutant(s)	Impaired Beneficial Use(s)	Potential Source(s)
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	NA	NA	NA
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	Sedimentation/ Siltation	Estuarine Habitat	Non-point Source, Point Source
			Freshwater Input		
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar	Indicator Bacteria	Contact Water Recreation	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth	Total Coliform	Shellfish Harvesting	Unknown Non-point Source, Unknown Point Source, Urban Runoff/Storm Sewers

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Receiving Water Assessment					Receiving Water Conditions	
			NPDES Receiving Water			SMC Program			
			Applicable Receiving Water Station(s)	2005-2010 LTEA	FY 11 & 12 WURMP	2005-2010 LTEA	FY 11 & 12 WURMP	Receiving Water Conditions	Line(s) of Evidence
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	NA	NA	NA	NA	NA	NA	NA
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	LPC-TWAS-1, LPC-MLS	Toxicity (*C. dubia* reproduction, *S. capricornutum* acute), Poor IBI, O/E, *Enterococcus* , Benthic Algae, Total N, TDS	Toxicity (*S. capricornutum* acute, Very Poor IBI ***Based on one sample in analysis***, *Enterococcus* , Total P, Dissolved P, TDS,	NA	NA	Impairment of EST and BIOL due to freshwater intrusion in Los Peñasquitos Lagoon during dry weather.	303(d) and Draft Sediment TMDL
								Elevated bacteria near NPDES monitoring locations in Los Peñasquitos Lagoon during dry weather.	RW monitoring data (current)
								Poor -Very Poor IBI scores near NPDES monitoring locations in Los Peñasquitos Lagoon during dry weather.	RW monitoring data (historic & current)
								Impairment of WARM from eutrophic conditions (total phosphorus, dissolved phosphorus, benthic algae, and total nitrogen) in Los Peñasquitos Lagoon during dry weather.	RW monitoring data
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar						Impairment of REC-1 due to indicator bacteria of the Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar during dry weather.	Bacteria TMDL
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth						Impairment of REC-1 due to total coliform of the Pacific Ocean Shoreline at Los Peñasquitos River Mouth during dry weather.	303(d)

WQIP Subwatershed	TMDL	303(d) Listed Waterbody	Urban Runoff Monitoring Assessment		
			MS4 Outfall and Dry Weather Monitoring Program		TMDL
			FY 11 & 12 WURMP	2005-2010 LTEA	WQBELs
Carmel Valley Creek	Draft Sediment TMDL and Bacteria TMDL	N/A	NA	NA	Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
Los Peñasquitos Lagoon	Draft Sediment TMDL and Bacteria TMDL	Los Peñasquitos Lagoon	*Enterococcus* , Fecal Coliform, Total N, Total P, TDS	Dissolved Copper, *Enterococcus* , Fecal Coliform, Total N, Total P, TDS	Lagoon Restoration (Order No. R9-2012-0033), *Enterococcus* , Fecal Coliform (Order No. R9-2013-0001; Attachment E.6)
	Bacteria TMDL	Pacific Ocean Shoreline, at Torrey Pines State Beach at Del Mar	No coastal outfall data	No coastal outfall data	*Enterococcus* , Fecal Coliform, Total Coliform (Order No. R9-2013-0001; Attachment E.6)
		Pacific Ocean Shoreline, at Los Peñasquitos River Mouth	No coastal outfall data	No coastal outfall data	NA

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APPENDIX F

Receiving Water Conditions, Potential Impacts of MS4 Discharges, and Priority Water Quality Conditions in the Los Peñasquitos WMA

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This appendix contains details of the analysis of receiving water conditions (Section 2.1), impacts from MS4 discharges (Section 2.2), and the factors that were evaluated to develop the final list of priority water quality conditions and high priority water quality conditions. The information is presented in three tables, which are described below.

Table F-1: Receiving Water Conditions and Potential Impacts of MS4 Discharges in the Los Peñasquitos WMA

Table F-1 presents all identified receiving water conditions in the Los Peñasquitos WMA and the potential impacts of the MS4 discharges. These conditions were identified as described in Sections 2.1 and 2.2 based on the considerations detailed in the table. These include:

- Available receiving water data (current or historic) or regulatory drivers that support the condition. A check mark in the table indicates that samples have exceeded water quality objectives or the 2010 303(d) list or a TMDL identifies the waterbody as impaired. Where possible, the data were divided by temporal extent (wet- or dry-weather).
- Available current or historic MS4 monitoring data indicating that the MS4 potentially causes or contributes to the condition. A check mark indicates that samples collected from the MS4 during wet- or dry-weather have exceeded water quality objectives. MS4 data from the subwatershed was typically used for this consideration; data for MS4 discharges directly to the receiving water body in question are rarely available.
- Identification of the MS4 as a source of the condition in the 2010 303(d) list or a TMDL.
- The factors that led to the determination that the condition exists and was therefore included in the table.

Table F-2: Priority Water Quality Conditions in the Los Peñasquitos WMA Subwatersheds

Table F-2 presents the following information for each priority water quality condition per the MS4 Permit (Provision B.2.b):

- The beneficial use impairment(s) associated with the priority water quality condition;
- The pollutant or stressor causing the beneficial use impairment, if known;
- The temporal extent of the priority water quality condition (dry and/or wet weather);
- The geographical extent of the priority water quality condition within the WMA, if known (based on the extent of the associated 303(d) listing or the location of the associated NPDES monitoring location);

- Lines of evidence leading to identification as a priority water quality condition, including evidence of MS4 discharges that may cause or contribute to the condition; and
- An assessment of the adequacy of the monitoring data to characterize the factors causing or contributing to the priority water quality condition, including consideration of spatial and temporal variation.

The table also lists the Responsible Agencies that potentially contribute to the condition. The contents of this table were determined by the assessment of the receiving water conditions and the MS4 impacts (presented in Table F-1).

Table F-3: Evaluation of Priority Water Quality Conditions in the Los Peñasquitos WMA

As described in Section 2.3, priority water quality conditions that were identified based on the methodology presented in Appendix A. The remaining priority water quality conditions were evaluated based on several factors to determine if they warranted elevation to high priority water quality conditions for this iteration of the Water Quality Improvement Plan. Table F-3 summarizes this evaluation. The priority water quality condition must meet all of the following criteria to be considered a high priority water quality condition:

- Supporting data are sufficient to characterize the receiving water condition. To be sufficient, multiple samples collected under quality controlled monitoring must have exceeded water quality objectives.
- Storm water or non-stormwater runoff is a predominant source. Samples or observations collected under quality controlled monitoring programs must indicate that MS4 discharges are a predominant source of the receiving water condition.
- Controllable by Responsible Agencies. The pollutant or stressor must be within the authority of the Responsible Agency to control. To be considered controllable, there must be a clear link between the MS4 contribution and the receiving water condition, and the potential strategies to address the condition must be applicable to the geographic extent of the condition.
- Cannot be addressed by strategies identified for other high priority water quality condition s. The condition was not elevated to a high priority water quality condition if strategies identified for other high priority water quality conditions are expected to address the condition

Table F-1
Receiving Water Conditions and Potential Impacts of MS4 Discharges in the Los Peñasquitos WMA

Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Carroll Canyon	Miramar Reservoir	Impairment of WARM due to eutrophic[1] conditions (total nitrogen as N)	–	✓	2010 303(d)	–	✓	–	Yes
	Soledad Canyon Creek	Impairment of WARM due to sediment toxicity	✓	✓	2010 303(d)	–	–	–	No; Toxicity cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
		Impairment of WARM due to selenium	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes
		Elevated *Enterococcus* near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data	–	✓	–	Yes
		Elevated fecal coliform near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data, public input	✓	–	–	Yes
		Elevated TDS near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data, public input	–	✓	–	Yes
		Elevated bifenthrin near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated TSS and turbidity near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Poor to very poor IBI scores near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data	–	–	–	No; Poor to very poor IBI scores cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
Los Peñasquitos Creek	Poway Creek	Impairment of WARM due to selenium and toxicity	✓	✓	2010 303(d) and receiving water monitoring data (toxicity only)	–	–	Wet, Dry	Yes
	Los Peñasquitos Creek	Impairment of WARM due to *Enterococcus*	✓	✓	2010 303(d) and current and historical outfall and receiving water monitoring data, public input	–	✓	–	Yes
		Impairment of WARM due to fecal coliform	✓	✓	2010 303(d) and current and historical outfall and receiving water monitoring data, public input	✓	–	–	Yes
		Impairment of WARM due to selenium	✓	✓	2010 303(d)	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of WARM due to toxicity	✓	✓	2010 303(d) and receiving water monitoring data	–	–	Wet, Dry	Yes
		Impairment of WARM due to eutrophication[1] (total nitrogen)	–	✓	2010 303(d) and receiving water monitoring data, public input	–	✓	–	Yes
		Elevated total phosphorus and dissolved phosphorus near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data, public input	–	✓	–	Yes

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
		Benthic algae growth near NPDES monitoring locations	–	✓	Historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Impairment of AGR due to TDS	✓	✓	2010 303(d) and receiving water monitoring data	✓	✓	–	Yes
Los Peñasquitos Creek	Los Peñasquitos Creek	Elevated bifenthrin near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated TSS and turbidity near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Poor to very poor IBI scores near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data	–	–	–	No; Poor to very poor IBI scores cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.
		Elevated chloride near the Southern California Stormwater Monitoring Coalition (SMC) monitoring location in Los Peñasquitos Creek	–	✓	SMC receiving water data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated sulfate near the SMC monitoring location in Los Peñasquitos Creek	–	✓	SMC receiving water data	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
Carmel Valley Creek	Carmel Valley Creek	No receiving water conditions were found	–	–	N/A	–	–	–	No; no receiving water conditions found
Los Peñasquitos Lagoon	Los Peñasquitos Lagoon	Impairment of EST and BIOL due to hydromodification, siltation, and sedimentation	✓	–	2010 303(d), Draft Sediment TMDL, and current and historical receiving water monitoring data, public input	✓	–	Wet	Yes
		Impairment of EST and BIOL due to freshwater discharges	–	✓	2010 303(d) and Draft Sediment TMDL, public input	–	✓	Dry	Yes
		Elevated *Enterococcus* near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data, public input	–	✓	–	Yes
		Elevated fecal coliform near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data, public input	✓	–	–	Yes
		Elevated bifenthrin near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data, public input	–	–	–	No; no MS4 data to justify designation as priority water quality condition.
		Elevated TDS near NPDES monitoring locations	✓	–	Current and historical receiving water monitoring data, public input	✓	–	–	Yes
		Poor to very poor IBI scores near NPDES monitoring locations	–	✓	Current and historical receiving water monitoring data, public input	–	–	–	No; Poor to very poor IBI scores cannot be identified as a priority water quality condition because the full impact of all environmental contributions including the MS4 have not been characterized.

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Subwatershed	Waterbody	Condition	Receiving Water Data or Regulatory Drivers Support Consideration as a Receiving Water Condition		Determining Factor(s) For Receiving Water Data	MS4 Monitoring Data Indicates Potential MS4 Impact		MS4 Listed As Source on 303(d) or TMDL	Elevated to Priority Water Quality Condition?
			Wet	Dry		Wet	Dry		
Los Peñasquitos Lagoon	Los Peñasquitos Lagoon	Elevated total phosphorus, dissolved phosphorus, benthic algae, and total nitrogen near NPDES monitoring locations	–	✓	Receiving water monitoring data, public input	–	✓	–	Yes
	Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	Impairment of REC-1 due to indicator bacteria (total coliform, fecal coliform, *Enterococcus*)	✓	✓	Bacteria TMDL	–	–	Wet, Dry	Yes
	Pacific Ocean Shoreline at Los Peñasquitos River Mouth	Impairment of SHELL due to total coliform	✓	✓	2010 303(d)	–	–	Wet, Dry	Yes

1. Only listed as a dry weather condition based on best professional judgment that wet weather impacts are not quantifiable.
✓= Criterion applies to temporal extent. – = Criterion does not apply to temporal extent. N/A = Not Applicable

Table F-2
Priority Water Quality Conditions in the Los Peñasquitos WMA Subwatersheds

Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Carroll Canyon Subwatershed											
Impairment of WARM in Miramar Reservoir	Eutrophic conditions (total nitrogen)	Dry	Miramar Reservoir 2010 303(d) listed segment	Current and historical subwatershed level outfall monitoring data	Y	Y	—	—	—	✓	—
Potential impairment of REC-1 in Soledad Canyon Creek	*Enterococcus*	Dry	Soledad Canyon Creek near NPDES monitoring location	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y	—	—	—	✓	—
Potential impairment of REC-1 in Soledad Canyon Creek	Fecal coliform	Wet	Soledad Canyon Creek near NPDES monitoring location	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y	—	—	—	✓	—
Impairment of WARM in Soledad Canyon Creek	Selenium	Wet, Dry	Soledad Canyon Creek 2010 303(d) listed segment	Urban runoff and storm sewers 2010 303(d) listed as source	Y	Y	—	—	—	✓	—
Potential Impairment of WARM in Soledad Canyon Creek	TDS	Dry	Soledad Canyon Creek near NPDES monitoring location	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y	—	—	—	✓	—

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Carroll Canyon Creek Subwatershed											
Potential Impairment of EST and BIOL in Los Peñasquitos Lagoon	Freshwater discharges	Dry	Soledad Canyon Creek near point of discharge to the Lagoon	Draft Sediment TMDL	N	N	—	—	—	✓	—
	Hydromodifi-cation, siltation, and sedimentation	Wet	Soledad Canyon Creek near point of discharge to the Lagoon	Current and historical receiving water monitoring data for TSS and turbidity; Draft Sediment TMDL	N	N	—	—	—	✓	—
Potential impairment of REC-1 in Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	*Enterococcus*, fecal coliform, total coliform	Wet, Dry	Soledad Canyon Creek MS4 discharges	WQBELs assigned per Bacteria TMDL	N	N	—	—	—	✓	—
Los Peñasquitos Creek Subwatershed											
Impairment of WARM in Poway Creek	Selenium	Wet, Dry	Poway Creek 2010 303(d) listed segment	Urban runoff, storm sewers 2010 303(d) listed as source	Y	Y	—	—	✓	—	✓
	Toxicity		Poway Creek 2010 303(d) listed segment	Urban runoff, storm sewers 2010 303(d) listed as source; receiving water monitoring data	N	Y	—	—	✓	—	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Los Peñasquitos Creek Subwatershed											
Potential impairment of WARM in Los Peñasquitos Creek	Eutrophic conditions (total phosphorus and dissolved phosphorus)	Dry	Los Peñasquitos Creek near NPDES monitoring location	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y[3]	—	—	—	✓	—
Impairment of WARM in Los Peñasquitos Creek	Eutrophic conditions (total nitrogen)	Dry	Los Peñasquitos Creek 2010 303(d) listed segment	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y[3]	—	—	—	✓	—
	Enterococcus	Wet, Dry	Los Peñasquitos Creek 2010 303(d) listed segment	Current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y	✓	—	—	✓	—
	Fecal coliform	Wet, Dry									
	Toxicity	Wet, Dry	Los Peñasquitos Creek 2010 303(d) listed segment	Storm sewers 2010 303(d) listed as source; current and historical receiving water	Y	Y[3]	✓	—	—	✓	—
Impairment of AGR in Los Peñasquitos Creek	TDS	Wet, Dry	Los Peñasquitos Creek 2010 303(d) listed segment	2010 303(d) listed; current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y[3]	✓	—	—	✓	—
Potential Impairment of in Los Peñasquitos Creek[4]	*Enterococcus* and fecal coliform	Dry	Los Peñasquitos Creek 2010 303(d) listed segment	2010 303(d) listed; current and historical receiving water; current and historical subwatershed level outfall monitoring data	N	Y	—	—	—	✓	—

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Los Peñasquitos Creek Subwatershed											
Potential Impairment of EST and BIOL in Los Peñasquitos Lagoon	Hydromodification, siltation, and sedimentation	Wet	Los Peñasquitos Creek near point of discharge to Lagoon	Current and historical receiving water monitoring data for TSS and turbidity; Draft Sediment TMDL	N	N	✓	—	✓	✓	✓
	Freshwater discharges	Dry	Los Peñasquitos Creek near point of discharge to Lagoon	Draft Sediment TMDL	N	Y	—	—	✓	✓	✓
Potential Impairment of REC-1 in Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	*Enterococcus*, fecal coliform, total coliform	Wet, Dry	Los Peñasquitos Creek MS4 discharges	WQBELs assigned per Bacteria TMDL	N	Y	✓	—	✓	✓	✓
Carmel Valley Creek Subwatershed											
Potential Impairment of EST and BIOL in Los Peñasquitos Lagoon	Freshwater discharges	Dry	Carmel Valley Creek near point of discharge to the Lagoon	Draft Sediment TMDL	Y	Y	—	—	—	✓	—
	Hydromodification, siltation, and sedimentation	Wet			Y	Y	—	—	—	✓	—

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Carmel Valley Creek Subwatershed											
Potential Impairment of REC-1 in Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	Carmel Valley Creek MS4 discharges	WQBELs assigned per Bacteria TMDL	Y	Y	—	—	—	✓	—
Los Peñasquitos Lagoon Subwatershed											
Potential impairment of WARM or BIOL at NPDES monitoring locations upstream of Los Peñasquitos Lagoon	TDS	Wet	NPDES monitoring locations upstream of Lagoon	Current and historical receiving water monitoring data located upstream of the Lagoon; historical subwatershed level outfall monitoring data	Y	Y	✓	✓	✓	✓	✓
Impairment of EST and BIOL in Los Peñasquitos Lagoon	Hydromodification, sedimentation and siltation	Wet	Los Peñasquitos Lagoon	Current and historical receiving water monitoring data for TSS and turbidity; Draft Sediment TMDL	N	N	✓	✓	✓	✓	✓
	Freshwater discharges	Dry	Los Peñasquitos Lagoon	2010 303(d) listed; Draft Sediment TMDL	N	N	—	✓	✓	✓	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Los Peñasquitos Lagoon Subwatershed											
Potential impairment of WARM or BIOL in Los Peñasquitos Lagoon	Total phosphorus Dissolved phosphorus Benthic algae Total nitrogen	Dry	NPDES monitoring locations upstream of Lagoon	Receiving water monitoring data; public input	Y	Y	✓	✓	✓	✓	✓
Potential Impairment of REC-1 in Los Peñasquitos Lagoon	*Enterococcus*	Dry	NPDES monitoring locations upstream of Lagoon	Current and historical receiving water monitoring data located upstream of the Lagoon; historical subwatershed level outfall monitoring data	Y	Y	✓	✓	✓	✓	✓
	Fecal coliform	Wet			Y	Y	✓	✓	✓	✓	✓
Potential Impairment of REC-1 in Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	*Enterococcus* Fecal coliform, and total coliform	Wet, Dry	Los Peñasquitos Lagoon MS4 discharges	WQBELs assigned per Bacteria TMDL	N	N	✓	✓	✓	✓	✓

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Priority Water Quality Condition (1)	Potential Stressor(s) (2)	Temporal Extent (3)	Geographical Extent (4)	Determining Factors (5)	Data Gaps (6)		Potentially Responsible Agencies				
					RW[1]	MS4[2]	CT	DM	P	SD	CO
Los Peñasquitos Lagoon Subwatershed											
Impairment of REC-1 in Pacific Ocean Shoreline at Torrey Pines State Beach at Del Mar	*Enterococcus*, fecal coliform, and total coliform	Wet, Dry	Pacific Ocean Shoreline at Torrey Pines 2010 303(d) listed segment	Bacteria TMDL	N	N	✓	✓	✓	✓	✓
Impairment of SHELL in Pacific Ocean Shoreline at Los Peñasquitos River Mouth	Total coliform	Wet, Dry	Pacific Ocean Shoreline at Los Peñasquitos River Mouth	2010 303(d)	N	N	✓	✓	✓	✓	✓

1. Are there gaps in the RW data used to characterize the priority water quality condition? (Y = yes; N = no)
2. Are there gaps in the MS4 data used to characterize the geographical contribution of the MS4 to priority water quality condition? (Y = yes; N = no)
3. Data are available to indicate the MS4 may be contributing to the priority water quality condition, but the full impact is unknown because all environmental contributions have not been characterized.
4. Based on the Bacteria TMDL.

CO = County of San Diego; CT = California Department of Transportation (Caltrans); DM = City of Del Mar; P = City of Poway; RW= Receiving Water; SD = City of San Diego

Table F-3
Evaluation of Priority Water Quality Conditions in the Los Peñasquitos WMA

Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Are Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/ Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed By Identified Strategies
Los Peñasquitos Creek	Impairment of WARM in Poway Creek	Selenium	—	—	—	✓
		Toxicity	✓	—	—	✓
	Potential impairment of WARM in Los Peñasquitos Creek	Eutrophic conditions (total phosphorus and dissolved phosphorus)	✓	—	—	—
	Impairment of WARM in Los Peñasquitos Creek	Eutrophic conditions (total nitrogen)	✓	—	—	—
		Enterococcus	✓	—	—	—
		Fecal coliform	✓	—	—	—
		Toxicity	✓	—	—	✓
	Impairment of AGR in Los Peñasquitos Creek	TDS	✓	—	—	✓
	Potential Impairment of REC-1 in Los Peñasquitos Creek	*Enterococcus* and fecal coliform	✓	—	—	—
Carroll Canyon	Impairment of WARM in Miramar Reservoir	Eutrophic conditions (total nitrogen)	✓	—	—	—
	Potential impairment of REC-1 in Soledad Canyon Creek	*Enterococcus*	✓	—	—	—

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Sub-watershed	Priority Water Quality Condition	Potential Stressor(s)	(a) Supporting Data Are Sufficient to Characterize the Receiving Water Conditions	(b) Storm Water/ Non-Storm Water Runoff Predominant Source	(c) Controllable by Responsible Agencies[1]	(d) Cannot Be Addressed By Identified Strategies
Carroll Canyon	Potential impairment of REC-1 in Soledad Canyon Creek	Fecal coliform	✓	—	—	—
	Impairment of WARM in Soledad Canyon Creek	Selenium	—	—	—	✓
	Potential Impairment of WARM in Soledad Canyon Creek	TDS	✓	—	—	✓
Carmel Valley Creek	All priority water quality conditions have been elevated to a highest priority water quality condition based on the review of the WMA regulatory drivers.					
Los Peñasquitos Lagoon	Potential impairment of WARM or BIOL at NPDES monitoring locations upstream of Los Peñasquitos Lagoon	TDS	—	—	—	✓
	Potential Impairment of REC-1 in Los Peñasquitos Lagoon	*Enterococcus*	—	—	—	—
	Potential Impairment of REC-1 in Los Peñasquitos Lagoon	Fecal coliform	—	—	—	—
	Impairment of SHELL in Pacific Ocean Shoreline at Los Peñasquitos River Mouth	Total coliform	—	—	—	—

"✓" – The criterion is met for the priority water quality condition.
"—" – The criterion is not met for the priority water quality condition.
1. The priority water quality condition is considered controllable if two criteria are met: (1) There is a clear link between the MS4 contribution and the receiving water conditions, and (2) The potential strategies that apply to the potential stressor are applicable for the drainage area of the receiving water condition.

APPENDIX G

Bacterial Conceptual Models and Literature Review

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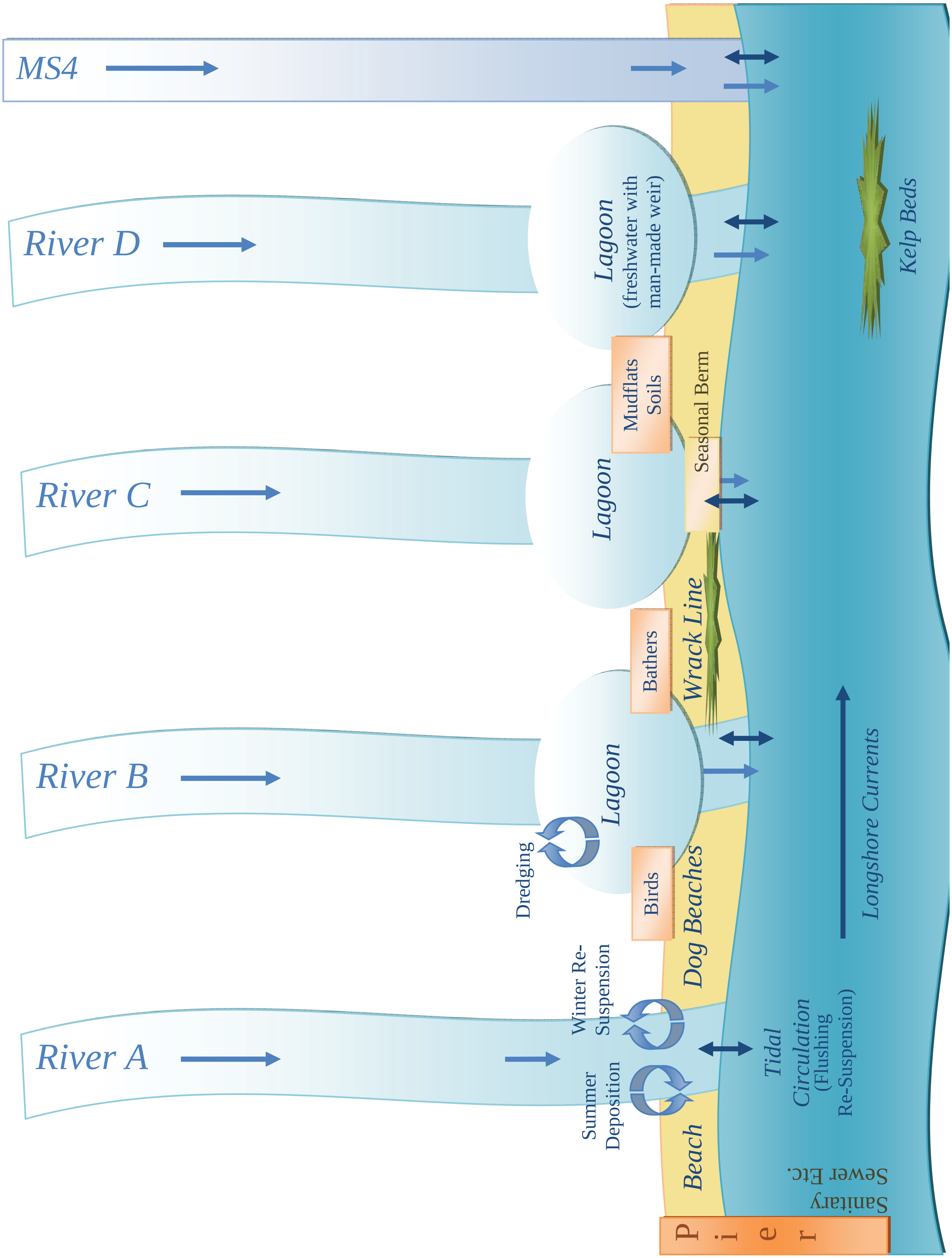

MS4
River D
River C
River B
River A
Lagoon
(freshwater with
man-made weir)
Lagoon
Lagoon
Mudflats
Soils
Seasonal Berm
Bathers
Wrack Line
Birds
Dog Beaches
Dredging
Winter Re-
Suspension
Summer
Deposition
Beach
Tidal
Circulation
(Flushing
Re-Suspension)
Longshore Currents
Kelp Beds
Sanitary
Sewer Etc.
P
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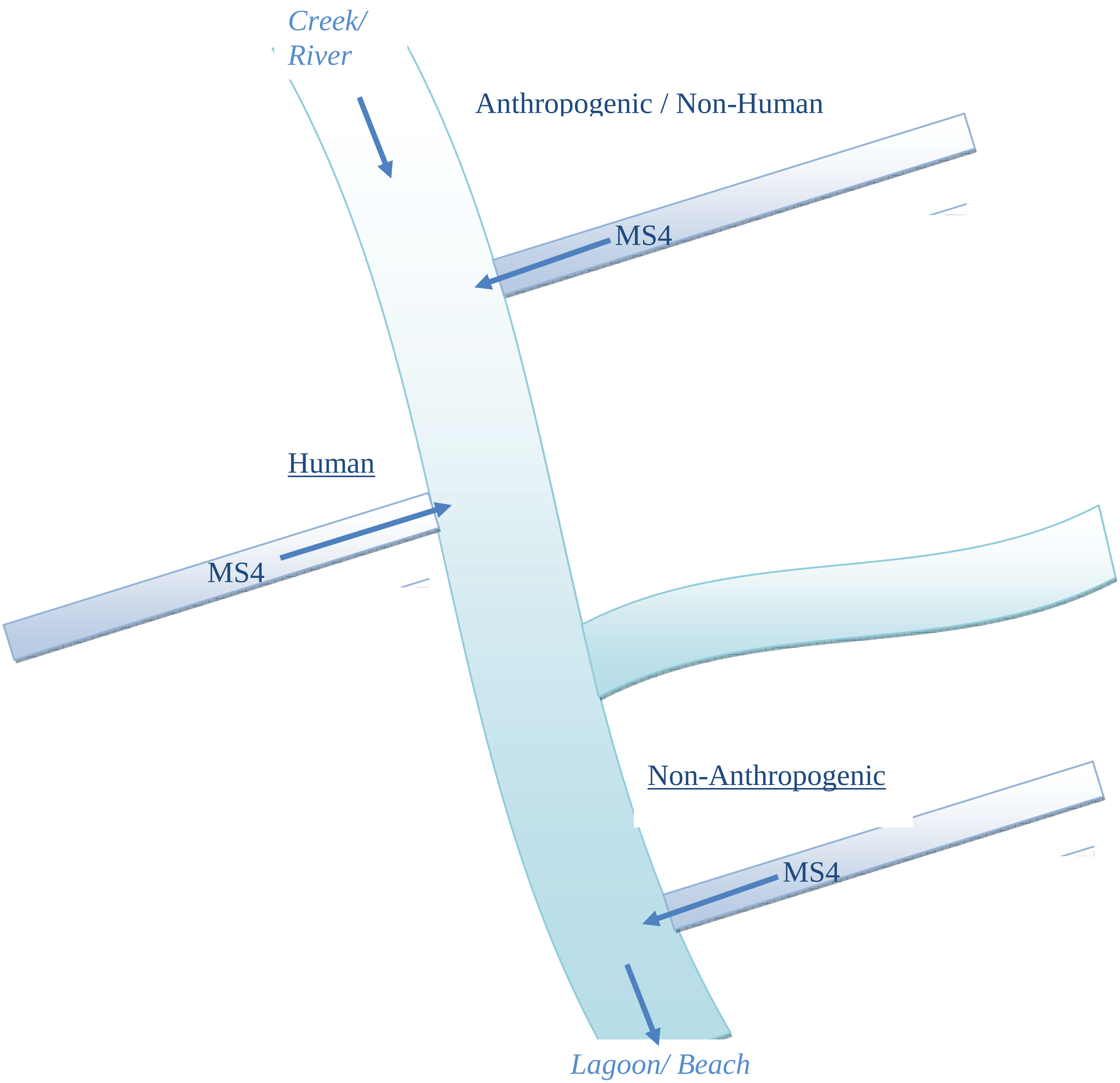
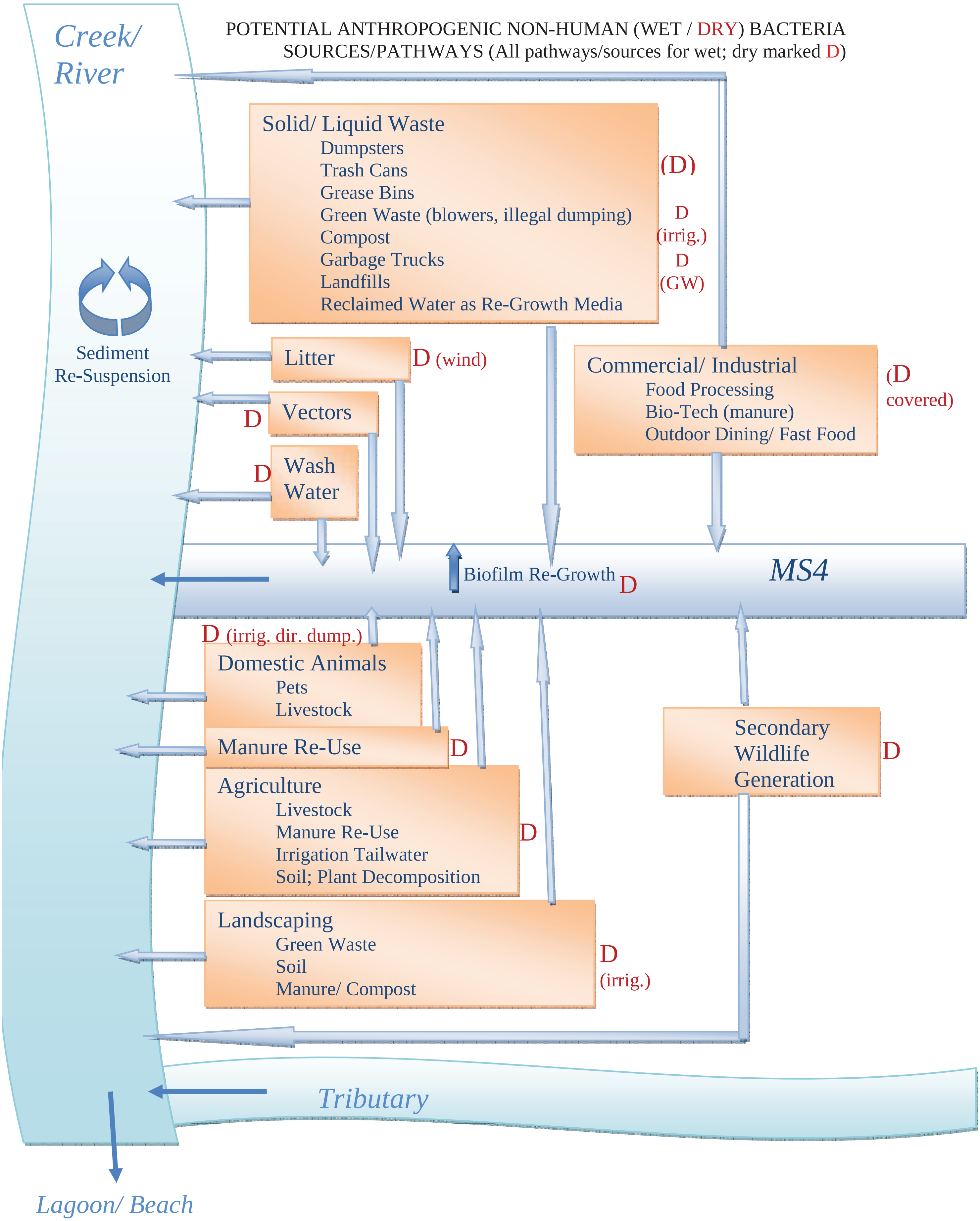
Conceptual Overview of Bacteria Sources

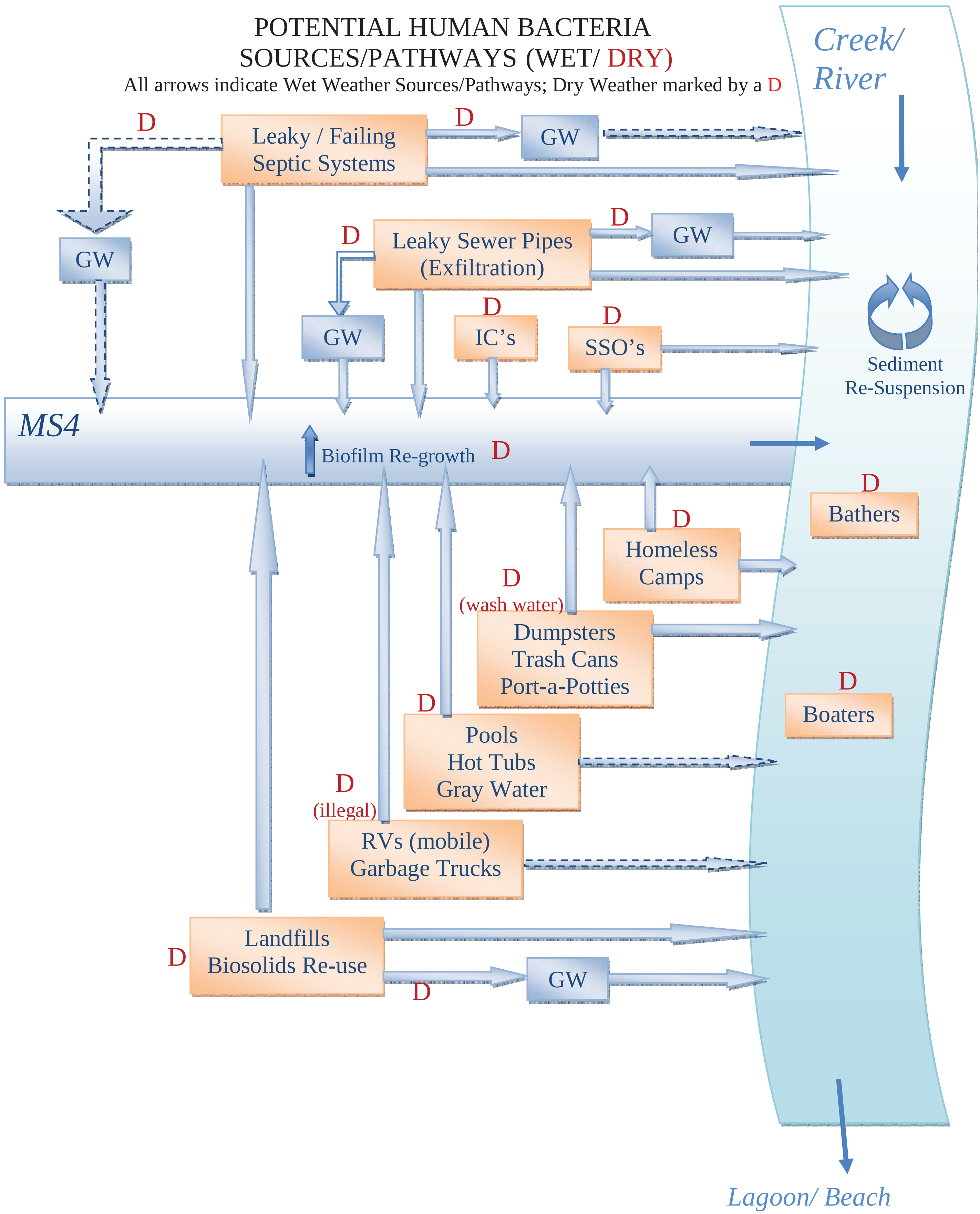




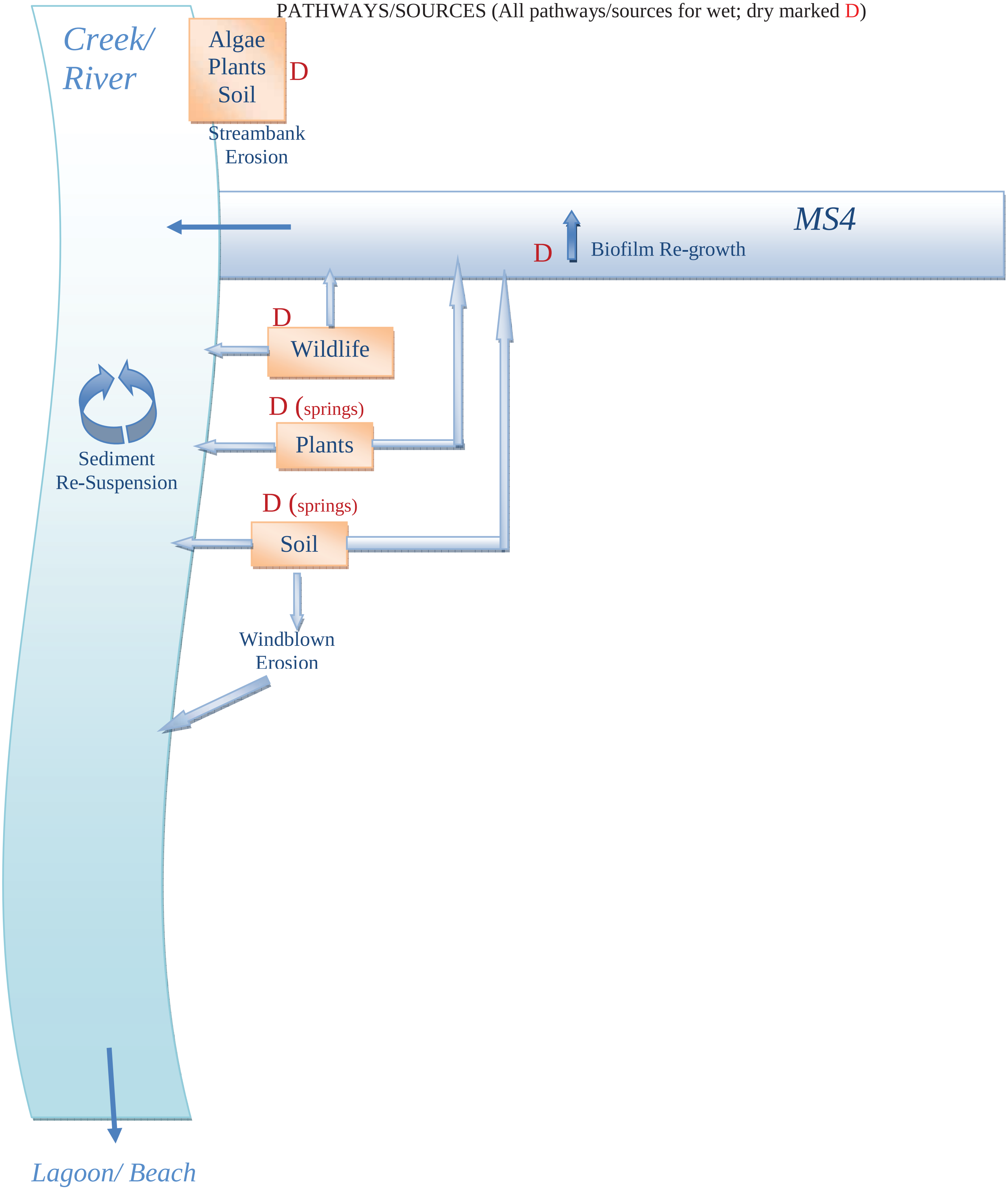
POTENTIAL ANTHROPOGENIC NON-HUMAN (WET / DRY) BACTERIA SOURCES/PATHWAYS (All pathways/sources for wet; dry marked D)
Creek/ River
Solid/ Liquid Waste
Dumpsters
Trash Cans
Grease Bins
Green Waste (blowers, illegal dumping)
Compost
Garbage Trucks
Landfills
Reclaimed Water as Re-Growth Media
(D)
D (irrig.)
D (GW)
Sediment Re-Suspension
Litter
D (wind)
Vectors
D
Wash Water
D
Commercial/ Industrial
Food Processing
Bio-Tech (manure)
Outdoor Dining/ Fast Food
(D covered)
Biofilm Re-Growth
D
MS4
D (irrig. dir. dump.)
Domestic Animals
Pets
Livestock
Manure Re-Use
D
Agriculture
Livestock
Manure Re-Use
Irrigation Tailwater
Soil; Plant Decomposition
D
Secondary Wildlife Generation
D
Landscaping
Green Waste
Soil
Manure/ Compost
D (irrig.)
Tributary
Lagoon/ Beach

POTENTIAL HUMAN BACTERIA
SOURCES/PATHWAYS (WET/ DRY)

All arrows indicate Wet Weather Sources/Pathways; Dry Weather marked by a D



POTENTIAL NON-ANTHROPOGENIC WET/ DRY BACTERIA
PATHWAYS/SOURCES (All pathways/sources for wet; dry marked D)



DRAFT TECHNICAL MEMORANDUM

Summary of Literature Review, Bacteria Source Identification

March 12, 2012

Prepared by: Armand Ruby Consulting in Association with AMEC

This Technical Memorandum summarizes work performed under Task 2, Literature Search and Data Review, for the County of San Diego Bacterial Indicators Source Identification Services Project. The work was overseen by a workgroup of San Diego County Stormwater Copermittee representatives, and included communication with scientists who have expertise in bacteria source tracking and identification. The literature review focused on identifying and summarizing studies that quantify sources and sinks for bacterial constituents in urban watersheds, and was international in scope.

The work products delivered for this task include this technical memorandum, a separate spreadsheet summary of each study/report reviewed, and a compilation of reviewed studies/reports on the AMEC ftp site:
ftp://ftp.mactec.com/Incoming/Copermittee%20Bact%20Lit%20Review/

The entries in this memorandum are ordered alphabetically by last name of primary author. Each entry begins with the study number (for cross-referencing back to the spreadsheet matrix), followed by the study title. Web links are provided when available.

A number of studies were found that contained information on indicator bacteria but did not include specific information related to source identification within urban watersheds. These studies are summarized as NSC (Not Source Characterization) studies, beginning on p. 53.

The "Bacteria Source ID Lit Review Matrix" Excel workbook contains the following worksheets:

- The "Source ID Studies Summary Table" worksheet contains summaries of all studies reviewed and found to have useful information on bacteria sources; for each of these studies, any identified sources are indicated as Probably, Potential, Low or Suspected (see "Legend" worksheet for definitions)
- The "# Citations by Source" worksheet contains a tally of the numbers of studies with identified information on each source type
- The "Sources Summary Table" worksheet contains condensed summaries of the studies that have information on each particular source type
- The "Data Summary Table" worksheet contains brief summaries of study data (this is a work in progress)
- The "NSC Studies" worksheet provides summaries of the NSC (Not Source Characterization) studies

56 - Human and bovine adenoviruses for the detection of source-specific fecal pollution in coastal waters in Australia

Warish Ahmed, A. Goonetilleke, and T. Gardner

http://eprints.qut.edu.au/37690/1/Human_and_bovine_adenoviruses_for_the_detection_of_source-specific_fecal_pollution_in_coastal_waters_in_Australia.pdf

Purpose - To enhance the scientific foundation for preemptive public health warnings, examine the relationship between rainfall and beach indicator bacteria concentrations using five years of fecal coliform data taken daily at 20 sites in southern California.

Results - There was a clear relationship between the incidence of rainfall and reduction in beach bacterial water quality in Los Angeles County. Bacterial concentrations remained elevated for five days following a storm, although they generally returned to levels below state water quality standards within three days. The length of the antecedent dry period had a minimal effect on this relationship, probably reflecting a quickly developing equilibrium between the decay of older fecal material and the introduction of new fecal material to the landscape.

Sources:
Probable –Septic (human waste), bovine (domestic animals), animal farms (agriculture),
Potential -
Possible -

31 - Evaluation of Multiple Sewage-Associated Bacteroides PCR Markers for Sewage Pollution Tracking

Warish Ahmed, A. Goonetilleke, D. Powell, and T. Gardner

http://eprints.qut.edu.au/29217/1/c29217.pdf

Purpose - The host specificity of the five published sewage-associated Bacteroides markers (i.e., HF183, BacHum, HuBac, BacH and Human-Bac) was evaluated in Southeast Queensland, Australia by testing fecal DNA samples (n = 186) from 11 animal species including human fecal samples collected via influent to a sewage treatment plant (STP).

Results - For the 5 sewage-associated markers tested in this study, the HF183 marker performed better than others. This marker showed 99% specificity to distinguish between the sources of human and animal fecal pollution. The performance of the five markers in terms of specificity was HF183 > BacHum > BacH > Human-Bac > HuBac.

78 - Detection and source identification of faecal pollution in non-sewered catchment by means of molecular markers host-specific

Warish Ahmed, D. Powell, A. Goonetilleke, and T. Gardner

http://s3.amazonaws.com/publicationslist.org/data/w.ahmed/ref-23/WST%20Article.pdf

Purpose - To validate the previously published host-specific PCR markers (i.e. HF183, HF134, CF128, BacCan and esp) for the detection of sources of faecal pollution by testing a large number of faecal samples from 13 host groups in Southeast Queensland, Australia.

Results - All 197 faecal samples (100%) from the 13 host groups were positive for general Bacteroides. Of the 42 (i.e. 30 sewage and 12 septic samples) sewage/septic samples tested, all were positive for the human-specific HF183 and HF134 Bacteroides markers. The HF183 marker could not be detected in any faecal samples from animal host groups suggesting that the suitability of this marker to detect human faecal pollution. In contrast, the HF134 marker was detected in 7 (35%) samples from dogs. The presence of this marker in dogs could be due to the transfer of faecal bacteria between human and their companion pets (Dick et al. 2005).

79 - Evaluation of Bacteroides markers for the detection of human faecal pollution
Warish Ahmed, J. Stewart, D. Powell, and T. Gardner
http://onlinelibrary.wiley.com/doi/10.1111/j.1472-765X.2007.02287.x/pdf
Purpose - Evaluating the specificity and sensitivity of human-specific HF183 and HF134 Bacteroides markers in various host groups and their utility to detect human faecal pollution in storm water samples collected from non-sewered catchments in Southeast Queensland, Australia.

Results - The specificity and sensitivity of the HF183 and HF134 Bacteroides markers was evaluated by testing 207 faecal samples from 13 host groups, including 52 samples from human sources (via sewage and septic tanks). Polymerase chain reaction analysis of these samples revealed the presence/absence of HF183 and HF134 across these host groups, demonstrating their suitability for distinguishing between human and animal faecal pollution. The HF183 marker was found to be more reliable than that of HF134, which was also found in dogs.

35 - Quantitative PCR assay of sewage-associated Bacteroides markers to assess sewage pollution in an urban lake in Dhaka, Bangladesh
Warish Ahmed, R. Yusuf, I. Hasan, A. Goonetilleke, and T. Gardner
http://eprints.qut.edu.au/37689/1/Quantitative_PCR_assay_of_sewage-associated_Bacteroides_markers_to_assess_sewage_pollution_in_an_urban_lake_in_Dhaka,_Bangladesh.pdf
Purpose - To assess the magnitude of sewage pollution in an urban lake in Dhaka, Bangladesh 34 by using Quantitative PCR (qPCR) of sewage-associated Bacteroides HF183 markers.

Results – From the 20 water samples tested, 14 (70%) and 7 (35%) were PCR positive for the HF183 and CF128 markers, respectively. The high numbers of enterococci and the HF183 markers indicate sewage pollution.

Sources:
Probable - Slum-like establishments (human waste), MS4 Infrastructure (human waste),
Potential -
Possible – Dogs and cows

139 - Coastal water quality impact of storm water runoff from an urban watershed in Southern California
Jong Ho Ahn, S.B. Grant, C.Q. Surbeck, P.M. DiGiacomo, N.P. Nezlin, and S. Jiang
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/528_B03_WQ_Appendix_I.pdf
Purpose - Assess the coastal water quality impact of storm water runoff from the Santa Ana River, which drains a large urban watershed located in southern California. This is the first wet weather study to examine the linkage between water quality in the surf zone -- where routine monitoring samples are collected and most human exposure occurs -- and water quality offshore of the surf zone.

Results - Storm water runoff from the Santa Ana River negatively impacts coastal water quality, both in the surf zone and offshore. However, the extent of this impact, and its human health significance, is influenced by numerous factors, including prevailing ocean currents, within-plume processing of particles and pathogens, and the timing, magnitude and nature of runoff discharged from river outlets over the course of a storm.

Sources:
Probable - Slum-like establishments (human waste), MS4 Infrastructure (human waste),
Potential -
Possible – Dogs and cows

17 - Lower San Luis Rey River Bacteria Source Identification Study
AMEC, UNC, City of Oceanside, SCCWRP, and USC
Purpose - The goal of the Project was to identify hot spots of fecal indicator bacteria; identify potential sources and prioritize those sources and locations for future bacteria reductions through management measures.

Results - There is evidence of the human-related bacterial sources throughout the river system. Sediment in the river mouth is a contributing source of fecal bacteria to the water column when the river mouth is closed to tidal exchange. The resident gull population was a probable source of fecal bacteria in the river mouth. Additional, monitoring is needed to identify human sources.

Sources:
Probable - Non-specific source (human waste),
Potential–Gulls (secondary wildlife), soil, sediment and sand (seasonal),
Possible - Sewage infrastructure, mobile sources (human waste), domestic animals

43 - Monitoring and Mitigation to Address Fecal Pathogen Pollution along California Coast
Applied Marine Sciences, Inc., University of California Davis, California Department of Fish and Game, and Marine Wildlife Veterinary Care and Research Center
Purpose - The goals of this research program were to use both laboratory and field approaches to investigate issues related to water quality monitoring and mitigation of fecal pathogen pollution along the central California coast.

Results - The universal Bacteroidales marker was detected in all water samples (100%). The human Bacteroidales marker was detected in 37% of samples, while the cow (8%) and dog (6%) bacteroidales markers were detected in less than 10% of samples. Overall, Bacteroidales concentrations ranged from 87-1.3 million gc/mL for universal markers, 45-17,268 gc/mL for human markers, 3-92 gc/mL for cow markers, and 12-575 gc/mL for dog markers.

Sources:
Probable – Non-specific source (human waste),
Potential - Dogs and livestock,
Possible –

68 - Little Sac River Watershed Bacterial Source Tracking Analysis
Dr. Claire Baffaut, Dr. C.A. Carson, and W. Rogers
https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/3029/LittleSacBacterial.pdf?sequence=1
Purpose - To identify the sources of bacteria found in the Little Sac River using rep-PCR analyses of fecal material.

Results - The data show that the highest fecal coliform loads come from unknown sources, geese, and human. Data show that sources differ by season but the magnitude of the contamination is not significantly affected by season.

Sources:
Probable – Wastewater treatment plant, Geese (non-specific source)
Potential – Cattle and horses
Possible – Septic (sewage infrastructure)

117 - SOURCES OF POLLUTANTS IN WISCONSIN STORMWATER
R.T. Bannerman, D.W. Owens, R.B. Dodds, and N.J. Hornewer
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.176.2404&rep=rep1&type=pdf
Purpose - Identification of critical source areas (streets, roads, parking lots, etc.) could reduce the amount of area needing best-management practices in two areas of Madison, WI. Targeting best-management practices to 14% of the residential area and 40% of the industrial area could significantly reduce contaminant loads by up to 75%.

Results - Streets will probably be a critical source area in every land use. The majority of the runoff loads for many contaminants may be from streets in residential and commercial land uses. Parking lots are probably another critical source for commercial and industrial land uses. About 77% of the area in the commercial land use would have to be managed to control at least 75% of the loads for all contaminants except fecal coliform bacteria.

Sources:
Probable – Sewer outfall, Street runoff (residential, commercial and industrial)

Potential – Cattle and horses
Possible – Septic (sewage infrastructure)

82 - Tiered Approach for Identification of a Human Fecal Pollution Source at a Recreational Beach: Case Study at Avalon Bay, Catalina Island, California
Alexandria B. Boehm, J.A. Fuhrman, R.D. Morse, and S.B. Grant
http://dornsife.usc.edu/labs/fuhrman/Documents/Publications/Tiered%20Approach.pdf
Purpose - In this study, a three-tiered approach is used to identify human and nonhuman sources of FIB in Avalon Bay, a popular resort community on Catalina Island in southern California.

Results - Most of the FIB contamination along the shoreline of the City of Avalon is due to sources inside the bay and, in particular, from the land side of the beach. During the 24-h survey, the most contaminated shoreline sites exhibited a semi-diurnal FIB pattern in which the concentrations increased during ebbing tides. The multiple instances of positive HF and HV assay results at shoreline stations indicate that human fecal contamination exists in Avalon Bay. The nuisance runoff and bird feces had the highest levels of FIB with TC, EC, and ENT consistently near or above the upper limit of detection for water samples 24 192 MPN/100 mL. With the exception of sample R101, pipe discharges from underneath the pier and wharf and the cooling water boat discharge had relatively low levels of FIB. Sample R101 was take from a broken pipe carrying gray water underneath the wharf and had TC and EC levels above our detection limit of 24 192 MPN/100 mL and ENT levels of 10 462 MPN/100 mL, which is 100 times higher than the CDHS single-sample standard. City officials repaired this pipe in early October. Subsurface water collected from within the five trenches had sporadically high levels of FIB.

Sources:
Probable – Non-specific source (urban land use; human waste), MS4 Infrastructure (dry weather runoff; human waste), birds (secondary wildlife), reclaimed water (leaking graywater pipe)
Potential –
Possible – Commercial/Industrial (boat cooling water, pier, and wharf discharges from pipes)

153 - Cross-Shelf Transport at Huntington Beach Implications for the Fate of Sewage Discharged through an Offshore Ocean Outfall
Alexandria B. Boehm, B.F. Sanders, and C.D. Winant
http://www-ccs.ucsd.edu/~cdw/mypubs/109.pdf
Purpose - Evaluate the potential for internal tides to transport wastewater effluent from the Orange County Sanitation District (OCSD) ocean outfall toward Huntington Beach.

Results - On the basis of these analyses, it remains unclear whether OCSD effluent impairs surf-zone water quality. However, OCSD plume cannot be ruled out as a contributor to poor bathing-water quality at Huntington Beach.

131 - Source Tracking in Lake Darling Watershed
Janice Boekhoff
http://www.igsb.uiowa.edu/wqm/Publications/Reports/LakeDarlingFinalReport.pdf
Purpose - Determine the source of fecal contamination in Lake Darling and the surrounding watershed.

Results - E. coli bacteria from most of the water samples at Lake Darling have been identified by DNA ribotyping as coming from unknown sources of fecal contamination (75% of the water samples had bacteria from unknown sources using the WHU library). More unknown source classifications than known sources suggested the E. coli isolate library was either not large enough or was not representative of all of the sources in the watershed.

Sources:
Probable – Secondary wildlife (cattle and swine), Wildlife (unknown)
Potential –
Possible – Commercial/Industrial (boat cooling water, pier, and wharf discharges from pipes)

83 - Detection of Genetic Markers of Fecal Indicator Bacteria in Lake Michigan and Determination of Their Relationship to Escherichia coli Densities Using Standard Microbiological Methods
Patricia A. Bower, C.O. Scopel, E.T. Jensen, M.M. Depas, and S.L. McLellan
http://aem.asm.org/content/71/12/8305.full.pdf+html
Purpose - Lake Michigan surface waters impacted by fecal pollution were assessed to determine the occurrence of genetic markers for Bacteroides and Escherichia coli.

Results - Human-specific Bacteroides spp. were found at three of the nine beach sites tested. Human-specific Bacteroides genetic marker is a sensitive measure of sewage contamination. Sanitary sewage overflow samples taken in the suburban part of the watershed showed the presence of cow-specific genetic marker, since the cow-specific primers do not differentiate between types of ruminants, i.e., elk, deer, and cows.

Sources:
Probable – CSO and SSO (Sewage infrastructure; human waste)
Potential – Sanitary sewer infiltration into the storm drain (Sewage infrastructure; human waste), Ruminant (wildlife; non-anthropogenic)
Possible – Sanitary sewer infiltration into the storm drain (Sewage infrastructure; human waste)

27 – Antibiotic Resistance Analysis of Fecal Coliforms to Determine Fecal Pollution Sources in a Mixed-Use Watershed
Brian S. Burnes
http://www.springerlink.com/content/q3213338g1578x88/fulltext.pdf

Purpose - Antibiotic resistance analysis was performed on fecal coliform (FC) bacteria from a mixed-use watershed to determine the source, human or nonhuman, of fecal coliform contamination.

Results - Human sources contribute a majority (>50%) of the baseflow FC isolates found in the watershed in urbanized areas. Chicken and livestock sources are responsible for the majority of the baseflow FC isolates found in the rural reaches of the watershed. Stormwater introduces FC isolates from domestic (~16%) and wild (~21%) sources throughout the watershed and varying amounts (up to 60%) from chicken and livestock sources. These results suggest that antibiotic resistance patterns of FC may be used to determine sources of fecal contamination and aid in the direction of water quality improvement.

Sources:
Probable – Urbanized watershed (human waste), cows and chickens (rural watershed)
Potential –Stormwater runoff,
Possible –

13 - Results from a Microbial Source-Tracking Study at Villa Angela Beach, Cleveland, Ohio 2007
Rebecca N. Bushon, E.A. Stelzer, and D.M. Stoeckel
Purpose - The overall goal of the study was to provide NEORSD with source-tracking information to aid in their understanding of elevated bacterial concentrations at Villa Angela Beach in Cleveland Ohio. To understand these elevation concentrations, 13 source samples (influent/effluent to sewage treatment plant, waterfowl feces from beach area, combined sewer overflow, stormwater outfall) and 33 beach-area water and sand samples were analyzed for E coli and 3 Bacteroides DNA markers

Results - Therefore, Btheta does not appear to be a useful human-associated marker for this beach area. In the Lake, human source is not a likely contributor of fecal bacteria, however, the gulls are a probable source. In Euclid Creek, there were strong signals of human sources on two occasions and gulls were not present. The sand did not have human sources present and gull sources were present in low concentrations.

Sources:
Probable -
Potential - Combined sewer overflow, influent/effluent to sewage treatment plant, waterfowl feces from beach area,
Possible -

85 - Population structure, persistence, and seasonality of autochthonous Escherichia coli in temperate, coastal forest soil from a Great Lakes watershed
Muruleedhara N. Byappanahalli, R.L. Whitman, D.A. Shively, M.J. Sadowsky, and S. Ishii
http://www.glsc.usgs.gov/_files/publications/population.pdf

Purpose - In this study, undisturbed, forest soils within six randomly selected 0.5 m exclosure plots (covered by netting of 2.3 mm mesh size) were monitored from March to October 2003 for E. coli in order to describe its numerical and population characteristics.

Results - In this study, soil was found as a potential habitat for the persistent, perhaps resident, E. coli populations in temperate conditions. While our studies showed that E. coli can occur in temperate forest soils, albeit at low densities, it also had the ability to persist for extended periods in these habitats, suggesting that it is not a transient organism in soil but perhaps part of the natural microflora. Even if this is not the case, its population resiliency suggests that soil-borne E. coli should be treated as background concentration in source and impact evaluation investigations.

Sources:
Probable – Soil/Sediment/Sand (non-anthropogenic)
Potential –
Possible – Gull, deer, geese, terns (wrackline; non-anthropogenic)

84 - Ubiquity and Persistence of Escherichia coli in a Midwestern Coastal Stream
Muruleedhara Byappanahalli, M. Fowler, D. Shively, and R. Whitman.
http://aem.asm.org/content/69/8/4549.full.pdf+html
Purpose - Dunes Creek, a small Lake Michigan coastal stream that drains sandy aquifers and wetlands of Indiana Dunes, has chronically elevated Escherichia coli levels along the bathing beach near its outfall. This study sought to understand the sources of chronically elevated Escherichia coli levels along the bathing beach near its outfall in Dunes Creek's central branch.

Results - Water samples analyzed during the 1999 and 2000 monitoring seasons clearly demonstrated that E. coli concentrations in Dunes Creek were significantly correlated with the park's beach water. Dunes Creek empties directly onto the state park's only swimming beach, indicating that the creek directly impacts bathing water quality. E. coli is common within the stream basin, especially in submerged, margin, and wetted bank sediments, with numbers rapidly decreasing landward beyond the banks. The relationship between E. coli concentration and stream order suggests that excessive ditching and, consequently, non-point source input via sediment transport are responsible for elevated E. coli density in the watershed.

Sources:
Probable – Soil/Sediment/Sand (non-anthropogenic)
Potential –
Possible – Non-specific source (groundwater; non-anthropogenic)

3 - Pismo Beach Fecal Contamination Source Identification Study; Final Report. Aug. 12, 2010
CAL POLY and City of Pismo Beach
http://www.coastalrcd.org/images/cms/files/PismoFinalReport-v1_4%5B1%5D.pdf

Purpose - To identify biological sources of fecal contamination. Primary sources found were bird fecal contamination.

Results - The data collected in this study clearly shows the main source of fecal contamination on the beach is bird droppings near the pier. Nearly 40% of the E. coli strains collected in this study matched bird fecal sources, and E coli strains with a pigeon-specific fingerprint were collected. In addition, measuring the time since a tide last washed the part of the beach being sampled was an excellent predictor of FIB count, indicating that deposition of fecal matter on the beach itself was a predominate contamination mode.

Sources:
Probable - Bathers, dogs, pigeons (secondary wildlife)
Potential - Cows
Possible -

86 - Sourcing faecal pollution from onsite wastewater treatment systems in surface waters using antibiotic resistance analysis
S. Carroll, M. Hargreaves, and A. Goonetilleke
http://eprints.qut.edu.au/4018/1/4018.pdf
Purpose - To identify the sources of faecal contamination in investigated surface waters and to determine the significance of onsite wastewater treatment systems (OWTS) as a major contributor to faecal contamination.

Results - Antibiotic resistance patterns (ARP) were established for a library of 717 known Escherichia coli source isolates obtained from human, domesticated animals, livestock and wild sources. The resulting ARP DA indicated that a majority of the faecal contamination in more rural areas was nonhuman; however, the percentage of human isolates increased significantly in urbanized areas using OWTS for wastewater treatment.

Sources:
Probable – Sewage infrastructure (onsite wastewater treatment systems; human waste)
Potential –
Possible –

28 - Faecal pollution source identification in an urbanising catchment using antibiotic resistance profiling, discriminant analysis and partial least squares regression
Steven P. Carroll, L. Dawes, L., M. Hargreaves, and A. Goonetilleke
http://eprints.qut.edu.au/19108/1/c19108.pdf
Purpose - Antibiotic Resistance Patterns (ARP) were established for a library of 1005 known E. coli source isolates obtained from human and non-human (domesticated animals, livestock and wild) sources in an urbanising catchment in Queensland State, Australia. Discriminant Analysis (DA) was used to differentiate between the ARP of source isolates and to identify the sources of faecal contamination.

Results - The resulting ARP (Antibiotic Resistance Patterns) DA (Discriminant Analysis) indicated that a majority of the faecal contamination in the rural areas was non-human. However, the percentage of human isolates increased significantly in urbanised areas using onsite systems for wastewater treatment. The PLS regression was able to develop predictive models which indicated a high correlation of human source isolates from the urban area.

Sources:
Probable - Urbanized watershed (human waste), agriculture, other (land use)
Potential –
Possible -

47 - Middle Santa Ana River Bacterial Indicator TMDL Data Analysis Report
CDM and Risk Sciences
Purpose - The primary goal of this study was "to develop an investigative strategy at the highest priority sites, including site-specific or subwatershed-specific activities."

Results – Analysis showed significant differences in the frequency with which molecular markers for humans, dogs, and cattle were detected at the various source evaluation sites. The sites with highest frequency of detection of host-specific markers included the Human marker at Box Springs Channel and Chris Basin; Bovine marker at Anza Drain, Cypress Channel and San Antonio Channel; and Domestic canine marker at Chris Basin, County Line Channel and Day Creek. Where the universal marker was measured, it was a quantified at levels much higher than the other measured markers, indicating the presence of many other sources of bacteria, e.g. birds, rodents, small mammals and reptiles. Preliminary review of land use data indicates that bacterial concentrations are positively correlated with degree of urban development and negatively correlated with the proportion of agricultural acreage and open space in the area.

Sources:
Probable – Non-specific source (human waste; 1 of 13 sites), dogs(1 of 13 sites) and cows(3 of 13 sites), commercial/industrial (anthropogenic non-human source), residential, commercial, and industrial (land use)
Potential -
Possible – Agriculture (anthropogenic non-human source),natural land use (non-anthropogenic) natural and agricultural (land use)

127 - Densities of fecal indicator bacteria in tidal waters of the Ballona Wetlands, Los Angeles County, California
John. H. Dorsey
http://www.freepatentsonline.com/article/Bulletin-Southern-California-Academy-Sciences/151712972.html
Purpose - Densities of fecal indicator bacteria (FIB) represented by total coliforms, E. coil and enterococci were measured within tidal channels of the Ballona Wetlands (Los Angeles County) to see of the wetlands act as a sink or source for these bacteria and to measure increases in FIB densities during wet weather.

Results - Results suggest that the wetlands may act as a sink in that FIB densities tended to be greater during flood flows into the wetlands, but less in water draining out of the system during ebb flows. However, this condition was not consistently met, especially at stations farthest from the tide gates. These sites could be reflecting increased FIB densities through regrowth within sediments and other unidentified sources.

Sources:
Probable –Storm drains
Potential –
Possible -

181 - Reduction of fecal indicator bacteria (FIB) in the Ballona Wetlands saltwater marsh (Los Angeles County, California, USA) with implications for restoration actions
John H. Dorsey, P.M. Carter, S. Bergquist and R. Sagarin
http://www.sciencedirect.com/science/article/pii/S004313541000388X/
Purpose - Determine FIB tidal dynamics within the wetland

Results - The wetlands act as both a source and sink for FIB depending on tidal conditions and exposure to sunlight. Future restoration actions would result in a tradeoff – increased tidal channels offer a greater surface area for FIB inactivation, but also would result in a greater volume of FIB-contaminated re-suspended sediments carried out of the wetlands on stronger ebb flows. As levels of FIB in Ballona Creek and Estuary diminish through recently established regulatory actions, the wetlands could shift into a greater sink for FIB.

119 - FECAL COLIFORM AND STREPTOCOCCUS CONCENTRATIONS IN RUNOFF FROM GRAZED PASTURES IN NORTHWEST ARKANSAS
D. R. Edwards, M.S. Coyne, P.F. Vendrell, T.C. Daniel, P.A. Moore, Jr., and J.F. Murdoch
http://www.pcwp.tamu.edu/docs/lshs/end-notes/Fecal%20Coliform%20and%20Streptococcus%20Concen-0982758667/Fecal%20Coliform%20and%20Streptococcus%20Concentrations%20in%20Runoff%20from%20Grazed%20Pastures%20and%20Northwest%20Arkansas.pdf
Purpose - Assess the effects of grazing, time of year, and runoff amounts on FC and FS concentrations and to evaluate whether FCIFS concentration ratios are consistent with earlier values reported as characteristic of animal sources.

Results - In general, FC and FS concentrations were not directly related to either treatment with animal manure or presence of grazing cattle. Ratios of FC to FS concentrations varied widely ranging from almost zero to more than 100. These data confirm earlier findings that FC/FS ratios are not a reliable indicator of the source of FC and FS in the runoff.

147 - FECAL-INDICATOR BACTERIA IN STREAMS ALONG A GRADIENT OF RESIDENTIAL DEVELOPMENT
Steven A. Frenzel and C.S. Couvillion
http://lshs.tamu.edu/docs/lshs/end-notes/fecal%20indicator%20bacteria%20in%20streams%20along%20a%20gradient%20of%20resid-3692103194/fecal%20indicator%20bacteria%20in%20streams%20along%20a%20gradient%20of%20residential%20development.pdf
Purpose - In order to adopt EPA water-quality standards for concentrations of Escherichia coli (E. coli) or enterococci, and study to determine the effects of urbanization on water quality.

Results - Areas served by sewer systems had significantly higher fecal-indicator bacteria concentrations than did areas served by septic systems. The areas served by sewer systems also had storm drains that discharged directly to the streams, whereas storm sewers were not present in the areas served by septic systems. Fecal-indicator bacteria concentrations were highly variable over a two-day period of stable streamflow, which may have implications for testing of compliance to water-quality standards.

120 - Soil: the environmental source of Escherichia coli and Enterococci in Guam's streams
R. Fujioka, C. Sian-Denton, M. Borja, J. Castro, and K. Morphew
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.1998.tb05286.x/pdf
Purpose - Test the hypothesis that faecal bacteria are able to establish themselves in the soil environments of tropical islands by conducting a study in Guam, a tropical pacific island with warmer temperatures and higher humidity than Hawaii (covered in a previous study).

Results - Results obtained in Guam were similar to the results obtained in Hawaii and provided convincing evidence that the faecal bacterial indicators selected by USEPA to establish recreational water quality standards are able to colonize the soil environments of warm, humid tropical islands, current hygienic water quality standards which are based on concentrations of faecal indicator bacteria may not be applicable in tropical islands and perhaps other subtropical and tropical countries in the world. In these countries, stream waters can be expected to contain elevated levels of faecal bacteria.

Sources:
Probable - Rainfall
Potential –
Possible -

91 - Use of composite data sets for source-tracking enterococci in the water column and shoreline interstitial waters on Pensacola Beach, Florida
Fred J. Genthner, J.B. James, D.F. Yates, and S.D. Friedman
http://64.9.200.77/lists/beachnet/2005-07/pdf00002.pdf

Purpose - Source identification was performed to better understand risk associated with higher densities of enterococci found in swash zone interstitial water (SZIW) as compared to adjacent bathing water on Pensacola Beach, FL.

Results - This study documents higher densities of enterococci in SZIW than in adjacent bathing waters on Pensacola Beach. Entrapment may partially account for increased bacteria densities, however, biological factors (nutrients, protection from predation) and physical factors (particulate matter, periodic wetting and drying, protection from solar irradiation) may not only allow the enhanced survival of bacteria but may actually provide a growth- promoting environmental niche on the beach.

Sources:
Probable – Seagull (secondary wildlife)
Potential –
Possible – **Non-specific source (human waste)**

46 - Laguna Watershed Study and Water Quality Improvement Feasibility Analysis
Geosyntec and UCSB
Purpose - To evaluate dry weather hydrology, microbiological indicators, bacterial sources and loads, and feasible water quality improvements for the Laguna Channel in Santa Barbara, CA.

Results – Based on the analysis of human-specific Bacteroides DNA, it appears that there is significant input of human fecal waste into some Laguna storm drains and into Laguna Channel. An obvious spatial correlation between measured FIB and Human specific Bacteroides Marker (HBM) concentrations could not be identified; similar trends between indicator species and HBM concentrations were also not observed.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible -

148 - Quantitative Detection of Hepatitis A Virus and Enteroviruses Near the United States-Mexico Border and Correlation with Levels of Fecal Indicator Bacteria
Richard M. Gersberg, M.A. Rose, R. Robles-Sikisaka, and A.K. Dhar
http://publichealth.sdsu.edu/publications/gersberg684.pdf
Purpose - To measure the levels of Hepatitis A virus (HAV) and enteroviruses in coastal waters, and compare to E. coli and enterococci.

Results - HAV and enterovirus were found in 93% of wet weather samples. Inadequate sewage infrastructure in Tijuana, Mexico, also contributes to the high levels found at some sites.

60 - Evaluation of Two Library-Independent Microbial Source Tracking Methods to Identify Sources of Fecal Contamination in French Estuaries
Michele Gourmelon, M.P. Caprais, R. Segura, C. Le Mennec, S. Lozach, J.Y. Piriou, and A. Rince
http://aem.asm.org/content/73/15/4857.full.pdf+html
Purpose - The aim of this study was to optimize and validate the two MST techniques (host-specific 16S rRNA gene markers from Bacteroidales and genotyping of F-specific RNA bacteriophages) on human and animal feces, sewage treatment plant (STP) sludge, wastewater samples, and pig liquid manure (PLM; pig slurry) collected in France. Both techniques were then applied to water samples collected at different times from three estuaries

Results - Humans and animals sources are detected as sources of E. coli and Enterococci contamination in the estuaries based on host-specific Bacteroidales and F-specific bacteriophages

Sources:
Probable – Septic (human waste), livestock (domestic animals), livestock (agriculture), birds (wildlife), birds (secondary wildlife)
Potential -
Possible -

23 - Generation of Enterococci Bacteria in Saltwater Marsh and its impact on the surf zone water quality
Steven B. Grant, B.F. Sanders, A.B. Boehm, A.J. Redman, J.H. Kim, R.D. Mrše, A.K. Chu, M. Gouldin, C.D. McGee, N.A. Gardiner, B.H. Jones, J. Svejkovsky, G.V. Leipzig, and A. Brown
https://www.crops.org/publications/jeq/pdfs/31/4/1300
Purpose - To characterize the sources and transport of Enterococcus in tidally influenced flood control channels and a saltwater marsh.

Results - We find that enterococci bacteria are present at high concentrations in urban runoff, bird feces, marsh sediments, and on marine vegetation. Surprisingly, urban runoff appears to have relatively little impact on surf zone water quality because of the long time required for this water to travel from its source to the ocean. On the other hand, enterococci bacteria generated in a tidal saltwater marsh located near the beach significantly impacts surf zone water quality.

Sources:
Probable – Marsh (non-anthropogenic; non-specific source), wildlife (marsh avian), marsh sediment, soil/sediment/sand
Potential –
Possible –

92 - Antibiotic Resistance Profiles to Determine Sources of Fecal Contamination in a Rural Virginia Watershed
Alexandria K. Graves, C. Hagedorn, A. Teetor, M. Mahal, A.M. Booth, and R.B. Reneau
https://www.crops.org/publications/jeq/pdfs/31/4/1300

Purpose - Antibiotic resistance analysis (ARA) was used to determine if enterococci of human origin were present in a stream (Spout Run) that passes through a rural non-sewered community (Millwood, VA)

Results - A human signature was found in Spout Run as it passed through upper and middle Millwood. No evidence of a human signature was found in Page Brook in an earlier report (Hagedorn et al., 1999), and no evidence of a human signature was found in any of the tributaries that form Spout Run in this study. There are 32 homes in upper Millwood, 21 homes in middle Millwood, and 13 homes in lower Millwood, all on individual septic systems. Repair or replacement of unsatisfactory systems (or installation of a community system) should result in removal of the human signature from Spout Run.

Sources:
Probable – Septic system (sewage infrastructure; human waste), Livestock (domestic animals; anthropogenic non-human sources), wildlife (non-anthropogenic)
Potential –
Possible –

2 - San Diego County Enterococcus Regrowth Study; Draft Final Report, June 11, 2011
John Griffith and D. Ferguson
Purpose - To investigate storm drains as a potential source of Enterococcus bacteria to San Diego's coastal waters during dry weather.

Results –The results of this study suggest that enterococci in these storm drain systems came from predominantly natural sources and include strains that are capable of growing on drain pipe surfaces. The results of the concrete coupon/growth study showed that enterococci were capable of attaching to and growing on concrete coupons. Testing of enterococci extracted from coupons in Cottonwood Creek revealed species and biotypes most closely related to freshwater plants and decomposed algae/vegetation. The majority (77%) of enterococci from the surfaces of coupons, pipe and cobble rock at a La Jolla storm drain were identified as an enterococcal species associated with plants.
A number of natural sources of enterococci were identified at Moonlight State Beach. In this study, up to 70% of creek water isolates were identified as a species commonly found on plants. Multivariate analysis of species and biotypes showed that enterococci in Cottonwood Creek were most similar enterococci found in decomposed algae and vegetation, freshwater plants and seawrack. At least 52% of enterococci in beach water were of a species found in plants, however 34% of isolates were either non-Enterococcus species or unidentifiable, suggesting the possibility of additional sources of enterococci that were not evaluated in this study. Some of the enterococci biotypes in beach water were the same ones found in decomposed algae and vegetation, freshwater plants and seawrack.
The low numbers of birds and predominance of E. faecalis in bird stools indicate that birds may not have been a major source of enterococci to creek and beach water, however the dissimilarity in enterococcal populations could also be related to different selection pressures.

All beach and storm drain/creek water samples tested for Bacteroidales indicated very low or non-detectable levels of the human marker, indicating that these samples had little or no evidence of human fecal material.

Sources:
Probable – MS4 Infrastructure (Human waste), avian (secondary wildlife), avian (non-anthropogenic)
Potential – Landscaping (irrigation and lawn clippings),
Possible – Wrackline, Plants (non-anthropogenic), seawrack, beach sand

121 - Escherichia coli and Enterococci at Beaches in the Grand Traverse Bay, Lake Michigan: Sources, Characteristics, and Environmental Pathways
Sheridan K. Haack, L.R. Fogarty, and C. Wright
http://www.glin.net/lists/beachnet/2007-07/pdf00000.pdf
Purpose - Overall objectives were to (i) quantify EC and ENT in dominant source materials and recreational waters; (ii) characterize selected source isolates using genomic (EC) or biochemical (ENT) profiling; (iii) identify associations between numbers of these two indicator bacteria groups and ambient conditions; (iv) identify processes that influence spatiotemporal variability of indicator bacteria at these beaches; and (v) evaluate standardized monitoring approaches in light of site-specific knowledge about sources and environmental processes

Results - Bird feces are likely one significant source of bacterial contamination to these beaches. Storm drains and the Boardman River contributed large numbers of EC and ENT to the bay, even during non-runoff conditions.
Sources:
Probable – Seawrack (vegetation and other detritus)
Potential –
Possible –

94 - Determining Sources of Fecal Pollution in a Rural Virginia Watershed with Antibiotic Resistance Patterns in Fecal Streptococci
C. Hagedorn, S.L. Robinson, J.R. Filtz, S.M. Grubbs, T.A. Angier, and R.B. Reneau Jr.
http://aem.asm.org/content/65/12/5522.full.pdf+html
Purpose - The objectives of this project were (i) to validate the method of using antibiotic resistance patterns in fecal streptococci and discriminant analysis (DA) to differentiate between human and animal sources and between certain types of animal sources with a larger database of known source isolates from a wider geographical region and (ii) to use this method in a watershed project to identify fecal pollution sources.

Results - The results presented affirm that antibiotic resistance patterns can be used with fecal streptococci to determine sources of fecal pollution in water. Results (detection of no human isolates) had a direct impact on water quality improvement in Page Brook, as local officials were able to focus restoration efforts on the actual sources (e.g., beef cattle) rather than on those that made no contribution to the water pollution.

Sources:
Probable – Cattle (domestic animals; anthropogenic non-human sources)
Potential – Waterfowl, deer unidentified (wildlife; non-anthropogenic)
Possible – Non-specific source (human waste)

69 - Influence of Freshwater Sediment Characteristics on Persistence of Fecal Indicator Bacteria
Laurence Haller, E. Amedegnato, J. Pote, and W. Wildi
http://www.springerlink.com/content/ju524662v67v4967/fulltext.pdf
Purpose - To investigate the effect of sediment characteristics such as particle grain size and nutrient and organic matter contents on the survival of fecal indicator bacteria including total coliforms, E. Coli, and Enterococcus.

Results - FIB survival in sediments and possible re-suspension are considerable significance for understanding permanent microbial pollution. Results revealed (1) FIB survived in sediments up to 50 days, (2) higher growth and lower decay rates of FIB in sediments with high levels of organic matter and nutrients and small grain size, (3) longer survival of Enterococcus compared to E. coli and total coliforms.

Sources:
Probable – Wastewater treatment plant (based on other studies), Soil/Sediment/Sand
Potential – Cattle and horses, storm runoff (MS4 Infrastructure; human waste), Agriculture
Possible – Septic (sewage infrastructure),Wastewater treatment plant, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use

193 - Soil: the environmental source of Escherichia coli and Enterococci in Hawaii's streams
C. M. Hardina, and R. Fukuda
http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=9200969&q=&uid=791338866&setcookie=yes
Purpose - To determine the concentrations and sources of Escherichia coli and enterococci in a typical stream (Manoa) in Hawaii.

Results - Soil is considered the most likely source for the high concentrations of indicator bacteria naturally present in the freshwater streams of Hawaii.

Sources:
Probable – Wastewater treatment plant (based on other studies), Soil/Sediment/Sand
Potential – Cattle and horses, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use
Possible – Septic (sewage infrastructure),Wastewater treatment plant, storm runoff (MS4 Infrastructure; human waste), Agriculture, Land use

61 - Combining targeted sampling and fluorometry to identify human fecal contamination in a freshwater creek
Peter G. Hartel, K. Rodgers, G.L. Moody, S.N.J. Hemmings, J.A. Fisher, and J.L. McDonald
http://www.iwaponline.com/jwh/006/0105/0060105.pdf
Purpose - The aim of this study was to conduct sampling at 2 reaches at Potato Creek, a freshwater creek in Georgia, and 1 tributary during baseflow and stormflow conditions and detect human sources of fecal contamination by using targeted sampling (finding hot spots of fecal contamination within the Creek and/or tributaries and re-sampling these spots) and fluorometry (detection of fluorescing compounds, optical brighteners, & laundry detergents)

Results - Humans, dogs, and cattle are the major suspected sources (not sampled) for fecal contamination in the Potato Creek reaches

Sources:
Probable -
Potential -
Possible – Broken home sewer line, dogs, cows, wildlife (non-anthropogenic),

63 - Drayton Harbor Watershed Microbial Source Tracking Pilot Study Phase 2: California Creek, Dakota Creek and Cain Creek Sub-watersheds
Hirsch Consulting Services
http://whatcomshellfish.whatcomcounty.org/Drayton/documents/DraytonHarborSanitarySurvey2010.pdf
Purpose - The objective of this study was to determine whether human or ruminant sources contribute to fecal contamination at selected sampling stations to inform follow-up investigations and corrective actions by Whatcom County and other agencies and to inform the Drayton Harbor Fecal Coliform TMDL Evaluation.

Results - Ruminant and human fecal sources threaten the shellfish harvest.

Sources:
Probable - Non-specific source (human waste), domestic animals,
Potential -
Possible -

67 - Sources and Mechanisms of Delivery of E. coli (bacteria) Pollution to the Lake Huron
Todd Howell
Purpose - To identify the potential sources of fecal pollution to the shoreline.

Results – The long-term fate of the potentially high E. coli loads delivered to the lake at these times is poorly understood. The association of E. coli with particulate material is thought to be a key mechanism by which survival and transport in the lake environment is enhanced.

Sources:
Probable – Agriculture,
Potential – Soil/Sediment/Sand
Possible - **Non-specific source (human waste), agriculture (listed under other with no degree of designation (probable, low, etc.)**

10 - Wrack promotes the persistence of fecal indicator bacteria in marine sands and seawater
Gregory J. Imamura, R.S. Thompson, A.B. Boehm, and J.A. Jay
http://onlinelibrary.wiley.com/doi/10.1111/j.1574-6941.2011.01082.x/full
Purpose - Study examined the relationship between beach wrack, FIB, and surrounding water and sediment at marine beaches along the California coast.

Results – FIB concentrations normalized to dry weight were the highest in stranded dry wrack, followed by stranded wet and suspended 'surf 'wrack. Laboratory microcosms were conducted to examine the effect of wrack on FIB persistence in seawater and sediment. Indigenous enterococci and Escherichia coli incubated in a seawater microcosm containing wrack showed increased persistence relative to those incubated in a microcosm without wrack. FIB concentrations in microcosms containing wrack-covered sand were significantly higher than those in uncovered sand after several days. These findings implicate beach wrack as an important FIB reservoir.

Sources:
Probable – Seawrack [1-Dry wrack (highest FIB), 2-wet wrack, 3-surf wrack]
Potential -
Possible -

57 - Presence and Growth of Naturalized Escherichia Coli in Temperate Soils from Lake Superior Watersheds
Satoshi Ishii, W.B. Ksoll, R.E. Hicks, and M.J. Sadowsky
http://aem.asm.org/content/72/1/612.full.pdf+html
Purpose - The goal of the study to was (i) examine the survival and persistence of E. coli populations in three soils in several coastal Lake Superior watersheds (extreme environmental conditions) and to determine if these E. coli strains have become naturalized to these soils, (ii) examine the genetic relatedness of soilborne E. coli strains from different locations, and (iii) determine if soilborne E. coli could actively multiply in the soils examined.

Results - E. Coli is able to survive and grow in soil, with growth occurring when temperature and nutrients are higher and able to survive in extreme environments (low temps). Animal feces of surrounding wildlife not shown to be likely source.
Sources:
Probable – Soil/Sediment/Sand
Potential -
Possible - Wildlife

156 - Sources and Persistence of Fecal Coliform Bacteria in a Rural Watershed
Rob C. Jamieson, R. J. Gordon, S. C. Tattrie, and G. W. Stratton
http://www.cawq.ca/journal/temp/journal/7.pdf#page=32
Purpose - Quantify the presence of fecal coliform bacteria in the surface waters of a rural watershed and to attempt to determine the primary sources of fecal pollution within rural watersheds.

Results - Fecal coliform levels frequently exceeded recreational water quality guidelines. At the watershed outlet, 94% of the collected samples exceeded the recreational water quality guideline during low flow conditions. Substantial bacterial loading was observed along stream reaches impacted by livestock operations. Bacterial loading was also observed along a stream reach that was not impacted by agricultural activities.

Sources:
Probable – Livestock
Potential -
Possible -

200 - The effect of cattle grazing on indicator bacteria in runoff from a Pacific Northwest watershed
M.D. Jawson, L.F. Elliott, K.E. Saxton, and D.H. Fortier
http://lshs.tamu.edu/docs/lshs/end-notes/the%20effect%20of%20cattle%20grazing%20on%20indica-1987218764/the%20effect%20of%20cattle%20grazing%20on%20indicator%20bacteria%20in%20runoff%20from%20a%20pacific%20northwest%20watershed.pdf
Purpose - Total coliform (TC), fecal coliform (FC), and fecal streptococcal (FS) numbers were monitored for 3 years to determine the effect of grazing on the presence of these organisms in runoff from a cattle grazed and a non-grazed watershed in the Pacific Northwest

Results - Sampling at several locations within the grazed watershed showed that sources of indicator bacteria were well distributed, and as a result were nonpoint after the initial runoff events. Thus, present FC recommendations developed for point-sources would not apply adequately to grazed land in the Pacific Northwest. Indicator bacteria as presently analyzed would not provide a basis for developing best management practices.

Sources:
Probable – Secondary Wildlife (Cows)
Potential -
Possible –

12 - 2009 Investigation of Spatial and Temporal Distribution of Human-specific Bacteroidales marker in Malibu Creek, Lagoon and Surfrider Beach

Jennifer Jay, R.F. Ambrose, V. Thulsiraj, and S. Estes
Purpose - The goal of the study is to understand the relationship between Fecal indicator bacteria (FIB) and human-specific Bacteroidales (HSB) in coastal wetland. The study examines the spatial & temporal relationship of human-specific Bacteroidales marker (HBM) & FIB in lower Malibu Creek, Lagoon, and Surfrider Beach during wet and dry weather to determine the presence of detectable concentrations of HBM in the lagoon and if concentrations of HBM correlate with FIB

Results - Of the 80 water samples analyzed within the Malibu watershed, five samples were positive for the human-specific HF183 Bacteroidales marker (HBM).The highest percent exceedance of FIB and HBM concentrations were measured during wet weather. During the study, 93.8% of the samples did not have detectable concentrations of HBM. These data do not rule out any particular potential sources of human fecal contamination.

Sources:
Probable -
Potential - storm drains
Possible - Septic systems, Tapia Wastewater Reclamation Facility disinfected discharge, wildlife and birds

98 - Microbial source tracking in a small southern California urban watershed indicates wild animals and growth as the source of fecal bacteria
Sunny C. Jiang, W. Chu B.H. Olson, J. He, S. Choi, J. Zhang, J.Y. Le, and P.B. Gedalanga
http://www.eng.uci.edu/files/07-1MST.pdf
Purpose - Apply three MST tools, namely, ARA, human viruses, and E. coli toxin biomarkers to aid in the cleanup of unknown pollution sources in Laguna Niguel. Laguna Niguel is a small urban watershed in southern California that experienced chronic fecal coliform and enterococci contamination, with concentrations on average of 2–4 orders of magnitude greater than State of California established type 2 recreational standards.

Results - Using three independent microbial source tracking methods, the results of this study indicate that human sewage was not a major contributor of fecal bacterial impairment in this small urban watershed. This study showed that rabbit feces contain one of the highest concentrations of Enterococcus spp. per unit weight.

Sources:
Probable – Urban land use (non-specific source), dogs (urban land use), cows and horses (rural open land use),
Potential –
Possible –

76 - Freshwater Beach Total Maximum Daily Load Microbial Source Tracking Study
Dr. Stephen H. Jones
http://des.state.nh.us/organization/divisions/water/wmb/tmdl/documents/sand_dam_appendix_b_beach.pdf
Purpose - The goal of this project was to investigate actual and potential bacterial sources at (3) public beaches. The approach reflects the latest concepts for efficient use of bacterial ribotyping for pollution source identification in New Hampshire, i.e., ribotyping of high priority samples and development of small local source species databases. This targeted approach was designed to optimize identification of the most significant contamination sources at the 3 beaches.

Results - Overall, birds were the most prevalent (37%) source species type, followed by livestock (24%), humans (5%), wild animals (4%) and pets (3%). The most commonly identified source species was geese (17 isolates), followed by cows and mixed avian (7) sheep (6), horses and ducks (3), septage, goat, wastewater effluent and dog (2), with single isolates identified as coming from deer, red foxes, wild turkeys and mixed wildlife.

Sources:
Probable – Livestock, birds (secondary wildlife)
Potential –
Possible – Non-specific source (human waste), pets, wildlife

99 - Tracking Bacterial Pollution Sources in Stormwater Pipes
Dr. Stephen H. Jones
http://www.unh.edu/users/unh/acad/colsa/marine-program/nhep/resources/pdf/trackingbacterialpollution-unh-03.pdf
Purpose - Determine the bacteria source species from two of the highest priority storm drain pipes that discharge to Hampton Harbor

Results - Many storm water/runoff studies have attributed fecal contamination to pet wastes. Of the four types of sources identified, pets were the least common, behind birds, humans and wildlife.

Sources:
Probable – Non-specific source (human waste), geese (secondary wildlife), cormorants (wildlife; non-anthropogenic)
Potential –
Possible – Cats and dogs (domestic animals; anthropogenic non-human sources), seagulls and pigeons (secondary wildlife), foxes, raccoons and coyotes (wildlife; non-anthropogenic)

32 - USING MULTIPLE ANTIBIOTIC RESISTANCE AND LAND USE CHARACTERISTICS TO DETERMINE SOURCES OF FECAL COLIFORM BACTERIAL POLLUTION
R. Heath Kelsey, G.I. Scott, D.E. Porter, B. Thompson, and L. Webster

http://www.springerlink.com/content/p5p4413ku0082707/fulltext.pdf
Purpose - Multiple Antibiotic Resistance (MAR) analysis and regression modeling techniques were used to identify surface water areas impacted by fecal pollution from human sources, and to determine the effects of land use on fecal pollution in Murrells Inlet, a small, urbanized, high-salinity estuary located between Myrtle Beach and Georgetown, South Carolina.

Results - MAR results suggest that the majority of the fecal pollution detected in the Murrells Inlet estuary may be from non-human sources, including fecal coliforms isolated from areas in close proximity to high densities of active septic tanks.

Sources:
Probable -
Potential -
Possible -

144 - Bacteria Attenuation Modeling and Source Identification in Kranji Catchment and Reservoir
Kathleen B. Kerigan, and J.M. Yeager
http://censam.mit.edu/publications/yeager.pdf
Purpose - Determine the bacterial loading of Kranji Catchment and Reservoir and how this will affect planned recreational use of the reservoir.

Results - Farm run-off near the reservoir was the bacterial source of greatest concern. The relatively high concentrations coupled with the short travel time, which diminishes opportunity for attenuation, resulted in high concentrations reaching the reservoir downstream levels.

73 - Draft Calleguas Creek Watershed Quantitative Microbial Source Tracking Study
Beverly Kildare, V. Rajal, S. Tiwari, D. Thompson, B. McSwain, S. Wuertz, D. Bambic, and G. Reide (Report Prepared by UC Davis in Collaboration with Larry Walker Associates)
Wuertz, S., Bambic, D., and Reide, G. (Report Prepared by UC Davis in Collaboration with Larry Walker Associates)
http://www.calleguas.com/ccwmp/DRAFT_CCW_MST_061406.pdf
Purpose - The goal of this microbial source tracking (MST) study was to provide quantitative, host-specific fecal source data and assist in the development of a bacteria TMDL for the Calleguas Creek Watershed(CCW).

Results - Urban areas were found to be sources of human and canine bacteria to Arroyo Simi and Conejo Creek. The Tapo Canyon site, which is upstream of urban influences, exhibited the lowest concentrations and ratios of the mixed-human marker, but the highest concentrations and ratios of the cow/horse marker. Analysis of tertiary-treated wastewater samples indicates that mixed-human Bacteroidales concentrations may be relatively high in discharged effluent. However, such cells are most likely non-viable and thus not associated with water quality objective exceedances.

Sources:
Probable – Non-specific source (human waste), dogs (canine urban land use), cows and horses (rural and open space)
Potential –
Possible –

100 - Non-point source pollution: Determination of replication versus persistence of Escherichia coli in surface water and sediments with correlation of levels to readily measurable environmental parameters
Julie Kinzelman, S.L. McLellan, A.D. Daniels, S. Cashin, A. Singh, S. Gradus, and R. Bagley
http://www.iwaponline.com/jwh/002/0103/0020103.pdf
Purpose - Racine, Wisconsin, located on Lake Michigan, experiences frequent recreational water quality advisories in the absence of any identifiable point source of pollution. This research examines the environmental distribution of Escherichia coli in conjunction with the assessment of additional parameters (rainfall, turbidity, wave height, wind direction, wind speed and algal presence) in order to determine the most probable factors that influence E. coli levels in surface waters.

Results - This study indicates that persistence, rather than environmental replication of E. coli, is responsible for the majority of microorganisms recovered from foreshore sands, submerged sands and surface waters at Racine, Wisconsin, beaches along Lake Michigan.

Sources:
Probable – Non-specific source (persistence in surface water; non-anthropogenic), Soil/Sediment/Sand (persistence)
Potential –
Possible –

135 - Source tracking faecal contamination in an urbanised and a rural waterway in the Nelson-Tasman region, New Zealand
M. Kirs, V.J. Harwood, A.E. Fidler, P.A. Gillespie, W.R. Fyfe, A.D. Blackwood, and C.D. Cornelisen
http://www.tandfonline.com/doi/pdf/10.1080/00288330.2010.535494
Purpose - Eight MST markers, including general, ruminant and human-associated Bacteroidales markers, a duck-associated E2 marker, a gull-associated Catellicoccus marimammalium marker and three additional human markers [Enterococcus faecium esp gene, Methanobrevibacter smithii nifH gene, and human polyoma viruses (HPyVs)] were tested for host specificity and sensitivity using an array of animal faecal samples of known origin and wastewater samples.

Results - The validation and application of a suite of end-point PCR assays for MST markers enabled us to identify the presence of faecal contamination from multiple sources, including humans, in a New Zealand urbanised waterway. Outcomes demonstrate that MST markers developed overseas can be utilised in New Zealand context.

150 - PISMO BEACH FECAL CONTAMINATION SOURCE IDENTIFICATION STUDY

Christopher L. Kitts, M.W. Black, M.Y. Moline, A.K. Hamrick, I.C. Robbins, A.A. Schaffner, and N.I. Boutet

http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1325&context=bio_fac

Purpose - Identify the biological sources of fecal contamination as well as the physical and environmental factors that influence the levels of bacteria in the ocean waters at Pismo Beach, California.

Results - The main source of fecal contamination on the beach is bird droppings near the pier. Both wave direction and current direction worked to push high concentrations of FIB away from the pier as the main source of fecal contamination.

Sources:
Probable – Sewage Infrastructure, Domestic animals (dogs, cats and horses), Secondary wildlife (cows, pigeons and gulls)
Potential –
Possible –

101 - Presence and Sources of Fecal Coliform Bacteria in Epilithic Periphyton Communities of Lake Superior

Winfried B. Ksoll, S. Ishii, M.J. Sadowsky, and R.E. Hicks

http://aem.asm.org/content/73/12/3771.full.pdf+html

Purpose - (i) determine if fecal coliforms and E. coli populations are present and persist in periphyton communities from a harbor and Lake Superior, (ii) identify the most probable sources of E. coli found in periphyton, (iii) use laboratory microcosms to examine colonization and survival of E. coli in natural periphyton communities, and (iv) estimate the contribution of periphyton borne E. coli to overlying waters.

Results - Although many E. coli strains isolated from periphyton may have originated from waterfowl and sewage effluent, other strains appeared to be unique to the periphyton studied and may have developed self-sustaining naturalized populations in these communities. E. coli cells attached to periphyton, whether they are unique to these periphyton communities or not, can detach and contribute to fecal coliform numbers measured in coastal waters. This confounds the use of fecal coliforms as a reliable indicator of recent fecal contamination of recreational waters.

Sources:
Probable –
Potential – Sewage effluent (wastewater treatment plant; human waste), waterfowl (wildlife; non-anthropogenic), algae (non-anthropogenic)
Possible –

65 - Microbial Source Tracking Study for South Cypress Creek
Thomas B. Lawrence, P.E. (City of Memphis, Division of Public Works)
Purpose - The objective of this project was to be able to determine possible sources of fecal coliform levels found in South Cypress Creek, as well as to be able to try to quantify the impacts. By identifying the sources of the impacts, the City will work to achieve the goal of the Clean Water Act by addressing the specific sources where possible.

Results – Data indicated that there may be both diffuse sources of Avian fecal coliform (such as deposited areas that are washed into the creek at a slow rate), as well as direct discharges into the creek, providing the high numbers. The total human impact was fairly low. Thus, pet contributions may be more related to storm water runoff, rather than would be seen with the other major source types which may be related to direct contact with the creek water. For sources attributed to Wild Animals, the number of isolates was higher than all of the other sources in all fecal result groups, except for the "TNTC" group, where it was second to Avian.

Sources:
Probable – avian (secondary wildlife), wildlife (including birds),
Potential -
Possible - Non-specific source (human waste), domestic animals,

39 - LINKING ON-FARM DAIRY MANAGEMENT PRACTICES TOSTORM-FLOWFECAL COLIFORM LOADING FOR CALIFORNIA COASTALWATERSHEDS
David J. Lewis, E.R. Atwill, M.S. Lennox, L. Hou, B. Karle, and K.W. Tate
http://waterquality.ucanr.org/documents/Dairy_Management_Resources7451.pdf
Purpose - We have conducted a systems approach study of 10 coastal dairies and ranches to document fecal coliform concentration and loading to surface waters at the management decision unit scale. Water quality samples were collected on a storm event basis from loading units that included: manure management systems; gutters; storm drains; pastures; and corrals and lots.

Results – Fecal coliform load from units of concentrated animals and manure are significantly more than units such as pastures while storm flow amounts were significantly less. Fecal coliform concentrations demonstrate high variability both within and between loading units. Fecal coliform concentrations for pastures range from 206 to 2,288,888 cfu/100 ml and for lots from 1,933 to 166,105,000 cfu/100 ml.

Sources:
Probable - Manure Management Systems, Stockpiles, and lots (agriculture),
Potential – MS4 Infrastructure (human waste), pasture (land use)
Possible -

15 - Evaluation of Chemical, Molecular, and Traditional Markers of Fecal Contamination in an Effluent Dominated Urban Stream
R.M. Litton, J.H. Ahn, B. Sercu, P.A. Holden, D.L. Sedlak, and S.B. Grant
http://pubs.acs.org/doi/abs/10.1021/es101092g

Purpose - To perform a quantitative sanitary survey of the Middle Santa Ana River, in southern California, utilizing a variety of source tracking tools, including traditional culture-dependent fecal markers, speciation of enterococci isolates, culture-independent fecal markers, and chemical markers of sewage and wastewater

Results - The results support the notion that regrowth of fecal indicator bacteria (FIB) in river sediments may lead to a decoupling between FIB and pathogen concentrations in the water column and thus limit the utility of FIB as an indicator of recreational waterborne illness in inland waters.

Sources:
Probable - in-situ growth in streambed sediments
Potential - effluent stream tributary to Santa Ana River, tributary to RW (Riverside WWTP plant stream tributary to Santa Ana River
Possible - Riverside WWTP & discharge pipe

128 - Snapshot investigation of likely contaminant sources in the Tilligerry Estuary catchment (Zones 5A and 5B)
S.A. Lucas, P.M. Geary, P.J. Coombes, and R.H. Dunstan
http://scholar.googleusercontent.com/scholar?q=cache:F75WyRF5YdUJ:scholar.google.com/&hl=en&num=100&as_sdt=0,5&as_vis=1
Purpose - a) To provide a "snapshot" of water quality in major surface waters draining to the estuary and within the estuary after a particularly wet period. The samples were analysed for nutrients (orthophosphate and nitrate), total coliforms, faecal coliforms, E.Coli, faecal streptococci and faecal sterols and; b) To interpret the most likely sources of faecal contamination from the data obtained as elevated faecal coliform concentrations had been recorded after significant rainfall in the past.

Results - However, the high microbial concentrations observed in major surface drains on the western and eastern side of the estuary also warrant further investigation, however it is clear that the majority of faecal contamination in the estuary is from agricultural land uses. A management program to control and mitigate runoff sources from agricultural lands in the catchment is therefore seen as an integral part of any plan to reduce faecal contamination in Tilligerry estuary.

Sources:
Probable –Human Waste (Non-specific source), Herbivores (Secondary Wildlife)
Potential -
Possible -

62 - Bacteriological methods for distinguishing between human and animal faecal pollution of water: results of fieldwork in Nigeria and Zimbabwe
D. Duncan Mara and J. Oragui
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2536379/pdf/bullwho00087-0144.pdf

Purpose - Recently, methods have been developed to distinguish between human and animal faecal pollution in temperate climates. The present study assessed the applicability and practicality of these methods in tropical countries.

Results - Ruminant and human fecal sources threaten the shellfish harvest.

Sources:
Probable –domestic animals,
Potential - Non-specific source (human waste), Non-specific source (anthropogenic non-human source),
Possible -

207 - Identifying sources of fecal contamination inexpensively with targeted sampling and bacterial source tracking
J.L. McDonald, P.G. Hartel, L.C. Gentit, C.N. Belcher, K.W. Gates, K. Rodgers, J.A. Fisher, K.A. Smith, and K.A. Payne
http://www.water.rutgers.edu/Source_Tracking/Enterococcus/IdentifyingSourcesofFecalContaminationInexpensivelywithTargetedSamplingandBacterialSource.pdf
Purpose - Our objective was to identify the sources of fecal contamination inexpensively at St. Andrews Park and Sea Island during calm and stormy weather conditions using targeted sampling and two or more BST methods: Enterococcus speciation, the detection of the esp gene, and fluorometry.

Results - Targeted sampling, when combined with two or more of three BST methods-enterococcal speciation, detection of the esp gene, and fluorometry--was able to identify sources of fecal contamination quickly, easily, and inexpensively.

Sources:
Probable – Wildlife (Birds)
Potential -
Possible –Human Waste (Non-specific source), Sewage infrastructure (leaking sewer lines), Unspecified wildlife

26 - Application of Bacteroides fragilis Phage as an Alternative Indicator of Sewage Pollution in Tampa Bay, Florida
Molly R. McLaughlin, and J.B. Rose
http://www.springerlink.com/content/922l116k3286u5p3/fulltext.pdf
Purpose - The use of bacteriophages were evaluated in the drainage basins of Tampa Bay

Results – In this study, the phages that infect B. fragilis host RYC2056 (RYC), including phage B56-3, and host ATCC 51477-HSP40 (HSP), including the human specific phage B40-8, were evaluated in the drainage basins of Tampa Bay, 7 samples (n=62), or 11%,
tested positive for the presence of phages infecting the host HSP, whereas 28 samples, or 45%, tested positive using the host RYC.

Sources:
Probable – Septic (sewage infrastructure),
Potential -
Possible -

4 - PB Point Bacterial Source Investigation Final Data Report
MEC- Weston and City of San Diego
Purpose - The goal of this study was to use molecular and standard bacterial indicator techniques to assess the host origin of the bacteria found in the receiving waters at PB point.

Results - The results of the PCR analysis are also presented in Table 2. Of the ten receiving water samples collected (not including duplicates), four (75-R on 8/15, 75R on 8/18, 75-L on 8/18 and 75-R on 8/20) were positive for the general PCR marker (GB), suggesting the presence of fecal material. Among the four samples that tested positive for the general marker, two were positive for at least one of the human-specific markers (75-L on 8/18 and 75-R on 8/20), which suggests the presence of bacteria from human origin.

Although the values for the bacterial indicators from all of the storm drain samples were high, only one (not including duplicates) of the five storm drain samples was positive for the general PCR marker (SD-0 on 8/15). None of the storm drain samples were positive for either of the two human markers.

Sources:
Probable –
Potential – Non-specific source (human waste)
Possible -

55 - MISSION BAY - Clean Beaches Initiative Bacterial Source Identification Study
MEC- Weston and City of San Diego
Purpose - The overall goal of this study was to identify the sources of bacterial contamination to Mission Bay.

Results -Results from both MST methods utilized in Phase II confirmed that the large majority of the enteric bacteria in Mission Bay originates from birds and contributions from human sources are insignificant

Sources:
Probable – Avian (secondary wildlife),
Potential –Dogs, over-irrigation, MS4 Infrastructure (delta sediment at storm drain outlet)
Possible - park restrooms and RV pump stations (human waste), boats and homeless(mobile sources), groundwater (non-anthropogenic), marine mammals, bay sediment

105 - Temporal and Spatial Variability of Fecal Indicator Bacteria: Implications for the Application of MST Methodologies to Differentiate Sources of Fecal Contamination
Marirosa Molina
http://www.environmental-center.com/Files%5C7698%5Carticles%5C5788%5CMolina20600.pdf
Purpose - Identify and compare the temporal and spatial variability of fecal indicator bacteria from a specific host in manure and water samples and evaluate the implications of such variability on microbial source tracking approaches and applications.

Results - Building an enterococci library is a time-consuming, expensive approach that has the potential to provide a great deal of information when the proper statistical analytical approach (in this case it was cluster analysis) is used to interpret the results. Application of a library-independent approach, such as the Bacteroides markers allows for a much faster and possibly less expensive results, but there remains a lack of thorough temporal, spatial and specificity analyses of the few genetic markers available so far.

Sources:
Probable – Cattle (domestic animals; anthropogenic non-human sources)
Potential –
Possible –

38 - Bacteria Monitoring and Source Tracking in Corpus Christi Bay at Cole and Ropes Parks
Joanna Mott, M. Lindsey, R. Sealy, and A. Smith
http://www.cbbep.org/publications/virtuallibrary/1010.pdf
Purpose - In this study water samples from the six Texas Beach Watch stations at Ropes and Cole Parks were analyzed to detect the esp marker as an indicator of human contamination at these locations. Additionally, data on three other human-specific markers--Bacteroidales, Human 2 Polyoma Viruses (HPyVs), and ethanobrevibacter.smithii—from another study, are included in this report for comparison with the esp analysis results.

Results - Human source contamination was detected at Ropes and Cole Park stations under ambient weather conditions as measured by several human-specific markers. The esp gene was detected when levels of enterococci at Ropes Park were higher following rainfall and suggest a human contribution at this location presumably either from storm drain outflow or non-point source run-off. For Ropes and Cole Parks, a broader bacteria source tracking project is recommended to examine not only human, but other sources of contamination.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible – MS4 Infrastructure (human waste),

72 - Bacteria Source Tracking on the Mission and Aransas Rivers
Joanna Mott, R. Lehman, Ph.D. and A. Smith
Purpose - In this study, bacteria source tracking (BST) was used to evaluate the sources of fecal contamination in the Mission and Aransas River segments and to provide additional data for assessment of sources of contamination into Copano Bay, the water body into which both segments empty.

Results - The majority of unknown source isolates collected from water samples at the five sampling stations along the Mission and Aransas tidal segments were classified as human source. Overall, 63.7-66.9% of unknown source isolate profiles from the composite (ARA+CSU) dataset were classified as treated human sources (originating from treated wastewater effluent). The remaining unknown source isolates were classified as livestock animals and wildlife, with cow, horse and duck contributions accounting for the majority of the animal sources in both the composite dataset and PFGE profiles.

Sources:
Probable – Wastewater treatment plant, cows, horses, ducks
Potential –
Possible – Gulls (secondary wildlife), hogs

41 - Multi-scale landscape factors influencing stream water quality in the state of Oregon
Maliha S. Nash, D.T. Heggem, D. Ebert, T.G. Wade, and R.K. Hall
http://www.springerlink.com/content/y17u3uh60155w313/fulltext.pdf
Purpose - This study used the State of Oregon surface water data to determine the likelihood of animal pathogen presence using enterococci and analyzed the spatial distribution and relationship of biotic (enterococci) and biotic (nitrogen and phosphorous) surface water constituents to landscape metrics and others (e.g. human use, percent riparian cover, natural covers, grazing, etc.).

Results – Landscape metrics related to amount of agriculture, wetlands and urban all contributed to increasing nutrients in surface water but at different scales. The probability of having sites with concentrations of enterococci above the threshold was much lower in areas of natural land cover and much higher in areas with higher urban land use within 60 m of stream. A 1% increase in natural land cover was associated with a 12% decrease in the predicted odds of having a site exceeding the threshold. Opposite to natural land cover, a one unit change in each of manmade barren and urban land use led to an increase of the likelihood of exceeding the threshold by 73%, and 11%, respectively. Change in urban land use had a higher influence on the likelihood of a site exceeding the threshold than that of natural land cover.

Sources:
Probable - Urbanized land use
Potential -
Possible – Agriculture

66 - Coastal Nonpoint Source Pollution Monitoring Program
New Jersey Department of Environmental Protection
Purpose - To identify the causes of the degrading water quality in the upper Navesink River. Perform stormwater monitoring to delineate major sources of fecal contamination. Utilize specialize tests, including coliphage and Multiple Antibiotic Resistance (MAR) analyses, to identify the sources of contamination (i.e., human, domestic animal, and wildlife). Once identified, actions can be recommended and taken to eliminate or reduce the impact.

Results – Results for Microbial Source Tracking indicators (F+RNA coliphage and Multiple Antibiotic Resistance) suggest a human source of fecal contamination at sites. Sites were identified as 'hot spots' for further source investigations.

Sources:
Probable - Non-specific source (human waste),wildlife
Potential – Domestic animals,
Possible -

1 - Multi-tiered Approach Using Quantitative Polymerase Chain Reaction for Tracking Source of Fecal Pollution to Santa Monica Bay, Ca, February 2005
Rachel T. Noble, J.F. Griffith, A.D. Blackwood, J.A. Fuhrman, J.B. Gregory, X. Hernandez, X. Liang, A.A. Bera, and K. Schiff
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2005_06AnnualReport/AR0506_181-194.pdf
Purpose - The objective of this study was to identify the contribution and quantify the loading of fecal contamination to the SMB using a multi-tiered approach. No discussion on what fecal source types (agriculture, birds, dogs) are impacting Santa Monica Bay

Results - Measurements of Bacteroides sp. and enterovirus indicated the presence of human fecal contamination throughout the system. Bacteroides sp. was present in 33% of mainstem samples. Enterovirus was present in 44% of mainstem samples. The concordance among these measurements was nearly complete; almost every location that detected Bacteroides sp. was also positive for enterovirus.

Sources:
Probable - Non-specific Source (human waste)
Potential -
Possible-

108 - Use of Fecal Steroids to Infer the Sources of Fecal Indicator Bacteria in the Lower Santa Ana River Watershed, California: Sewage Is Unlikely a Significant Source
James A. Noblet, D.L. Young, E.Y. Zeng and S. Ensari
ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/JournalArticles/444_fecal_steroids.pdf
Purpose - Utilize a suite of fecal steroids, as chemical markers to examine whether sewage was a significant source of FIB within the lower Santa Ana River watershed.

Results - The results implied that sewage was not a significant source of fecal steroids, and therefore perhaps FIB to the study area. Instead, birds may be one possible source of the intermittently high levels of FIB observed in the lower Santa Ana River watershed and the nearby surf zone.

Sources:
Probable –
Potential – Gulls (secondary wildlife; anthropogenic non-human sources)
Possible – Sewage infrastructure (human waste), dogs (domestic animals; anthropogenic non-human sources)

109 - Fecal source tracking by antibiotic resistance analysis on a watershed exhibiting low resistance
Yolanda Olivas, and B.R. Faulkner
http://www.springerlink.com/content/k02q5v6748702773/fulltext.pdf
Purpose - To test the efficiency of the antibiotic resistance analysis (ARA) method under low resistance by tracking the fecal sources at Turkey Creek, Oklahoma exhibiting this condition.

Results - The original seasonal and annual DA of the stream sources showed no significant difference between human and livestock input rates in winter, spring and summer ($0.56 \leq P \leq 0.76$). Deer was consistently lower than the other two sources ($0.00 \leq P \leq 0.30$). In fall, the human source predominated over livestock and deer ($P<0.0001$). Revision of the original DA using the rates of misclassification, decreased classification into the human and deer sources by 6–7% ($0.22 \leq P \leq 0.33$), and increased classification into livestock by 13–14% ($0.04 \leq P \leq 0.06$), showing the significance of the original DA misclassification. In conclusion, the major effect of low antibiotic resistance to this ARA work was a significant level of negative misclassification into the livestock source.

Sources:
Probable – Non-specific source (human waste), livestock (domestic animals; anthropogenic non-human sources)
Potential – Deer (wildlife; non-anthropogenic)
Possible –

143 - Investigation of Faecal Pollution and Occurrence of Antibiotic Resistant Bacteria in the Mooi River System as a Function of a Changed Environment
M.J. Pantshwa, A.M. van der Walt, S.S. Cilliers, and C.C. Bezuidenhout
http://www.ewisa.co.za/literature/files/2008_137.pdf
Purpose - Water quality monitoring and assessments are of paramount importance to identify the river confluence vulnerable to the pollution impacts of urbanization. Investigate some physico-chemical parameters, levels of faecal pollution and occurrence of antibiotic resistant bacteria in the Mooi River system as a function of a changed environment.

Results - Non-human sources contributed greater towards faecal pollution. Urban gradient was recognized in terms of faecal indicator species distribution. Higher levels of antibiotic resistant bacteria were detected in urban sites when compared to lower upstream and elevated downstream levels.

75 - Middle Rio Grande Microbial Source Tracking Assessment Report
Parsons Water & Infrastructure Inc.
Purpose - The objective of this project was to identify specific sources of fecal coliform causing high levels of bacteria in the Middle Rio Grande.

Results - Overall, ribotyping results show, the largest fraction of E. coli matched those found in avian sources, followed by canine, human/sewage, rodents, bovine, and equine. The source of approximately 9 percent of the E. coli could not be identified. With the exception of rodents, only a few species of wild mammals were identified as sources of fecal coliform found in water: deer or elk, raccoon, coyote, bear, and opossum. It should be noted that an unknown fraction of the canine isolates may be from coyotes and foxes, as many E. coli strains are resident both in domestic dogs and wild canines.

Sources:
Probable – Cats, dogs, birds (wildlife)
Potential – Non-specific source (human waste), livestock, rodents (secondary wildlife), Wildlife (deer or elk, raccoon, coyote, bear, and opossum)
Possible –

125 - Bacterial Contamination and Antibiotic Resistance in Fecal Coliforms from Glacial Water Runoff
S.P. Pathak, and K. Gopal
http://www.springerlink.com/content/fup31h3742514123/fulltext.pdf
Purpose - Assess the bacteriological contamination in glacial water runoff from the Gangotri glacier and Gangetic river system (Gaumukh to Rishikesh) by enumerating aerobic heterotrophs, coliforms, fecal coliforms and fecal streptococci. Antibiotic resistance among the fecal coliforms, identified as E. coli, was also studied.

Results - Contamination of coliform was observed in all samples, while fecal coliform and fecal streptococci were detected in 17 and 18 samples, respectively (Fig. 2). Thus, bacteriological analysis exhibited maximum contamination in most of the water samples from post-Gangotri and Gangetic stations. The observed increase in the proportion of coliforms and fecal coliforms was statistically significant ($p < 0.001$). The counts of fecal streptococci in all study stretches were too low for statistical comparison.

129 - Fecal BMAP Implementation: Identification of Probable Sources in the Butcher Pen Creek Watershed
PBS&J
http://publicfiles.dep.state.fl.us/dear/BMAP/LowerStJohns/Tributaries%20Fecal%20Coliform%20BMAPs/Technical_Reports/ButcherPen/Final%20Draft%20Butcher%20Pen%20WBID%202322%20Tech%20Report%20041008.pdf
Purpose - FDEP has verified 54 tributaries of the Lower St. Johns River—located throughout Duval County and in small portions of Clay and St. Johns Counties—as impaired for fecal coliform, and TMDLs must be developed for these waterbodies. Local stakeholders in the Lower St. Johns Basin, in conjunction with FDEP, are currently working to develop a Basin Management Action Plan (BMAP) to implement the TMDLs for fecal coliform.

Results - Elevated levels of fecal coliforms following rainfall may be an indication that unidentified pollution sources (e.g., leaking wastewater conveyance systems) are being transported by stormwater into Butcher Pen Creek. This evaluation indicates that the probable sources of fecal contamination in the Butcher Pen Creek WBID are human-related. Although Butcher Pen Creek does not have a designated septic tank phase-out area, some areas of the basin have likely had OSTDS failures, as indicated by the existence of septic tank repair permit applications, especially in the northeast corners of the watershed. Therefore, it is likely that there still remain isolated and problematic septic systems that are contaminating the neighboring surface waters.

Sources:
Probable – Sewage infrastructure (SSO events),
Potential – Wastewater discharge
Possible –

34 - Origin and spatial–temporal distribution of faecal bacteria in a bay of Lake Geneva, Switzerland
John Poté, N. Goldscheider, L. Haller, J. Zopfi, F. Khajehnouri, and W. Wildi
http://doc.rero.ch/lm.php?url=1000,43,4,20100511154847-XI/Pot_John_-_Origin_and_spatial-temporal_distribution_of_faecal_bacteria_20100511.pdf
Purpose - To quantify the input flux rates of faecal bacteria from the main contamination sources and to assess their spatial and temporal distribution in the bay, in order to estimate the human health risk related to recreational activities and drinking water use.

Results - The highest FIB concentrations in the near-surface water of the bay consequently occur during floods and mixed lake conditions. Although the thermocline protects the epilimnion from contamination in summer, effluent water may spread in the hypolimnion and reach the drinking-water pumping station 3.8 km further to the west.

Sources:
Probable – Wastewater Treatment Plant
Potential –
Possible –

110 - Classification Tree Method for Bacterial Source Tracking with Antibiotic Resistance Analysis Data
Bertram Price, E.A. Venso, M.F. Frana, J. Greenberg, A. Ware, and L. Currey
http://aem.asm.org/content/72/5/3468.full.pdf+html
Purpose - Apply the statistical method known as classification trees to build a model for BST for the Anacostia Watershed in Maryland.

Results - Applying the tree classification model to the 1,565 Anacostia River water isolates yielded the following distribution of sources: 468 (29.9%) pet, 222 (14.2%) human, 437 (27.9%) livestock, and 438 (28.0%) wildlife. These results were determined from analysis of all the water isolates, which represent six monitoring stations with samples collected monthly for 1 year. Therefore, the source distribution presented here does not account for the distribution of high-flow and low-flow periods, which may contribute different sources to the streams. Also, note that bacterial sources can be site specific in a watershed, given the non-conservative nature of bacterial transport. For the purpose of this analysis, all the water isolates from the six monitoring stations were used to estimate the overall watershed relative source contributions. The results based on this averaging method indicate that humans contribute the least bacterial contamination to the Anacostia River. The other sources of bacterial contamination are evenly distributed among pet animals, livestock, and wildlife.

Sources:
Probable – Pets and livestock (domestic animals; anthropogenic non-human sources), wildlife (non-anthropogenic)
Potential – Non-specific sources (human waste)
Possible –

113 - Quantitative microbial faecal source tracking with sampling guided by hydrological catchment dynamics
G. H. Reischer, J.M. Haider, R. Sommer, H. Stadler, K.M. Keiblinger, R. Hornek, W. Zerobin, R.L. Mach, and A.H. Farnleitner
http://onlinelibrary.wiley.com/doi/10.1111/j.1462-2920.2008.01682.x/pdf
Purpose - Apply modern quantitative microbial source tracking methods on a large and complex karstic spring catchment in context with hydrology and other water quality parameters over a prolonged period of time in order to comprehensively, qualitatively and quantitatively characterize the pollution sources.

Results - 1) Established and evaluated a new sampling concept with consideration for the whole seasonal hydrological catchment variability and special emphasis on strong pollution events.
2) Demonstrated the ability of quantitative microbial source tracking studies to quantitatively link source-specific marker levels to general faecal pollution indicators in order to estimate the contribution of one source group to total faecal pollution as measured in conventional faecal monitoring.

3) Showed that the thorough investigation of catchment hydrology and pollution dynamics is a prerequisite for successful quantitative microbial source tracking study design.

Sources:
Probable – Ruminant (wildlife; non-anthropogenic)
Potential – Non-specific sources (human waste)
Possible – Soil/Sediment/Sand

133 - Assessment of Sources of Bacterial Contamination At Santa Cruz County Beaches
John Ricker and S. Peters
ftp://ftpdpla.water.ca.gov/users/prop50/10045_SantaCruz/Work%20Plan%20CD%2004/reference%20plans%20and%20background%20information/Sources%20of%20Contamination%20at%20SCC%20Beaches%202005.pdf
Purpose - Determine the source and health threat of elevated bacteria levels at Santa Cruz County beaches

Results - The most significant source of beach contamination in Santa Cruz County is discharge from the creeks, with a high urban runoff component during both wet and dry weather. 22 point plan to be implemented to improve water quality

Sources:
Probable – Non-specific sources (human waste), Sewage infrastructure (storm drains), Domestic animals (dogs), Secondary wildlife (birds), Wildlife (rats)
Potential –
Possible –

42 - Bacterial Source Tracking Pilot Study DNA Fingerprinting, Human Bacteroidetes ID and Human Enterococci ID
Rogue Valley Council of Governments
Natural Resources Department
Purpose - The purpose of the pilot study was 1) to determine whether bacteria found in local streams is from human or animal sources and 2) to evaluate different BST methodology for future use within the Rogue Valley.

Results - DNA Fingerprinting results show that animal fecal matter is present, but were inconclusive in identifying whether human contamination was present. Many of the analyzed colonies could not be matched to animal or human sources. However, based on the isolates identified, animals are the primary contributor of bacteria to Ashland Creek, Baby Bear, and Griffin Creek (31 of 50).

Sources:
Probable - Domestic animals, wildlife,
Potential -
Possible – Non-specific source (human waste)

7 - Microbiological Water Quality at Reference Beaches in Southern California During Wet Weather
Kenneth Schiff, J. Griffith, and G. Lyon
http://www.sccwrp.org:8060/pub/download/DOCUMENTS/TechnicalReports/448_reference_beach.pdf
Purpose - The contribution of non-human sources of bacteria was quantified at coastal reference beaches in southern California. Provides an overview of sampling methods and analytical results for reference beaches are discussed. Bacteria sources were not identified

Results – Based on the results from this study, natural contributions of nonhuman fecal indicator bacteria were sufficient to generate exceedances of the State of California water quality thresholds during wet weather. Total coliform, E. coli, and enterococcus samples collected during wet weather exceeded water quality thresholds greater than 10 times more frequently during wet weather than during recent dry weather in summer or winter, although the frequency differed by beach. San Onofre State Beach had the greatest concentrations of bacteria and the greatest frequency of water quality threshold exceedances. This may have been the result of several factors that we cannot disentangle. First, San Onofre Creek was the largest watershed we sampled, which may have led to a greater number of nonhuman sources of fecal indicator bacteria upstream. Second, San Onofre Creek had the largest and most mature lagoon of any site sampled, which was located at the beach interface and may have attracted nonhuman fecal sources(i.e. birds). Third, San Onofre Creek was the only discharge where we found human enteric virus. The San Onofre Creek watershed had the greatest fraction of developed land use (3%) of any of the other watershed systems and human activities are known to occur in the lower part of this watershed.

Sources:
Probable – Non-specific source (anthropogenic)
Potential – Non-specific source (human waste)
Possible –

221 - Presence of Bacteroidales as a Predictor of Pathogens in Surface Waters of the Central California Coast
A. Schriewer, W.A. Miller, B.A. Byrne, M.A. Miller, S. Oates, P.A. Conrad,, D. Hardin, H.H. Yang, N. Chouicha, A. Melli, D. Jessup, C. Dominik, and S. Wuertz
http://ukpmc.ac.uk/articles/PMC2935056
Purpose - Evaluate the value of Bacteroidales genetic markers and fecal indicator bacteria (FIB) to predict the occurrence of waterborne pathogens in ambient waters along the central California coast.

Results - The ability to predict pathogen occurrence in relation to indicator threshold cutoff levels was evaluated using a weighted measure that showed the universal Bacteroidales genetic marker to have a comparable or higher mean predictive potential than standard FIB. This predictive ability, in addition to the Bacteroidales assays providing information on contributing host fecal sources, supports using Bacteroidales assays in water quality monitoring programs.

77 - Tracking Sources of Fecal Pollution in a South Carolina Watershed by Ribotyping Escherichia coli: A Case Study
Troy M. Scott, J. Caren, G.R. Nelson, T.M. Jenkins, and J. Lukasik
http://sourcemolecular.com/pdfs/scott3.pdf
Purpose - To describe the effective use of the ribotyping microbial source tracking procedure to determine the source(s) of Escherichia coli within a South Carolina watershed.

Results - Prior to investigating potential fecal inputs into this watershed, a significant human source was suspected as the primary input; however, of the 515 E. coli isolated from water samples collected during the course of this study, 88% were typed as being of animal fecal origin. Thus, this study was integral in the realization that animals may be a significant source of contamination and that remediation efforts should be redirected to accommodate these findings. Of the 454 animal isolates analyzed, 51 RT profiles were directly matched from a specific animal source. Of these, 22 (43%) were classified as coming from deer feces and 9 (18%) directly matched those generated from dog feces.

Sources:
Probable – Wildlife (deer, raccoons, birds and pelicans),
Potential – Non-specific source (human waste), cats and dogs, gulls (secondary wildlife)
Possible –

19 - Sewage Exfiltration As a Source of Storm Drain Contamination during Dry Weather in Urban Watersheds
Bram Sercu
http://pubs.acs.org/doi/abs/10.1021/es200981k
Purpose - To determine whether transmission of sewage is occurring from leaking sanitary sewers directly to leaking separated storm drains, field experiments were performed in three watersheds in Santa Barbara, CA.

Results – Above-background RWT peaks were detected in storm drains in high-risk areas, and multiple locations of sewage contamination were found. Sewage contamination during the field studies was confirmed using the human-specific Bacteroidales HF183 and Methanobrevibacter smithii nifH DNA markers. This study is the first to provide direct evidence that leaking sanitary sewers can directly contaminate nearby leaking storm drains with untreated sewage during dry weather and suggests that chronic sanitary sewer leakage contributes to downstream fecal contamination of coastal beaches.

Sources:
Probable -
Potential -
Possible -

6 - Storm Drains are Sources of Human Fecal Pollution during Dry Weather in Three Urban Southern California Watersheds
Bram Sercu, L.C. Van de Werehorst, J. Murray, and P.A. Holden
http://www.santabarbaraca.gov/NR/rdonlyres/C3B1ADAE-37E8-4F89-8F2D-1A24FBAB8D6A/0/Sercuetal_ESnT_2009_v43p2938SI.pdf
Purpose - Dry weather bacteria monitoring in urbanized Santa Barbara, CA watersheds

Results - Of the 80 water samples analyzed within the Malibu watershed, five samples were positive for the human-specific HF183 Bacteroidales marker (HBM).The highest percent exceedance of FIB and HBM concentrations were measured during wet weather. During the study, 93.8% of the samples did not have detectable concentrations of HBM. These data do not rule out any particular potential sources of human fecal contamination.

Sources:
Probable -
Potential - Sewage infrastructure, non-stormwater discharges, MS4 infrastructure (less likely – human waste), MS4 infrastructure (anthropogenic non-human sources)
Possible -

116 - Identification of human fecal pollution sources in a coastal area: a case study at Oostende (Belgium)
Sylvie Seurinck, M. Verdievel, W. Verstraete, and S.D. Siciliano
http://www.iwaponline.com/jwh/004/0167/0040167.pdf
Purpose - Identify fecal pollution sources in the North Sea and produce a model required to predict fecal pollution

Results - The canal Gent-Oostende, the Dode Kreek and Gauwelozekreek, the Voorhaven, and the Montgommerydok contained high levels of the indicator bacteria. The European E. coli standard (5 £ 102/ 100 ml) suggested in the revised draft Bathing Water Directive (Council of the European Communities 2000) was exceeded most of the time at these sites. The human specific Bacteroides marker was detected in almost all water samples from these sites, which indicates that they are regularly contaminated with human fecal pollution. The river Noordede, the Visserijdok and the beach water at 2 sites were only lightly contaminated based on the European E. coli standard. At these sampling sites the human-specific Bacteroides marker was less frequently detected and in lower amounts, except at one locations where high concentrations of 107 human-specific Bacteroides marker per l were recorded at the beginning of the sampling survey and at the end. The detection of indicator organisms and the human specific Bacteroides marker was strongly related to rainfall for this coastal area.

Sources:
Probable – Non-specific sources (human waste)
Potential –Wildlife (non-anthropogenic)
Possible –

11 - Regrowth of Enterococci & Fecal Coliform in Biofilm. Printed in The Journal for Surface Water
John F. Skinner, J. Guzman, and J. Kappeler
Purpose - The goal of the study was to determine the sources of high numbers of enterococci and fecal coliform found in street gutter runoff flowing from residential areas to the Dover Drive storm drain in Newport Beach, Orange County

Results – Bacteria counts in runoff from washing the sidewalk using bacteria-free hose water were 220 enterococci/100 ml and 180 fecal coliform/100 ml. Washoff water from the driveway by manually flooding a residential front lawn was 160 enterococci/100 ml and 9 fecal coliform/100 ml. Runoff from flooding the grass contained 1,250 enterococci/100 ml and 2,000 fecal coliform/100 ml. Water draining directly into the gutter through a hole cut through the curb grew out 70 enterococci/100 ml and 100 fecal coliform/100 ml.

Bacteria-free hose water was introduced into a dry street gutter and tested for enterococci and fecal coliform at 10 meters, 45 meters, and 100 meters downstream when the flow from the hose water reached those locations. There was a progressive rise of both enterococci and fecal coliform bacteria with the increased distance of flow. The levels of fecal indicator bacteria were 26,000 enterococci/100 ml and 14,000 fecal coliform/100 ml when the water reached the 100-meter test site, the last testing station. The source of these high numbers of bacteria is suspected to be coming from regrowth in the street gutters.

The findings of these studies provide evidence that regrowth of both enterococci and fecal coliform bacteria are occurring in biofilm located in residential street gutters and storm drains in Newport Beach.

Sources:
Probable - Street gutter biofilm regrowth (MS4 infrastructure)
Potential – Dog excrement (not tested), lawn irrigation runoff, sidewalk and driveway runoff (Solid/liquid waste), residential washwater, residential lawn runoff
Possible - Residential backyard and side yard patios, roof gutter drains but not tested

49 - F+ RNA Coliphages as Source Tracking Viral Indicators of Fecal Contamination
Dr. Mark D. Sobsey, D.C. Love, and G.L. Lovelace
http://webmail.ciceet.unh.edu/news/releases/springReports07/pdf/sobsey.pdf
Purpose - To evaluate and apply novel, cost-effective technologies and methods for the detection, quantification and identification of sources of microbial contaminants and the characterization of those sources as human or nonhuman.

Results - Microbial indicator concentrations in water and shellfish were higher at sites with greater wastewater treatment plant discharges. Of the 9 estuaries in the study, 4 were impacted by point source discharges of waste water treatment plant (WWTP) effluent. Human point source pollution in this study was primarily from waste water treatment plant (WWTP) treated effluent and possibly raw sewage leaks, while likely human non-point sources included urban runoff, seepage from septic tanks, and boat dumping. Sites with non-human non-point fecal waste contained populations of wildfowl (goose, duck, gull), wild horses, other feral animals, agricultural animals, a dog park and urban pet waste. At 4 estuaries the impacted sites included human point and non-point sources, while the non-impacted sites were pristine sites with wildlife refuges or were geographically separated from human populations. In the Tijuana River Reserve in Southern CA human impacts were documented at all study sites, so in the absence of a truly pristine or non-impacted site, a site with only non-point source runoff from human development was compared to a more contaminated site at the mouth of the Tijuana River containing untreated sewage from Mexico.

Sources:
Probable -
Potential – Sewage infrastructure, Urban runoff (MS4 infrastructure - human waste; suspected to potential)
Possible -

45 - Faecal sterols analysis for the identification of human faecal pollution in a non-sewered catchment.
D. Sullivan, P. Brooks, N. Tindale, S. Chapman, and Ahmed, W.
http://publicationslist.org/data/w.ahmed/ref-14/Daryle_s%20article_%20WST_revised%20version.pdf
Purpose - To identify human faecal pollution in a non-sewered catchment using faecal sterols.

Results - In this study, faecal sterol analysis was used to identify the presence of human sourced faecal pollution or others (non-point sources) in two adjacent creeks of North Maroochy Catchment. It appears that stanols concentrations generally increased with increased catchment runoff. After moderate rainfall, high coprostanols levels found in water samples indicated human faecal pollution and defective septic systems are the most likely sources of pollution. The human signal was traced on one occasion to a defective septic system. In contrast, it appears that during dry weather human faecal pollution is not occurring in the study catchment.

Sources:
Probable – Septic (sewage infrastructure),
Potential –
Possible -

124 - Ecological Control of Fecal Indicator Bacteria in an Urban Stream
Cristiane Q. Surbeck, S.C. Jiang, and S.B. Grant
http://lshs.tamu.edu/docs/lshs/end-notes/ecological%20control%20of%20fecal%20indicator%20bacteria%20in%20an%20urban%20stream-1429959691/ecological%20control%20of%20fecal%20indicator%20bacteria%20in%20an%20urban%20stream.pdf

Purpose - Determine the source(s) of elevated FIB concentrations in Cucamonga Creek, a concrete-lined urban stream in southern California. Flow in the creek consists primarily of treated and disinfected wastewater effluent, mixed with relatively smaller but variable flow of runoff from the surrounding urban landscape.

Results - Mass and volume balance calculations indicate that treated wastewater is not a significant source of FIB to Cucamonga Creek. Runoff from the urban landscape appears to be the primary source of FIB loading to Cucamonga Creek during both dry weather and wet weather periods. Observations from the study imply that DOC and FIB concentrations in runoff should co-vary, which is indeed the case both at Cucamonga Creek and in many agricultural and urban streams along the California coast. These results are not consistent with the hypothesis that FIB are static contaminants (like sediments or nutrients) with well-defined and land-use-specific export coefficients, as has been suggested for catchments in the United Kingdom. Rather, our data suggest that nonpoint source FIB impairments in southern California are best viewed as an ecological phenomenon, in which a dynamic balance between FIB sources, nutrient availability, competition with other heterotrophic bacteria, and predator prevalence determines the magnitude and extent of FIB pollution and its human health implications.

Sources:
Probable – Non-specific Source (Human Waste), Domestic animals (dogs), Secondary Wildlife (birds)
Potential –
Possible -

50 - B Street/Broadway Piers, Downtown Anchorage, and Switzer Creek Storm Drain Characterization Study
Tetra Tech, City of San Diego
Purpose - To further characterize the City's storm drain system discharges during both wet and dry weather. This monitoring program evaluated the potential sources of the pollutants-of-concern (POCs) throughout the MS4 system and collected data to calibrate and validate preliminary wet weather runoff modeling efforts for the San Diego Bay TMDLs.

Results - Bacteria concentrations from residential land use site DBR01 are higher than commercial land use site DBC02. The differences in bacteria concentrations across land use sampling sites were compared using t-test or Mann- Whitney Rank Sum test if data do not meet normality test. The results suggested significant difference in concentrations between the two sampling sites for both events and for all three microbiological parameters. Higher concentrations were found at the residential site (DBR01) than the commercial land use site (DBC02).

Sources:
Probable – Residential (Land use)
Potential – Commercial (Land use)
Possible -

53 - Chollas Storm Drain Characterization Study
Tetra Tech, City of San Diego
Purpose - To further characterize the City's storm drain system discharges during both wet and dry weather. This monitoring program evaluated the potential sources of the pollutants-of-concern (POCs) throughout the MS4 system and collected data to calibrate and validate preliminary wet weather runoff modeling efforts for the San Diego Bay TMDLs.

Results - The measured enterococcus and coliform concentrations generally showed large variations. The enterococcus concentrations showed a number of exceedances of the basin action level at a number of sites including several commercial and industrial sites and two residential sites. Fecal coliform concentrations were generally below action levels, with a few industrial and residential sites showing some exceedances. Total coliform concentrations showed a large number of exceedances at seven out of the ten sampling sites. The difference in bacteria concentrations across land use sampling sites was compared based on median concentrations and using the Mann-Whitney Rank Sum test (Table 7-4). The results suggested significant difference in concentrations among the sampling sites for both events and for all three microbiological parameters. Higher concentrations were found at two commercial (CHC07 and CHC12), industrial (CHI08) and two residential sites (CHR03 and CHR04).

Sources:
Probable – Commercial/Industrial (anthropogenic non-human sources; potential to probable), Commercial and industrial (land use)
Potential – Residential (land use)
Possible -

9 - Using Microbial Source Tracking to Support TMDL Development and Implementation
Tetra Tech, Inc. and Herrera Environmental Consultants
Purpose - Provides an overview of Microbial Source Tracking (MST) and how it can be used to support TMDL development and implementation. The document covers potential uses of MST, descriptions of common MST methods, factors for selecting an MST method and designing an MST study, and examples of MST studies used to support TMDL development or implementation.

Results – ID Study: The Bacteroides PCR results generally supported the PFGE results that wildlife was the predominant source of fecal bacteria in the sampled streams. The genetic fingerprinting showed that greater than 10 percent of the total E. coli colonies isolated were from dogs, and cats were almost 20 percent. In addition, there were two days on lower Hauser Creek when Idaho's primary contact water quality criterion for E. coli was exceeded, during which dogs were the source of over 40 percent of the isolates. Horses and cattle each did not exceed 10 percent of the total E. coli isolates; however, horses were greater than 15 percent of the E. coli isolates. Although humans made up 11 percent of the total E. coli colonies isolated on Right Fork Hauser Creek, only one E. coli colony was isolated from water samples collected on days when the water quality criterion was exceeded.

OR: Results indicated widespread contamination from ruminants (non-elk) and, in certain river segments of the Trask, Miami, and Tillamook Rivers and Holden Creek, significant contamination from humans.

NM: Overall, ribotyping results show the largest fraction of E. coli matched those found in avian sources, followed by canine, human/sewage, rodents, bovine, and equine. The source of approximately 9 percent of the E. coli could not be identified.

VA: MST Results indicate majority of sources derive from wildlife and livestock, followed by humans, and then pets.

NH: Ribotyping identified source species for 76% (19/25) of the E. coli isolates in the water samples. The remaining isolates (24%) could not be matched with certainty to patterns in the ribopattern database. Of the identified isolates, geese constituted the largest portion (52%) followed by livestock [sheep (12%) and cows (4%) for a total of 16%] and dogs (8%).

MI: During dry conditions, the human biomarker was present at all sites, except one site. The results were always negative for the human biomarker, giving a strong indication that E. coli from human sources was not impacting this site during dry conditions. Positive results for the other sites suggest that there are dry-weather sources of E. coli of human origin. These human sources of E. coli could include cross-connections between the sanitary and storm sewer systems, illicit discharges to storm sewers, failed on-site sewage disposal systems, and leaking sanitary sewers.

SD: Among the isolates for which the source could be identified, 26% were equine (horse) and 30% were ovine (sheep). Other identified animal sources include porcine (pig), bovine (cow), canine (dog), feline (cat) and human. Based on review of available information and communication with state and local authorities, the primary nonpoint sources of fecal coliform within the Beaver Creek watershed include agricultural runoff, as well as wildlife and human sources. Septic systems are assumed to be the primary human source of bacteria loads to Beaver Creek. The HSPF model was used to determine the contribution of fecal coliform bacteria from identified sources in the Beaver Creek watershed and evaluate the implementation of BMPs to control these sources.

Sources:
Probable – Geese (NH), avian (NM)
Potential – Non-specific source (human waste – NM, OR), sewage infrastructure (MI), illegal connections, domestic animals (NH, ID, NM), agriculture (OR), secondary wildlife (ID)
Possible -

37 - Monitoring Report for Bacterial Source Tracking Segments 0806, 0841, and 0805 of the Trinity River Bacteria TMDL
Texas Institute for Applied Environmental Research (TIAER)
http://repositories1.lib.utexas.edu/bitstream/handle/2152/7038/crwr_onlinereport08-08.pdf?sequence=2

Purpose - This report includes information on study area, characteristics, materials and methods of bacterial source tracking, and results and findings of the source tracking study.

Results – Overall, each of the source contributors showed a definite trend, whether positive or negative, as one moves downstream from Segment 0806, through Segment 0841, and into Segment 0805. The categories did show consistencies in source species. The avian category was consistently dominated by non waterfowl species, while the livestock category's contribution was shared by bovine and horses. Mammalian wildlife was found to be high in rodent species and raccoons, while the pet category was found to be consistently led by dogs.

Sources:
Probable – Non-specific source (human waste – potential to probable)
Potential - Pets and livestock, avian and mammals (wildlife)
Possible -

149 - Assessment of the Origins of Microbiological Contamination of Groundwater at a Rural Watershed in Chile
Mariela Valenzuela, M.A. Mondaca, M. Claret, C. Perez, B. Lagos, and O. Parra
http://www.scielo.org.mx/pdf/agro/v43n4/v43n4a10.pdf
Purpose - To improve the state of knowledge on the microbiological quality of groundwater at a rural watershed. Characterize the microbiological quality of the groundwater and to identify sources of contamination.

Results - The main source of fecal contamination is of animal origin, a diffuse one. Concentrations of bacterial indicators have a temporal basis showing variable levels among seasons, with a higher concentration in the rainy one. All 42 wells analyzed contained opportunistic pathogens.

167 - Bacterial pathogens in Hawaiian coastal streams-Associations with fecal indicators, land cover, and water quality
E.J. Viau, K.D. Goodwin, K.M. Yamahara, B.A. Layton, L.M. Sassoubre, S.L. Burns, H.I. Tong, S.H. Wong, and A.B. Boehm
http://www.sciencedirect.com/science/article/pii/S0043135411001448
Purpose - To understand the distribution of five bacterial pathogens in O'ahu coastal streams and relate their presence to microbial indicator concentrations, land cover of the surrounding watersheds, and physical-chemical measures of stream water quality.

Results - Results implicate streams as a source of pathogens to coastal waters. Future work is recommended to determine infectious risks of recreational waterborne illness related to O'ahu stream exposures and to mitigate these risks through control of land-based runoff sources.

146 - EFFECTS OF RUNOFF CONTROLS ON THE QUANTITY AND QUALITY OF URBAN RUNOFF AT TWO LOCATIONS IN AUSTIN, TEXAS

Clarence T. Welborn, and J.E. Veenhuis
http://pubs.usgs.gov/wri/1987/4004/report.pdf
Purpose - Determine if the rapid urban development in the Austin metropolitan area is causing an increase in the peak discharges from storm runoff and the degradation of the quality in receiving waters.

Results - Loads of most constituents and total densities of bacteria at the mall site were substantially larger in the inflow than in the outflow. The total densities of bacteria at the outflow were less by about 80 percent. Discharge weighted concentration data for Alta Vista indicate that the grass-covered swales and the grass-covered detention area had little or no effects on reducing concentrations or densities of most water-quality constituents.

Sources:
Probable – Residential, Industrial and Commercial Land Use(street, lawn and parking lot runoff)
Potential -
Possible -

14 - Tecolote Creek Microbial Source Tracking Summary Phases I, II, and III
Weston Solutions
Purpose - To investigate the bacterial sources, origins, and loads in the Tecolote Creek watershed and to assess and characterize specific priority activity contributions.

Results – Wet weather bacteria loads from individual land uses indicated that there were no significant differences between different land uses with flows merging and combining throughout drainage areas. There was some indication that higher loads were attributable to transportation corridors, commercial areas, and industrial land uses. Dry weather loads were higher in residential and commercial areas with specific activities identified as including poorly maintained dumpsters leaking high concentrations of indicator bacteria. A key transport mechanism found especially in commercial and industrial areas was over-irrigation. Residential areas were found to be abiding by water conservation recommendations, but this was not seen in commercial and industrial areas.

During dry weather, five positive Bacteroides samples were obtained. Each follow-up investigation failed to locate a point source; however, in every instance there was evidence of transient human activity. During wet weather, only 1 sample from a total of 37 samples collected over 9 storms was found to be positive for Bacteroides. This sample was collected during the early phase of the storm flows in an area known to be a transient area.

Biofilms on the walls of the MS4 system in particular were found to grow rapidly and contain high numbers of enterococci. Speciation of these enterococci determined that the origins were most likely environmental rather than fecal. Further investigation determined that the storm water, with high numbers of enterococci of fecal origin, was the primary inoculation mechanism but that biofilms matured rapidly into complex communities with a variety of species present. The high flows generated during wet weather were found to cause significant biofilm sloughing. The impact of biofilms on wet weather loads of indicator bacteria into receiving waters would appear to be significant. Sediments and biofilms within the creek and MS4 system were found to be significant reservoirs.

Sources:
Probable - Biofilm (MS4 Infrastructure), Sediment and biofilms in Tecolote Creek, Sediment and biofilms in MS4 Infrastructure
Potential - MS4 Infrastructure (anthropogenic non-human sources) Land use (residential, commercial, schools, restaurants, nurseries, golf course, livestock & domestic animal, industrial, Open space/Parks/Recreation, transportation corridors)
Possible -

52 - Dry Weather Bacterial Source Identification Study in the Mouth of Chollas Creek
Weston Solutions and the City of San Diego
Purpose - 1. What are the sources and magnitudes of dry weather urban runoff and associated indicator bacteria that influence water quality at the mouth of Chollas Creek?
2. What BMPs may be put in place to reduce or eliminate the influence of dry weather urban runoff at the mouth of Chollas Creek?

Results - During dry weather, there is no hydrologic connection between the mouth of Chollas Creek (the area influenced by tidal action) and the upstream drainage. Thus, bacteria found in the receiving waters of the creek mouth originate from sources that discharge directly to the mouth (i.e., storm drains). The highest bacterial concentrations were associated with the two storm drains near the National Avenue Bridge. Concentrations of indicator bacteria associated with the other identified storm drains were lower, but still contributed to elevated concentrations in the receiving water in the south fork and main stem, respectively. Two sources of flow that contributed to the high bacterial concentrations were identified as (1) over-irrigation of landscaping at the strip mall located at National Avenue and 35th Street and (2) a freshwater slough adjacent to a freeway off ramp that periodically discharges to a storm drain in the south fork of the creek.

Sources:
Probable - Storm drains and scour ponds at storm drain outlet; MS4 infrastructure; human waste), over-irrigation (landscaping)
Potential – Non-specific source (Freshwater slough; non-anthropogenic)
Possible -

54 - Regional Harbor Monitoring Program Pilot Project 2005-08 Summary Final Report
Weston Solutions and the City of San Diego
Purpose - The core monitoring program assesses the conditions found in the harbors based on comparisons to historical reference values for the four harbors and comparisons of contaminant concentrations to known surface water and sediment thresholds using chemistry, bacterial, toxicology, and benthic infaunal community indicators.
Results - Based on the results of the Pilot Project, the following statements can be made: 1) All bacterial concentrations were well below AB 411 levels, 2) The majorities of the marina and

freshwater-influenced strata contained sediments that were not toxic, 3) Benthic infaunal communities in both strata occurred at intermediate levels of disturbance, 4) Toxicity levels in the marina sediments generally were better than harbor-wide historical conditions, 5) Toxicity levels and benthic infaunal communities did not differ between the two strata, and 6) From 2005-2007, no negative short-term trends were evident for any indicator that would be indicative of a degrading condition.

70 - 2009-2010 Coastal Storm Drain Monitoring Annual Report
Weston Solutions, Inc. and County of San Diego Copermittees
Purpose - To determine the impacts that storm drains have on coastal receiving waters.

Results - There were a total of 28 exceedances of the total coliform storm drain action level. Twelve sites had at least one exceedance for total coliform, of which 3 had a total coliform exceedance on multiple dates.

Sources:
Probable – Cats
Potential –Cows, horses, fox, cormorants,
Possible – Non-specific source (human waste), gulls (secondary wildlife), Wildlife (muskrats, raccoons, coyotes, rabbits, turkeys and geese)

74 - MICROBIAL SOURCE TRACKING IN TWO SOUTHERN MAINE WATERSHEDS Report Number: MSG-TR-04-03March 2004Merriland River, Branch Brook and Little River (MBLR) Watershed Report
Kristen Whiting-Grant, F. Dillon, C. Dalton, Dr. M. Dionne, and Dr. S. Jones
Purpose - This study focuses on the Merriland River, Branch Brook and Little River (MBLR) watershed in Wells, Kennebunk and Sanford Maine, where chronic and persistent bacterial contamination from unidentified sources has restricted shellfish harvesting.

Results - Cats were the most frequently identified single source of bacterial contamination (21%); followed by cow (11%); fox (7%); cormorant (5%); human, rabbit, muskrat, horse and gull (all at3%); turkey (2%); and goose, raccoon, coyote and dog (all at 1%). Also note that ribotypes for 35% of the bacteria samples analyzed by JEL could not be identified, which is to say that no clear matches could be established between ribotypes of known source species and ribotypes from unknown water samples.

Sources:
Probable – Cats
Potential –Cows, horses, fox, cormorants,
Possible – Non-specific source (human waste), gulls (secondary wildlife), Wildlife (muskrats, raccoons, coyotes, rabbits, turkeys and geese)

64 - Microbial Source Tracking in the Dungeness Watershed, Washington
D.L. Woodruff, N.K. Sather, V.I. Cullinan, and S.L. Sargeant
Purpose - To determine the sources of fecal coliform pollution that have been impacting the water quality and shellfish harvesting activities for more than a decade.

Results – The predominant sources of fecal coliform contamination in the Dungeness from all matrix types (e.g. water, sediment, wrack) in the freshwater and marine environments were, in rank order, avian (19.6%), gull (12.5%), waterfowl (9.7%), raccoon (9.2%), unknown (7.3%), human-derived (7.1%), rodent (6.3%) and dog (4.3%). When bird groups were combined, they represented in total about 42% of samples collected and analyzed throughout the study.

Sources:
Probable – Wildlife,
Potential - Non-specific source (human waste), domestic animals,
Possible -

44 - Quantitative Pathogen Detection and MST Combined with modeling of fate and transport of Bacteroidales in San Pablo Bay.
Stefan Wuertz, F. Bombardelli, K. Sirikanchana, A. Schriewer, and Z. Kaveh
Purpose - To develop a decision-making took in the form of a 3-D model to benefit coastal managers both in terms of pinpointing major sources of fecal pollution and maximizing the usefulness of any monitoring activity.

Results – Monitoring results indicated low-level general and human-derived fecal contamination in the bay, while cow- and dog-derived contamination was not detected, except for one sample which contained dog-specific genetic marker. Human viruses were also below the sample detection limit. The pollution was more likely to come from surrounding urban areas or wastewater treatment facilities than from agricultural farm land or wildlife areas.

Sources:
Probable – Non-specific source (human waste),
Potential -
Possible – Dogs and cows

232 - Indicator organism sources and coastal water quality: a catchment study on the island of Jersey
M.D. Wyer, D. Kay, G.F. Jackson, H.M. Dawson, J. Yeo, and L. Tanguy
http://www.ncbi.nlm.nih.gov/pubmed/7730205
Purpose - Compliance monitoring of bathing waters at La Grève de Lecq on the North coast of Jersey revealed a significant deterioration in water quality between 1992 and 1993, as indexed by presumptive coliform, presumptive Escherichia coli and streptococci concentrations. During the 1993 bathing season the beach failed to attain the compliance with the EC Guideline criteria for presumptive E. coli and streptococci.

Results - A bacteriological survey of the stream catchment draining to the beach revealed that: (i) concentrations of faecal indicator organisms were enhanced at high discharge after rainfall; and (ii) a captive water fowl population, which expanded between 1990 and 1993, was a potential source of faecal pollution.

233 - Beach sands along the California coast are diffuse sources of fecal bacteria to coastal waters
K.M. Yamahara, B.A. Layton, A.E. Santoro, and A.B. Boehm
http://pubs.acs.org/doi/abs/10.1021/es062822n
Purpose - The potential for FIB to be transported from the sand to sea was investigated at a single wave-sheltered beach with high densities of ENT in beach sand

Results - We collected samples of exposed and submerged sands as well as water over a 24 h period in order to compare the disappearance or appearance of ENT in sand and the water column. Exposed sands had significantly higher densities of ENT than submerged sands with the highest densities located near the high tide line. Water column ENT densities began low, increased sharply during the first flood tide and slowly decreased over the remainder of the study. During the first flood tide, the number of ENT that entered the water column was nearly equivalent to the number of ENT lost from exposed sands when they were submerged by seawater. The decrease in nearshore ENT concentrations after the initial influx can be explained by ENT die-off and dilution with clean ocean water. While some ENT in the water and sand at LP might be of human origin because they were positive for the esp gene, others lacked the esp gene and were therefore equivocal with respect to their origin.

58 - High-Throughput and Quantitative Procedure for Determining Sources of Escherichia coli in Waterways by Using Host-Specific DNA Marker Genes
Tao Yan, M.J. Hamilton, and M.J. Sadowsky
http://aem.asm.org/content/73/3/890.full.pdf+html
Purpose - The objective of the study was to evaluate a high-throughput, semi-automated, quantitative procedure for determining sources of *E. coli* in waterways by using host-specific DNA marker genes of geese and ducks and robot-assisted high-throughput technology. Although the objective was to evaluate the method, the seasonal goose/duck population as a bacteria source was evaluated at 2 lakes frequented with migratory goose/duck populations and an additional lake that is not frequented by migratory goose

Results - The relative contributions of fecal *E.coli* from the geese/ducks were estimated to be 34% and 51% in Lake Superior and Lake Calhoun, respectively and 0.28% at Lake Hartwell (which has no migratory goose population)

Sources:
Probable – Wildlife (Lake Calhoun, Lake Superior),
Potential -
Possible–Wildlife (Lake Hartwell which has no migratory goose populations)

NSC (Not Source Characterization) Studies

137 - Relationship between rainfall and beach bacterial concentrations on Santa Monica Bay beaches

Drew Ackerman and S. B. Weisberg

http://www.sccwrp.org:8060/pub/download/DOCUMENTS/AnnualReports/2001_02AnnualReport/18_ar37-drew.pdf

Purpose - To enhance the scientific foundation for preemptive public health warnings, examine the relationship between rainfall and beach indicator bacteria concentrations using five years of fecal coliform data taken daily at 20 sites in southern California.

Results - There was a clear relationship between the incidence of rainfall and reduction in beach bacterial water quality in Los Angeles County. Bacterial concentrations remained elevated for five days following a storm, although they generally returned to levels below state water quality standards within three days. The length of the antecedent dry period had a minimal effect on this relationship, probably reflecting a quickly developing equilibrium between the decay of older fecal material and the introduction of new fecal material to the landscape.

175 - Persistence and potential growth of the fecal indicator bacteria, Escherichia coli in shoreline sand at Lake Huron

E.W. Alm, J. Burke, and E. Hagan

http://www.bioone.org/doi/abs/10.3394/0380-1330%282006%2932%5B401:PAPGOT%5D2.0.CO;2

Purpose - This study was initiated to test the hypothesis that high abundances of the fecal indicator Escherichia coli in shoreline sand at freshwater beaches can be explained, at least in part, by the ability of E. coli to persist and grow in beach sand.

Results - In controlled laboratory microcosm studies using autoclaved beach sand inoculated with E. coli strains previously isolated from ambient beach sand, E. coli densities increased from 2 CFU/g to more than 2 × 105 CFU/g sand after 2 days of incubation at 19°C, and remained above 2 × 105 CFU/g for at least 35 days. In field studies utilizing similarly inoculated beach sand in diffusion chambers incubated at a Lake Huron beach, E. coli also grew rapidly, reaching high densities (approximately 7.5 × 105 CFU/g), and persisting in a cultivable state at high density for at least 48 days. In comparison, E. coli levels in ambient beach sand adjacent to the chambers always had densities <100 CFU/g. Lake Huron beach sand clearly provides nutrients, temperatures, and other conditions needed to support growth of E. coli. The growth of E. coli in sterile sand diffusion chambers to higher levels than occurs in ambient beach sand may indicate the presence in ambient sand of biological controls on bacterial growth, such as predation or competition.

59 - Host Species-Specific Metabolic Fingerprint Database for Enterococci and Escherichia coli and Its Application to Identify Sources of Fecal Contamination in Surface Waters

Warish Ahmed, R. Neller, and M. Katoulli

http://aem.asm.org/content/71/8/4461.full.pdf+html

Purpose - To characterize two fecal indicator bacteria, enterococci and E. coli, from different host groups (i.e., animal species) to develop a metabolic fingerprint database to identify the source(s) of fecal contamination in a creek in Australia.

Results - Out of 27 water samples:10% of the biochemical phenotypes (BPT) found for enterococci belonged to human origin, 61% belonged to animals tested. 13% of the BPTs found for E. coli belonged to human origin and 54% belonged to animals tested. The remaining BPT found for Enterococci and E. coli belonged to BPTs shared between humans and animals or did not match database

Sources:
Probable –Septic (human waste), animal farms (domestic animals), animal farms (agriculture),
Potential -
Possible -

80 - Persistence and Differential Survival of Fecal Indicator Bacteria in Subtropical Waters and Sediments
K.L. Anderson, J.E. Whitlock, and V.J. Harwood
http://aem.asm.org/content/71/6/3041.full.pdf+html
Purpose - Fecal coliforms and enterococci are indicator organisms used worldwide to monitor water quality. These bacteria are used in microbial source tracking (MST) studies, which attempt to assess the contribution of various host species to fecal pollution in water. Ideally, all strains of a given indicator organism (IO) would experience equal persistence (maintenance of culturable populations) in water; however, some strains may have comparatively extended persistence outside the host, while others may persist very poorly in environmental waters. Assessment of the relative contribution of host species to fecal pollution would be confounded by differential persistence of strains.

Results - IO persistence according to mesocosm treatment followed the trend: contaminated soil > wastewater > dog feces. E. coli ribotyping demonstrated that certain strains were more persistent than others in freshwater mesocosms, and the distribution of ribotypes sampled from mesocosm waters was dissimilar from the distribution in fecal material. These results have implications for the accuracy of MST methods, modeling of microbial populations in water, and efficacy of regulatory standards for protection of water quality. Saltwater had a negative effect on FC persistence, as the decay rates of FC (all inoculum sources combined) in saltwater sediments and water column were greater than those in freshwater. Saltwater also significantly increased enterococcal decay rates compared to freshwater. IO persistence tended to be greater in sediments than in the water column. The average decay rate of FC in sediments of freshwater mesocosms was significantly less than those in the water column, and the difference was nearly significantly at the $\alpha = 0.05$ level in saltwater ($P = 0.083$). Although decay rates of enterococci tended to be greater in the water column than in sediments, the difference was not significant in freshwater or saltwater mesocosms.

176 - Persistence and differential survival of fecal indicator bacteria in subtropical waters and sediments
K.L. Anderson, J.E. Whitlock, and V.J. Harwood
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1151827/
Purpose - This study utilized mesocosms designed to simulate natural conditions, which were inoculated with fecal material, to test the hypothesis that certain *E. coli* phylotypes exhibit greater persistence than others in aquatic environments.

Results - This study demonstrated a high degree of variability in the response of fecal indicator organisms to stresses in aquatic environments on all levels investigated. Responses to water type (saline versus fresh), location (sediment versus water column), and inoculum type all varied within and between indicator bacterial groups (FC and ENT). The discrepant results emphasize the difficulties encountered in attempting to regulate diverse types of water bodies by one regulatory standard. Also cautionary is the persistence of indicator organisms in sediments, which leads to elevation of their densities and a false indication of recent pollution in the water column after events such as rain storms, construction, or recreational use.

130 - LEVELS OF FECAL INDICATOR BACTERIA AT DOG BEACH AND NEARBY COASTAL BEACHES OF THE CITY OF SAN DIEGO, CA
Amir Baum
http://www.sandiegoriver.org/documents/baum_final_thesis.pdf
Purpose - An analysis of historical County of San Diego microbial marine water quality was conducted to quantitatively compare the levels of fecal indicator bacteria (FIB) levels at Dog Beach, located at the San Diego River Outlet, and nearby coastal beaches. Additionally, this study aimed to determine if relationships existed between daily average river flow/daily precipitation and FIB densities at Dog Beach and nearby coastal beach stations and if significant associations existed between daily precipitation and FIB single sample exceedances.

Results - The study found the strongest association between river flow, precipitation, and TC levels to be at river discharge points during wet months, but no significant association was found during dry weather. The study demonstrated that using a stratified-random sampling design, urban runoff outlets are a primary source of contaminated runoff with 90% of sites near urban runoff outlets failing water quality standards.

81 - Integrated Analysis of Established and Novel Microbial and Chemical Methods for Microbial Source Tracking
Anicet R. Blanch, L. Belanche-Muñoz, X. Bonjoch, J. Ebdon, C. Gantzer, F. Lucena, J. Ottoson, C. Kourtis, A. Iversen, I. Kühn, L. Mocé, M. Muniesa, J. Schwartzbrod, S. Skraber, G.T. Papageorgiou, H. Taylor, J. Wallis, and J. Jofre
http://aem.asm.org/content/72/9/5915.full.pdf+html
Purpose - The objectives of the present study were (i) to determine the most discriminant tracers showing wide and consistent geographical stability between all locations, (ii) to identify subsets of variables derived from tracers with the highest discriminant capacity, and (iii) to evaluate and

compare statistical or machine learning methods to develop predictive models for source tracking using the minimum number of these variables. In this multilaboratory study, different microbial and chemical indicators were analyzed in order to distinguish human fecal sources from nonhuman fecal sources using wastewaters and slurries from diverse geographical areas within Europe.

Results - Fecal coliforms, enterococci, clostridia, somatic coliphages, and total bifidobacteria were detected in almost all samples (other than a single sample in the case of total bifidobacteria) of both human and animal origin. They were more abundant in the animal samples than in the human samples, but this seems to be due to the higher fecal load of these samples, since relative densities were similar in both groups of samples.

21 - Enterococci Concentrations in Diverse Coastal Environments Exhibit Extreme Variability
A.R. Boehm
http://pubs.acs.org/doi/abs/10.1021/es071807v
Purpose - The study examines extreme temporal variations (periods between 1 min andZ4 h) in FIB concentrations in diverse marine coastal environments ranging from wave-sheltered to wave-exposed open ocean beaches.

Results - The high frequency variability indicates that regardless of sampling time, a single sample of water tells one little about the true water quality, so multiple samples need to be collected. If it is not feasible to collect multiple samples, then a spatially or temporally composited sample will improve the estimate of the true water quality.

157 - Methicillin-resistant Staphylococcus aureus (MRSA) in municipal wastewater: an uncharted threat?
S. Börjesson, A. Matussek, S. Melin, S. Löfgren, and P.E. Lindgren
http://www.mendeley.com/research/methicillinresistant-staphylococcus-aureus-mrsa-in-municipal-wastewater-an-uncharted-threat/#page-1
Purpose - (i) To cultivate methicillin-resistant Staphylococcus aureus (MRSA) from a full-scale wastewater treatment plant (WWTP), (ii) To characterize the indigenous MRSA-flora, (iii) To investigate how the treatment process affects clonal distribution and (iv) to examine the genetic relation between MRSA from wastewater and clinical MRSA.

Results - MRSA could be isolated on all sampling occasions, but only from inlet and activated sludge. The number of isolates and diversity of MRSA were reduced by the treatment process, but there are indications that the process was selected for strains with more extensive antibiotic resistance and PVL+ strains. The wastewater MRSA-flora had a close genetic relationship to clinical isolates, most likely reflecting carriage in the community.

158 - A seasonal study of the mecA gene and Staphylococcus aureus including methicillin-resistant S. aureus in a municipal wastewater treatment plant
S. Börjesson, S. Melin, A. Matussek, and P.E. Lindgren
http://www.loudounnats.org/pdf/09WRAseasonalstudyofmecASaureusandMRSAinafull-scaleWWTP.pdf
Purpose - Determine the effect of wastewater treatment processes on mecA gene concentrations, and the prevalence of S. aureus and MRSA over time. To achieve this a municipal wastewater treatment plant was investigated for the mecA gene, S. aureus and MRSA, using real-time PCR assays

Results - Using molecular methods and cultivation, MRSA was for the first time detected in a municipal activated sludge and trickling filter WWTP, but mainly in the early treatment steps, IN, PS and AS. The mecA gene and S. aureus could be detected throughout the year at all sampling sites. The wastewater treatment process reduces mecA gene concentrations, which can partly be explained by removal of biomass.

140 - Particle Associated Microorganisms in Stormwater Runoff
Michael Borst, and A. Selvakumar
http://www.epa.gov/ORD/NRMRL/pubs/600j03262/600j03262.pdf
Purpose - Investigate the effects of blending and chemical addition before analysis of the concentration of microorganisms in stormwater runoff play a significant role.

Results - Particle-associated microorganisms play an important, if often unmeasured, portion of the total organism count in stormwater. All organisms, except for E. coli, showed an increase in the measured concentration after blending samples at 22,000 rpm with or without the chemical mixture. Other than fecal streptococci, the organism concentrations decreased with the addition of the Camper's solution in both blended and unblended samples before analyses. There was a statistically significant interaction between the effects of Camper's solution and the effects of blending for all the organisms tested, except for total coliform. Blending did not alter the mean particle size significantly. The results show no correlation between increased total coliform, fecal coliform, and fecal streptococcus concentrations and the mean particle size.

87 - Direct comparison of four bacterial source tracking methods and use of composite data sets
E.A. Casarez, S.D. Pillai, J.B. Mott, M. Vargas, K.E. Dean and G.D. Di Giovanni
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2006.03246.x/pdf
Purpose - (i) To compare the identification ability of the four BST methods individually and in combination through the use of composite data sets and (ii) to evaluate the use of the developed data sets for the identification of faecal contamination sources in two Central Texas lakes suspected of being impacted by agricultural operations and dairy cattle.

Results - Best matching identification using the composite data set correctly identified 100% of the replicate QC cultures (precision), and had 100% accuracy for E. coli strain and source class identification of the isolates. Therefore, the four-method composite performed better than any single method.

154 - Removal of bacterial indicators of fecal contamination in urban stormwater using a natural riparian buffer
M.J. Casteel, G. Bartow, S.R. Taylor, and P. Sweetland
http://www.lmtf.org/FoLM/Plans/Water/VistaGrande/Casteeletal_10icud_paper.PDF
Purpose - Determine if riparian buffers are able to remove bacterial indicators of fecal contamination and other microbial contaminants from intermittent, high-volume flows such as those encountered during storm events in heavily urbanized areas.

Results - Analysis of lake water showed that levels of Escherichia coli and total coliforms increased significantly during storm events, indicating the presence of nonpoint sources of fecal contamination in the area surrounding the lake.

134 - Population structure and persistence of Escherichia coli in ditch sediments and water in the Seven Mile Creek Watershed
Ramyavardhanee Chandrasekaran
http://conservancy.umn.edu/bitstream/108879/1/Chandrasekaran_Ramyavardhanee_May2011.pdf
Purpose - Examined the population structure of E. coli and determined whether ditch sediments can serve as reservoirs of environmental E. coli in the Seven Mile Creek (SMC) watershed, a minor watershed located in south central Minnesota

Results - Further analysis of the count data revealed a strong correlation between E. coli concentrations and temperature profile at the SMC. E. coli densities in SMC water samples exceeded the permissible Minnesota standard (126 CFU/100 ml) predominantly during summer and fall seasons. In addition to temperature, rainfall also drastically influenced the dynamics and distribution of E. coli populations at the SMC. Results suggest that the seasonal variation in E. coli counts observed in water and sediments are most likely related to temperature, rainfall, and the patchy distribution of E. coli within sampling locations

88 - Relative Decay of Bacteroidales Microbial Source Tracking Markers and Cultivated Escherichia coli in Freshwater Microcosms
Linda K. Dick, Erin A. Stelzer, Erin E. Bertke, Denise L. Fong, and Donald M. Stoeckel
http://aem.asm.org/content/76/10/3255.full.pdf+html
Purpose - Fecal indicator bacteria (FIB), commonly used to regulate sanitary water quality, cannot discriminate among sources of contamination. The use of alternative quantitative PCR (qPCR) methods for monitoring fecal contamination or microbial source tracking requires an understanding of relationships with cultivate FIB, as contamination ages under various conditions in the environment. In this study, the decay rates of three Bacteroidales 16S rRNA gene markers (AllBac for general contamination and qHF183 and BacHum for human-associated contamination) were compared with the decay rate of cultivated Escherichia coli in river water microcosms spiked with human wastewater.

Results - A major finding of this study was that HF marker decay was consistent with, or significantly faster than, that of E. coli under all treatments. This indicates that the HF markers might be useful as conservative estimators of human origin E. coli even as fecal contamination ages in the environment.

118 - Bacteriological Quality of Runoff Water from Pastureland
J.W. Doran, and D.M. Linn
http://aem.asm.org/content/37/5/985.abstract
Purpose - Determine the bacteriological characteristics of pasture runoff and to compare them with runoff from an ungrazed area.

Results - We found no relationship between FC and FS counts in rainfall runoff and either rainfall or total runoff for most events. Bacteriological quality of snowmelt runoff. During the 3-year study, there were 10 snowmelt runoff events-two in 1976 and 8 in 1978. The levels of TC in snowmelt runoff from both grazed and ungrazed pasture areas exceeded recommended water quality standards . FC counts, often considered a better index of fecal contamination, were within recommended standards.

89 - Microbial source tracking using host specific FAME profiles of fecal coliforms
Metin Duran, Berat Z. Haznedaroglu, and Daniel H. Zitomer
http://www.prairieswine.com/pdf/3397.pdf
Purpose - The objective of this study was to investigate the host-specific differences in fatty acid methyl ester (FAME) profiles of fecal coliforms (FC).

Results - The results presented here provide further evidence that FAME profiles of indicator organisms have statistically significant host specificity and suggest that these differences may be useful in predicting sources of microbial pollution in water environments. However, more research is needed to determine the mechanisms causing the host specificity and to assess the possible temporal and spatial variations in FAME profiles before FAME can be applied in the field.

183 - Quantitative evaluation of enterococci and Bacteroidales released by adults and toddlers in marine water
S.M. Elmir, T. Shibata, H.M. Solo-Gabriele, C.D. Sinigalliano, M.L. Gidley, G. Miller, L.R.W. Plano, J. Kish, K. Withum, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2761526/
Purpose - The main objectives of the this study were to measure shedding of enterococci and Bacteroidales using traditional and emerging laboratory methods, and to evaluate shedding from toddlers and adults. The added value of the current study was the evaluation of shedding from toddlers (all prior studies used adult volunteers), and the use of additional methods of fecal indicator bacteria analyses (i.e. enterococci by CS and qPCR, and Bacteroidales by qPCR) as no data are available which directly measure fecal indicator bacteria shedding using these alternate methods.

Results - Human bathers have the potential to release significant amounts of fecal indicator bacteria into the water column via direct shedding off their body and via sand transported by their skin. Direct shedding from the body can include releases from fecally contaminated body areas and skin, and releases from fecally contaminated diapers. In this study, the quantity of enterococci released was a function of bathing cycle, sand exposure, beach sand contamination levels, and microbial flora variations between swimmers.

182 - Quantitative evaluation of bacteria released by bathers in a marine water
S.M Elmir, M.E. Wright, A. Abdelzaher, H.M. Solo-Gabriele, L.E. Fleming, G. Miller, M. Rybolowik, M.T. Peter Shih, S.P. Pillai, J.A. Cooper and E.A. Quaye
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2633726/
Purpose - This study focused on estimating the amounts of enterococci and S. aureus shed by bathers directly off their skin and indirectly via sand adhered to skin.

Results - This study demonstrated that bathers shed significant concentrations of enterococci and S. aureus into the water column and that S. aureus was shed at concentrations at least one order of magnitude greater than enterococci. This study also showed that total enterococci and S. aureus released by bathers decreased significantly between bathing episodes, in particular after the first wash cycle. This conclusion agrees with the long standing universal requirement that bathers should shower before entering recreational waters to reduce the microbial load in particular at swimming pools since the water volume is limited. It is concluded from this study that the enterococci contribution from sand adhered to skin, was small relative to the amount shed directly from the skin and represented less than 5% of the total enterococci shed by bathers.

159 - Staphylococcus aureus and fecal indicators in Egyptian coastal waters of Aqaba Gulf, Suez Gulf, and Red Sea
M.A. El-Shenawy
http://www.nodc-egypt.org/contacts_files/vol-31-2/Volume%2031%20%282%29%202005.PDF/9/Text.pdf
Purpose - Study the hygienic status of Egyptian coastal waters of Aqaba Gulf, Suez Gulf and Red Sea. The possibility of using *S.aureus* as supplementary indicator to the conventional bacterial indicators was another goal.

Results - 107 samples (53.5 %) of the 200 total examined samples were found to harbour S aureus exceeding the aforementioned guide standards. The present results concluded that addition of S. aureus as supplementary indicator to the conventional fecal indications may be useful for judging the marine water quality in Red Sea region.

138 - Sediment Bacterial Indicators in an Urban Shellfishing Subestuary of the Lower Chesapeake Bay
Carl W. Erkenbrecher Jr.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC244041/pdf/aem00190-0106.pdf

Purpose - Historically, the Lynnhaven, an urban shellfishing estuary of the lower Chesapeake Bay region, has been opened and closed periodically to shellfishing during the past 40 years due to high fecal coliform counts. Document the spatial and temporal distributions and compositions of bacteria in the sediments and overlying waters of an important urban shellfishing area in the lower Chesapeake Bay region, the Lynnhaven Estuary.

Results - Densities of all indicator bacteria were always significantly higher in the sediments than in the overlying subsurface waters. The major problems inherent in this system are nonpoint in their origin. The primary sources of the Lynnhaven's bacterial pollution appeared to be typical of urban and agricultural runoff, although failure of septic tank systems was suspected as a problem in the Lynnhaven's western branch. These results illustrated that sediments in shellfishing areas could serve as a reservoir for high densities of indicator bacteria and that, potentially, pathogens could pose a health hazard.

184 - Enumeration and speciation of enterococci found in marine and intertidal sediments and coastal water in southern California

D.M. Ferguson, D.F. Moore, M.A. Getrich, and M.H. Zhowandai

http://www.ochealthinfo.com/docs/public/h2o/Enumeration-speciation.pdf

Purpose - To determine the levels and species distribution of enterococci in intertidal and marine sediments and coastal waters at two beaches frequently in violation of bacterial water standards.

Results - High levels of Enterococcus in intertidal sediments indicate retention and possible regrowth in this environment. Significance and Impact of the Study: Re-suspension of enterococci that are persistent in sediments may cause beach water quality failures and calls into question the specificity of this indicator for determining recent faecal contamination.

90 - Comparison of Bacteroides-Prevotella 16S rRNA Genetic Markers for Fecal Samples from Different Animal Species

Lisa R. Fogarty and Mary A. Voytek

http://aem.asm.org/content/71/10/5999.full.pdf+html

Purpose - The goals of this study were to compare Bacteroides-Prevotella populations from nine host species collected at multiple geographical locations and to determine if unique populations could be identified for each host species that could be used to develop markers for fecal source tracking.

Results - Results support the use of molecular techniques to characterize Bacteroides-Prevotella populations as a means to improve the ability to track sources of fecal contamination, but also show the need for more development of these methods.

186 - Abundance and characteristics of the recreational water quality indicator bacteria Escherichia coli and enterococci in gull faeces

L.R. Fogarty, S.K. Haack, M.J. Wolcott, and R.L. Whitman

http://cws.msu.edu/documents/FogartyetalJAM2003.pdf

Purpose - To evaluate the numbers and selected phenotypic and genotypic characteristics of the faecal indicator bacteria Escherichia coli and enterococci in gull faeces at representative Great Lakes swimming beaches in the United States.

Results - Gull faeces could be a major contributor of E. coli (105–109 CFU g)1) and enterococci (104– 108 CFU g)1) to Great Lakes recreational waters. E. coli and enterococci in gull faeces are highly variable with respect to their genotypic and phenotypic characteristics and may exhibit temporal or geographic trends in these features.

162 - A preliminary investigation of fecal indicator bacteria, human pathogens, and source tracking markers in beach water and sand
K.D. Goodwin, L. Matragrano, D. Wanless, C. Sinigalliano, and M.J. LaGier
http://yyy.rsmas.miami.edu/groups/ohh/projects/microbesresearch/GoodwinERK2_4.pdf
Purpose - Data suggesting that fecal indicating bacteria may persist and/or regrow in sand has raised concerns that fecal indicators may become uncoupled from sources of human fecal pollution. To investigate this possibility, wet and dry beach sand, beach water, riverine water, canal water, and raw sewage samples were screened by PCR for certain pathogenic microbes and molecular markers of human fecal pollution.

Results - Overall, this analysis pointed to the need to find better methods of extracting nucleic acids from environmental samples in order to reduce the possibility of false negative results. High quality nucleic acids need to be consistently and efficiently delivered to the detector system if the relationship between fecal indicators and human pathogens and human source tracking markers is to be elucidated.

93 - Comparing Wastewater Chemicals, Indicator Bacteria Concentrations, and Bacterial Pathogen Genes as Fecal Pollution Indicators
Sheridan K. Haack, Joseph W. Duris, Lisa R. Fogarty, Dana W. Kolpin, Michael J. Focazio, Edward T. Furlong, and Michael T. Meyer
https://www.crops.org/publications/jeq/pdfs/38/1/248
Purpose - Compare fecal indicator bacteria (FIB) (fecal coliforms, Escherichia coli [EC], and enterococci [ENT]) concentrations with a wide array of typical organic wastewater chemicals and selected bacterial genes as indicators of fecal pollution in water samples collected at or near 18 surface water drinking water intakes.

Results - In our study, which examined ambient waters in various land use environments with a wide range of FIB concentrations, fecal pollution was indicated by gene-based and/or chemical-based markers for 14 of the 18 tested samples, with little relation to FIB standards.

95 - Development of Goose- and Duck-Specific DNA Markers To Determine Sources of Escherichia coli in Waterways
Matthew J. Hamilton, Tao Yan, and Michael J. Sadowsky
http://aem.asm.org/content/72/6/4012.full.pdf+html

Purpose - The development and validation of host source-specific genetic markers for E. coli strains originating from Canada geese (*Branta canadensis*).

Results - SSH was successfully used to identify seven DNA markers with high levels of hybridization specificity for E. coli strains originating from geese. Combined, the marker DNAs were capable of identifying about 76% of the goose E. coli strains examined and 73% of the duck E. coli strains examined.

192 - Waterfowl Abundance Does Not Predict the Dominant Avian Source of Beach Escherichia coli
D.L. Hansen, S. Ishii, M.J. Sadowsky, and R.E. Hicks
https://www.soils.org/publications/jeq/abstracts/40/6/1924?access=0&view=pdf
Purpose - The horizontal, fluorophore enhanced, rep-PCR (HFERP) DNA fingerprinting technique was used to identify potential sources of Escherichia coli in water, nearshore sand, and sediment at two beaches in the Duluth-Superior Harbor, near Duluth, MN, and Superior, WI, during May, July, and September 2006.

Results - Waterfowl, including Canada geese, ring-billed gulls, and mallard ducks, were the largest source of E. coli that could be identified in water (55–100%), sand (59–100%), and sediment (92–100%) at both beaches. Although ring-billed gulls were more abundant in this harbor, Canada geese were usually the dominant source of waterfowl E. coli found at these beaches.

96 - Validation and field testing of library-independent microbial source tracking methods in the Gulf of Mexico
Valerie J. Harwood, Miriam Brownell, Shiao Wang, Joe Lepo, R.D. Ellender, Abidemi Ajidahun, Kristen N. Hellein, Elizabeth Kennedy, Xunyan Ye, and Christopher Flood
http://www.usm.edu/bst/pdf/Water%20Res%202009.pdf
Purpose - Standardize and validate MST methods across laboratories in coastal Gulf of Mexico states.

Results - An SOP was developed that allowed simultaneous purification of DNA for viral and bacterial markers, and gave comparable results among three laboratories. The method performance was generally similar whether it was conducted in buffer, fresh water or salt water; however, the human Bacteroidales method had a lower limit of detection in buffer and in salt water compared to fresh water.

97 - Fidelity of bacterial source tracking: Escherichia coli vs. Enterococcus spp. and minimizing assignment of isolates from non-library sources
W.M. Hassan, R.D. Ellender and S.Y. Wang
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2006.03077.x/pdf
Purpose - Improve the fidelity of library-dependent bacterial source tracking efforts in determining sources of faecal pollution.

Results - The use of enterococci provides higher rates of correct source assignment compared with E. coli. The use of similarity thresholds to decide whether to accept source assignments made by computer programmes reduces the rate of mis-assignment of non-library isolates.

197 - Contact with beach sand among beachgoers and risk of illness
C. D. Heaney, E. Sams, S. Wing, S. Marshall, K. Brenner, A.P. Dufour, and T.J. Wade
http://aje.oxfordjournals.org/content/170/2/164.full.pdf
Purpose - The purpose of this study is to better understand the illness risk associated with beach sand that can harbor high concentrations of fecal indicator organisms, as well as fecal pathogens.

Results - The results of our study suggest that, among beachgoers participating in a large prospective cohort study at beaches nearby sewage treatment discharges, reported contact with beach sand (defined as either digging in the sand or having one's body buried in the sand) was associated with an elevated risk of enteric illnesses (gastrointestinal illness and diarrhea). Being buried in the sand was more strongly associated with enteric illness than was digging in the sand. We also observed a higher proportion of people who got sand in their mouth among those buried in the sand (40%) compared with those who dug in the sand (20%).

155 - The Impact of Rainfall on Fecal Coliform Bacteria in Bayou Dorcheat (North Louisiana)
Dagne D. Hill, W.E. Owens, and P.B. Tchounwou
www.mdpi.com/1660-4601/3/1/114/pdf
Purpose - Assess the effect of surface runoff amounts and rainfall amount parameters on fecal coliform bacterial densities in Bayou Dorcheat in Louisiana.

Results - Nonpoint source pollution that is carried by surface runoff has a significant effect on bacterial levels in water resources.

199 - Beach sand and sediments are temporal sinks and sources of Escherichia coli in Lake Superior
Satoshi Ishii, D.L. Hansen, R.E. Hicks, and M.J. Sadowsky
http://pubs.acs.org/doi/pdf/10.1021/es0623156
Purpose - Report on a 2-year investigation of the seasonal variation of E. coli concentrations in water, sand, and sediment at the DBC Beach in the Duluth-Superior Harbor of Lake Superior.

Results - Waterfowl in addition to humans can be a significant source of fecal indicator bacteria like E. coli at Great Lakes beaches. Although waterfowl have been reported to carry a limited number of pathogenic E. coli (36), which was also found our study, they may harbor other potential pathogens such as Salmonella and Campylobacter (37). The potential health risks associated with waterfowl-borne bacteria found at beaches needs to be investigated in the future.

122 - Fecal bacteria and sex hormones in soil and runoff from cropped watersheds amended with poultry litter
Michael B. Jenkins, D.M. Endale, H.H. Schomberg, and R.R. Sharpe
http://phoenix.nal.usda.gov/bitstream/10113/15527/1/IND44044786.pdf
Purpose - Determine if applications of poultry litter to small watersheds would contribute to the load of fecal bacteria and sex hormones to soil and runoff

Results - Under the conditions of drought and conservation tillage, the rates at which we applied poultry litter to the four cropped watersheds appeared to have little or no significant effect on (a) soil community of fecal indicator bacteria, (b) concentrations of estradiol and testosterone in surface soil, and (c) quantities of estradiol and testosterone coming off the watersheds with runoff.

202 - Bacteroidales Diversity in Ring-Billed Gulls (*Laurus delawarensis*) Residing at Lake Michigan Beaches
S.N. Jeter, C.M. McDermott, P.A. Bower, J.L. Kinzelman, M. J. Bootsma, G.W. Goetz, and S.L. McLellan
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2655448/pdf/2261-08.pdf
Purpose - This study investigated the occurrence and diversity of Bacteroidales fecal bacteria in gulls residing in the Great Lakes region.

Results - A total of 467 gull fecal samples from five coastal beaches spanning Lake Michigan's western shore and one inland beach on Lake Winnebago were screened for the presence of Bacteroidales by PCR. There was a low but consistent occurrence of Bacteroidales in the gull populations at these beaches.

151 - The Impact of Annual Average Daily Traffic on Highway Runoff Pollutant Concentrations
Masoud Kayhanian, A. Singh, C. Suverkropp, and S. Borroum
http://escholarship.org/uc/item/86f8c8n8
Purpose - Evaluate correlations between annual average daily traffic and storm water runoff pollutant concentrations generated from California Department of Transportation highway sites.

Results - No direct linear correlation was found between highway runoff pollutant mean concentrations and AADT. However, through multiple regression analyses, it was shown that AADT has an influence on most highway runoff constituent concentrations, in conjunction with factors associated with watershed characteristics and pollutant build-up and wash off.

102 - Development of Bacteroides 16S rRNA Gene TaqMan-Based Real-Time PCR Assays for Estimation of Total, Human, and Bovine Fecal Pollution in Water
Alice Layton, Larry McKay, Dan Williams, Victoria Garrett, Randall Gentry, and Gary Sayler
http://aem.asm.org/content/72/6/4214.full.pdf+html

Purpose - Design real-time PC assay to target Bacteroides species (AllBac) present in human, cattle, and equine feces.

Results - This assay was shown empirically to be proportional to the concentration of human, bovine, and equine feces in water and thus can be used to estimate fecal concentrations without calculating the number of Bacteroides cells in the sample. The simplicity of performing these assays by direct PCR of water samples suggests that these assays may be field deployable and thus would aid data collection in watersheds with inherently high spatial and temporal variabilities.

203 - Persistence of fecal indicator bacteria in Santa Monica Bay beach sediments
C.M. Lee, T.Y. Lin, C.C. Lin, G.A. Kohbodi, A. Bhatt, R. Lee, and J.A. Jay
http://www.sciencedirect.com/science/article/pii/S004313540600220X
Purpose - This study involved monitoring the fecal indicator bacteria (FIB) levels in water and sediment at three ocean beaches (two exposed and one enclosed) during a storm event, conducting laboratory microcosm experiments with sediment from these beaches, and surveying sediment FIB levels at 13 beaches (some exposed and some enclosed).

Results - Results from microcosm experiments showing similar, dramatic growth of FIB in both overlying water and sediment from all beaches, as well as results from the beach survey, support the hypothesis that the quiescent environment rather than sediment characteristics can explain the elevated sediment FIB levels observed at enclosed beaches. This work has implications for the predictive value of FIB measurements, and points to the importance of the sediment reservoir.

205 - Phylogenetic Diversity and Molecular Detection of Bacteria in Gull Feces
J. Lu, J.W. Santo Domingo, R. Lamendella, T. Edge, and S. Hill
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2446513/
Purpose - To determine the occurrence of *C. marimammalium* in waterfowl, species-specific 16S rRNA gene PCR and real-time assays were developed and used to test fecal DNA extracts from different bird (n = 13) and mammal (n = 26) species.

Results - To determine the occurrence of *C. marimammalium* in waterfowl, species-specific 16S rRNA gene PCR and real-time assays were developed and used to test fecal DNA extracts from different bird (n = 13) and mammal (n = 26) species.

103 - Genetic Diversity of Escherichia coli Isolated from Urban Rivers and Beach Water
Sandra L. McLellan
http://aem.asm.org/content/70/8/4658.full.pdf+html
Purpose - Evaluate the genetic profiles of E. coli strains found in stormwater, where fecal pollution is derived from multiple uncharacterized host sources, and compare these profiles to known host sources of pollution.

Results - There does not appear to be a proportional relationship between fecal indicator bacteria from a host and what is actually detected in the environment, which will be an important consideration when developing methods for fecal pollution source tracking. Matching of isolates to the entire data set demonstrated that strains from a type of sample (e.g., gull, sewage, stormwater, river water, beach water) were most similar to other strains from the same host or environmental source. These findings may be a function of geographic distribution rather than host source specificity.

126 - Identification and Quantification of Bacterial Pollution At Milwaukee County Beaches

Sandra L. McLellan, and E.T. Jensen

http://www.glwi.freshwater.uwm.edu/research/genomics/ecoli/media/Technical%20document%209-12-05.pdf

Purpose - Assess the bacterial contaminant load in the waters and sand at beaches within Milwaukee County.

Results - Bacterial water data collected during the summer 2005 beach surveys suggests a positive relationship between rainfall and increased E. coli levels at these particular beach sites. Sewage contamination could potentially reach the beach during combined sewage overflows, or from nearby sewer infrastructure failures.

104 - Evaluation of Repetitive Extragenic Palindromic-PCR for Discrimination of Fecal Escherichia coli from Humans, and Different Domestic and Wild Animals

Bidyut Mohapatra, Klaas Broersma, Rick Nordin and Asit Mazumder

http://web.uvic.ca/~h2o/publications/Mohapatra%20et%20al.%20MI07pdf.pdf

Purpose - Investigate the potential of rep-PCR in differentiating e. coli isolates of human, domestic and wild animal origin that might be used as a molecular tool to identify the possible source(s) of fecal pollution of source water.

Results - Rep-PCR DNA fingerprinting results provide evidence about the robustness of this method, and it's simple and cost-effective screening tool to isolate and track non-point sources of fecal contamination.

106 - Evaluation of antibiotic resistance analysis and ribotyping for identification of faecal pollution sources in an urban watershed

D.F. Moore, V.J. Harwood, D.M. Ferguson, J. Lukasik, P. Hannah1, M. Getrich and M. Brownell

http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2672.2005.02612.x/pdf

Purpose **-** The accuracy of ribotyping and antibiotic resistance analysis (ARA) for prediction of sources of faecal bacterial pollution in an urban Southern California watershed was determined using blinded proficiency samples. Low rates of correct classification for E. coli proficiency isolates compared with the ARCCs of the libraries indicate that testing of bacteria from samples that are not represented in the library, such as blinded proficiency samples, is necessary to accurately measure predictive ability. The library-based MST methods used in this study may not be suited for determination of the source(s) of faecal pollution in large, urban watersheds.

Results - None of the methods performed well enough on the proficiency panel to be judged ready for application to environmental samples.

210 - Species distribution and antimicrobial resistance of enterococci isolated from surface and ocean water
D.F. Moore, J.A. Guzman, and C. McGee
http://www.glin.net/lists/beachnet/2008-05/pdf00000.pdf
Purpose - The species identification and antimicrobial resistance profiles were determined for enterococci isolated from Southern California surface and ocean waters.

Results - *Enterococcus faecalis, E. faecium, E. casseliflavus and E. mundti* are the most commonly isolated Enterococcus species from urban runoff and receiving waters in Southern California.

107 - A review of technologies for rapid detection of bacteria in recreational waters
Rachel T. Noble and Stephen B. Weisberg
http://www.environmental-expert.com/Files%5C19961%5Carticles%5C6674%5C479_rapid_detection_recreational_waters.pdf
Purpose - Review new methods that have the potential to reduce measurement period for fecal indicator bacteria from more than a day to less than an hour to reduce risk of swimmers to fecal bacteria.

Results - Enzyme substrate methods are most likely to be the first rapid methods adopted for recreational water quality. Enzymatic substrate methods are based on the same capture technology as currently-approved EPA methods, with greater speed attained through enhanced detection technology. As such, the relationship to health risk can be established by demonstrating that the new detection capability produces equivalent results to existing procedures.

214 - Comparison of total coliform, fecal coliform, and enterococcus bacterial indicator response for ocean recreational water quality testing
Rachel T. Noble, D.F. Moore M.K. Leecaster, C.D. McGee, and S.B. Weisberg
http://www.ochealthinfo.com/docs/public/epi/h2o/Water-Research-Publication-2003.pdf
Purpose - To compare the relationship between the bacterial indicators, and the effect that changing the standards would have on recreational water regulatory actions, three regional studies were conducted along the southern California shoreline from Santa Barbara to San Diego, California.

Results - Cumulatively, our results suggest that replacement of a TC standard with an EC standard will lead to a five-fold increase in failures during dry weather and a doubling of failures during wet weather. Replacing a TC standard with one based on all three indicators will lead to an eight-fold increase in failures. Changes in the requirements for water quality testing have strong implications for increases in beach closures and restrictions.

217 - Relationships between sand and water quality at recreational beaches
M.C. Phillips, H.M. Solo-Gabriele, A.M. Piggot, J.S. Klaus and Y. Zhang
http://www.sciencedirect.com/science/article/pii/S0043135411006269
Purpose - Enterococci are used to assess the risk of negative human health impacts from recreational waters. Studies have shown sustained populations of enterococci within sediments of beaches but comprehensive surveys of multiple tidal zones on beaches in a regional area and their relationship to beach management decisions are limited.

Results - We sampled three tidal zones on eight South Florida beaches in Miami-Dade and Broward counties and found that enterococci were ubiquitous within South Florida beach sands although their levels varied greatly both among the beaches and between the supratidal, intertidal and subtidal zones.

218 - Shedding of Staphylococcus aureus and methicillin-resistant Staphylococcus aureus from adult and pediatric bathers in marine waters
L.R.W. Plano, A.C. Garza, T. Shibata, S.M. Elmier, J. Kish, C.D. Sinigalliano,M.L. Gidley, G. Miller, K. Withum, L.E. Fleming, and H.M. Solo-Gabriele
http://www.biomedsearch.com/attachments/00/21/21/10/21211014/1471-2180-11-5.pdf
Purpose - The primary aim of this study was to evaluate the amount and characteristics of the shedding of methicillin sensitive S. aureus, MSSA and MRSA by human bathers in marine waters.

Results - Twelve of 15 MRSA isolates collected from the water had identical genetic characteristics as the organisms isolated from the participants exposed to that water while the remaining 3 MRSA were without matching nasal isolates from participants. The amount of S. aureus shed per person corresponded to 105 to 106 CFU per person per 15-minute bathing period, with 15 to 20% of this quantity testing positive for MRSA. These findings clearly demonstrate that adults and toddlers shed their colonizing organisms into marine waters and therefore can be sources of potentially pathogenic S. aureus and MRSA in recreational marine waters. Additional research is needed to evaluate recreational beaches and marine waters as potential exposure and transmission pathways for MRSA.

111 - A comparison of ARA and DNA data for microbial source tracking based on source-classification models developed using classification trees
Bertram Price, Elichia Venso, Mark Frana, Joshua Greenberg, and Adam Ware
http://faculty.salisbury.edu/~mffrana/Cell%20Biol%20Spring%2008/Frana%20paper,%20after.pdf

Purpose - Determine whether increased reliability, if any, of library-based MST developed with DNA data is sufficient to justify its higher cost, where source predictions are used in TMDL surface water management programs.

Results - While the overall rates of correct classification are higher for the DNA data than for the ARA data, the resulting source predictions for both data indicate similar TMDL surface water bacterial contamination reduction strategies. Questioning the value of DNA data relative to ARA data for MST intended for application in a TMDL program is justified, and the answer may favor ARA data for this application.

112 - Quantitative PCR Method for Sensitive Detection of Ruminant Fecal Pollution in Freshwater and Evaluation of This Method in Alpine Karstic Regions
Georg H. Reischer, David C. Kasper, Ralf Steinborn, Robert L. Mach, and Andreas H. Farnleitner
http://aem.asm.org/content/72/8/5610.full.pdf+html
Purpose - Establish a method for the sensitive quantification of ruminant fecal pollution in spring water and groundwater from alpine karstic regions important for public water supplies. Identify a ruminant-specific genetic marker in fecal members of the phylum Bacteroidetes.

Results - The marker could be found at concentrations ranging from not detectable in 4.5 liters (KPAS) to 106 marker equivalents per liter (LKAS2 flood). Strong differences in occurrence were obvious and in accordance with the expected different levels of ruminant fecal.

Preliminary experiments testing the stability of the marker in highly diluted fecal suspensions in spring water at ambient temperatures (4°C) found no strong reduction of detectable marker levels during an incubation period of 2 months.

After additional evaluation, the assay might allow the specific allocation of fecal pollution in alpine water sources, enabling target oriented measures in the catchment area and thus facilitating watershed management. Furthermore, it could also provide additional information for quantitative microbial risk assessment studies as part of water safety plans recommended by the WHO (35), allowing the relative estimation of ruminant fecal input compared to other sources.

164 - Pathogenic fungi: an unacknowledged risk at coastal resorts? New insights on microbiological sand quality in Portugal
R. Sabino, C. Verissimo, M.A. Cunha, B. Wergikoski, F.C. Ferreira, R. Rodrigues, H. Parada, L. Falcão, L. Rosado, C. Pinheiro, E. Paixão, and J. Brandão
http://www.sciencedirect.com/science/article/pii/S0025326X11001962
Purpose - Determine the presence of yeasts, pathogenic fungi, dermatophytes, total coliforms, Escherichia coli and intestinal enterococci in sand at thirty-three beaches across Portugal.

Results - Results showed that 60.4% of the samples were positive for fungi and that 25.2% were positive for the bacterial parameters. The most frequent fungal species found were Candida sp. and Aspergillus sp., whereas intestinal enterococci were the most frequently isolated bacteria.

Positive associations were detected among analyzed parameters and country-regions but none among those parameters and sampling period. Regarding threshold values, we propose 15 cfu/g for yeasts, 17 cfu/g for potential pathogenic fungi, 8 cfu/g for dermatophytes. Eighty four cfu/g for coliforms, 250 cfu/g for E. coli, and 100 cfu/g for intestinal enterococci.

114 - The use of ribotyping and antibiotic resistance patterns for identification of host sources of Escherichia coli strains

M. Samadpour, M.C. Roberts, C. Kitts, W. Mulugeta and D. Alfi

http://onlinelibrary.wiley.com/doi/10.1111/j.1472-765X.2004.01630.x/pdf

Purpose - To compare antibiotic resistance and ribotyping patterns ability to identify triplicate isolates sent from a group of 40 Escherichia coli taken from seven host sources.

Results - Of the 120 isolates, 22 isolates were resistant to ampicillin, streptomycin, tetracycline and trimethoprim and 98 isolates were susceptible. Antibiotic patterns identified 33 of the triplicates and three of the six groups had isolates from multiple hosts. Ribotyping divided the isolates into 27 ribotype groups with all triplicates grouped into the same ribotype group with one host per group.

219 - The effects of rainfall on Escherichia coli and total coliform levels at 15 Lake Superior recreational beaches

R. Sampson, S. Swiatnicki, C. McDermott, and G. Kleinheinz

http://www.environmental-expert.com/Files%5C6063%5Carticles%5C9235%5C11-12-6.pdf

Purpose - Fifteen beaches along Lake Superior were monitored over the course of the 2003 and 2004 summer swimming seasons from mid-May through mid-September. Water samples were collected at these 15 beaches less than 24-h after a rainfall event of at least 6 mm. The effect of rainfall on bacterial concentrations along the Wisconsin shores of Lake Superior was investigated.

Results - No relationship between rainfall amount and bacterial concentrations at any of the 15 beaches tested was found. Although other researchers have observed a direct positive relationship between rainfall and E. coli levels in beach water, we found no significant relationship for Lake Superior beaches. This is an important finding given the fact that beach closures are often based upon rainfall alone rather than on actual E. coli concentration measurements. This study reinforces the fact that the data obtained at one location should not necessarily be extrapolated to beach closure decisions at other locations.

141 - Modeling the dry-weather tidal cycling of fecal indicator bacteria in surface waters of an intertidal wetland

Brett F. Sanders, F. Arega, and M. Sutula

ftp://www.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2005_06AnnualReport/AR0506_051-66.pdf

Purpose - Utilize a developed model and apply it to predict the dry-weather tidal cycling of FIB in Talbert Marsh, in response to loads from urban runoff, bird feces and resuspended sediments.

Results - Model predictions show that surface water concentrations of TC, EC, and ENT in the wetland are driven by loads from urban runoff and resuspended wetland sediments. The model more accurately predicts TC than EC or ENT. The crucial role that sediments play in the cycling of FIB is highlighted by this study. Sediments function as a reservoir of FIB that may accumulate FIB due to regrowth or settling, or shed FIB when tidal currents or storm flows scour away or even just disturb surficial particles.

115 - Patterns of Antimicrobial Resistance Observed in Escherichia coli Isolates Obtained from Domestic- and Wild-Animal Fecal Samples, Human Septage, and Surface Water
Raida S. Sayah, J.B. Kaneene, Y. Johnson, and R. Miller
http://aem.asm.org/content/71/3/1394.full.pdf+html
Purpose - (i) To identify patterns of antimicrobial agent resistance of E. coli strains obtained from human septage, domestic animals, and wildlife living in the Red Cedar watershed in Michigan, and (ii) to compare these antimicrobial agent resistance patterns with those of E. coli strains obtained from surface water in the same watershed.

Results - Antimicrobial agent resistance was detected in all types of samples collected (Table 4). The most frequently encountered form of resistance in all samples was resistance to tetracycline (27.3%), followed by resistance to cephalothin (22.7%), resistance to sulfisoxazole (13.3%), and resistance to streptomycin (13.1%). Animal fecal samples exhibited resistance to all agents tested, while human septage and river water samples showed resistance to three agents and one agent, respectively.
Resistance to cephalothin was present in all types of samples, while tetracycline resistance and streptomycin resistance were found in all types of samples except river water. Resistance to tetracycline was present in both fecal and farm environment samples from all livestock species, while resistance to trimethoprim-sulfamethoxazole was present in both types of samples from only dairy cattle and equids.

142 - Tracking sources of bacterial contamination in stormwater discharges from Mission Bay, California
Kenneth C. Schiff, and P. Kinney
ftp://www.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/1999AnnualReport/07_ar06.pdf
Purpose - Identify whether wet-weather discharges were the predominant source of bacterial contamination to receiving waters.

Results - Seasonal cycles were evident, with the highest levels of total coliform, fecal coliform and enterococcus occurring during the wettest months.

220 - Microbiological Water Quality at Reference Beaches in Southern California During Wet Weather. Technical Report #448
Kenneth C. Schiff, J. Griffith, and G. Lyon

http://www.sccwrp.org:8060/pub/download/DOCUMENTS/TechnicalReports/448_reference_beach.pdf
Purpose - Assess the microbial water quality at reference beaches following wet weather events in southern California.

Results - Based on the results from this study, natural contributions of nonhuman fecal indicator bacteria were sufficient to generate exceedances of the State of California water quality thresholds during wet weather.

145 - Water Quality Indicators and the Risk of Illness in Non-Point Source Impacted Recreational Waters
Kenneth C. Schiff, S.B. Weisberg and J.M. Colford Jr.
ftp://swrcb2a.waterboards.ca.gov/pub/rwqcb2/TMDL-WEF/5d.pdf
Purpose - Determine if: 1) water contact increased the risk of illness in the two weeks following exposure to water in Mission Bay? and 2) did the risk of illness increase with increasing levels of microbial indicators of water quality?

Results - Outside of skin rash and diarrhea, there was no statistically increased risk of 12 other symptoms, including highly credible gastrointestinal illness (HCGI). These results contrast with most other recreational bathing studies, most likely because of the lack of human sources of fecal pollution.

165 - Variation of microorganism concentrations in urban stormwater runoff with land use and seasons
A. Selvakumar, and M. Borst
http://www.iwaponline.com/jwh/004/0109/0040109.pdf
Purpose - This study investigates if variations in concentrations of microorganisms by at least 1/3-log at the 95% level of confidence are potentially attributable to land use and seasons. Differences less than 1/3-log have little practical importance even if there is statistical significance as the sensitivity of the analyses procedure is less than these.

Results - Statistically significant differences were found between land uses for all microorganisms studied except for E. coli. Other than E. coli, the microbial concentrations in stormwater runoff consistently vary within and between land uses. Generally, the concentrations in runoff from high-density residential areas are higher than the concentrations in other tested land uses.

222 - Indicator microbes correlate with pathogenic bacteria, yeasts and helminthes in sand at a subtropical recreational beach site
A.H. Shah, A.M. Abdelzaher, M. Phillips, R. Hernandez, H.M. Solo-Gabriele, J. Kish, G. Scorzetti, J.W. Fell, M.R. Diaz, T.M. Scott, J. Lukasik, V.J. Harwood,, S. McQuaig, C.D. Sinigalliano, M.L. Gidley, D. Wanless, A. Ager, J. Lui, J.R. Stewart, L.R. Plano, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pubmed/21447014

Purpose - The objectives of this study were to evaluate the presence and distribution of pathogens in various zones of beach sand (subtidal, intertidal and supratidal) and to assess their relationship with environmental parameters and indicator microbes at a non-point source subtropical marine beach.

Results - Results indicate that indicator microbes may predict the presence of some of the pathogens, in particular helminthes, yeasts and the bacterial pathogen Staphylococcus aureus including methicillin-resistant forms. Indicator microbes may thus be useful for monitoring beach sand and water quality at non-point source beaches.

132 - Evaluation of conventional and alternative monitoring methods for a recreational marine beach with non-point source of fecal contamination

Tomoyuki Shibata, H.M. Solo-Gabriele, C.D. Sinigalliano, M.L. Gidley, L.R.W. Plano, J.M. Fleisher, J.D. Wang, S.M. Elmir, G. He, M.E. Wright, A.M. Abdelzaher, C. Ortega, D. Wanless, A.C. Garza, J. Kish, T. Scott, J. Hollenbeck, L.C. Backer, and L.E. Fleming

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2966524/

Purpose - Compare enterococci (ENT) measurements based on the membrane filter, ENT(MF) with alternatives that can provide faster results including alternative enterococci methods (e.g. chromogenic substrate (CS), and quantitative polymerase chain reaction (qPCR)), and results from regression models based upon environmental parameters that can be measured in real-time.

Results - In addition to physico-chemical and hydrometeorological parameters, results also suggested that bacterial indicator levels were affected by the numbers of animals on the beach which may also have seasonal patterns associated with their numbers and fecal inputs. Thus, levels of enterococci at non-point source beaches are affected by a myriad of environmental factors and input loadings which are very difficult to capture within simple regression models.

223 - Adhesion of Enterococcus faecalis in the nonculturable state to plankton is the main mechanisms responsible for persistence of this bacterium in both lake and seawater

C. Signoretto, G. Burlacchini, M. del Mar Lleò, C. Pruzzo, M. Zampini, L. Pane, G. Franzini, and P. Canepari

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC525140/

Purpose - In this study we describe the results of the monitoring of the microbiological quality of both freshwater and marine water by applying an approach consisting of detecting both culturable and nonculturable enterococci which are present in water and adherent to the plankton in order to evaluate to what extent the adhesion to plankton and the VBNC state may represent survival strategies and contribute to the formation of environmental reservoirs of these microorganisms.

Results - We show that molecular methods for the detection of enterococci resulted in a higher number of positive samples than the culture method. The most interesting result of this study was the observation that in Lake Garda E. faecalis is almost exclusively found either adhering to plankton or in water, and not both. This result was also confirmed by the results in seawater, although not to such an evident extent.

123 - TRANSPORT OF FECAL BACTERIA FROM POULTRY LITTER AND CATTLE MANURES APPLIED TO PASTURELAND

M.L. Soupir, S. Mostaghimi, E.R. Yagow, C. Hagedorn, and D.H. Vaughan

http://www.environmental-center.com/Files%5C0%5Carticles%5C9338%5CTransportOfFecalBacteria.pdf

Purpose - An understanding of the overland transport mechanisms from land applied waste is needed to improve design of best management practices (BMPs) and modeling of nonpoint source (NPS) pollution.

Results - Results of this comparative study clearly indicate that cowpies have a greater potential to contribute high fecal bacteria concentrations into streams than the land application of liquid dairy manure or turkey litter, although bacteria concentrations in runoff from all treatments exceeded Federal standards for primary contact in the United States. The relationship between runoff rates and concentrations of the indicator species was dependent upon the animal waste application, the indicator species and antecedent soil moisture conditions.

152 - Variability of Indicator Bacteria at Different Time Scales in the Upper Hoosic River Watershed

Elena Traister, and S.C. Anisfeld

http://www.forestry.yale.edu/uploads/publications/Anisfeld-pub03.pdf

Purpose - Evaluate whether the Upper Hoosic River Basin is meeting water quality criteria for indicator bacteria.

Results - Bacterial levels were higher in more developed watersheds; in summer rather than winter; in storms rather than baseflow; and in the early morning rather than afternoon.

227- Prevalence of yeasts in beach sand at three bathing beaches in South Florida

C. Vogel, A. Rogerson, S. Schatz, H. Laubach, A. Tallman, and J. Fell

http://www.sciencedirect.com/science/article/pii/S004313540700108X

Purpose - Determine the abundance and types of yeasts in the wet and dry sand of three recreational beaches in South Florida.

Results - While definitive statements cannot be made, high levels of yeasts may have a deleterious bearing on human health and the presence of such a diverse aggregation of species suggests that yeasts could have a role as indicators of beach health.

224 - Effect of waterfowl (Anas platyrhynchos) on indicator bacteria populations in a recreational lake in Madison, Wisconsin

J.H. Standridge, J.J. Delfino, L.B. Kleppe, and R. Butler

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC243530/pdf/aem00202-0205.pdf

Purpose - Determine the level of effect that waterfowl has on the water quality of a Madison, WI lake.

Results - The most common human health hazard associated with ducks is swimmer's itch, or echinostoma revolutum (12). The duck tapeworm can also occasionally infect humans (4). Ducks have often been implicated as carriers and disseminators of Salmonella (1, 3, 11, 12, 16, 17). The occurrence of these zoonoses indicates that fecal contamination from ducks is a human health hazard and that beach closings based on the presence of high counts of fecal coliform indicator bacteria are warranted. Future surveys aimed at detecting the possible presence of Salmonella in the Vilas Park beach area are indicated.

228 - Estimation of enterococci input from bathers and animals on a recreational beach using camera images
J.D. Wang, H.M. Solo-Gabriele, Am. M. Abdelzher, and L.E. Fleming
http://www.sciencedirect.com/science/article/pii/S0025326X10001062
Purpose - Develop a counting methodology to better understand non-point source load impacts. Enterococci inputs to the study beach site (located in Miami, FL) are dominated by non-point sources (including humans and animals).

Results - Enterococci source functions were computed from the observed number of unique individuals for average days of each month of the year, and from average load contributions for humans and for animals. Results indicate that dogs represent the larger source of enterococci relative to humans and birds.

229 - Hand-mouth transfer and potential for exposure to E. coli and F+ coliphage in beach sand, Chicago, Illinois
R.L. Whitman, K. Przybyla-Kelly, D.A. Shively, M.B. Nevers, and M.N. Byappanahalli
http://www.ncbi.nlm.nih.gov/pubmed/19590129
Purpose - Examine the transferability of Escherichia coli and F+ coliphage (MS2) from beach sand to hands in order to estimate the potential subsequent health risk.

Results - Using dose-response estimates developed for swimming water, it was determined that the number of individuals per thousand that would develop gastrointestinal symptoms would be 11 if all E. coli on the fingertip were ingested or 33 if all E. coli on the hand were ingested. These results suggest that beach sand may be an important medium for microbial exposure; bacteria transfer is related to initial concentration in the sand; and rinsing may be effective in limiting oral exposure to sand-borne microbes of human concern.

169 - Microbial load from animal feces at a recreational beach
M.E. Wright, H.M. Solo-Gabriele, S. Elmir, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/pdf/nihms138348.pdf
Purpose - The goal of this study was to quantify the microbial load (enterococci) contributed by the different animals that frequent a beach site.

Results - The highest enterococci concentrations were observed in dog feces with average levels of 3.9 x 10(7) CFU/g; the next highest enterococci levels were observed in birds averaging 3.3 x 10(5)CFU/g. The lowest measured levels of enterococci were observed in material collected from shrimp fecal mounds (2.0 CFU/g). A comparison of the microbial loads showed that 1 dog fecal event was equivalent to 6940 bird fecal events or 3.2 x 10(8) shrimp fecal mounds. Comparing animal contributions to previously published numbers for human bather shedding indicates that one adult human swimmer contributes approximately the same microbial load as one bird fecal event. Given the abundance of animals observed on the beach, this study suggests that dogs are the largest contributing animal source of enterococci to the beach site.

231 - Microbial load from animal feces at a recreational beach
M.E. Wright, H.M. Solo-Gabriele, S. Elmir, and L.E. Fleming
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/
Purpose - Quantify the microbial load (enterococci) contributed by the different animals that frequent a beach site.

Results - Results from this study provide evidence that dog feces represent the largest animal source to the study site. Improved management of dog feces at the beach could potentially reduce enterococci inputs to the beach, thereby decreasing the number of advisories for beach sites which are frequented by significant numbers of dogs.

8 - Are microbial indicators and pathogens correlated? A statistical analysis of 40 years of research
J. Wu, S. C. Long, D. Das and S. M. Dorner
http://www.iwaponline.com/jwh/up/wh2011117.htm
Purpose - The data were analyzed to assess factors affecting correlations using a logistic regression model considering indicator classes, pathogen classes, water types, pathogen sources, sample size, the number of samples with pathogens, the detection method, year of publication and statistical methods.

136 - Monitoring and Modeling Non-Point Source Contributions of Host-Specific Fecal Contamination in San Pablo Bay
Stefan Wuertz, F.A. Bombardelli, K. Sirikanchana, and D. Wang
http://escholarship.org/uc/item/8tk0z6p0.pdf
Purpose - This study employed mathematical and numerical transport models in concert with new molecular techniques to (i) characterize the sources of fecal contamination of water bodies and (ii) quantify the loads and distributions of *Bacteroidales* marker DNA sequences originating from different animal hosts in San Pablo Bay.

Results - Microbial source tracking using fecal *Bacteroidales* is an effective way to monitor fecal pollution of coastal waters. Low levels of the universal genetic marker are ubiquitous throughout

San Pablo Bay. The human marker BacHum-UCD was found in 75% of all samples but no cow- and almost no dog-specific marker was detected.

234 - Growth of enterococci in unaltered, unseeded beach sands subjected to tidal wetting
K.M. Yamahara, S.P. Walters, and A.B. Boehm
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2655449/
Purpose - To establish if naturally occurring enterococci can replicate in beach sands under environmentally relevant conditions.

Results - The results provide evidence that enterococci may not be an appropriate indicator of enteric disease risk at recreational beaches subject to nonpoint sources of pollution.

170 - A water quality modeling study of non-point sources at recreational marine beaches
X. Zhu, J.D. Wang, H.M. Solo-Gabriele, L.E. Fleming
http://www.sciencedirect.com/science/article/pii/S0043135411001266
Purpose - A model study was conducted to understand the influence of non-point sources including bather shedding, animal fecal sources, and near shore sand, as well as the impact of the environmental conditions, on the fate and transport of the indicator microbe, enterococci, at a subtropical recreational marine beach in South Florida.

Results - Enterococci released from beach sand during high tide caused mildly elevated concentration for a short period of time (ten to twenty of CFU/100 ml initially, reduced to 2 CFU/100 ml within 4 h during sunny weather) similar to the average baseline numbers observed at the beach. Bather shedding resulted in minimal impacts (less than 1 CFU/100 ml), even during crowded holiday weekends. In addition, weak current velocity near the beach shoreline was found to cause longer dwelling times for the elevated concentrations of enterococci, while solar deactivation was found to be a strong factor in reducing these microbial concentrations.

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APPENDIX H

Identification of Goals

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APPENDIX H. IDENTIFICATION OF GOALS

Numeric goals must be developed to support Water Quality Improvement Plan implementation and are used to measure progress toward addressing the highest priority water quality conditions. Numeric goals may take a variety of forms, but must be quantifiable so that progress toward and achievement of the goals are measurable. Applicable Total Maximum Daily Load (TMDL) targets are required to be incorporated as Water Quality Improvement Plan goals. As these conditions are TMDL derived, each highest priority water quality condition may include multiple criteria or indicators. In accordance with the MS4 Permit and applicable regulatory drivers, final goals and reasonable interim goals for each five-year period from Water Quality Improvement Plan approval to the anticipated final goal compliance date (including an interim goal for this permit term) have been developed.

Within the Los Peñasquitos WMA, the Sediment TMDL dictates the sediment final and interim goals, applicable during wet weather. The Bacteria TMDL is the driver for bacteria final and interim goals, which are applicable during both dry and wet weather. A TMDL represents the maximum amount of a pollutant of concern that a water body can receive and still attain water quality standards. TMDLs can take a variety of forms, including concentration-based TMDLs, which focus on reducing pollutant sources to achieve a maximum pollutant concentration consistent with existing water quality objectives (WQOs), and load-based TMDLs, which focus on reducing sources to achieve a watershed-specific maximum load that is protective of beneficial uses. Reduction of freshwater discharges during dry weather will assist in compliance with both TMDLs.

Although the Pacific Ocean shoreline segment was removed from the 303d list for Recreational Water Contact (REC-1) impairment in 2010, calculation of the Bacteria TMDL had already begun and the segment remained in the TMDL through adoption in 2011. The Los Peñasquitos shoreline segment was then incorporated into the Bacteria TMDL requirements within the MS4 Permit in 2013. Therefore, the Bacteria TMDL targets are required to be incorporated into the Water Quality Improvement Plan goals.

Responsible Agencies must meet the wet weather Sediment TMDL targets within 20 years of TMDL adoption (Fiscal Year [FY] 35), the Bacteria TMDL targets within 20 years of TMDL adoption (FY31) and dry weather Bacteria TMDL targets within 10 years (FY21). The reduction of freshwater discharges will assist in compliance with both TMDLs, but the dry weather bacteria targets will be the driver for addressing freshwater discharges by FY21. Both TMDLs identify receiving water and watershed targets, providing multiple compliance pathways to meet TMDL interim and final targets.

This appendix presents the Sediment TMDL and Bacteria TMDL numeric targets, how the targets were derived, and how the targets were translated into Water Quality Improvement Plan numeric goals. Section H.1 presents the interim and final Water Quality Improvement Plan sediment numeric goals. Section H.2 presents the interim and final Water Quality Improvement Plan bacteria numeric goals. Section H.3 presents the Water Quality Improvement Plan interim and final freshwater discharge numeric goals.

H.1 Identification of Sediment Numeric Goals

The Sediment TMDL addresses the Los Peñasquitos Lagoon impairment due to sedimentation and siltation based on an exceedance of the narrative water quality objectives. Because the water quality objective (WQO) for sediment is narrative, the Basin Plan does not explicitly state a numeric target that must be reached, but requires the TMDL to set numeric targets specific to the Los Peñasquitos WMA to evaluate the attainment of objectives. The narrative states, "The suspending sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses" (Regional Board, 1994).

The beneficial uses that are most sensitive to increased sedimentation are estuarine habitat and preservation of biological habitats of special significance. Deposition of watershed sediment contributes to elevation increases within the Lagoon, which is a critical variable that determines the productivity and stability of these uses. Current watershed sediment loads and legacy impacts from urbanization (e.g., land development resulting in increased runoff and erosion rates and physical impacts of construction of the railway berms, Highway 101, and access roads affecting hydrologic exchanges) have been identified as contributors to the Lagoon's sedimentation impairment (Regional Board, 2012).

The TMDL calculated a Lagoon numeric target and a watershed numeric target. Both were based on a "reference condition" identified within the Lagoon itself. Considering various lines of evidence, the TMDL estimated that the Lagoon was likely achieving the water quality standard for sediment in the mid-1970s. The numeric targets used the Lagoon and watershed conditions present during the mid-1970s as the reference condition for each target.

H.1.1 Sediment TMDL Targets

Lagoon mapping was used to establish the Lagoon numeric target, which is expressed as an increasing trend in the total area of tidal saltmarsh and non-tidal saltmarsh toward 346 acres. This target acreage represents 80% of the total acreage of tidal and non-tidal saltmarsh present in 1973. As of 2010, 262 acres of tidal saltmarsh and non-tidal saltmarsh are present in the Lagoon. The calculation and interpretation of the numeric target as an increasing trend in acreage takes into account other factors impacting the salt marsh habitat in the lagoon, as well as the length of time necessary to successfully restore the biological, physical, chemical, and hydrological structural characteristics of saltmarsh habitat. The final lagoon numeric target requires the successful restoration of tidal and non-tidal salt marsh to achieve a lagoon total of 346 acres. This can either mean:

1. Successful restoration of 80% of the 1973 acreage of lagoon saltmarsh habitat (346 acres); or

2. Demonstrate that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.

The watershed numeric target is expressed as mass of sediment per wet period (211 days from October 1st through April 30th of each year). The historical land use (mid-1970s) distribution compared to Year 2000 was used to calculate the targets of 12,360 tons per wet period. Two broad categories of sediment sources were identified: 1) Pacific Ocean and 2) watershed sources which consist of all point and nonpoint sources of sediment in the watershed draining to the lagoon. Sediment contributions from the Pacific Ocean are considered a nonpoint, natural background source of sediment. The remainder of the estimated load, 2,580 tons/year, was assigned to the collective Sediment TMDL responsible parties. The parties identified by the TMDL include the Responsible Agencies for this Water Quality Improvement Plan, in addition to Phase II MS4 permittees, general construction storm water NPDES permittees, and general industrial storm water NPDES permittees. This reduction is a 67% sediment load reduction from Year 2000 load to the historical (mid-1970s) load by the collective TMDL responsible parties.

Ultimately, the final TMDL Lagoon numeric target must be achieved within 20 years of the approved TMDL. Interim milestones in the TMDL Staff Report, attached to the Sediment TMDL Resolution, require incremental watershed sediment load reductions during the 20 year period. The interim TMDL milestones were the basis for the interim numeric goals for Water Quality Improvement Plan development and are presented in Table H-1.

Table H-1
Sediment TMDL Interim and Final Milestones

<table>
<tr><th rowspan="2">Compliance Year</th><th>5 years</th><th>9 years</th><th>13 years</th><th>15 years</th><th>20 years</th></tr>
<tr><th>FY20</th><th>FY24</th><th>FY28</th><th>FY30</th><th>FY35</th></tr>
<tr><td colspan="6">Compliance with TMDL Interim and Final Milestones</td></tr>
<tr><td>Lagoon Target (Restoration of Saltmarsh Habitat)</td><td colspan="4">Increasing trend towards 346 acres of saltmarsh habitat</td><td rowspan="3">Successful restoration of salt marsh habitat to total 346 acres[1]</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>Watershed Target (% Load Reduction)</td><td>20%</td><td>40%</td><td>60%</td><td>80%</td></tr>
</table>

Note:
1. This can either mean:
   - Successful restoration of 80% of the 1973 acreage of lagoon saltmarsh habitat (346 acres); or
   - Demonstrate that implementation actions are active on and/or affecting 346 acres with continued monitoring to ensure 80% target achievement.

% = percent

As stated in the TMDL, current sediment loading is not the only cause of the Lagoon impairment. Historical loading, including activities within the Lagoon, contributed to the impairment. While the TMDL assigned sediment load reductions to the TMDL responsible parties, additional measures were also suggested, including the reduction of freshwater discharges and Lagoon restoration. All three strategies will contribute to the increase in saltmarsh habitat. Thus the strategies selected in the Water Quality Improvement Plan will target both sediment and freshwater reduction within their jurisdiction, in addition to collaboration with WMA stakeholders and TMDL responsible parties in potential restoration activities.

The TMDL receiving water goal is successful restoration of salt marsh habitat, as defined above. Restoration strategies taken in the Lagoon require collaboration with all other parties, including but not limited to the Responsible Agencies listed in this Water Quality Improvement Plan, watershed and Lagoon stakeholders, and other agencies that have jurisdiction in or regulatory control over the Lagoon. Therefore, the final receiving water goal for this Water Quality Improvement Plan is successful restoration of 346 acres of salt marsh habitat, achieved by a collaborative effort among Responsible Agencies and other TMDL responsible parties.

H.1.2 Sediment Goals Expressed as Sediment Load Reduction

To translate TMDL watershed goals to the Responsible Agencies for implementation planning, the TMDL watershed models were updated to better reflect current conditions and improve the accuracy of load estimates for Water Quality Improvement Plan development. The land use distribution was updated to compare Year 2009 land use to the historical land use conditions. One representative water year (water year 2003) was selected to simulate wet weather conditions during both time periods. Water Year 2003 represents typical wet and dry weather conditions within the subwatershed, based on an analysis of rainfall data over a 20-year time period. Because the Water Quality Improvement Plan focuses on implementation planning through an adaptive management framework, using a representative water year will more accurately assist the Responsible Agencies in designing programs and BMPs to reach the targets.

In addition, the updated model was used to calculate load reductions by subwatershed. Four subwatersheds are defined for the Water Quality Improvement Plan: 1) Carmel Valley Creek, 2) Los Peñasquitos Creek, 3) Carroll Canyon Creek, and 4) the area draining directly to the Lagoon. The reference load, the current load, and load reduction required was estimated for each subwatershed and is presented in Table H-2. Because the mass of sediment reduction is, in part, related to rainfall, which varies by year, the percent load reduction required was selected as the sediment numeric goal for the Water Quality Improvement Plan. This reflects the varying weather conditions from year to year and still allows for implementation planning to provide assurance that the programs and BMPs selected will attain the goals.

Table H-2
Sediment Numeric Goals by Subwatershed

Subwatershed	Reference[1] Sediment Load (Tons/Wet Period)	Current[2] Sediment Load (Tons/Wet Period)	Sediment Reduction Required (Tons/Wet Period)	Sediment Reduction Required (% Load Reduction)	Final Compliance Date
	Estimated Using WY 2003[3] Rainfall Data				
Wet Period (Oct 1 – April 30)					
Carmel Valley Creek	99	475	376	79.2%	2035
Los Peñasquitos Creek	861	1631	771	47.2%	
Carroll Canyon Creek	521	1004	484	48.2%	
Direct Drainage to Los Peñasquitos Lagoon	82	126	44	34.8%	

Note:
1. The Reference modeled load was estimated using mid-1970s land use information.
2. The Current model load was estimated using 2009 land use.
3. Sediment loading for both the reference and current wet period used rainfall data from WY2003, and average rainfall year.

% = percent

Because of the collaborative nature of meeting the TMDL Lagoon and watershed numeric targets, jurisdictional goals have been assigned to each Responsible Agency named in this Water Quality Improvement Plan to provide a method to assess Responsible Agency progress toward achieving goals on an individual basis. The updated model results from the Water Quality Improvement Plan modeling effort were used to allocate jurisdictional responsibility by subwatershed. The current load (in tons/wet period) for WY 2003 by subwatershed (Table H-1) was multiplied by the percentage of land area of each jurisdiction. The result, in tons/year, was then multiplied by the appropriate subwatershed percent load reduction required. Two jurisdictions, the City of San Diego and the County of San Diego, are located in multiple subwatersheds. For those jurisdictions, the sum of the load reductions required are presented along with a WMA percent load reduction. This allows those jurisdictions the greatest flexibility in implementation across subwatersheds to support the beneficial uses of the lagoon. This method also retains jurisdictional equitability by first assigning load reductions on a subwatershed scale and then summing to the WMA scale. Again, because the mass of sediment reduction is, in part, related to rainfall, which varies by year, the percent load reduction required was selected as the sediment numeric goal for the Water Quality Improvement Plan. Table H-3 presents the jurisdictional goals by subwatershed[1].

Table H-3
Jurisdictional Sediment Goals for Los Peñasquitos WMA

Subwatershed	City of Del Mar	City of Poway	City of San Diego	San Diego County
Current Sediment Load by Jurisdiction (tons/ wet period)				
Carmel Valley Creek			455	
Los Peñasquitos Creek		677	848	76
Carroll Canyon Creek			962	7.6
Direct Drainage to Lagoon	1.6		121	
Percent Load Reduction Required (%)				
Carmel Valley Creek			79.2%	
Los Peñasquitos Creek		47.2%	47.2%	47.2%
Carroll Canyon Creek			48.2%	48.2%
Direct Drainage to Lagoon	34.8%		34.8%	
Load Reduction Required (tons/ wet period)				
Carmel Valley Creek			360	
Los Peñasquitos Creek		320	401	36
Carroll Canyon Creek			463	3.7
Direct Drainage to Lagoon	0.6		42.0	
Jurisdictional Sum for Los Peñasquitos WMA	0.6 (34.8%)	320 (47.2%)	1266 (53.1%)	40 (47.6%)

% = percent

Interim goals, identified in Table H-1, were applied equally to each jurisdiction. Increasing incremental reductions are required during the 20 years after TMDL approval. For example, in FY20, each jurisdiction is required to reduce their sediment load by 20%. Therefore, the City of Del Mar must reduce their sediment load by 7.0% (20% of 34.8%) by FY20. The City of Poway must reduce their sediment load by 9.4% (20% of 47.2%) by FY20. The City of San Diego must reduce their sediment load by 10.6% (20% of 53.1%) by FY20. The County of San Diego must reduce their sediment load by 9.5% (20% of 47.6%) by FY20. Jurisdictional goals are presented in Section 4.1 of this Water Quality Improvement Plan.

[1] Caltrans has jurisdiction in all four subwatersheds. Caltrans' sediment load was calculated, but is not included in Table H-2. Caltrans MS4 Permit does not identify a sediment load reduction required for the Sediment TMDL and is therefore not included within this Water Quality Improvement Plan.

H.1.3 Compliance Pathways to Meet the Sediment TMDL

The Sediment TMDL was incorporated into the MS4 Permit in an amendment dated February 11, 2015. Attachment E.7 to the MS4 Permit provides the following options to demonstrate interim compliance with the Sediment TMDL:

(1) There is no direct or indirect discharge from the Responsible Copermittee's MS4s to the receiving water; OR

(2) The final receiving water limitation under Specific Provision 7.b.(2)(a) is met; OR

(3) There are no exceedances of the Copermittee's portion of interim effluent limitations under Table 7.2 at the Responsible Copermittee's MS4 outfalls; OR

(4) The Responsible Copermittees have submitted and is fully implementing a Water Quality Improvement Plan, accepted by the San Diego Water Board, which provides reasonable assurance that the Copermittee's portion of the interim TMDL compliance requirements described in Attachment A of the Resolution No. R9-2010-0033 will be achieved by the interim compliance date.

While the amended MS4 Permit was approved with language incorporating the Sediment TMDL in Attachment E, additional language is currently being reviewed by the Regional Board which would add consistency and clarification with the Sediment TMDL to the final compliance determination. The MS4 Permit provides the following options to demonstrate final compliance with the Sediment TMDL; the italicized text is expected to be incorporated in a future amendment:

(1) Successful restoration of 80 percent of the 1973 acreage of tidal and non-tidal lagoon salt marsh (346 acres) *as described in Attachment A of Resolution No. R9-2010-0033*; OR

(2) The Responsible Copermittees develop and implement the Water Quality Improvement Plan as follows:

(a) Incorporate the BMPs required under Specific Provision 7.b.(2)(c)(ii) *and/or other implementation actions to achieve compliance with Specific Provision 7.b.(3)(a)* as part of the Water Quality Improvement Plan,

(b) Include an analysis in the Water Quality Improvement Plan, utilizing a watershed model or other watershed analytical tools, to demonstrate that the implementation of the BMPs required under Provision 7.b.(2)(c)(ii) or other implementation actions *to* achieve compliance with Specific Provision 7.b.(3)(a),

(c) The results of the analysis must be accepted by the San Diego Water Board as part of the Water Quality Improvement Plan,

(d) The Responsible Copermittees continue to implement the BMPs required under Specific Provision 7.b.(2)(c)(ii) or other implementation actions, AND

(e) The Responsible Copermittees continue to perform the specific monitoring and assessments specified in Specific Provision 7.d to demonstrate compliance with Specific Provision 7.b.(3)(a).

Section 5 of the Water Quality Improvement Plan provides additional information on the monitoring that will be completed for assessment. The compliance analysis, modeling conducted to provide assurance that interim and final goals will be met, is discussed in more detail in Appendix J and Section 4.3 of the Water Quality Improvement Plan.

H.2 Identification of Bacteria Numeric Goals

The final and interim bacteria numeric goals were derived from water quality-based effluent limitations (WQBELs) identified in the Bacteria TMDL and incorporated into the MS4 Permit. Bacteria TMDL WQBELs include receiving water limitations and effluent limitations, presented in multiple formats. The receiving water limitations and effluent limitations are discussed in detail in Section H.2.1 and Section H.2.2, respectively. Attachment E.4 of the Municipal Permit provides the following options to meet numeric goals and to demonstrate final compliance with the Bacteria TMDL:

(1) There is no direct or indirect discharge from the Responsible Agency's municipal separate storm sewer systems (MS4s) to the receiving water; OR

(2) There are no exceedances of the final receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(3) There are no exceedances of the final effluent limitations at the Responsible Agency's MS4 outfalls; OR

(4) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the final effluent limitations; OR

(5) The Responsible Agencies can demonstrate that exceedances of the final receiving water limitations in the receiving water are due to loads from natural sources, AND pollutant loads from the Responsible Agencies' MS4 are not causing or contributing to the exceedances; OR

(6) The Responsible Agencies develop and implement the Water Quality Improvement Plan as follows:

(a) The Responsible Agencies incorporate best management practices (BMPs) to achieve the receiving water limitations and/or the effluent limitations,

(b) The Responsible Agencies include an analysis in the Water Quality Improvement Plan, utilizing a watershed model or other watershed analytical tools, to demonstrate that the implementation of the BMPs achieves compliance with the final receiving water and/or effluent limitations,

(c) The results of the analysis must be accepted by the San Diego Water Board as part of the Water Quality Improvement Plan,

(d) The Responsible Agencies continue to implement the BMPs, and

(e) The Responsible Agencies continue to perform the specific monitoring and assessment specified to demonstrate compliance with the receiving water and effluent limitations (RWQCB, 2013a).

H.2.1 Receiving Water Limitations

Bacteria TMDL receiving water limitations are expressed as concentrations and as an allowable exceedance frequency. The limitations vary depending on the weather condition. The Bacteria TMDL identified WQBELs based on precipitation: wet weather (one day of 0.2 inches of rainfall or more plus three days) and dry weather (all other days, including those in the winter season). For each condition, receiving water targets were identified based on WQOs (Table H-4). WQOs are concentrations of bacteria indicators identified as acceptable levels for recreational contact (REC-1). Wet weather conditions are episodic and short in duration; therefore, single sample maximum WQOs apply. Geometric mean WQOs apply during dry weather when monitoring results over a longer duration are averaged and assessed. The WQOs do not account for a natural increase in bacteria loads during storm events. To account for background bacteria concentrations during wet weather, the Bacteria TMDL incorporated an allowable exceedance frequency of the WQO based on a reference (mostly undeveloped) watershed.

The TMDL targets are directly incorporated as Water Quality Improvement Plan numeric goals. Table H-4 presents the TMDL receiving water limitations, and thus the Water Quality Improvement Plan numeric goals for the Pacific Ocean shoreline at the Los Peñasquitos lagoon mouth and the final compliance date.

Table H-4
Final Receiving Water Numeric Goals within Los Peñasquitos WMA

Indicator Bacteria	Shoreline WQO (MPN/100mL)	Shoreline Allowable Exceedance Frequency[1]	Shoreline WQO (MPN/100mL)	Shoreline Allowable Exceedance Frequency
	Wet Weather (Single Sample Maximum)[2]		Dry Weather (30-day Geometric Mean)[3]	
	Final Compliance: April 4, 2031		Final Compliance: April 4, 2021	
Fecal coliform	400	22%	200	0%
Enterococcus	104	22%	35	0%
Total coliform	10,000	22%	1,000	0%

Note:

1. The 22% allowable exceedance frequency only applies to wet weather days. For dry weather days, the dry weather bacteria densities must be consistent with the single sample maximum REC-1 water quality objects in the Ocean Plan.
2. During wet weather days, only the single sample maximum receiving water limitations are required to be achieved.
3. During dry weather days, the single sample maximum and 30-day geometric mean receiving water limitations are required to be achieved.

mL = milliliters; MPN = most probable number; WQO = water quality objective

The Bacteria TMDL specifies a final receiving water limitation allowable exceedance frequency of 22 percent during wet weather periods based on reference conditions, but allows no exceedances during dry weather. To assess compliance, the Bacteria TMDL expressed exceedances of WQOs as the percentage of days that the appropriate WQO was allowed to exceed per year. The TMDL calculated this value using a mass-based conversion based on bacteria loading, as required by federal regulations (Bacteria TMDL, 2010). The TMDL load was calculated by multiplying the WQOs by the daily modeled stream flow. Modeled daily loads greater than this threshold were flagged as an exceedance. Modeled daily loads were classified as occurring on either wet days or dry days to determine compliance with the different weather-based requirements. For wet weather, the Bacteria TMDL specifies a final allowable exceedance frequency of 22 percent based on reference conditions, while no exceedances are allowed during dry weather. For wet weather, the daily load from wet days greater than the TMDL load and the calculated allowable exceedance load (load from the 22 percent of the allowable days) were flagged as exceedances. For dry days, the daily load from dry days greater than the TMDL load were flagged as exceedances.

The number of total wet and dry weather days will change by year, but the percentage of exceedance days is the compliance point. For example, the TMDL calculated the number of allowable exceedance days for the critical, or wettest, year within the model period, water year 1993. The number of wet weather days was 98; therefore, the final number of allowable wet weather exceedance days for the critical year would have been 22 (rounded expression of 22 percent of 98 days). The final allowable number of dry weather exceedance days for the critical year is zero, because a reference condition was not applied to dry weather days in the TMDL. Final compliance with wet weather WQBELs is required in FY31. Final compliance with dry weather WQBELs is required in FY21.

H.2.2 Effluent Limitations

The Bacteria TMDL provides two expressions of effluent limitations. The first expression is equivalent to the receiving water limitations, but is assessed at MS4 outfalls (Table H-5). The second expression is a mass-based load reduction from the subwatersheds discussed below.

Table H-5
Final Effluent Limitations Expressed as an Exceedance Frequency for Los Peñasquitos River WMA

Indicator Bacteria	WQO (MPN/100mL)	MS4 Outfall Allowable Exceedance Frequency[1]	WQO (MPN/100mL)	MS4 Outfall Allowable Exceedance Frequency
	Wet Weather (Single Sample Maximum)[2]		Dry Weather (30-day Geometric Mean)[3]	
	Final Compliance: April 4, 2031		Final Compliance: April 4, 2021	
Fecal coliform	400	22%	200	0%
Enterococcus	104	22%	35	0%
Total Coliform	10,000	22%	1,000	0%

Note:
1. The 22% allowable exceedance frequency only applies to wet weather days. For dry weather days, the dry weather bacteria densities must be consistent with the single sample maximum REC-1 water quality objects in the Ocean Plan.
2. During wet weather days, only the single sample maximum receiving water limitations are required to be achieved.
3. During dry weather days, the single sample maximum and 30-day geometric mean receiving water limitations are required to be achieved.

% = percent; mL = milliliters; MPN = most probable number; WQO = water quality objective

Another expression of WQBELs is the percent bacteria load reduction required from the watershed to meet the WQOs expressed as an allowable exceedance frequency. The TMDL was calculated by multiplying the WQOs by the average daily modeled stream flow. Modeled daily loads greater than this threshold were flagged as an exceedance. The allowable exceedance load for wet weather was calculated by summing the top 22 days (22 percent of the 98 wet weather days in the critical year) with the highest modeled daily loads. This load was then subtracted from the modeled wet weather total for the year. The difference between the remaining modeled load and the TMDL load represents the load reduction required for wet weather. The percent load reduction is calculated by dividing the exceedance load by the total annual load for the critical year.

The final load reductions estimated to meet receiving water goals are presented in Table H-6.

Table H-6
Final Effluent Limitations Expressed as an Exceedance Frequency for Los Peñasquitos WMA

Indicator Bacteria	Percent Watershed Load Reduction Required	
	Wet Weather	Dry Weather
	Final Compliance: April 4, 2031	Final Compliance: April 4, 2021
Fecal coliform	2.0%	96.6%
Enterococcus	1.9%	99.4%
Total coliform	1.6%	96.5%

Dry weather WQBELs, expressed as percent watershed load reduction, were calculated using the same formula, but daily loads were calculated using a slightly different model (steady-state plug-flow reactor model) in the Bacterial TMDL. Two variations in the calculation are that (1) an allowable load using the reference watershed approach was not applied for dry weather, per the TMDL, and (2) the percent load reductions were calculated based on a 30-day period for comparison with the 30-day geometric mean WQO. Otherwise, the TMDL load was calculated in the same manner as that for the wet weather load and the difference between the remaining modeled load and the TMDL load is the load reduction required for dry weather. The percent load reduction is calculated by dividing the exceedance load by the total monthly load for the critical year.

H.2.3 Interim Goals and Existing Conditions

The first five TMDL interim compliance pathways are the same as the final compliance pathways. In addition, two compliance pathways (6 and 7 below) provide interim compliance calculated using a midpoint between existing conditions and final targets. Finally, compliance pathway 8 provides interim compliance with the TMDL if the Responsible Agencies are implementing strategies selected and included in a watershed model or other analytical tool to demonstrate that the interim TMDL compliance requirements will be met. Attachment E.4 of the Municipal Permit provides the following options to meet interim numeric goals and to demonstrate interim compliance with the Bacteria TMDL:

(1) There is no direct or indirect discharge from the Responsible Agency's municipal separate storm sewer systems (MS4s) to the receiving water; OR

(2) There are no exceedances of the final receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(3) There are no exceedances of the final effluent limitations at the Responsible Agency's MS4 outfalls; OR

(4) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the final effluent limitations; OR

(5) The Responsible Agencies can demonstrate that exceedances of the final receiving water limitations in the receiving water are due to loads from natural sources, AND pollutant loads from the Responsible Agencies'' MS4 are not causing or contributing to the exceedances; OR

(6) There are no exceedances of the interim receiving water limitations in the receiving water at, or downstream of, the Responsible Agency's MS4 outfalls; OR

(7) The pollutant load reductions for discharges from the Responsible Agencies' MS4 outfalls are greater than or equal to the interim effluent limitations; OR

(8) The Responsible Agencies submit and are fully implementing a Water Quality Improvement Plan, accepted by the San Diego Water Board, which provides reasonable assurance that the interim TMDL compliance requirements will be achieved by the interim compliance dates.

Interim goals are identified for each expression of WQBELs and each weather condition. Bacteria TMDL wet and dry weather interim compliance is calculated as the halfway point between the existing, 2002 conditions and the final TMDL target. The MS4 Permit allows an alternative interim compliance date from the original Bacteria TMDL compliance date (MS4 Permit, Attachment E). Interim compliance of receiving water or effluent limitations is most reasonably attained in FY24 for wet weather and FY19 for dry weather. Updates to existing programs, changes in municipal ordinances, and collaboration within jurisdictions, WMAs, and the region have been occurring since the Bacteria TMDL and the 2013 MS4 Permit were adopted and are ongoing. Through CLRP and Water Quality Improvement Plan development, planning efforts are underway, including measures to secure funding and increase general momentum to implement and expand storm water and water conservation measures. The alternative compliance dates allow for the success of the monitoring, assessment, and goal and strategy adaptation process detailed within this Water Quality Improvement Plan.

The TMDL model used data through 2002, which is why 2002 is considered the existing condition. The existing condition does not necessarily reflect current conditions, nor is it the Water Quality Improvement Plan baseline for all goals. The existing condition for load reductions is assumed to be 0% in 2002, as that was the beginning of implementation planning. The Bacteria TMDL estimated the 2002 existing exceedance frequency for wet weather since wet weather data was not available. The MS4 permit requires the dry weather exceedance frequency to be calculated and presented in the Water Quality Improvement Plans. For each indicator bacteria, available monitoring data collected between January 1, 1996 and December 31, 2002 was assessed and compared to 30-day geometric mean WQOs.

Table H-7 presents the existing condition for the receiving water and effluent limitations and the interim TMDL compliance target for Los Peñasquitos River. The Bacteria TMDL estimates that the 2002 wet weather exceedance frequency for fecal coliforms, *Enterococcus*, and total coliforms were 30 percent for all indicator bacteria species based on modeling results. To calculate dry weather exceedance frequencies, 138 results were available for *Enterococcus*, 145 results for fecal coliforms, and 146 results for total coliforms between 1996 and 2002. The exceedance frequency using geomeans (percent of dry weather days with a geomean exceeding the geomean WQO) was 19% for *Enterococcus*, 4% for fecal coliforms, and 1% for total coliforms. Interim compliance is 50% of the existing condition.

Table H-7
Existing Conditions and Interim TMDL Targets for Los Peñasquitos WMA

Bacteria Indicator	Receiving Water Exceedance Frequency		Effluent Load Reduction		Interim Compliance Date
	Existing 2002 Condition	Interim Compliance[1]	Existing 2002 Condition	Interim Compliance[1]	
Wet Weather					
Fecal coliform	30%[2]	26%	0%	1.0%[2]	April 4, 2024
Enterococcus	30%[2]	26%	0%	1.0%[2]	
Total coliform	30%[2]	26%	0%	0.8%[2]	
Dry Weather					
Fecal coliform	4%[3]	2.0%[2]	0%	48.3%[2]	April 4, 2019
Enterococcus	19%[3]	9.5%[2]	0%	49.7%[2]	
Total coliform	1%[3]	0.5%[2]	0%	48.3%[2]	

Note:
1. Interim compliance is calculated as 50% between the existing condition and the final TMDL target.
2. Source: Bacteria TMDL
3. Source: Monitoring data
% = percent; N/A = not applicable

The difference between the existing dry weather exceedance frequency and the dry weather load reduction highlights the shortcomings of dry weather modeling based on limited observed data. Uncertainties in the model may result in a potential disconnect between receiving water quality and watershed loading estimates. An exceedance frequency of less than 20% based on monitoring data would seem to require a lower load reduction from the watershed than 99%; however this highlights the difference between concentration and load-based information which incorporates potential uncertainties in modeling dry weather flows. A 99% watershed load reduction likely overstates the actual load reduction required to meet final compliance. Regardless of the load reduction required, the primary strategy during dry weather is to eliminate dry weather flows, which will, in turn, reduce and eliminate pollutant loading. In the Water

Quality Improvement Plan, dry weather reduction strategies and progress towards meeting them are more frequently discussed in terms of flow reduction, rather than load reduction. This acknowledges the related benefit to load reductions, but highlights the source or transport mechanism for dry weather implementation.

H.2.4 Compliance Pathways

Interim and final compliance with the Bacteria TMDL, as incorporated into the MS4 Permit, may be demonstrated by the Responsible Agencies using any one of the methods presented in the previous sections. Section 5 of the Water Quality Improvement Plan provides additional information on the monitoring that will be completed for assessment. The compliance analysis, modeling conducted to provide assurance that interim and final goals will be met, is discussed in more detail in Appendix J and Section 4.3 of the Water Quality Improvement Plan.

H.3 Freshwater Discharge Numeric Goals

Neither the Sediment TMDL nor the Bacteria TMDL identified the reduction of freshwater discharge required to assist in meeting TMDL targets. The Sediment TMDL Technical Report cites studies and monitoring data that demonstrate an increase in flow associated with urbanization, however not all of that flow is a result of direct discharge from the MS4. The geology of the watershed particularly in the lower watershed allows infiltrated water, including irrigation water, to percolate directly to the creeks.

For the purpose of Water Quality Improvement Plan numeric goals, freshwater discharges from the MS4s throughout the watershed will be assessed. Irrigation runoff is the predominant source of freshwater discharges, and indicator bacteria, during dry weather from the MS4. Modeling within the San Diego region, including in Los Peñasquitos WMA, indicates that a 25% reduction in irrigation (modeled as a reduction in irrigated land by 25% and the reduction of overspray by 35%) results in an average 80% reduction in fecal coliforms and an average 85% reduction in surface flows (flows through an MS4). These results combined with the estimated 10% load reduction gained by other nonstructural activities, reaches or nearly reaches the load reductions estimated to be required to be in compliance with Bacteria TMDL targets, particularly considering the limitations of the dry weather modeling discussed in Section H.2.3.

The 25% reduction in irrigation is inline and slightly more aggressive than California's statewide 20x2020 Water Conservation Plan (20x2020 Plan) which aims to reduce the urban water demand by 20% per capita by 2020. In California, outdoor water consumption exceeds 40% of overall urban water use (DWR, 2010). The reduction of irrigation (or outdoor water) demand not only benefits receiving water conditions, including the restoration of saltmarsh habitat, but also reduces costs of new water infrastructure and reduces water-related energy among other benefits discussed in the 20x2020 Plan.

The strategies used to reduce and eliminate dry weather flows will be encouraged and implemented throughout the watershed, not only reducing freshwater discharges directly to the lagoon through MS4 outfalls but to tributaries upstream through MS4 discharges, surface runoff, and percolation through groundwater seeps. By targeting a reduction in irrigation, both irrigation runoff and overall anthropogenic contributions to a rising groundwater table will be addressed.

REFERENCES

California Department of Water Resources (DWR). 20x2020 Water Conservation Plan. February, 2010. http://www.swrcb.ca.gov/water_issues/hot_topics/20x2020/docs/20x2020plan.pdf

San Diego Regional Water Quality Control Board (Regional Board). 2010. *Revised TMDL for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region (including Tecolote Creek)*. Resolution No. R9-2010-0001. Approved February 10, 2010. http://www.waterboards.ca.gov/sandiego/water_issues/programs/tmdls/docs/bacteria/updates_022410/2010-0210_BactiI_Resolution&BPA_FINAL.pdf.

San Diego Regional Water Quality Control Board (Regional Board). 2012. Order Number R9-2012-0033, *Total Maximum Daily Load for Sedimentation in Los Peñasquitos Lagoon*.

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APPENDIX I

Jurisdictional Strategies and Schedules

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APPENDIX I. JURISDICTIONAL STRATEGIES AND SCHEDULES

Strategy selection within the Los Peñasquitos WMA is discussed in Section 4.2.1 and Appendix J. This appendix provides the selected strategies for each Responsible Agency including the implementation approach and level of effort required. The corresponding implementation year and duration provide context for when the strategy will be implemented. Strategies not being implemented upon approval of the Water Quality Improvement Plan provide a future date for implementation or a trigger for implementation in the future. Responsible Agencies are continually collaborating with internal jurisdictional departments, other Responsible Agencies, stakeholders, and watershed groups and non-profit organizations, and these collaborating entities are presented in the jurisdictional strategies tables as well. The strategies are subject to change and will be modified through the adaptive management process, as needed.

I.1 Caltrans Strategies

Caltrans' jurisdiction areas include roadways, land adjacent to roadways, and facilities; Caltrans' jurisdictional strategies specifically focus on BMP implementation to reduce known pollutants within these areas. Caltrans is not permitted within the MS4 Permit; however, Caltrans is subject to similar requirements through its MS4 Permit (SWRCB, 2013). Though not permitted within the MS4 permit, Caltrans has voluntarily contributed to the Water Quality Improvement Plan effort to provide a consistent and subwatershed-wide approach to meeting applicable TMDL requirements. Caltrans voluntary contributions include a detailed list of strategies developed and provided in Table I-1 below. The strategies and schedules presented in Table I-1 are subject to change and are contingent upon annual budget approvals and funding availability. They will be modified through the adaptive management process as needed.

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Table I-1
Caltrans Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Responsible City Department and Other Collaborating Departments or Agencies
Jurisdictional Strategies					
Design Stormwater Program					
CT-1	Update and implement design BMPs.	Office of Stormwater Management Design (OSWMD) develops, evaluates, and enhances guidance documents and tools. Refer to Landscape Architecture Program (LAP).	Jurisdiction-wide	FY16	HQ (OSWMD)
CT-1.1	Update and implement Landscape Architecture Program (LAP).	LAP provides technical assistance on new and ongoing research related to permanent erosion control and permanent BMPs. In addition, the LAP develops methods to enhance roadside vegetation, which protects slopes from erosion and sediment loss, and may remove pollutants from stormwater runoff.	Jurisdiction-wide	FY16	HQ (OSWMD)
CT-1.2	Implement native landscape/LID Design Guide Strategy.	Require native landscaping/LID in stormwater data report and project plan design guide. Done as part of erosion control. The Project Planning and Design Guide (PPDG) includes an online training program. Projects go through the same review process for native landscape reviews. If project is greater than an acre, subject to a stormwater data report. Minor projects are not subject to as extensive reviews. Try to treat 100% of roadway.	Jurisdiction-wide	FY16	District 11 with HQ (OSWMD)
CT-2	Train staff on Design Stormwater Program.	Train staff on Design Stormwater Program. Curriculum updated to reflect the latest strategies.	Jurisdiction-wide	FY16	District 11
CT-3	Plan and implement treatment BMPs as appropriate.	Treatment BMPs are planned and implemented to comply with Caltrans NPDES Permit project development requirements, TMDL waste load allocations, location specific requirements, and the requirements in the Project Planning and Design Guide (PPDG) according to the Targeted Design Constituent (TDC) approach. The treatment BMP consideration process favors infiltration of stormwater and directs staff to evaluate LID strategies first.	Jurisdiction-wide	FY16	District 11 NPDES and Design with HQ (OSWMD)
CT-4	Develop procedures to encourage mitigation for projects within the same watershed.	Caltrans will investigate procedures to mitigate within the same watershed as new projects.	Jurisdiction-wide	FY16	District 11 NPDES and Stewardship
CT-5	Implement a self-audit program to ensure BMPs are designed, implemented, and maintained.	Design Compliance Monitoring Program is a self-audit program that uses the SWDR (Stormwater Data Report) as a tool for documenting compliance with the design pollution prevention and treatment BMP requirements of the 1999 NPDES Permit, 2012 NPDES Permit, and the Caltrans' 2003 Statewide SWMP. The SWDR and its checklists are reviewed by District staff to ensure that BMPs are being considered and appropriately incorporated into Caltrans' projects. This review also ensures stormwater compliance throughout the project planning and design phases.	Jurisdiction-wide	FY16	District 11 NPDES
Construction Management					
CT-6	Administer a program to oversee implementation of BMPs during the construction phase of Caltrans projects. Includes inspections at an appropriate frequency and enforcement of requirements.	Caltrans complies with the statewide Construction General Permit. The district holds pre-construction meetings for all projects that require a SWPPP. For larger projects, there are year-round, weekly inspections.	Jurisdiction-wide	FY16	District 11 with the Division of Construction
CT-7	Construction stormwater training for District staff.	Continue implementation of the construction stormwater classes offered throughout the Caltrans districts by the Division of Construction. Classes updated to reflect latest permit requirements.	Jurisdiction-wide	FY16	District 11 with the Division of Construction
CT-8	Implement a self-audit program to ensure compliance with water quality requirements.	Continue implementation of the Construction Compliance Evaluation Plan. Evaluates contractor's SWPPP or WPCP implementation and assesses compliance with water quality requirements, evaluates stormwater contract administration, and incorporates quality control, quality assurance, and independent assurance elements.	Jurisdiction-wide	FY16	District 11 NPDES

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Responsible City Department and Other Collaborating Departments or Agencies
CT-9	Maintenance training for employees.	The Division of Maintenance has formal stormwater management training sessions for new employees and refresher training for existing staff. Both types of courses are scheduled from one to 15 hours in length. In addition to formal training, Division of Maintenance policy is that Supervisors conduct stormwater BMP tailgate meetings a minimum of every 10 working days or when there is a change in the type of work activity. These meetings are to review BMPs prior to conducting roadside maintenance activities.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
Maintenance					
CT-10	Administer a program to require implementation of minimum BMPs for facilities and leased space (air space leases).	Refer to SWMP. Leased space is required to meet current stormwater regulations.	Jurisdiction-wide	FY16	District 11 with ROW Department
CT-11	Inspection of facilities and leased areas.	The Department will continue to reduce the potential for storm water pollution by the development and implementation of Facility Pollution Prevention Plans (FPPPs), which specify controls to minimize contact between storm water and the various substances at highway maintenance facilities. Per Maintenance Manual Vol.2 under F Family, periodic inspections are conducted to evaluate whether the BMPs are adequate and properly implemented. The SWMP states this provision regarding FPPP. *Maintenance Facility Pollution Prevention Plans. Facility Pollution Prevention Plans (FPPP) has been developed for each maintenance facility owned or operated by the Department. The FPPPs describe the activities conducted at the facility and the BMPs to be implemented to reduce the discharge of pollutants in storm water runoff from these facilities. Supervisors inspect their maintenance facilities monthly to monitor the implementation and adequacy of the BMPs. A report that includes the date of the inspection, the name of the inspector, observations, and recommended corrective actions is prepared by the Supervisor. All inspection records will be maintained for a period of 3 years. Any observed instances of non-compliance will be reported to the District Maintenance.*	Jurisdiction-wide	FY16	District 11 with ROW Department
CT-12	Implement BMPs targeting reduction of over-irrigation.	Reduce over irrigation by requiring native, drought tolerant plants and irrigation system improvements.	Jurisdiction-wide	FY16	District 11 Landscape and Stewardship
CT-13	Proactively monitor for erosion, and complete repair and slope stabilization.	Division of Maintenance conducts inspections on a five-year cycle. Program includes self-imposed goal to annually inspect approximately 20% of slopes in each District and includes investigating public complaints and widely understood problem areas (WUPAs).	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
MS4 Infrastructure					
CT-14	Inspect and clean catch basins and conduct source investigations to identify upstream source of materials.	Inspect catch basins once every three years with 1/3 inspected per year. If needed, catch basins are cleaned. If a catch basin is cleaned, a source inspection is conducted to identify source of sediment or other material.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
CT-15	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	Prioritize MS4 repairs. Funding for repairs based on size of project. Districts are able to conduct small repairs immediately, while larger projects are prioritized for repair out of annual budget.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
Roads and Streets					
CT-16	Implement operation and maintenance activities on streets and roadways.	Refer to Work Plan.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
CT-16.1	Implement street sweeping.	Every road swept once a month. To meet performance schedule, street sweepers are replaced on a four-year cycle.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
CT-16.2	Perform sweeping of medians on high-volume arterial roadways.	Medians with shoulders are swept approximately once per month.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Responsible City Department and Other Collaborating Departments or Agencies
CT-17	Implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers.	Refer to Vegetation Control Plan. Caltrans is actively reducing fertilizer/pesticide application and only applies to targeted areas. All pesticide use is reported to the California Department of Pesticide Regulation.	Jurisdiction-wide	FY16	District 11 with Roadside Maintenance Office and California DPR
Illicit Connections/Illegal Discharges					
CT-18	Identify and resolve potential illicit connections/illegal discharges (IC/IDs).	Continue maintaining a hotline for reporting of illicit discharges. Majority of calls come from contractors and construction and maintenance staff. Continue coordination with other jurisdictions to address IC/IDs and provide written notification of potential IC/IDs associated with a municipality's jurisdiction.	Jurisdiction-wide	FY16	District 11 with other jurisdictions
CT-19	Identify erosion and slope stabilization issues on private or municipal property and inform the source for repair.	When Caltrans staff or contractors identify erosion or slopes in need of repair, it is treated as an IC/ID and the property owner is notified.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
Public Education and Participation					
CT-20	Implement a public education and participation program to raise awareness of stormwater pollution and prevention on California's freeways and highways.	Continue to implement the "Don't Trash California" Campaign, Adopt-A-Highway program, and partner with local organizations.	Jurisdiction-wide	FY16	District 11 with HQ (OSWMD)
CT-20.1	Conduct trash cleanups.	Conduct trash cleanups through local probation and adopt-a-highway programs. Encourage prevention through "Don't Trash California" campaign.	Jurisdiction-wide	FY16	District 11 Division of Maintenance
CT-20.2	Target school-based education and outreach.	Provide outreach to schools raising awareness of stormwater pollution through watershed model demonstrations. Hold bring-your-child-to-work days with watershed model.	Jurisdiction-wide	FY16	District 11 with HQ (OSWMD)
Other Nonstructural Strategies					
CT-21	To provide sanitation and trash management, implement access control in targeted areas.	As necessary, implement methods such as rip-rap, chain link fences, and remove low-lying brush to discourage use of right-of-way areas.	Jurisdiction-wide	FY16	District 11 NPDES, Design and Maintenance
CT-22	Continue participating in source reduction initiatives.	Continue participation in Brake Pad Partnership through work with California Stormwater Quality Association.	Jurisdiction-wide	FY16	HQ with CASQA
CT-23	Removal of invasive plants.	Removal of invasive plants through maintenance and construction programs.	Jurisdiction-wide	FY16	District 11 with Division of Maintenance
CT-24	Protect areas that are functioning naturally.	Required as part of the stormwater data report (SWDR), the Project Planning and Design Guide (PPDG), and the Natural Environment as Treatment (NEAT) programs, Caltrans minimizes disturbance of exiting vegetation and avoids hardscapes.	Jurisdiction-wide	TBD	District 11 with HQ (OSWMD)
CT-25	Collaborate with Responsible Agencies on Water Quality Improvement Plans.	Voluntarily participate in the development of the Water Quality Improvement Plan and continue to collaborate with RAs on water quality planning and implementation projects.	Jurisdiction-wide	FY16	District 11
Green Infrastructure					
CT-26	Caltrans Construction (#172824)	Bioswales were installed in 2005 along Route 56.	Los Peñasquitos Creek Subwatershed	In place	District 11
CT-27	Caltrans Construction (#EA-2T0934)	Bioswales were installed in 2011 along Route 15.	Los Peñasquitos Creek & Carroll Canyon Creek Subwatersheds	In place	District 11
CT-28	Construct Managed Lanes (HOV/BRT Lanes) (#2T2004)	1 bioswale is under construction along Route 805 to treat about 7.75 acres.	Carroll Canyon Creek Subwatershed	2012	District 11

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Responsible City Department and Other Collaborating Departments or Agencies
CT-29	Direct Access Ramp (#2T0951)	3 Bioretention filtration units and 4 flogard screen filters along Route 15 will be used to treat 5.4 acres.	Los Peñasquitos Creek Subwatershed	2014	District 11
Multiuse Treatment Areas					
CT-30	Caltrans Construction (#080934)	1 detention basin was constructed in 2005 at the intersection of route 15 and route 56. The basin is 213 SF and treats 4.9 acres.	Los Peñasquitos Creek Subwatershed	In place	District 11
CT-31	Construct Managed Lanes (HOV/BRT Lanes) (#2T2004)	Installation of 1 detention basin in 2012. The basin is 30,350 SF and will treat 15.5 acres.	Carroll Canyon Creek Subwatershed	2012	District 11

I.2 City of Del Mar Strategies

The City of Del Mar has selected jurisdictional strategies that best suit the topography and characteristics of its jurisdiction in order to comply with Permit requirements. Del Mar is highly developed and the land use primarily consists of low-density residential and commercial areas. The City's long-standing sustainable planning requirements limit the amount of impervious surface areas for developments. This has resulted in less impervious surface areas within the City than other urbanized areas in the region. The City of Del Mar will be implementing strategies to target residential and commercial areas which includes a robust property-based inspection program. The City will consider green infrastructure strategies, but the options may be limited due to right-of-way constraints and bluff stabilization concerns in many parts of the City of Del Mar. The City of Del Mar has identified the jurisdictional strategies in Table I-2 to assist in meeting the Water Quality Improvement Plan goals. A compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met.

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Table I-2
City of Del Mar Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation
Jurisdictional Strategies					
Development Planning					
All Development Projects					
DM-1	For all development projects, administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area, where applicable and feasible.	Refer to JRMP.	City-wide	FY16	Ongoing
DM-2	Train staff on LID regulatory changes during annual stormwater training.	Formal staff training implemented annually during stormwater training.	City-wide	FY16	Ongoing
DM-3	Maintain existing floor area ratio requirements to limit impervious surface areas.		City-wide	FY16	Ongoing
DM-4	Continue retention of native vegetation - New or redevelopment projects within the Lagoon Overlay Zone shall include the retention of the maximum amount of native vegetation on the site. Revegetation or landscaping of sites within the Lagoon Overlay Zone shall include the use of non-invasive, drought tolerant species native to the San Diego coastal region and which are compatible with adjacent wetland habitat species.	Refer to Municipal Code.	City-wide	FY16	Ongoing
Priority Development Projects (PDPs)					
DM-5	For PDPs, administer a program requiring implementation of on-site structural BMPs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs.	Refer to JRMP.	City-wide	FY16	Ongoing
DM-6	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	Refer to JRMP.	City-wide	FY15	Ongoing
Construction Management					
DM-7	Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.	Refer to JRMP; Construction site inventory updated monthly and inspections of prioritized sites are conducted biweekly year round.	City-wide	FY16	Ongoing
Existing Development					
Commercial, Industrial, Municipal, and Residential Facilities and Areas					
DM-8	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	Refer to JRMP; Programmatic inspection/maintenance frequency included in JRMP update.	City-wide	FY16	Ongoing
DM-8.1	Update minimum BMPs for commercial, industrial, and municipal existing development and enforce. Includes BMPs for water-using mobile businesses.	Refer to JRMP; minimum BMPs updated within JRMP update.	City-wide	FY16	As-needed
DM-8.2	Provide BMP factsheet to water-using mobile businesses when business license is granted.	To ensure implementation of minimum BMPs for water -using mobile businesses, when a business license is granted for a water-using mobile business, a BMP factsheet is provided.	City-wide	FY16	Ongoing
DM-8.3	Conduct property-based commercial, industrial, municipal, and residential inspections. Includes identification and addressing unmitigated incidents of power washing discharges.	Refer to JRMP. Inspections of commercial, industrial, municipal, and multi-family residential areas conducted a minimum of six times per year.	City-wide	FY16	Ongoing
DM-8.4	Update municipal swimming pool discharge ordinance to ensure discharges from swimming pools meet permit requirements.	Refer to JRMP.	City-wide	Before FY16	As needed

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation
DM-9	Implement pet waste program.	Implement education and prevention program. Pet waste bag dispensers and trash bins provided in public areas. Pet waste removal occurs as part of Dog Beach maintenance.	City-wide	FY16	Ongoing
DM-10	Promote and encourage implementation of designated BMPs at residential areas.		City-wide	FY16	Ongoing
DM-10.1	Promote and collaborate with water agencies and other groups to encourage implementation of water conservation programs that improve water quality by reducing over-irrigation with smart products or turf replacement and capturing rain water in residential areas.	Collaborate with MWD and promote their SoCal Water$mart rebates and products such as weather based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor system, rain barrels, and turf removal. Collaborate with San Diego County Water Authority (SDCWA) and promote their Water Smart irrigation system checkups and turf replacement incentives.	City-wide	FY16	Ongoing
DM-11	Promote and encourage implementation of designated BMPs in commercial areas.	Collaborate with MWD and promote their SoCal Water$mart rebates and products such as weather based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor system, rain barrels, and turf removal.	City-wide	FY16	Ongoing
MS4 Infrastructure					
DM-12	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.).	Refer to JRMP.	City-wide	FY16	Ongoing
DM-12.1	Perform catch basin cleaning.	Inspect and clean catch basins annually.	City-wide	FY16	Ongoing
DM-12.2	Repair and replace MS4 components as needed to provide source control from MS4 infrastructure.		City-wide	FY16	Ongoing
DM-13	Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers and identify sewer leaks and areas for sewer pipe replacement.	Refer to Sanitary Sewer Management Plan.	City-wide	FY16	Ongoing
Roads, Street, and Parking Lots					
DM-14	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Refer to JRMP	City-wide	FY16	Ongoing
DM-14.1	Enhanced street sweeping by use of regenerative air vacuum sweepers.	Enhanced sweeping implemented by using regenerative air vacuum sweepers. Residential areas are swept 2x per year; primary roads (Camino Del Mar) and business district are swept 2x per month. Collection and bike lanes and medians are swept 2x per month.	City-wide	FY16	Ongoing
DM-14.2	Perform sweeping of medians on high-volume arterial roadways.	Primary roads and business district medians are swept 2x per month.	Primary roads & business district	FY16	Ongoing
Pesticide, Herbicides, and Fertilizer BMP Program					
DM-15	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Refer to JRMP.	City-wide	FY16	Ongoing
Retrofit and Rehabilitation in Areas of Existing Development					
DM-16	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Refer to JRMP.	City-wide	FY16	Ongoing
DM-17	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	Refer to JRMP	City-wide	FY16	Ongoing

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation
Illicit Discharge, Detection, and Elimination (IDDE) Program					
DM-18	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Refer to JRMP.	City-wide	FY16	Ongoing
DM-19	Conduct frequent visual outfall monitoring to identify and eliminate illicit discharges.	As part of the patrol-based program for the construction, existing development, and outfall inventories, visit outfalls a minimum of six times per year to identify and eliminate potential illicit discharges.	City-wide	FY16	Ongoing
Public Education and Participation					
DM-20	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Refer to JRMP.	City-wide	FY16	Ongoing
DM-20.1	Continue outreach to property managers responsible for HOAs and Maintenance Districts.	As part of the patrol-based program for the residential existing development inventory, provide frequent education and contact to HOAs and maintenance districts targeting outdoor activities and trash areas.	TBD	FY16	Ongoing
DM-20.2	Continue education and outreach to reduce over-irrigation through patrol program.	Once per year outside of business hours, patrol jurisdiction for incidents of over-irrigation and leave door-hangers identifying problem areas and appropriate corrective actions.	TBD	FY16	Ongoing
DM-20.3	Conduct trash cleanups through community-based organizations involving target audiences.	In partnership with I Love a Clean San Diego, host a site in Del Mar during two beach clean-ups per year.	TBD	FY16	Ongoing
DM-20.4	Review City storm water website and identify and implement required updates to reflect WQIP and JRMP revisions.	Update City Clean Water Program website with WQIP and JRMP information and highlight what the community can do for water quality.	City-wide	FY16	As needed
DM-20.5	Collaborate with regional education and outreach efforts.	Participate in Regional Think Blue campaign and collaborate with other regional efforts to provide consistent message or efficiency in training for targeted audiences.	City-wide	FY16	Ongoing
Enforcement Response Plan					
DM-21	Implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.	Refer to JRMP.	City-wide	FY16	Ongoing
Additional Nonstructural Strategies					
DM-22	Continue participating in source reduction initiatives.	Continue implementation of cigarette ban on beaches, parks and in commercial areas.	City-wide	FY16	Ongoing
DM-23	Proactively monitor for erosion and complete minor repair and slope stabilization as needed.	Post-storm monitoring is conducted to identify slope and bluff erosion in priority areas. As-needed, repairs and slop stabilization are completed.	City-wide	FY16	Ongoing
DM-24	Protect areas that are functioning naturally.	As opportunities arise, where feasible, the City will protect areas that are functioning naturally. This may include avoiding hardscape development and degradation in unpaved open space areas and creating permanent open space protections to undeveloped city-owned land.	TBD	TBD	As available
DM-25	City will consider alternative compliance program on a case by case basis.	Refer to JRMP.	TBD	Optional	TBD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation
DM-26	If a regional education group for the equestrian community and property owners is developed by the County of San Diego, contribute to the effort through outreach, education, and policy measures.		TBD	Optional	TBD
DM-27	If a regional outreach program for the development community is created, provide technical education and outreach support on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	Participate in the development of a regional outreach program to the development community if it occurs.	TBD	Optional	TBD
DM-28	Conduct special studies	San Diego Regional Reference Stream Study (currently being conducted by the Southern California Coastal Water Research Project). The study will develop numeric targets that account for "natural sources" to establish the concentrations or loads from streams in a minimally disturbed or "reference" condition. Refer to Section 5.1 for further details.	Los Peñasquitos WMA Subwatershed	Optional	TBD
DM-28.1	Reference watershed study	Los Peñasquitos WMA special study will assess sediment loads in the watersheds upstream of the Draft Sediment TMDL compliance monitoring locations. Includes the analysis of sediment water column loads, stream bedload, and air monitoring. Implemented in a phased approach. Monitoring will occur first in the Carroll Canyon subwatershed. The Los Peñasquitos Creek and Carmel Valley Creek subwatersheds will be monitored in subsequent phases. Refer to Section 5.1 for further details.	Los Peñasquitos WMA Subwatershed	Optional	TBD
DM-29	Collaborate with other watershed stakeholders on programs where mutual benefits to water quality may be achieved for the watershed.	Pursue opportunities for coordinated efforts with stakeholders to address water quality issues in the watershed.	TBD	TBD	TBD
Green Infrastructure					
DM-30	0.001 acre BMP has been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 0.06 acre with a total storage volume of 0.002 acre-foot.	Construction, operation and maintenance of 0.001 total parcel acreage of potential on-site treatment projects on public parcels.	Los Peñasquitos Lagoon Subwatershed	FY22	Ongoing
Green Streets					
DM-31[1]	0.06 acres of green streets (0.03 acres of permeable pavement and 0.03 acres of bioretention) have been identified as potential opportunities for green street projects to treat a drainage area of 2.59 acres.	Construction, operation and maintenance of 0.06 acres of green streets (0.03 acres of permeable pavement and 0.03 acres of bioretention) to treat a drainage area of 2.59 acres.	Los Peñasquitos Lagoon Subwatershed	FY22	Ongoing
DM-32	If interim load reduction goals are not met, potential opportunities for green streets will be considered.	Adaptive management process.	TBD	Optional	TBD
Multiuse Treatment Areas					
Other Opportunities					
DM-33[1]	Implement 0.18 acres with a total storage volume of 0.35 ac-ft. of multiuse treatment area projects on public/private parcels and/or through public-private partnerships.	Construction, operation and maintenance of multiuse treatment area projects on private parcels and/or through public-private partnerships.	Los Peñasquitos Lagoon Subwatershed	FY26, FY33	Ongoing
Dry Weather Flow Separation and Treatment Projects					
DM-34	If interim load reduction goals are not met, dry weather flow separation and treatment projects may be considered.	Adaptive management process.	TBD	Optional	TBD

Notes: 22nd DAA = 22nd District Agricultural Association; CWP = Clean Water Program; MWD = Metropolitan Water District; SDCWA = San Diego County Water Authority

1. Strategy has been identified as potential based on results of a model that may not be reflective of the small drainage area that leads from Del Mar to the lagoon. The strategy is presented until further analysis (including monitoring data) can confirm or revise the needs and strategies.

I.3 City of Poway Strategies

The City of Poway, located in the middle of the watershed, tends to have larger lot sizes and more pervious surfaces. In addition to administrative JRMP strategies, the focus is on source control, such as open trash enclosures and a public waste yard, through monitoring and reducing the pollutant source exposure and storm water runoff,. Strategies and implementation details are presented below. The City of Poway has identified the jurisdictional strategies in Table I-3 to assist in meeting the Water Quality Improvement Plan goals. A compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met.

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Table I-3
City of Poway Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Jurisdictional Strategies						
Development Planning						
All Development Projects						
PW-1	For all development projects, administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area, where applicable and feasible.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
Priority Development Projects (PDPs)						
PW-2	For PDPs, administer a program requiring implementation of on-site structural BMPs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
PW-3	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	Refer to JRMP.	City-wide	FY16	As needed	DSD
PW-3.1	Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover.	Implemented through the Minor Development Review process and the plan check process.	City-wide	FY16	As needed	DSD
PW-4	Administer an alternative compliance program to on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects). Refer to Section 4.2.5. and Appendix N for further details.	Refer to JRMP.	City-wide	FY16	As needed	DSD
Construction Management						
PW-5	Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.	Refer to JRMP; Perform daily inspections during construction.	City-wide	FY16	Ongoing	DSD
Existing Development						
Commercial, Industrial, Municipal, and Residential Facilities and Areas						
PW-6	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	Refer to JRMP; Commercial/industrial/municipal are inspected annually, with municipal receiving more frequent inspections by staff.	City-wide	FY16	Ongoing	DSD
PW-6.1	Review policies and procedures to ensure discharges from swimming pools meet permit requirements.	Annually review policies and procedures.	City-wide	Prior to FY16	As needed (Annually)	DSD
PW-6.2	Track stationary and mobile businesses through communication with Business Licensing Division.	Maintain through the City's Commercial/Industrial program.	City-wide	FY16	Ongoing	DSD with Administrative Services
PW-7	Promote and encourage implementation of designated BMPs with all new construction.		City-wide	FY16	Ongoing	DSD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
PW-7.1	Promote MWD and other groups to encourage implementation of water conservation programs that improve water quality by reducing over-irrigation with smart products or turf replacement and capturing rain water in residential areas.	Collaborate with MWD to promote their SoCal Water$mart rebates and products such as weather based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor system, rain barrels, and turf removal. Collaborate with San Diego County Water Authority (SDCWA) to promote their Water Smart irrigation system checkups and turf replacement incentives.	City-wide	FY16	Ongoing	DSD with MWD and SDCWA
PW-8	Promote and encourage implementation of designated BMPs in commercial areas.	Collaborate with MWD and promote their SoCal Water$mart rebates and products such as weather based irrigation controllers, rotating sprinkler nozzles, soil moisture sensor system, rain barrels, and turf removal.	City-wide	FY16	Ongoing	DSD with MWD
PW-9	Implement program to investigate illegal grading on private property.	Program to investigate reports of illegal grading. Maintain records of reported illegal gradings and immediately investigate. If activity violates grading or stormwater regulation, issued a "Stop Work" notice and must obtain grading permit and correct stormwater violations. Reports are tracked in "Trackit" software as a code violation and bi-monthly meetings to discuss the status of reports. Grading cases are subject to a strict timeline of action, and enforcement is upped until either compliance, or a Notice of Violation is filed against the property. If it is a stormwater issue, the City's on-call stormwater contractor corrects the issue and City liens the property for payment.	City-wide	FY16	Ongoing	DSD
MS4 Infrastructure						
PW-10	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.).	Refer to JRMP.	City-wide	FY16	Ongoing	DSD with DPW
PW-10.1	Perform catch basin cleaning.	Inspect and clean catch basins annually.	City-wide	FY16	Ongoing	DPW
PW-10.2	Clean open-channels and repair scour ponds to reduce pollutant loads and invasive plants and animals.	Inspect and clean open channels and scour ponds.	City-wide	FY16	Ongoing	DPW
PW-10.3	Proactively repair and replace corrugated metal pipe (CMP) MS4 components to provide source control from MS4 infrastructure.	Implement CMP replacement program with an emphasis on pipes in open canyons.	City-wide	FY16	Ongoing	DSD with DPW
PW-11	Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers and identify sewer leaks and areas for sewer pipe replacement.	Program implemented through sewer maintenance and inspection program.	City-wide	FY16	Ongoing	DSD with DPW
Roads, Street, and Parking Lots						
PW-12	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Refer to JRMP; The City of Poway is divided into 7 zones for road operation and maintenance activities; rotational cycle: one zone inspected each year	City-wide	FY16	Ongoing	DSD with DPW
PW-12.1	Implement street sweeping.	Refer to JRMP; all areas swept twice per month.	City-wide	FY16	Ongoing	DPW
PW-12.2	Increase maintenance on access roads by proactively monitoring for erosion and completing minor repair and slope stabilization.		City-wide	FY16	Ongoing	DSD with DPW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
PW-12.3	Increase maintenance on access trails by proactively monitoring for erosion and completing minor repair and slope stabilization.		City-wide	FY16	Ongoing	DSD with DPW
PW-13	Enhance street sweeping through route optimization (sweep all routes twice per month).			FY18		
Pesticide, Herbicides, and Fertilizer BMP Program						
PW-14	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
Retrofit and Rehabilitation in Areas of Existing Development						
PW-15	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.		City-wide	TBD	Ongoing	DSD
PW-16	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.		City-wide	TBD	Ongoing	DSD
Illicit Discharge, Detection, and Elimination (IDDE) Program						
PW-17	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
Public Education and Participation						
PW-18	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
PW-18.1	Target school-based education and outreach.	Through "I Love a Clean San Diego," give school presentations to fourth-graders eight times per year.	City-wide	FY16	Ongoing	DSD with I Love a Clean San Diego
PW-18.2	Conduct education through community-based organizations.	Through "I Love a Clean San Diego," staff street fair booths twice per year.	City-wide	FY16	Ongoing	DSD with I Love a Clean San Diego
PW-18.3	Review City storm water website and identify and implement required updates to reflect WQIP and JRMP revisions.	Review City storm water website, identify and implement required updates to reflect WQIP and JRMP revisions.	City-wide	Prior to FY16	As needed	DSD
PW-18.4	Target human behavior in parks and other public areas including trash reduction or other high impact behavior to habitat, wildlife, and water quality.	Implement trash reduction programs by increasing the number of trash and recycling bins during high-traffic public events and in public parks.	City-wide	FY16	Ongoing	DSD
PW-18.5	Collaborate with regional education and outreach efforts.	Participate in Regional Think Blue campaign and collaborate with other regional efforts to provide consistent message or efficiency in training for targeted audiences.	City-wide	FY16	Ongoing	DSD with regional education and outreach campaigns

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Enforcement Response Plan						
PW-19	Implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.	Refer to JRMP.	City-wide	FY16	Ongoing	DSD
Additional Nonstructural Strategies						
PW-20	Conduct special studies.	San Diego Regional Reference Stream Study (currently being conducted by the Southern California Coastal Water Research Project). The study will develop numeric targets that account for "natural sources" to establish the concentrations or loads from streams in a minimally disturbed or "reference" condition. Refer to Section 5.1 for further details.	City-wide	TBD	TBD	DSD
PW-20.1	Reference watershed study.	Los Peñasquitos WMA special study will assess sediment loads in the watersheds upstream of the Draft Sediment TMDL compliance monitoring locations. Includes the analysis of sediment water column loads, stream bedload, and air monitoring. Implemented in a phased approach. Monitoring will occur first in the Carroll Canyon subwatershed. The Los Peñasquitos Creek and Carmel Valley Creek subwatersheds will be monitored in subsequent phases. Refer to Section 5.1 for further details.	City-wide	FY16	Ongoing	DSD
PW-21	As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and acquiring privately-owned undeveloped open areas.	As opportunities arise, where feasible, avoid hardscape development and degradation in unpaved open space areas, create permanent open space protections to undeveloped city-owned land, and acquire privately owned undeveloped parcels of land.	TBD	Optional	As available	DSD
Green Infrastructure						
PW-22	0.26 ac have been identified as potential opportunities for green infrastructure implementation on public parcels.	Construction, operation, and maintenance of 0.26 ac of bioretention and permeable pavement.	Los Peñasquitos Creek Subwatershed	FY22	Ongoing	DSD
Green Streets						
PW-23	32.42 acres of permeable pavement and 32.47 acres of bioretention have been identified as potential opportunities for green street projects.	Construction, operation and maintenance of 32.42 acres of permeable pavement and 32.47 acres of bioretention for green streets.	Los Peñasquitos Creek Subwatershed	FY22	Ongoing	DSD
Multiuse Treatment Areas						
Infiltration and Detention Basins						
PW-24	Community Detention Basin	Community Detention Basin is already in place.	Community Rd.	In place	Ongoing	DSD
PW-25	Gate Detention Basin	Gate Detention Basin is already in place.	Gate Dr.	In place	Ongoing	DSD
PW-26	Kirkham Detention Basin	Kirkham Detention Basin is already in place.	Kirkham Way	In place	Ongoing	DSD
PW-27	Stotler Detention Basin	Stotler Detention Basin is already in place.	Stotler Ct.	In place	Ongoing	DSD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
PW-28	Stowe Detention Basin	Stowe Detention Basin is already in place.	Stowe Dr.	In place	Ongoing	DSD
PW-29	If interim load reduction goals are not met and additional multiuse treatment areas are required, a constructed wetland system can be implemented in the open space adjacent to Carriage Road.	Construction, operation, and maintenance of a 1.7 ac Constructed Wetland System would treat approximately 9,567 acres of drainage area (APN 3175012400).	Open space adjacent to Carriage Rd.	FY22	Ongoing	DSD
PW-30	If interim load reduction goals are not met and additional multiuse treatment areas are required, a dry extended detention basin can be implemented in Hilleary Park.	Construction, operation and maintenance of a 1.6 ac Dry Extended Detention Basin would treat approximately 138 acres of drainage area (APN 3171020700).	Hilleary Park	FY22	Ongoing	DSD
Additional Watershed Opportunities						
PW-31	Through adaptive management and additional analysis in the future, the City will identify and implement one or more of the following opportunities to meet numeric goals: 1) participate in restorative efforts for the Los Peñasquitos Lagoon with stakeholders, 2) MS4 outfall repair and relocation, 3) slope stabilization, 4) stream restoration, 5) implementation of sediment detention basins upstream of Los Peñasquitos Lagoon or 6) new strategies not yet identified.	Through adaptive management and additional analysis in the future, the City will identify and implement one or more of the following opportunities to meet numeric goals: 1) participate in restorative efforts for the Los Peñasquitos Lagoon with stakeholders, 2) MS4 outfall repair and relocation, 3) slope stabilization, 4) stream restoration, 5) implementation of sediment detention basins upstream of Los Peñasquitos Lagoon or 6) new strategies not yet identified.	Los Peñasquitos WMA	FY26, FY33	Ongoing	DSD
Stream, Channel, and Habitat Rehabilitation Projects						
PW-32	Rattlesnake Creek Project (stabilization of ephemeral tributary segment to Rattlesnake Creek)	This project involves the stabilization of a section of an ephemeral tributary to Rattlesnake Creek, which is located west of Midland Road, between Kentfield Drive and Norwalk Street. The project will involve grading in order to widen the channel bottom and contour the banks. It will include installation of rip rap, turf reinforcement matting, concrete pillow blocks, and a headwall, landscape removal and replacement, temporary BMPs, a temporary diversion system, and temporary irrigation.	West of Midland Rd, between Kentfield Dr. and Norwalk St.	2016 (estimated)	TBD	DSD

Notes: DSD = Development Services Department; DPW = Department of Public Works; MWD = Metropolitan Water District; SDWCA = San Diego County Water Authority

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I.4 City of San Diego Strategies and Funding Needs

The City of San Diego (City) has identified water quality improvement strategies that are expected to provide the greatest benefits to the watershed and its residents, businesses, communities within the City's jurisdictional boundaries.

Strategies were selected by evaluating the following considerations, in descending priority:

- Potential to reduce pollutant loads for the highest priority condition condition(s)
- Potential to reduce loads for other pollutants (including priority water quality conditions)
- Cost effectiveness,
- Feasibility and ease of implementation
- Social impacts and benefits
- Other[1] impacts and benefits

The strategies that provide the best value, most return on investment, and greatest range of benefits will be recommended, as needed, as the City moves forward in its water quality improvement efforts. The recommended strategies chosen will be consistent with those already identified in the Comprehensive Load Reduction Plans (CLRPs) for various TMDLs in the San Diego Region.

The City is currently developing a framework to evaluate potential other benefits the recommended strategies may provide beyond improved water quality. These additional benefits may be financial, environmental, or societal. The recommended strategies will be scored based on the number of other benefits they provide, and may guide future updates to the Water Quality Improvement Plan (Appendix L).

The cumulative storm water quality benefits of the recommended strategies identified in this Plan are needed to achieve the level of effort needed to demonstrate progress toward achieving the Water Quality Improvement Plan's (Plan) interim and final numeric goals. It is important to note that these strategies are subject to change through the iterative, adaptive management process set forth in this Water Quality Improvement Plan. Through the adaptive management process the City will be able to implement strategies and assess their impact to water quality and use new available information to refine, modify, remove, replace, or add strategies which will ensure the most effective suite of strategies are being implemented. Therefore, actual implementation of strategies is dependent upon both approval of funding in future annual budgets and adjustments that may occur as part of the iterative process.

[1] Other benefits refer to outcomes of a strategy beyond water quality improvements. Other benefits can include reduced air pollution, increased water conservation, watershed protection, public open space, aesthetics-induced property value increases, and increased business investments.

The recommended strategies will be implemented by the City; they are not intended to be implemented by private entities (e.g., development, business, industry, etc.). Some of the City's strategies, such as development planning, may have implications for private entities. The City has also developed a schedule as a best estimate of the shortest amount of time required to plan and implement the strategies. A compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met.

Optional strategies are activities that may be implemented by the City at its discretion through the iterative approach. Unlike the recommended strategies, optional strategies have not been determined to be necessary in order to achieve the Plan's interim and final numeric goals. However, the City may select from the optional strategies at any time when identified triggers are met, or if the current suite of recommended strategies is not demonstrating sufficient progress toward achieving interim or final numeric goals.

The City's Storm Water Division leads the City's efforts to protect and improve water quality and reduce flood risk. These activities include but are not limited to: public education, employee training, water quality monitoring, source identification, code enforcement, watershed management, and Best Management Practices development/implementation within the City's jurisdictional boundaries. The Storm Water Division is also tasked with providing the most efficient storm drain system operation and maintenance services including inspection, maintenance, and repair of storm drain systems in the public right of way and drainage easements. The complete list of strategies undertaken by the Storm Water Division is presented in this section.

The City has developed projected funding needs that will be used to submit annual budget requests to secure the resources necessary to comply with the Municipal Permit. These funding needs include four general categories:

(1) Storm Water Division funding needs to implement day-to-day operational JRMP activities as required by Provision E in the Municipal Permit;

(2) Storm Water Division funding needs for flood risk management programs associated with the JRMP, such as infrastructure repair and replacement;

(3) Storm Water Division funding needs for activities managed by the Storm Water Division to meet the goals identified in the WQIP; and

(4) Funding needs for City departments and divisions other than the Storm Water Division to implement day-to-day operational JRMP activities, as required by the Municipal Permit. Examples of JRMP activities include administration, training, and best management practice (BMP) implementation.

The City's Storm Water Division funding needs (which represent the first three categories above) are presented below as "City of San Diego" funding needs, but do not include funding needs for other City departments and divisions to implement required JRMP activities (category four above) because the recommended strategies included in this plan only apply to the City's Storm Water Division. For more information about the funding needs for non-Storm Water Division departments and divisions, please refer to the fiscal analysis in the City's Jurisdictional Runoff Management Plan (Section 10). Table I-4 presents the projected funding needs to implement the Los Peñasquitos WMA Water Quality Improvement Plan through FY40. The compliance period for Los Peñasquitos is through FY35, when the final goals are expected to be met. To maintain comparability among Water Quality Improvement Plan projected funding needs for different WMAs (the City is in six WMAs with different compliance schedules), ongoing operation and maintenance costs after the compliance period (between FY36 and FY40 for Los Peñasquitos) are included in Table I-4. However, the majority of the funding will be needed within the first 20 years to meet the numeric goals. Twenty five year funding needs (FY16 - FY40) for the Los Peñasquitos WMA are presented for JRMP activities, flood risk management programs, and Water Quality Improvement Plan activities by funding source: the City's General Fund (GF) or Capital Improvement Projects (CIP) funds. The General Fund is generally used for nonstructural strategies, design support, and operations and maintenance (O&M) of structural projects. CIP funding is used during the design and construction phase of structural projects. The source of the funding needs is the Storm Water Division's 2015 Watershed Asset Management Plan (WAMP) Cost Update, which will be made available on the Storm Water Division's website[2] in July 2015

Figure I-1 illustrates the projected fiscal year annual funding needs over the 25-year compliance period for the Storm Water Division to implement its JRMP activities, flood risk management programs, and Water Quality Improvement Plan activities in the Los Peñasquitos WMA. Figure I-2 shows the projected fiscal year GF and CIP funding needs for each of these years. Figure I-3 and Figure I-4 show the projected fiscal year GF and CIP funding needs, respectively, by category for each of these years. The recommended strategies selected are presented in Table I-5. The City's schedule table is found in Table I-6.

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[2] http://www.sandiego.gov/stormwater/plansreports/

Table I-4
City of San Diego Projected Fiscal Year Funding Needs by Funding Source and Category for the Los Peñasquitos WMA (FY16-40)[1]

General Fund	
Water Quality Improvement Plan	$137,696,813
JRMP	$65,904,084
Flood Risk Management	$126,918,777
Sub Total General Fund	$330,519,674
CIP	
Water Quality Improvement Plan	$969,161,878
JRMP	$0
Flood Risk Management	$31,532,052
Sub Total CIP	$1,000,693,930
Total	
25 FY Los Peñasquitos WMA Total Need	$1,331,213,604

1. Does not include funding needs for other City of San Diego Departments or Divisions to implement JRMP required activities.

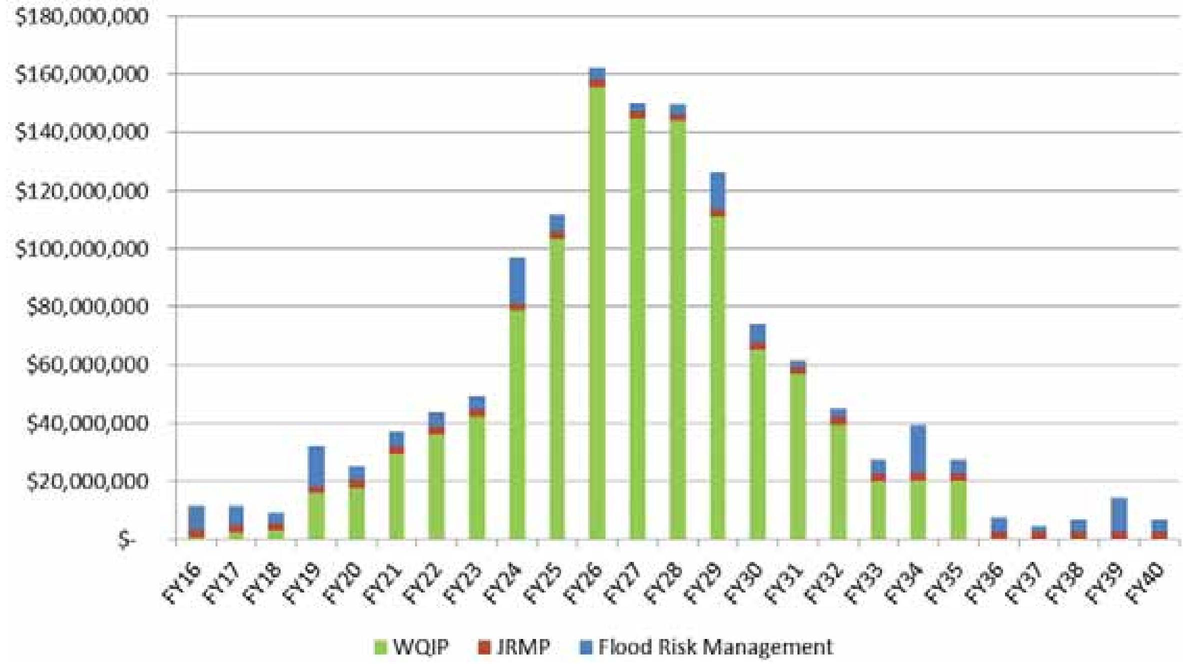

Figure I-1
City of San Diego Projected Fiscal Year Annual Funding Needs by Category for the Los Peñasquitos WMA

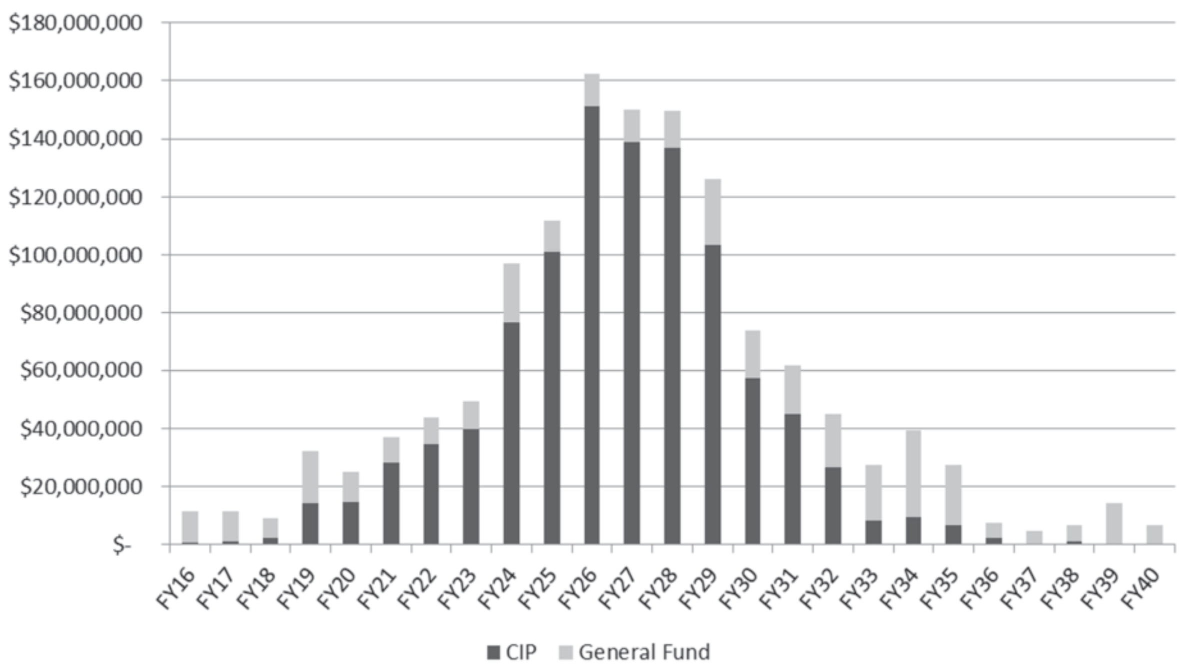

Figure I-2
City of San Diego Projected Fiscal Year Annual Funding Needs by Funding Source for the Los Peñasquitos WMA

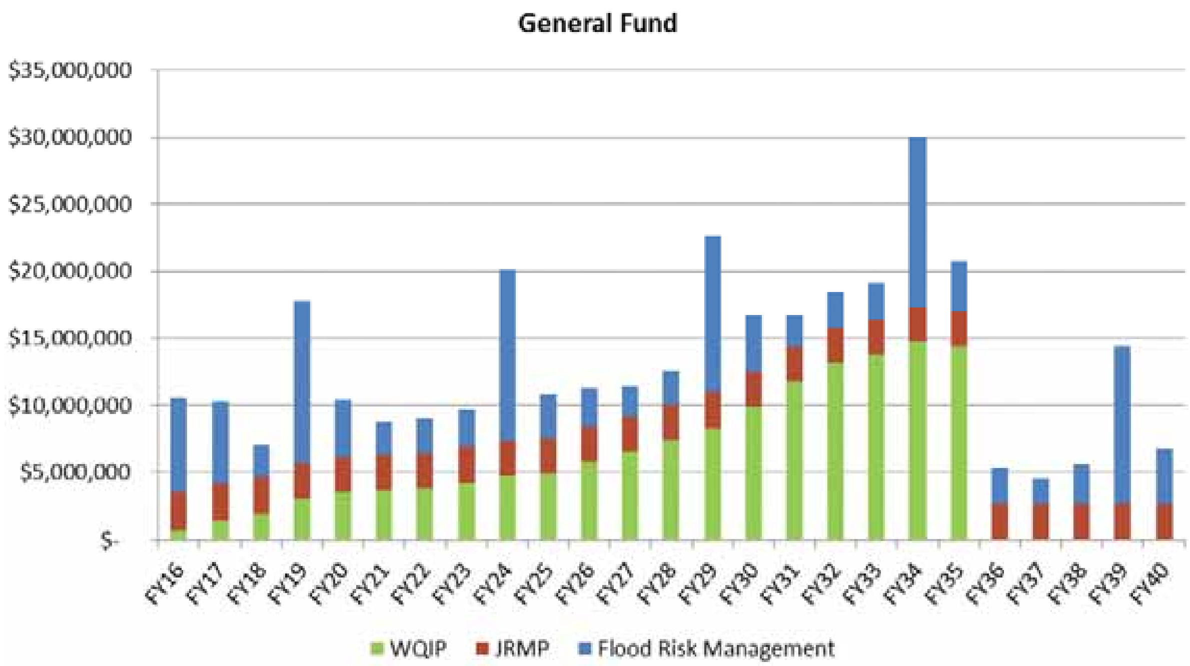

Figure I-3
City of San Diego Projected Fiscal Year Annual General Fund Funding Needs for the Los Peñasquitos WMA

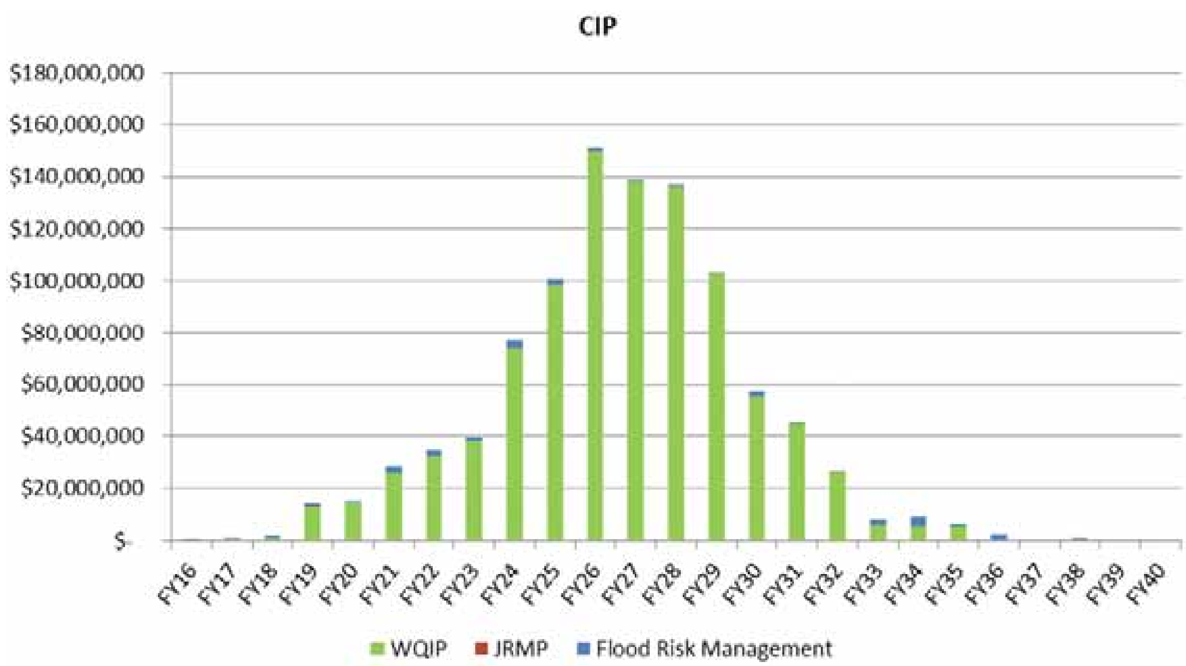

Figure I-4
City of San Diego Projected Fiscal Year Annual CIP Funding Needs for the Los Peñasquitos WMA

Table I-5
City of San Diego Jurisdictional Strategies

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Jurisdictional Strategies						
Development Planning						
All Development Projects						
CSD-1	Establish guidelines and standards for all development projects; provide technical support related to implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area or implement easements to protect water quality, where applicable and feasible. Includes internal coordination and collaboration between City departments (DSD, PWD, and Engineering) to improve success and long-term benefits of BMPs.	Refer to JRMP Section 4.	City-wide	Prior to FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.1	Investigation and research of emerging technology.	Annually the Construction & Development Standards Group identifies new tasks to conduct literature review, communication with researchers outside of the City, physical testing and experimentation of new or emerging technologies, and other research with the goal of updating tools available for reducing pollutant loads from development and redevelopment sites.	City-wide	Prior to FY16	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.2	Approve and implement a green infrastructure policy.	The City will begin developing a policy in FY16 that will increase the green infrastructure requirements for City CIP projects. This policy will be coordinated with ongoing efforts to update City design manuals and LID design standards for public LID BMPs.	City-wide	FY16 (Begin)	As needed	T&SW with DSD and PWD
CSD-1.3	Develop Design Standards for Public LID BMPs.	Improve quality of design to ensure efficiency and reliability in public designs.	City-wide	FY14-FY15	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-1.4	Outreach to impacted industry regarding minimum BMP requirement updates.	Affects commercial, industrial, and residential development.	City-wide	FY15	As needed	TBD
CSD-2	Train staff on LID regulatory changes and LID practices.	Formal training is required for all staff involved in development plan review to increase knowledge of LID BMPs. Goal of training associated with LID practices and regulations is to promote LID implementation and to avoid adverse conditions such as trees planted within swales, or planned drainage patterns which obstruct or inhibit LID performance.	City-wide	FY16	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-3	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities to support compliance with the MS4 Permit and TMDLs in a reasonable manner. Ensure consistency with the City of San Diego's BMP Design Manual. Update the Storm Water Standards Manual accordingly.	Municipal codes and ordinances will be brought to City Council for consideration to encourage LID implementation (e.g., runoff detention and filtration using natural filters and stormwater retention for reuse). LID stormwater management will be encouraged in proposed codes and ordinances associated with development and redevelopment projects, which are brought to City Council for consideration.	City-wide	FY15	As needed	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

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CSD-4	Create a manual that outlines right-of-way design standards.	Create a manual that includes flood control performance standards, permanent BMP elements design standards, design standards for green streets and other BMPs, and maintenance access. Provides drainage and streets design standards. Opportunity to merge various existing manuals and provide consistency.	City-wide	FY15	One time	T&SW with DSD and PWD
CSD-5	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	Technical education and outreach to the development community includes outreach on design standards, City design manuals, and the WMAA.	City-wide	Prior to FY16	Ongoing	T&SW with DSD
Priority Development Projects (PDPs)						
CSD-6	For PDPs, provide technical support to other City departments to ensure implementation of on-site structural BMPs to control pollutants and manage hydromodification by developing City wide storm water development standards and design guidelines.	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing structural BMPs that control pollutants and manage hydromodification. Included in that understanding are requirements to confirm proper design and construction through processes controlled by other City departments.	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-6.1	Institute a program to verify and enforce maintenance and performance of treatment control BMPs.	Refer to JRMP Section 4.5.	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	Refer to JRMP Section 4.	City-wide	FY15	Every 5 years/ permit cycle	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.1	Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.	Amend BMP Design Manual and zoning standards/requirements which address reduction of pollutants for common areas of trash build-up (e.g. restaurants, supermarkets, "big box" retail stores with food, pet stores). Most effective method for source control of bacteria and trash is to employ four-sized trash enclosures with a cover over trash areas.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.2	Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.	Amend BMP Design Manual and zoning requirements (including retrofits) to provide supplemental standards for animal facilities (including animal shelters, dog daycares, veterinary clinics, groomers, pet car stores, and breeding, boarding, and training facilities). Supplemental standards may include requiring covered trash enclosures, identification of landscaped relief areas on site plans, ensuring drainage connections and treatment swales for areas that will not drain to the sanitary sewer, as well as inspection of grading, drainage, and landscaping for outdoor exercise areas.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

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CSD-7.3	Amend BMP Design Manual for nurseries and garden centers.	Amend BMP Design Manual to provide supplemental standards for plant nurseries and garden centers. Standards will focus on reducing irrigation runoff, and loading of sediment, pesticides, and nutrients. Measures may include: covered outdoor storage, green waste management BMPs, improved irrigation efficiency to reduce dry-weather runoff, and containment of runoff from impervious areas where plants and materials are stored.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-7.4	Amend BMP Design Manual for auto-related uses.	Amend BMP Design Manual to provide supplemental standards for automotive-related uses to reduce loading of metals, oils, grease, and trash. Measures may include: four-sized covered trash enclosures, and careful review of auto-related usage areas (e.g. garage bays at repair shops) for grading, drainage, and drain connections to sanitary sewer systems.	City-wide	FY15	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-8	Develop and administer an alternative compliance program for on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects). Refer to Section 4.2.5.	Refer to JRMP Section 4.2.3.1.	City-wide	FY15	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-8.1	Create a fund that allows habitat acquisition, protection enhancement, and restoration in conjunction with other cooperating entities including community groups, academic institutions, state county, and federal agencies, etc.	This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
Construction Management						
CSD-9	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing temporary BMPs that control sediment and other pollutants during the construction phase of projects. Included in that understanding are requirements to inspect at appropriate frequencies and effectively enforce requirements through process controlled by other City departments.	Refer to JRMP Section 5.	City-wide	FY16	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
Existing Development						
Commercial, Industrial, Municipal, and Residential Facilities and Areas						
CSD-10	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	Refer to JRMP Sections 6, 7, and 8.	City-wide	FY16	Ongoing	T&SW with DSD, PUD, & PWD
CSD-10.1	Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include required street sweeping, catch basin cleaning, and maintenance of private roads and parking lots in targeted areas.	Refer to JRMP Appendix IX.	City-wide	FY15	Every 5 years	T&SW

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CSD-10.2	Outreach to property managers and trash haulers to elevate the emphasis of power washing as a pollutant source.	Emphasis will be placed on non-compliant washing as an enforceable violation.	City-wide Residential, commercial and industrial areas	FY15	Ongoing	T&SW
CSD-10.3	Implement property based inspections.	Property-based inspections increase awareness and responsibility for individual properties to tackle issues associated with trash, landscapes, and parking areas. Expanding beyond the business-level inspections will achieve different and more effective opportunities for education, outreach, inspection, and enforcement to encourage water conservation strategies.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-10.4	Review policies and procedures to ensure discharges from swimming pools meet permit requirements.	Verify and bring to City Council for consideration an update (as needed) for the City's Municipal Code (43.0301) to meet new permit requirements for swimming pool discharges.	City-wide	FY15	As needed	T&SW, City Attorney (Civil & Criminal)
CSD-11	Promote and encourage implementation of designated BMPs for residential and non-residential areas.	Landscape-based rebates are a "gateway" for adoption of other beneficial practices and are one of the nonstructural methods which address impacts from single-family residential areas (City of San Diego 2011 program development background study). Residential incentives can include: education and training (neighborhood watershed field days), and aggressive subsidies or rebates for grass replacement and rainwater harvesting. Existing programs will be expanded overall, and also have targeted expansion within specific subwatershed, particularly with highest water quality priority conditions.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, MWD, CWA & local water agencies
CSD-11.1	Residential and Commercial BMP: Rain Barrel	The existing PUD rebate program will continue for residential properties and expand for commercial properties for water collection, conservation, and reuse with rain barrels.	City-wide Residential Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.2	Residential and Commercial BMP: Grass Replacement	The existing PUD grass replacement cash rebate program will continue and expand for residential and commercial properties. Program encourages a reduction in water use through the conversion of non-artificial grass to water wise plant material, while maintaining a high level of living landscape to benefit the environment. Program does not allow for conversion to artificial turf.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.3	Residential and Commercial BMP: Downspout Disconnect	Disconnecting downspouts provide alternate runoff pathways from rooftops, sidewalks, driveways, and roads. Disconnecting downspouts from residential areas to pervious land can allow for depression storage and infiltration.	City-wide Residential and Commercial Areas	FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.4	Residential and Commercial BMP: Microirrigation	The existing PUD micro-irrigation rebate program will continue and increase for residential and commercial properties. Application of microirrigation aims to improve the efficiency of landscape irrigation through the precise application of water.	City-wide Residential Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies
CSD-11.5	Provide Onsite Water Conservation Surveys.	Provide free onsite water conservation surveys to commercial and residential customers to reduce overirrigation and to encourage water conservation.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing	T&SW with DSD, PUD, PWD, & local water agencies

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MS4 Infrastructure						
CSD-12	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, channels as allowed by resource agencies, detention basins, pump stations, etc.) for water quality improvement and for flood control risk management.	Refer to JRMP Section 7.	City-wide	FY16	Ongoing	T&SW
CSD-12.1	Enhanced catch basin cleaning to increase pollutant removal (up to 4 times per year) in the rainy season.	To increase pollutant load removal, catch basins will be cleaned up to four times per year in the rainy season. The City of San Diego's pilot study found that major pollutants may vary from neighborhood to neighborhood (yard waste versus trash and sediment). Implementation may be adapted based on catch basin record keeping and cleaning optimization. Increase in frequency will be phased over 4 Fiscal Years.	Los Peñasquitos WMA: High priority areas identified in pilot study	FY16	Ongoing	T&SW
CSD-12.2	Increased frequency of catch basin inspection and as-needed cleaning.	For every segment of channel that is cleared, the City will conduct an inspection and as-needed cleaning of every catch basin within 100 feet of the cleared segment of channel. Additional inspection and as-needed cleaning will occur every three months for one year after the segment of channel is cleared.	Los Peñasquitos WMA (31 open channel segments)	FY13	5 years (ends FY18)	T&SW
CSD-12.3	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	In order to limit inflow of pollutants and reduce pollutant loads, proactive measures will be taken to improve, repair, and replace MS4 components. The City of San Diego will start a multi-year program of repairing and replacing storm drain pipes to reduce sediment loading to the MS4. Development of an assessment management program and bond issues will be addressed. Exploration of daylighting pipes will take place where feasible and appropriate.	City-wide	FY16	Ongoing	T&SW
CSD-12.4	Replacement of hard assets including storm drains and structures.	Refer to JRMP Section 7.	City-wide	FY16	Ongoing	T&SW
CSD-13	Coordinate with other City departments (PUD) to implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	Refer to JRMP Section 7.	City-wide	FY16	Ongoing	T&SW with PUD
CSD-13.1	Identify sewer leaks and areas for sewer pipe replacement prioritization.	Risk assessment to include identifying targeted areas (age, location, proximity to MS4), coming up with methodology, pilot, desktop exercise/analysis.	City-wide	FY16	As needed	T&SW with PUD
Roads, Street, and Parking Lots						
CSD-14	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Refer to JRMP Section 7.	City-wide	FY16	Ongoing	T&SW
CSD-14.1	Outreach to street sweeping enhancement-targeted areas.	Division staff will conduct a thorough education and outreach effort beginning months in advance of the expansion of sweeping routes. Staff will work with the affected Council offices, community stakeholders, non-governmental organizations and community groups to build community awareness and acceptance of the enhanced sweeping program.	Los Peñasquitos WMA	FY16	Ongoing	T&SW

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CSD-14.2	Enhance street sweeping through equipment replacement (replace mechanical sweepers with regenerative air sweepers) and route optimization (sweep all routes twice per month) in targeted areas.	Following outreach and posting, street sweeping efforts will be increased in target areas (those with sediment or metals as a highest priority water quality conditions). Replacement of street sweeping equipment with high-efficiency regenerative air and vacuum-assisted sweepers over time is expected to further increase load reductions (even if current routes and frequencies remain unchanged).	Los Peñasquitos WMA	FY17	Ongoing	T&SW
CSD-14.3	Initiate sweeping of medians on high-volume arterial roadways.	Medians of roadways are also a potential source of pollutants. Consider implementing or increasing sweeping of medians. Consider mechanical and hand sweeping techniques.	City-wide	FY17	Ongoing	T&SW
CSD-14.4	Implement additional street sweeping (Settlement Agreement).	City shall increase street sweeping frequency by prioritizing high traffic commercial routes adjacent to maintained channel with vacuum-assisted sweeper for every 400 linear feet of vegetation that is removed (except for removal of invasive species, e.g., Arundo) within a drainage area. Sweeping shall be conducted in median areas that are not subject to regular sweeping routes, and shall occur at a frequency of at least once per quarter for one calendar year after maintenance.	Los Peñasquitos WMA	FY13	5 years (ends FY18)	T&SW
Pesticide, Herbicides, and Fertilizer BMP Program						
CSD-15	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Refer to JRMP Sections 7, 8, and 9.	City-wide	FY16	Ongoing	T&SW with Parks and Rec
Retrofit and Rehabilitation in Areas of Existing Development						
CSD-16	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Refer to JRMP Appendix XIX. The Offsite Alternative Compliance Program will include methods for identifying and assessing potential retrofit projects in existing development areas. Retrofit project selection will be based upon a variety of factors including proximity to high priority water quality conditions, potential pollutant load removal effectiveness, and feasibility of implementation. The program will include protocols related to funding mechanisms for project construction and long-term maintenance, payment and credit structures, and water quality equivalency standards.	City-wide	TBD	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-17	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	Refer to JRMP Appendix XIX. The Offsite Alternative Compliance Program (Section 4.2.5.4 and Appendix N) will include methods for identifying and assessing potential stream, channel, or habitat rehabilitation projects in existing development areas. Rehabilitation project selection will be based upon a variety of factors including existing stream or habitat degradation, potential future cumulative stream or habitat impacts, and feasibility of implementation. The program will include protocols related to funding mechanisms for project construction and long-term maintenance, payment and credit structures, and water quality equivalency standards.	City-wide	TBD	Ongoing	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community

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Illicit Discharge, Detection, and Elimination (IDDE) Program						
CSD-18	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Refer to JRMP Section 3.	City-wide	Prior to FY16	Ongoing	T&SW
Public Education and Participation						
CSD-19	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Refer to JRMP Section 9.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-19.1	Continue implementation of a Pet Waste Program.	Pet Waste Program includes outreach on "Scoop the poop", installation of posts for dispensers, distribution of lawn signs, and attendance at dog-related community activities.	City-wide	Prior to FY16	Ongoing	T&SW with Parks and Rec
CSD-19.2	Promote and encourage implementation of designated BMPs in commercial and industrial areas.	Provide education and outreach on BMPs for commercial businesses and industrial facilities.	City-wide Non-residential Areas	Prior to FY16	Ongoing	T&SW with PUD; Funding: Prop 84 and water districts (MWD)
CSD-19.3	Expand outreach to homeowners' association (HOA) common lands and HOA incentives.	Approaches to consider include: offering incentives to HOAs and maintenance districts to adopt water-conserving/efficiency and stormwater-reduction changes to their landscapes, irrigation, and maintenance; conducting workshops with property managers; providing supplemental standards, inspection, or enforcement for HOA-managed properties.	City-wide	FY16	Ongoing	T&SW
CSD-19.4	Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.	Approaches to engage HOAs and property managers include: conducting workshops with property managers, providing supplemental standards, inspections or enforcement around HOA properties, and offering incentives to HOAs and maintenance districts to adopt changes to landscapes, irrigation, or maintenance which promote water conservation or stormwater reduction. Property managers are also a target for enhanced outreach.	City-wide	FY16	Ongoing	T&SW
CSD-19.5	Enhance and expand trash cleanups through community-based organizations involving target audiences.	Increase effectiveness and reach of trash/beach cleanups and community based efforts by engaging community groups to self-define and carry-out trash clean-ups. Longstanding partnerships and sponsorships with I Love A Clean San Diego and others are recommended to be continued and enhanced. To effectively target stream clean-up efforts, focus on partnerships with community organizations which provide strong engagement with target audiences and communities.	City-wide	FY16	Ongoing	T&SW; Park and Rec

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CSD-19.6	Improve consistency and content of websites to highlight enforceable conditions and reporting methods.	Websites will be updated to provide a user-friendly format and clarity for stormwater violations, conditions which citizens can and should report, and how to make such reports. Examples of reports for common incidents will be developed and posted which may vary locally and regionally. Photographs of allowable practices as well as illegal practices should be shown for utmost clarity. Displaying hotline numbers prominently on the website and near the photographs of illegal practices will ensure that those seeking to report will be able to do so easily. Also ensure hotline number and website are searchable and can be retrieved by simple internet searches.	City-wide	Prior to FY16	Ongoing	T&SW
CSD-19.7	Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.	Educate residents on practices of small-scale or on-site composting to protect local water quality. May include targeted education of owners of chickens. Outreach can be coordinated through the San Diego County Agriculture, Weights, and Measures division.	Los Peñasquitos WMA	FY16	Ongoing	T&SW with County of San Diego Ag, Weights, and Measures
CSD-19.8	Enhance school and recreation-based education and outreach.	Develop curriculum and establish distribution in public schools. Includes education on water conservation.	City-wide	FY15	Ongoing	T&SW, PUD with community-based organization
CSD-19.9	Develop education and outreach to reduce irrigation runoff.	Example approaches to reduce or eliminate irrigation runoff may include: education and outreach, prohibition, enhanced enforcement of existing prohibitions, and pilot projects such as the City of Del Mar's pilot door hanger project.	City-wide	Prior to FY16	Ongoing	T&SW with PUD
CSD-19.10	Develop regional training for water-using mobile businesses.	Consider development of supplemental standards for mobile businesses including: covered trash enclosures, careful review of washing areas (grading, drainage, landscaping, sanitary sewer system connectivity), and appropriate signage (either through zoning for retrofits or "best fix" approaches, or through BMP Design Manual standards). Businesses may include carpet cleaners, tile installers, plumbers, etc.	City-wide	FY16	Ongoing	T&SW
CSD-19.11	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	Use effectiveness surveys to enhance existing education and outreach programs while proactively keeping up with and incorporating changing regulatory requirements.	City-wide	FY16	Ongoing	T&SW
CSD-19.12	Continue to promote and encourage implementation of Integrated Pest Management (IPM) for residents and businesses.	The City will continue to provide education on IPM techniques during presentations and on the City's Think Blue website.	City-wide	Prior to FY16	Ongoing	T&SW
Enforcement Response Plan						
CSD-20	Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Storm Water Code Enforcement Unit's Standard Operating Procedures (SOPs) - Enforcement Response Plan.	Refer to JRMP Appendix XIII.	City-wide	Prior to FY16	Ongoing	T&SW with PUD, other City enforcement compliance programs

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CSD-20.1	Increase enforcement of irrigation runoff.	Increased enforcement policies against irrigation runoff will be established in tandem with the education and outreach programs on how these actions lead to pollutant loading. By shifting to property-based inspections irrigation runoff can be handled as enforceable violations once the public is well-informed.	City-wide	FY16	Ongoing	T&SW
CSD-20.2	Increase enforcement of water-using mobile businesses.	In addition to education, pollution associated with mobile business sources can be handled through policy, code development, inspections of business practices, and enforcement.	City-wide	FY16	Ongoing	T&SW
CSD-21	Increase enforcement of all minimum BMPs for existing residential, commercial, and industrial development.	Increased enforcement of existing development minimum BMPs.	City-wide	FY16	As needed	T&SW
CSD-22	Increase enforcement associated with property-based inspections.	Shifting inspections from businesses-specific to property-based will increase effectiveness and sense of responsibility and ownership. Education and outreach must be followed up with inspection and enforcement of regulations to encourage proper landscape and water conservation strategies.	City-wide	FY16	Ongoing	T&SW
CSD-23	Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.	Refer to Minimum BMPs in JRMP (Appendix IX).	City-wide	FY16	Ongoing	T&SW
CSD-24	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	Eroding and unstable slope areas on private property (excluding construction sites) will be identified as potential sediment loading sources and subject to enforcement. In the short term, this will target enhanced inspection and enforcement programs to ensure inspectors address erosion and slope instability for the purpose of education.	City-wide	FY16	Ongoing	T&SW
Additional Nonstructural Strategies						
CSD-25	Conduct a Comprehensive Benefits Analysis to identify benefits other than water quality that are applicable to each of the specific WQIP strategies.	The analysis identifies which other benefits apply to each strategy, and documents the assumptions making those linkages. The delineation of other benefits to strategies includes a general description of each benefit, and a listing of the assumptions that were made to link those benefits to strategies. In addition, the other benefits are characterized with respect to who is directly affected: the city, local residents, local businesses, or visitors. This analysis may be used as part of the adaptive management process to modify future strategies.	City-wide	FY15	One time	T&SW
CSD-26	Address and clean up trash from transient encampments with collaboration from the Homeless Outreach Team.	Coordinate with the Homeless Outreach Team to respond to transient encampment trash complaints.	City-wide	FY16	Ongoing	T&SW with Police, ESD, Urban Corps, Alpha Project
CSD-27	Continue participating in source reduction initiatives.	Source reduction initiatives are ultimately the most effective measure to remove pollutants from surface waters, where feasible. Bans or progressive phase-outs that may be considered include: leaf blowers, plastic bags, architectural copper (generally a legacy issue), as well as prohibiting or more aggressively regulating vehicle washing. Additional source reduction initiatives to consider include pesticide sales at hardware stores and irrigation supply stores.	City-wide	Prior to FY16	Ongoing	T&SW

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CSD-27.1	Coordinate with Fleet Services to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available.	Consider legislative mandate and cooperative implementation of copper-free brake pads on city-owned vehicle to reduce pollutant deposition.	City-wide	FY18	Ongoing	T&SW, ESD with PWD (Fleet Services)
CSD-28	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	Actively identify and repair eroding slopes that may be contributing to sediment loading. Prepare an inventory and assessment of eroding areas and their risk to surface waters. Follow assessment with a schedule for ongoing inspection and stabilization (potentially based on a number or percentage of sites annually). Consider Caltrans program as a template.	City-wide	FY16	Ongoing	T&SW
CSD-29	Conduct special studies.	Special studies will be conducted to gather data to identify pollutant sources, appropriate targets, or other information. Includes collaboration with universities.	City-wide	FY16	Ongoing	T&SW
CSD-29.1	Los Peñasquitos Watershed Special Study	Los Peñasquitos WMA special study will assess sediment loads in the watersheds upstream of the Draft Sediment TMDL compliance monitoring locations. Includes the analysis of sediment water column loads, stream bedload, and air monitoring. Implemented in a phased approach. Monitoring will occur first in the Carroll Canyon subwatershed. The Los Peñasquitos Creek and Carmel Valley Creek subwatersheds will be monitored in subsequent phases. Refer to Section 5.1 for further details.	Los Peñasquitos WMA	FY16	One time	T&SW
CSD-29.2	Participate in Reference Watershed Study.	The San Diego Regional Reference Stream Study (currently being conducted by the Southern California Coastal Water Research Project). The study will develop numeric targets that account for “natural sources” to establish the concentrations or loads from streams in a minimally disturbed or “reference” condition. Refer to Section 5.1 for further details.	Region-wide	Prior to FY16	One time	T&SW, SCCWRP, Regional copermittees
CSD-29.3	Participate in Reference Beach Study.	The San Diego Regional Reference Beach Study will develop numeric targets that account for “natural sources” to establish the concentrations or loads from the beach in a minimally disturbed or “reference” condition. The purpose of this monitoring program is to advise the public of potential health risks that could occur with water contact recreation at local beaches. DEH will post a health advisory notice or close a beach when FIB results are above REC-1 water quality standards.	Region-wide (Los Peñasquitos WMA)	Prior to FY16	One time	T&SW, SCCWRP, Regional copermittees
CSD-29.4	Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit.	Using the adaptive management process outlined in Section 6, remove 303(d) delisted beach segments from the Bacteria TMDL and Attachment E of the MS4 Permit.	Los Peñasquitos WMA	FY16	Ongoing	T&SW, Potential Stakeholders, Coastkeeper
CSD-29.5	Conduct a Cost of Service Study.	Conduct a Cost of Service Study that will examine the full cost of flood control and storm water strategies needed to comply with storm water regulations for the City of San Diego. The City of San Diego’s Watershed Asset Management Plan will be used as the basis for the study.	City-wide	FY16	One time	TBD
CSD-29.6	Conduct a special study on outfall repair/relocation.	Implement fourth phase of a special study which will identify priority locations for outfall repair/relocation and sediment load reductions.	Los Peñasquitos WMA	FY16	One time	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-30	Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	SROI is an economics-based framework for evaluating quantitative and qualitative performance metrics and monetizing them, if possible, along a triple bottom line (i.e. financial, societal, and environmental). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW and public participation
CSD-31	Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for individuals experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	Support a non-profit or consortium to provide sanitation services associated with hygiene as well as trash management for persons experiencing homelessness. Rented or purchased shower/sanitary trailers providing mobile showers may be organized at specifically scheduled locations and times. This provision has been proposed as a method for preventing surface water usage for sanitation and bathing, as well as opportunity for outreach and referral by social service agencies. The trash management services will include providing trash bags, trash collection areas, and shower/sanitary facilities at centers which provide daytime shelter to their clients, or on a mobile-basis for known transit camps. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, 4) partners have been identified and formal MOUs have been developed, and 5) consensus and community support has been achieved.	City-wide	Optional	TBD	T&SW
CSD-32	Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals, where feasible.	Perform a feasibility study to determine if implementing an UTC program would be beneficial to the City's goals. UTC intercepts rainfall through increased coverage of leaves, branches, and stems and reduces runoff from the storm drainage system. Benefits associated with enhancing an UTC include reducing heat island effects and air pollution in addition to aesthetics and community benefits. Where feasible, native trees will be utilized to prevent invasive trees from migrating to open spaces and to conserve water. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured.	City-wide	Optional	TBD	Planning Dept. with T&SW, SANDAG, and Nature Conservancy

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-33	Conduct a feasibility study to test Permeable Friction Course (PFC), a porous asphalt that overlays impermeable asphalt.	Perform an assessment to determine the feasibility of implementing PFC on City streets. PFC, an overlay of porous asphalt, is an innovative roadway material that improves driving conditions in wet weather and water quality. Placed in a layer 25-50mm thick on top of regular impermeable pavement, PFC allows rainfall to drain within the porous layer rather than on top of the pavement. PFC has also been shown to reduce concentrations of pollutants commonly observed in highway runoff. PFC incorporates stormwater treatment into the roadway surface and does not require additional right-of-way. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured.	City-wide	Optional	One time	T&SW with DSD, PWD, BIA, NGOs, Copermittees, and Engineering Community
CSD-34	As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	This strategy may be implemented if there is interest in participation by the public or private entity with current control of the land. Conditions to be met also include 1) identification of partners, if needed (public, private, non-profit), 2) identification of costs and potential sources of funding, 3) final agreement by public or private entity with current control of the land, 4) final agreement by all other participating partners including acceptance by intended land- or asset-owning City department, and 5) funding in place.	City-wide	Optional	TBD	TBD
CSD-35	Participate in a watershed council or group if one is established.	This strategy may be triggered as 1) partners have been identified and formal MOUs have been developed and 2) consensus and community support has been achieved.	City-wide	Optional	TBD	TBD
CSD-36	Prohibit introduction of invasive plants in new development and redevelopment projects.	Coordinate with the City's Development Services Department to continue to prohibit introduction of invasive species such as Arundo donax and Cortaderia selloana for new development or redevelopment projects as specified in the City's municipal code for landscape.	City-wide	Prior to FY16	Ongoing	T&SW with DSD
CSD-37	Collaborate with watershed stakeholders to plan and implement projects that will further Los Peñasquitos Lagoon restoration efforts and reduce flooding in the lower watershed.	Efforts may include 1) dredging of tidal channels and inlet area to restore and maintain tidal circulation and facilitate draw down times of floodwater in the lagoon and 2) modeling and/or studies to analyze sediment transport and flood control options. This strategy may be triggered as 1) funding is identified and secured, 2) staff resources are identified and secured, 3) partners have been identified and formal MOUs are developed and executed, 4) permits required by regulatory agencies are secured, and 5) consensus and community support is achieved.	Los Peñasquitos WMA	Optional	TBD	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
Green Infrastructure						
CSD-38	Del Mar Mesa Neighborhood Park (Project 985)	This site contains small catchment basins and some impervious areas treated by landscape buffers to treat a drainage area of 3.0 acres.	Los Peñasquitos Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-39	Miramar Water Treatment Plant (Project ID 1177)	Vegetated swales (0.44 acre) are in-place to treat a drainage area of 18 acres.	Los Peñasquitos Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-40	Carroll Canyon Road Extension (Project ID 1007)	Vegetated swale will treat onsite runoff of a drainage area of 5.3 acres, in conjunction with other multiuse treatment areas.	Carroll Canyon Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-41	Camino Ruiz Neighborhood Park (Project ID 140)	Vegetated swale is in-place to treat on-site runoff of a drainage area of 1.49 acres. Two bioretention areas are proposed to provide treatment of runoff generated by the 85th percentile storm from the parking lot area. These facilities are proposed to be installed within existing landscaping areas. Additional storage is required to capture the 85th percentile runoff volume from the north side of the parking area and is proposed to be provided in permeable pavement parking stalls adjacent to the proposed bioretention area. The retrofit exceeds applicable regulatory requirements by treating runoff from impervious surfaces through bioretention to capture the 85th percentile storm runoff.	Los Peñasquitos Creek Subwatershed	FY15	Ongoing	T&SW with PWD
CSD-42	Breen Park Site - Development (Project ID 857 & 858 & 859 & 860)	Vegetated swales are in-place to treat on-site runoff of a drainage area of 1.33 acres. Swales adjacent to the parking lot are proposed to be converted into bioretention areas to provide treatment for the runoff generated by the 85th percentile storm. The landscaped area on the north side of the park entrance is proposed to be converted to a bioretention area to provide additional treatment of existing impervious area that currently discharges from the site with no treatment. The retrofit exceeds applicable regulatory requirements by treating runoff from 50,377 more square feet of impervious surface than the initial site design and providing enhanced pollutant removal through bioretention and treatment of the 85th percentile storm.	Los Peñasquitos Creek Subwatershed	FY15	Ongoing	T&SW with PWD
CSD-43	Rancho Peñasquitos Skate park (Project ID 866)	Two small infiltration units (basins/trenches) are used to treat on-site runoff of a drainage area of 2.08 acres.	Los Peñasquitos Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-44	Fire Station #47 (Project ID 992)	Vegetated swale is in-place to treat on-site runoff of a drainage area of 1 acre.	Carmel Valley Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-45	Torrey Del Mar Neighborhood Park (Project ID 1022)	Two vegetated filter strips and two vegetated swales are in-place to treat on-site runoff of a drainage area of 3.68 acres.	Carmel Valley Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-46	Hilltop Community Park- Development of bioretention areas	Two bioretention facilities are proposed to provide for treatment of the majority of the study area, a drainage area of 0.273 acre. An existing landscaped area near Oviedo Way is proposed to be converted to a bioretention area along with the conversion of three landscaped areas within the existing parking lot area to bioretention areas. The parking lot bioretention areas are proposed to be linked by a narrow bioswale between parking stalls. Additional treatment is proposed to be provided through the conversion of 5 parking stalls to permeable pavement. The retrofit exceeds applicable regulatory requirements by treating runoff from impervious surfaces through bioretention to treat the 85th percentile storm runoff.	Carmel Valley Creek Subwatershed	FY15	Ongoing	T&SW with PWD
CSD-47	0.96 acre of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 37.86 acres with a total storage volume of 1.69 acre-feet.	Staggered construction, operation, and maintenance of 0.96 acres of bioretention to treat an impervious drainage area of 37.86 acres with a total storage volume of 1.69 acre-feet.	Carmel Valley Creek Subwatershed	FY22	Ongoing	T&SW with PWD; Potential to collaborate with transit agencies, public school districts, and state and federal agencies
CSD-48	17.18 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 582.71 acres with a total storage volume of 27.21 acre-feet.	Staggered construction, operation, and maintenance of 17.18 acres of bioretention to treat an impervious drainage area of 582.71 acres with a total storage volume of 27.21 acre-feet.	Carroll Canyon Creek Subwatershed	FY26	Ongoing	T&SW with PWD; Potential to collaborate with transit agencies, public school districts, and state and federal agencies
CSD-49	2.40 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 145.75 acres with a total storage volume of 6.86 acre-feet.	Staggered construction, operation, and maintenance of 2.40 acres of bioretention to treat an impervious drainage area of 145.75 acres with a total storage volume of 6.86 acre-feet.	Los Peñasquitos Creek Subwatershed	FY26	Ongoing	T&SW with PWD; Potential to collaborate with transit agencies, public school districts, and state and federal agencies
CSD-50	1.33 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 48.97 acres with a total storage volume of 2.14 acre-feet.	Staggered construction, operation, and maintenance of 1.33 acres of bioretention to treat an impervious drainage area of 48.97 acres with a total storage volume of 2.14 acre-feet.	Los Peñasquitos Lagoon Subwatershed	FY28	Ongoing	T&SW with PWD; Potential to collaborate with transit agencies, public school districts, and state and federal agencies
Green Streets						
CSD-51	53.20 acres of green streets (26.6 acres of bioretention and 26.6 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 1,746.8 acres with a total storage volume of 72.54 acre-feet.	Staggered construction, operation and maintenance of 53.20 acres of green streets (26.60 acres of bioretention and 26.60 acres of pervious pavement) to treat a total drainage area of 1,746.8 acres with a total storage volume of 72.54 acre-feet.	Carmel Valley Creek Subwatershed	FY26	Ongoing	T&SW

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-52	55.92 acres of green streets (27.96 acres of bioretention and 27.96 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 2,345.5 acres with a total storage volume of 86.16 acre-feet.	Staggered construction, operation and maintenance of 55.92 acres of green streets (27.96 acres of bioretention and 27.96 acres of pervious pavement) to treat a total drainage area of 2,345.5 acres with a total storage volume of 86.16 acre-feet.	Carroll Canyon Creek Subwatershed	FY26	Ongoing	T&SW
CSD-53	121.42 acres of green streets (60.71 acres of bioretention and 60.71 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 4,128.6 acres with a total storage volume of 186.11 acre-feet.	Staggered construction, operation and maintenance of 121.42 acres of green streets (60.71 acres of bioretention and 60.71 acres of pervious pavement) to treat a total drainage area of 4,128.6 acres with a total storage volume of 186.11 acre-feet.	Los Peñasquitos Creek Subwatershed	FY24	Ongoing	T&SW
CSD-54	9.06 acres of green streets (4.53 acres of bioretention and 4.53 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 12.37 acres.	Staggered construction, operation and maintenance of 9.06 acres of green streets (4.53 acres of bioretention and 4.53 acres of pervious pavement) to treat a total drainage area of 12.37 acres.	Los Peñasquitos Lagoon Subwatershed	FY26	Ongoing	T&SW
Multiuse Treatment Areas						
Infiltration and Detention Basins						
CSD-55	Ashley Falls	A 10.16 acre retention basin (large scale storm storage) designed to capture a drainage area of 29.7 acres.	Los Peñasquitos Creek Subwatershed	FY19	Ongoing	T&SW with PWD
CSD-56	Flintkote Sediment Detention Basin	A 0.2 acre sediment detention basin designed to treat a total drainage area of 35 acres.	Los Peñasquitos Lagoon Subwatershed	FY26	Ongoing	T&SW with PWD
CSD-57	Upper Sorrento Valley Road Sediment Detention Basin	An 11.1 acre sediment detention basin designed to treat a drainage area of 9,306 acres.	Carroll Canyon Creek Subwatershed	FY22	Ongoing	T&SW with PWD
CSD-58	Los Peñasquitos Lagoon Sediment Basin	Construction of a custom-designed basin to maximize sediment interception from Los Peñasquitos Creek, while minimizing effects on surrounding habitat and protecting nearby developments from flooding and preserving view corridors of nearby residents (Los Peñasquitos Lagoon Sediment Basin Monitoring & Maintenance Plan). Total footprint for this basin is 10.16 acres designed to treat a drainage area of 36,375 acres.	Los Peñasquitos Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-59	A surface infiltration basin can be implemented in open space adjacent to Carmel Knolls Drive upon detailed site assessment.	Construction, operation and maintenance of a 2.3 acre (footprint) surface infiltration basin to treat a total drainage area of 301 acres (on 2.3 acres of available space, APN 3044604700).	Carmel Valley Creek Subwatershed	FY21	Ongoing	T&SW with PWD
CSD-60	A subsurface detention basin in Sandburg Park upon detailed site assessment.	Construction, operation and maintenance of a 3.2 acre (footprint) surface detention basin to treat a total drainage area of 268 acres (on 5 acres of available space, APN 3093215000). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Los Peñasquitos Creek Subwatershed	FY25	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-61	A surface infiltration basin can be implemented in Carmel Creek Neighborhood Park and Elementary School upon detailed site assessment.	Construction, operation and maintenance of a 1.5 acre (footprint) surface infiltration basin to treat a total drainage area of 66 acres (on 11.5 acres of available space, APN 3044501200).	Carmel Valley Creek Subwatershed	FY22	Ongoing	T&SW with PWD
CSD-62	A dry extended detention basin can be implemented in Maddox Park upon detailed site assessment.	Construction, operation and maintenance of a 5 acre (footprint) dry extended detention basin to treat a total drainage area of 570 acres (on 5 acres of available space, APN 3110304100).	Carroll Canyon Creek Subwatershed	FY21	Ongoing	T&SW with PWD
CSD-63	A subsurface detention basin can be implemented in Dingeman Elementary School and Spring Canyon Park upon detailed site assessment.	Construction, operation and maintenance of a 3.6 acre (footprint) subsurface detention basin to treat a total drainage area of 559 acres (on 11 acres of available space, APN 3194721200). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Los Peñasquitos Creek Subwatershed	FY24	Ongoing	T&SW with PWD
CSD-64	A dry extended detention basin in open space next to Canyonside Park Driveway can be implemented upon detailed site assessment.	Construction, operation and maintenance of a 1.8 acre (footprint) dry extended detention basin to treat a total drainage area of 181 acres (on 4.6 acres of available space, APN 3094130100).	Los Peñasquitos Creek Subwatershed	FY25	Ongoing	T&SW with PWD
CSD-65	A subsurface detention gallery can be implemented in Del Mar Trails Park upon detailed site assessment.	Construction, operation and maintenance of a 0.1 acre (footprint) subsurface detention gallery to treat a total drainage area of 19 acres (on 3 acres of available space, APN 3073316700). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Carmel Valley Creek Subwatershed	FY23	Ongoing	T&SW with PWD
CSD-66	A subsurface detention basin in Mira Mesa High school can be implemented upon detailed site assessment.	Construction, operation and maintenance of a 2.9 acre (footprint) subsurface detention basin to treat a total drainage area of 261 acres (on 9.6 acres of available space, APN 3110410200). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Carroll Canyon Creek Subwatershed	FY23	Ongoing	T&SW with PWD
CSD-67	A subsurface detention gallery can be implemented in Sage Canyon Park upon detailed site assessment.	Construction, operation and maintenance of a 0.1 acre (footprint) subsurface detention gallery to treat a total drainage area of 14.4 acres (on 7.5 acres of available space; APN 4476123700, APN 4476123600). Subsurface detention basins would be designed and constructed per all applicable City safety codes and standards.	Los Peñasquitos Creek Subwatershed	FY26	Ongoing	T&SW with PWD
CSD-68	If interim load reduction goals are not met and additional multiuse treatment areas are required, an infiltration basin(s) may be considered on publicly owned open spaces in canyon areas on a case-by-case basis when no other opportunities for load reductions exist.	Construction, operation, and maintenance of infiltration basin(s) in canyon areas. 8 potential canyon sites, owned by City of San Diego, have been identified in Los Peñasquitos WMA that provide up to 60 acres of available space (out of 174 acres of total parcel acreage). This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, and 3) staff resources are identified and secured.	Los Peñasquitos WMA	Optional	TBD	T&SW with PWD
Stream, Channel and Habitat Rehabilitation Projects						
CSD-69	El Cuervo del Norte Wetlands	The El Cuervo Norte wetlands were built upon 23.3 acres upstream of the long-term MLS monitoring station. Flows from Los Peñasquitos Creek are diverted into the wetlands, creating the potential for solids to settle out and thus reduce the TSS measured at the MLS.	Los Peñasquitos Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-70	El Cuervo del Sur Wetlands	On a total of 2.3 acres, the primary mitigation strategy in this plan involve the minor grading (one to three feet) of the Site to create three riparian plant zones. Maintenance activities planned during the maintenance and monitoring program revolve around the establishment of the plantings to a self-sufficient state.	Los Peñasquitos Creek Subwatershed	FY16	Ongoing	T&SW with PWD
CSD-71	If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.	This strategy may be triggered as 1) funding to address MS4 discharges is identified and secured, 2) staff resources are identified and secured, 3) partners have been identified and formal MOUs have been developed, 4) permits required by regulatory agencies are secured, and 5) recommendations from the community are identified and consensus and community support has been achieved.	Areas identified during feasibility studies	Optional	TBD	T&SW
Water Quality Improvement BMPs						
Proprietary BMPs						
CSD-72	Rehco Rd.	A HSU unit is used to treat onsite runoff on the north end of Rehco Road.	Carroll Canyon Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-73	North Torrey Pines Road Bridge (Project ID 1017)	Two drainage inserts are used to treat onsite runoff.	Carroll Canyon Creek & Los Peñasquitos Lagoon Subwatersheds	Prior to FY16	Ongoing	T&SW with PWD
CSD-74	Scripps Ranch Boulevard Median Improvements (Project ID 901)	Two bioclean drainage inserts are used to treat onsite runoff.	Carroll Canyon Creek & Los Peñasquitos Lagoon Subwatersheds	Prior to FY16	Ongoing	T&SW with PWD
CSD-75	Northwest Area Police Substation (Project ID 1365)	A Hydrodynamic Separation System is used to treat onsite runoff.	Los Peñasquitos WMA	Prior to FY16	Ongoing	T&SW with PWD
CSD-76	Peñasquitos West Grading (Project ID 1051)	Two Hydrodynamic Separation Systems are used to treat onsite runoff.	Carmel Valley Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-77	Carmel Valley Road Enhancements (Project ID 860)	Hydrodynamic Separation Systems are used to treat onsite runoff.	Carmel Valley Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-78	Genesee Widening (Project ID 900)	Hydrodynamic Separation Systems are used to treat onsite runoff.	Carroll Canyon Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-79	Mira Sorrento Place and Vista Sorrento Parkway (Project ID 850)	Hydrodynamic Separation Systems are used to treat onsite runoff.	Carroll Canyon Creek Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-80	Ocean Air Park (Project ID 906)	Hydrodynamic Separation Systems are used to treat onsite runoff.	Los Peñasquitos Lagoon Subwatershed	Prior to FY16	Ongoing	T&SW with PWD
CSD-81	Otay Mesa/ Nestor Library- Development of treatment unit.	Because of the limited space available at the site and geotechnical issues associated with the proximity to steep slopes, it is recommended that a Filterra type or approved equivalent treatment unit be retrofitted to treat flows from the 85th percentile storm. The retrofit exceeds applicable regulatory requirements by treating runoff from 11,800 more square feet of impervious surface than the initial site design and by treating flows from the 85th percentile storm.	Los Peñasquitos WMA	FY15	Ongoing	T&SW with PWD
Dry Weather Flow Separation and Treatment Projects						
CSD-82	If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.	Construction of dry weather flow separation and treatment projects, where identified. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, and 4) permits required by regulatory agencies are secured.	Downstream reaches where persistent dry weather flows have been observed	Optional	TBD	T&SW with PWD
Trash Segregation						
CSD-83	If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.	Construction of trash segregation (Trash Guards, etc.) projects, where identified. This strategy may be triggered as 1) interim goals are not met, 2) funding to address MS4 discharges is identified and secured, 3) staff resources are identified and secured, and 4) permits required by regulatory agencies are secured.	High-loading areas city-wide	Optional	TBD	T&SW with PWD
Additional Opportunities						
CSD-84	Participate in restorative efforts for the Los Peñasquitos Lagoon in collaboration with TMDL Responsible Parties and other stakeholders.	Collaborate with TMDL Responsible Parties and other stakeholders to promote and support the restoration of the Los Peñasquitos Lagoon. Efforts will be coordinated with the Lagoon Enhancement Program currently being updated by the Los Peñasquitos Lagoon Foundation. This effort will require that 1) funding to address MS4 discharges is identified and secured, 2) staff resources are identified and secured, 3) partners are identified and formal MOUs are developed and executed, 4) permits required by regulatory agencies are secured, and 5) consensus and community support are achieved.	Los Peñasquitos Lagoon Subwatershed	FY20	Ongoing	T&SW with TMDL Responsible Parties and Los Peñasquitos WMA stakeholders

ID	Strategy	Implementation Approach	Location	Implementation or Construction Year Start	Frequency of Implementation	Responsible City Department and Other Collaborating Departments or Agencies
CSD-85	Through adaptive management and additional analysis in the future, the City will identify and implement one or more of the following opportunities to meet numeric goals: 1) MS4 outfall repair and relocation, 2) slope stabilization, 3) stream restoration, 4) implementation of sediment detention basins upstream of Los Peñasquitos Lagoon or 5) new strategies not yet identified.	Through adaptive management and additional analysis in the future, the City will identify and implement one or more of the following opportunities to meet numeric goals: 1) MS4 outfall repair and relocation, 2) slope stabilization, 3) stream restoration, 4) implementation of sediment detention basins upstream of Los Peñasquitos Lagoon or 5) new strategies not yet identified.	Los Peñasquitos WMA	FY28	Ongoing	T&SW

Notes: DSD= Development Services Department; PUD = Public Utilities Department; PWD = Public Works Department; T&SW = Transportation and Storm Water Division; WAMP = Watershed Asset Management Plan; TBD = will be determined during the next fiscal year.

Table I-6
City of San Diego Annual Schedule

Construction
Ongoing Implementation/ O&M
As needed/Design

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
Jurisdictional Strategies																								
Development Planning																								
All Development Projects																								
CSD-1	Establish guidelines and standards for all development projects; provide technical support related to implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area or implement easements to protect water quality, where applicable and feasible. Includes internal coordination and collaboration between City departments (DSD, PWD, and Engineering) to improve success and long-term benefits of BMPs.	City-wide	Prior to FY16	Ongoing																				
CSD-1.1	Investigation and research of emerging technology.	City-wide	Prior to FY16	As Needed																				
CSD-1.2	Approve and implement a green infrastructure policy.	City-wide	FY16 (Begin)	As Needed																				
CSD-1.3	Develop Design Standards for Public LID BMPs.	City-wide	FY14-FY15	As Needed																				
CSD-1.4	Outreach to impacted industry regarding minimum BMP requirement updates.	City-wide	FY15	As Needed																				
CSD-2	Train staff on LID regulatory changes and LID practices.	City-wide	FY16		As Needed																			
CSD-3	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities to support compliance with the MS4 Permit and TMDLs in a reasonable manner. Ensure consistency with the City of San Diego's BMP Design Manual. Update the Storm Water Standards Manual accordingly.	City-wide	FY15	As Needed																				
CSD-4	Create a manual that outlines right-of-way design standards.	City-wide	FY15	One time																				
CSD-5	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	City-wide	Prior to FY16	Ongoing																				
Priority Development Projects (PDPs)																								
CSD-6	For PDPs, provide technical support to other City departments to ensure implementation of on-site structural BMPs to control pollutants and manage hydromodification by developing City wide storm water development standards and design guidelines.	City-wide	FY16		Ongoing																			
CSD-6.1	Institute a program to verify and enforce maintenance and performance of treatment control BMPs.	City-wide	FY16		Ongoing																			
CSD-7	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	City-wide	FY15	Cycle																				
CSD-7.1	Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.	City-wide	FY15	One time																				

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-7.2	Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.	City-wide	FY15	One time																				
CSD-7.3	Amend BMP Design Manual for nurseries and garden centers.	City-wide	FY15	One time																				
CSD-7.4	Amend BMP Design Manual for auto-related uses.	City-wide	FY15	One time																				
CSD-8	Develop and administer an alternative compliance program for on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects). Refer to Section 4.2.5.	City-wide	FY15	Ongoing																				
CSD-8.1	Create a fund that allows habitat acquisition, protection enhancement, and restoration in conjunction with other cooperating entities including community groups, academic institutions, state county, and federal agencies, etc.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
Construction Management																								
CSD-9	Coordinate with other City departments to promote and confirm a thorough understanding of requirements for implementing temporary BMPs that control sediment and other pollutants during the construction phase of projects. Included in that understanding are requirements to inspect at appropriate frequencies and effectively enforce requirements through process controlled by other City departments.	City-wide	FY16		Ongoing																			
Existing Development																								
Commercial, Industrial, Municipal, and Residential Facilities and Areas																								
CSD-10	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.	City-wide	FY16		Ongoing																			
CSD-10.1	Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include required street sweeping, catch basin cleaning, and maintenance of private roads and parking lots in targeted areas.	City-wide	FY15	Cycle																				
CSD-10.2	Outreach to property managers and trash haulers to elevate the emphasis of power washing as a pollutant source.	City-wide Residential, commercial and industrial areas	FY15	Ongoing																				
CSD-10.3	Implement property based inspections.	City-wide	Prior to FY16	Ongoing																				
CSD-10.4	Review policies and procedures to ensure discharges from swimming pools meet permit requirements.	City-wide	FY15	As Needed																				
CSD-11	Promote and encourage implementation of designated BMPs for residential and non-residential areas.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
CSD-11.1	Residential and Commercial BMP: Rain Barrel	City-wide Residential Areas	Prior to FY16	Ongoing																				

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
CSD-11.2	Residential and Commercial BMP: Grass Replacement	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
CSD-11.3	Residential and Commercial BMP: Downspout Disconnect	City-wide Residential and Commercial Areas	FY16		Ongoing																			
CSD-11.4	Residential and Commercial BMP: Microirrigation	City-wide Residential Areas	Prior to FY16	Ongoing																				
CSD-11.5	Provide Onsite Water Conservation Surveys.	City-wide Residential and Commercial Areas	Prior to FY16	Ongoing																				
MS4 Infrastructure																								
CSD-12	Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, channels as allowed by resource agencies, detention basins, pump stations, etc.) for water quality improvement and for flood control risk management.	City-wide	FY16		Ongoing																			
CSD-12.1	Enhanced catch basin cleaning to increase pollutant removal (up to 4 times per year) in the rainy season.	Los Peñasquitos WMA: High priority areas identified in pilot study	FY16		Ongoing																			
CSD-12.2	Increased frequency of catch basin inspection and as-needed cleaning.	Los Peñasquitos WMA (31 open channel segments)	FY13																					
CSD-12.3	Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.	City-wide	FY16		Ongoing																			
CSD-12.4	Replacement of hard assets including storm drains and structures.	City-wide	FY16		Ongoing																			
CSD-13	Coordinate with other City departments (PUD) to implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	City-wide	FY16		Ongoing																			
CSD-13.1	Identify sewer leaks and areas for sewer pipe replacement prioritization.	City-wide	FY16		As Needed																			
Roads, Street, and Parking Lots																								
CSD-14	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	City-wide	FY16		Ongoing																			
CSD-14.1	Outreach to street sweeping enhancement-targeted areas.	Los Peñasquitos WMA	FY16		Ongoing																			

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
CSD-14.2	Enhance street sweeping through equipment replacement (replace mechanical sweepers with regenerative air sweepers) and route optimization (sweep all routes twice per month) in targeted areas.	Los Peñasquitos WMA	FY17			Ongoing																		
CSD-14.3	Initiate sweeping of medians on high-volume arterial roadways.	City-wide	FY17			Ongoing																		
CSD-14.4	Implement additional street sweeping (Settlement Agreement).	Los Peñasquitos WMA	FY13																					
Pesticide, Herbicides, and Fertilizer BMP Program																								
CSD-15	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	City-wide	FY16		Ongoing																			
Retrofit and Rehabilitation in Areas of Existing Development																								
CSD-16	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	City-wide	TBD																					
CSD-17	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	City-wide	TBD																					
Illicit Discharge, Detection, and Elimination (IDDE) Program																								
CSD-18	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	City-wide	Prior to FY16	Ongoing																				
Public Education and Participation																								
CSD-19	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	City-wide	Prior to FY16	Ongoing																				
CSD-19.1	Continue implementation of a Pet Waste Program.	City-wide	Prior to FY16	Ongoing																				
CSD-19.2	Promote and encourage implementation of designated BMPs in commercial and industrial areas.	City-wide Non-residential Areas	Prior to FY16	Ongoing																				
CSD-19.3	Expand outreach to homeowners' association (HOA) common lands and HOA incentives.	City-wide	FY16		Ongoing																			
CSD-19.4	Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.	City-wide	FY16		Ongoing																			
CSD-19.5	Enhance and expand trash cleanups through community-based organizations involving target audiences.	City-wide	FY16		Ongoing																			
CSD-19.6	Improve consistency and content of websites to highlight enforceable conditions and reporting methods.	City-wide	Prior to FY16	Ongoing																				
CSD-19.7	Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.	Los Peñasquitos WMA	FY16		Ongoing																			
CSD-19.8	Enhance school and recreation-based education and outreach.	City-wide	FY15	Ongoing																				

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-19.9	Develop education and outreach to reduce irrigation runoff.	City-wide	Prior to FY16	Ongoing																				
CSD-19.10	Develop regional training for water-using mobile businesses.	City-wide	FY16		Ongoing																			
CSD-19.11	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	City-wide	FY16		Ongoing																			
CSD-19.12	Continue to promote and encourage implementation of Integrated Pest Management (IPM) for residents and businesses.	City-wide	Prior to FY16	Ongoing																				
Enforcement Response Plan																								
CSD-20	Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Storm Water Code Enforcement Unit's Standard Operating Procedures (SOPs) - Enforcement Response Plan.	City-wide	Prior to FY16	Ongoing																				
CSD-20.1	Increase enforcement of irrigation runoff.	City-wide	FY16		Ongoing																			
CSD-20.2	Increase enforcement of water-using mobile businesses.	City-wide	FY16		Ongoing																			
CSD-21	Increase enforcement of all minimum BMPs for existing residential, commercial, and industrial development.	City-wide	FY16		As needed																			
CSD-22	Increase enforcement associated with property-based inspections.	City-wide	FY16		Ongoing																			
CSD-23	Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.	City-wide	FY16		Ongoing																			
CSD-24	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	City-wide	FY16		Ongoing																			
Additional Nonstructural Strategies																								
CSD-25	Conduct a Comprehensive Benefits Analysis to identify benefits other than water quality that are applicable to each of the specific WQIP strategies.	City-wide	FY15	One time																				
CSD-26	Address and clean up trash from transient encampments with collaboration from the Homeless Outreach Team.	City-wide	FY16		Ongoing																			
CSD-27	Continue participating in source reduction initiatives.	City-wide	Prior to FY16	Ongoing																				
CSD-27.1	Coordinate with Fleet Services to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available.	City-wide	FY18				Ongoing																	
CSD-28	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	City-wide	FY16		Ongoing																			
CSD-29	Conduct special studies.	City-wide	FY16		Ongoing																			
CSD-29.1	Los Peñasquitos Watershed Special Study	Los Peñasquitos WMA	FY16		One time																			
CSD-29.2	Participate in Reference Watershed Study.	Region-wide	Prior to FY16	One time																				
CSD-29.3	Participate in Reference Beach Study.	Region-wide (Los Peñasquitos WMA)	Prior to FY16	One time																				
CSD-29.4	Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit.	Los Peñasquitos WMA	FY16		Ongoing																			

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-29.5	Conduct a Cost of Service Study.	City-wide	FY16		One time																			
CSD-29.6	Conduct a special study on outfall repair/relocation.	Los Peñasquitos WMA	FY16		One time																			
CSD-30	Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-31	Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for individuals experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-32	Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals, where feasible.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-33	Conduct a feasibility study to test Permeable Friction Course (PFC), a porous asphalt that overlays impermeable asphalt.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-34	As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-35	Participate in a watershed council or group if one is established.	City-wide	Optional	If triggered, begin planning, acquiring funding and resources																				
CSD-36	Prohibit introduction of invasive plants in new development and redevelopment projects.	City-wide	Prior to FY16	Ongoing																				
CSD-37	Collaborate with watershed stakeholders to plan and implement projects that will further Los Peñasquitos Lagoon restoration efforts and reduce flooding in the lower watershed.	Los Peñasquitos WMA	Optional	If triggered, begin planning, acquiring funding and resources																				
Green Infrastructure																								
CSD-38	Del Mar Mesa Neighborhood Park (Project 985)	Los Peñasquitos Creek Subwatershed	Prior to FY16																					
CSD-39	Miramar Water Treatment Plant (Project ID 1177)	Los Peñasquitos Creek Subwatershed	Prior to FY16																					
CSD-40	Carroll Canyon Road Extension (Project ID 1007)	Carroll Canyon Creek Subwatershed	Prior to FY16																					
CSD-41	Camino Ruiz Neighborhood Park (Project ID 140)	Los Peñasquitos Creek Subwatershed	FY15																					
CSD-42	Breen Park Site - Development (Project ID 857 & 858 & 859 & 860)	Los Peñasquitos Creek Subwatershed	FY15																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-43	Rancho Peñasquitos Skate park (Project ID 866)	Los Peñasquitos Creek Subwatershed	Prior to FY16																					
CSD-44	Fire Station #47 (Project ID 992)	Carmel Valley Creek Subwatershed	Prior to FY16																					
CSD-45	Torrey Del Mar Neighborhood Park (Project ID 1022)	Carmel Valley Creek Subwatershed	Prior to FY16																					
CSD-46	Hilltop Community Park- Development of bioretention areas	Carmel Valley Creek Subwatershed	FY15																					
CSD-47	0.96 acre of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 37.86 acres with a total storage volume of 1.69 acre-feet.	Carmel Valley Creek Subwatershed	FY22																					
CSD-48	17.18 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 582.71 acres with a total storage volume of 27.21 acre-feet.	Carroll Canyon Creek Subwatershed	FY26																					
CSD-49	2.40 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 145.75 acres with a total storage volume of 6.86 acre-feet.	Los Peñasquitos Creek Subwatershed	FY26																					
CSD-50	1.33 acres of bioretention have been identified as potential opportunities for green infrastructure implementation on public parcels to treat an impervious drainage area of 48.97 acres with a total storage volume of 2.14 acre-feet.	Los Peñasquitos Lagoon Subwatershed	FY28																					
Green Streets																								
CSD-51	53.20 acres of green streets (26.6 acres of bioretention and 26.6 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 1,746.8 acres with a total storage volume of 72.54 acre-feet.	Carmel Valley Creek Subwatershed	FY26																					
CSD-52	55.92 acres of green streets (27.96 acres of bioretention and 27.96 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 2,345.5 acres with a total storage volume of 86.16 acre-feet.	Carroll Canyon Creek Subwatershed	FY26																					
CSD-53	121.42 acres of green streets (60.71 acres of bioretention and 60.71 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 4,128.6 acres with a total storage volume of 186.11 acre-feet.	Los Peñasquitos Creek Subwatershed	FY24																					
CSD-54	9.06 acres of green streets (4.53 acres of bioretention and 4.53 acres of pervious pavement) have been identified as potential opportunities for green street projects to treat a total drainage area of 12.37 acres.	Los Peñasquitos Lagoon Subwatershed	FY26																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
Multiuse Treatment Areas																								
Infiltration and Detention Basins																								
CSD-55	Ashley Falls	Los Peñasquitos Creek Subwatershed	FY19																					
CSD-56	Flintkote Sediment Detention Basin	Los Peñasquitos Lagoon Subwatershed	FY26																					
CSD-57	Upper Sorrento Valley Road Sediment Detention Basin	Carroll Canyon Creek Subwatershed	FY22																					
CSD-58	Los Peñasquitos Lagoon Sediment Basin	Los Peñasquitos Creek Subwatershed	Prior to FY16																					
CSD-59	A surface infiltration basin can be implemented in open space adjacent to Carmel Knolls Drive upon detailed site assessment.	Carmel Valley Creek Subwatershed	FY21																					
CSD-60	A subsurface detention basin in Sandburg Park upon detailed site assessment.	Los Peñasquitos Creek Subwatershed	FY25																					
CSD-61	A surface infiltration basin can be implemented in Carmel Creek Neighborhood Park and Elementary School upon detailed site assessment.	Carmel Valley Creek Subwatershed	FY22																					
CSD-62	A dry extended detention basin can be implemented in Maddox Park upon detailed site assessment.	Carroll Canyon Creek Subwatershed	FY21																					
CSD-63	A subsurface detention basin can be implemented in Dingeman Elementary School and Spring Canyon Park upon detailed site assessment.	Los Peñasquitos Creek Subwatershed	FY24																					
CSD-64	A dry extended detention basin in open space next to Canyonside Park Driveway can be implemented upon detailed site assessment.	Los Peñasquitos Creek Subwatershed	FY25																					
CSD-65	A subsurface detention gallery can be implemented in Del Mar Trails Park upon detailed site assessment.	Carmel Valley Creek Subwatershed	FY23																					
CSD-66	A subsurface detention basin in Mira Mesa High school can be implemented upon detailed site assessment.	Carroll Canyon Creek Subwatershed	FY23																					
CSD-67	A subsurface detention gallery can be implemented in Sage Canyon Park upon detailed site assessment.	Los Peñasquitos Creek Subwatershed	FY26																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-68	If interim load reduction goals are not met and additional multiuse treatment areas are required, an infiltration basin(s) may be considered on publicly owned open spaces in canyon areas on a case-by-case basis when no other opportunities for load reductions exist.	Los Peñasquitos WMA	Optional	If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement multiuse treatment area projects.																				
Stream, Channel and Habitat Rehabilitation Projects																								
CSD-69	El Cuervo del Norte Wetlands	Los Peñasquitos Creek Subwatershed	Prior to FY16																					
CSD-70	El Cuervo del Sur Wetlands	Los Peñasquitos Creek Subwatershed	FY16																					
CSD-71	If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.	Areas identified during feasibility studies	Optional	If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement rehabilitation projects.																				
Water Quality Improvement BMPs																								
Proprietary BMPs																								
CSD-72	Rehco Rd.	Carroll Canyon Creek Subwatershed	Prior to FY16																					
CSD-73	North Torrey Pines Road Bridge (Project ID 1017)	Carroll Canyon Creek & Los Peñasquitos Lagoon Subwatersheds	Prior to FY16																					
CSD-74	Scripps Ranch Boulevard Median Improvements (Project ID 901)	Carroll Canyon Creek & Los Peñasquitos Lagoon Subwatersheds	Prior to FY16																					
CSD-75	Northwest Area Police Substation (Project ID 1365)	Los Peñasquitos WMA	Prior to FY16																					
CSD-76	Peñasquitos West Grading (Project ID 1051)	Carmel Valley Creek Subwatershed	Prior to FY16																					
CSD-77	Carmel Valley Road Enhancements (Project ID 860)	Carmel Valley Creek Subwatershed	Prior to FY16																					
CSD-78	Genesee Widening (Project ID 900)	Carroll Canyon Creek Subwatershed	Prior to FY16																					

ID	Strategy	Location	Implementation or Construction Year Start	FY 15 and Earlier	FY 16	FY 17	FY 18	FY 19	FY 20	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30	FY 31	FY 32	FY 33	FY 34	FY 35
CSD-79	Mira Sorrento Place and Vista Sorrento Parkway (Project ID 850)	Carroll Canyon Creek Subwatershed	Prior to FY16																					
CSD-80	Ocean Air Park (Project ID 906)	Los Peñasquitos Lagoon Subwatershed	Prior to FY16																					
CSD-81	Otay Mesa/ Nestor Library- Development of treatment unit.	Los Peñasquitos WMA	FY15																					
Dry Weather Flow Separation and Treatment Projects																								
CSD-82	If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.	Downstream reaches where persistent dry weather flows have been observed	Optional	If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement dry weather flow separation projects.																				
Trash Segregation																								
CSD-83	If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.	High-loading areas city-wide	Optional	If triggered, begin planning (acquire funding and resources, conduct site feasibility analysis and site selection) to implement trash segregation projects.																				
Additional Opportunities																								
CSD-84	Participate in restorative efforts for the Los Peñasquitos Lagoon in collaboration with TMDL Responsible Parties and other stakeholders.	Los Peñasquitos Lagoon Subwatershed	FY20																					
CSD-85	Through adaptive management and additional analysis in the future, the City will identify and implement one or more of the following opportunities to meet numeric goals: 1) MS4 outfall repair and relocation, 2) slope stabilization, 3) stream restoration, 4) implementation of sediment detention basins upstream of Los Peñasquitos Lagoon or 5) new strategies not yet identified.	Los Peñasquitos WMA	FY28																					

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I.5 County of San Diego Strategies

Open space, agriculture, and other low-density land uses cover much of the County of San Diego's jurisdiction within the Los Peñasquitos WMA. The jurisdictional strategies reflect this and were chosen because they are well suited for these types of land uses. The County of San Diego has identified the jurisdictional strategies in Table I-7 to assist in meeting the Water Quality Improvement Plan goals. A compliance analysis using a watershed model was conducted to identify the strategies required to be implemented to meet interim and final goals. The adaptive management process provides the framework to evaluate progress toward meeting the goals and allows for modification of strategies. As strategies are modified, the compliance analysis will be updated as needed to provide assurance that numeric goals will be met.

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	Strategy	Program Type (see notes at bottom)	Permit Reference	Sources	Frequency	Schedule
Jurisdictional Runoff Management Programs (JRMP) Strategies						
Illicit Discharge, Detection, and Elimination (IDDE) Program						
1	Maintain MS4 map to facilitate IDDE program	Base	MS4 Permit, Section E.2.b(1)	N/A	Annually	FY15
2a	Use municipal personnel/contractors to identify and report ICIDs	Base	MS4 Permit, Section E.2.b(2)	IC/IDs	ongoing	ongoing
	updated focused training for County field staff	Enhanced		all pollutants	Annually	FY16
2b	Collect effluent on the ground (EOG), sanitary sewer overflow (SSO) data	Base	MS4 Permit, Section E.2.b( )	OWTS/SSO	ongoing	ongoing
	Address septic system failures where observed	Base		human sources	ongoing	ongoing
3	Maintain a hotline and email address for public reporting of potential ICIDs.	Base	MS4 Permit, Section E.2.b(3)	IC/IDs	ongoing	ongoing
	Refer homeless issue complaints to Sheriff or appropriate jurisdictions	Base		human sources	ongoing	ongoing
	Bilingual hotline answered by I Love a Clean San Diego (ILACSD; live operator) with multiple avenues for online reporting	Enhanced		IC/IDs	ongoing	FY16
	investigate the feasibility of developing a pilot program (including training) - volunteer surveillance program	Optional		IC/IDs	TBD/in dev.	FY16
4	Implement practices and procedures to address spills that may discharge into MS4	Base	MS4 Permit, Section E.2.b(4)	IC/IDs	ongoing	ongoing
	coordinate spill response with responsible sewer agencies	Base		SSOs	ongoing	FY16
	implement septic system rebate program with availability of grant funding	Optional		OWTS	ongoing	FY16
	develop a pilot online septic system maintenance outreach program	Optional committed		OWTS	ongoing	ongoing
5	Implement practices and procedures to prevent/limit infiltration of seepage from sanitary sewers	Base	MS4 Permit, Section E.2.b(5)	Sewer infrastructure	ongoing	ongoing
6	Coordinate with upstream Copermittees and/or entities to prevent ID from upstream sources into the MS4	Base	MS4 Permit, Section E.2.b(6)	IC/IDs	ongoing	ongoing
7	Monitor MS4 outfalls for discharges of potential ICIDs	Base	MS4 Permit, Section E.2.c	Persistent/ transient flows	Annually	ongoing
8	Develop and implement a strategy for investigating and addressing ICIDs.	Base	MS4 Permit, Section E.2.d	IC/IDs	One time	FY15
Development Planning						
9	All development projects: Implement or require implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area, where applicable and feasible.	Base	MS4 Permit, Section E.3.a	new and redevelopment	ongoing	ongoing
10	Priority Development Projects: In addition to requirement for all development projects, implement or require implementation of onsite structural BMPs to control pollutants and manage hydromodification for PDPs.	Base	MS4 Permit, Sections E.3.b & E.3.c	new and redevelopment	ongoing	ongoing
11	Consider feasibility of developing an alternative compliance program to enable "offsite" compliance for new and redevelopment projects.	Optional	MS4 Permit, Section E.3.c(3)	new and redevelopment	in development	future
12	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.	Base	MS4 Permit, Section E.3.d	new and redevelopment	in development	FY16
	Conduct BMP Manual Training - Internal	Base		new and redevelopment	one time	FY16
	Conduct BMP Manual Training - External	Enhanced		new and redevelopment	one time	FY16
13	Implement a program that requires and confirms PDP structural BMPs are designed, constructed, and maintained to remove pollutants.	Base	MS4 Permit, Section E.3.e	new and redevelopment	ongoing	ongoing
14	Enforce legal authority established for all development projects to achieve compliance.	Base	MS4 Permit, Section E.3.f	new and redevelopment	ongoing	ongoing
	update county ordinance related to land development; reference to updated BMP manual	Base		new and redevelopment	one time	FY15
	Investigate feasibility of developing a Green Streets Program	Optional		All	TBD	TBD
Construction Management						
15	Maintain and update a watershed-based inventory of all construction projects issued a local permit that allows ground disturbance or soil disturbing activities.	Base	MS4 Permit, Section E.4.b(1)	Construction: waste management, portable toilets	quarterly	FY16

	Strategy	Program Type (see notes at bottom)	Permit Reference	Sources	Frequency	Schedule
16	Implement or require implementation of BMPs that are site specific, seasonally appropriate and construction phase appropriate. Includes inspections at an appropriate frequency and enforcement of requirements.	Base	MS4 Permit, Sections E.4.c & E.4.d(1)	Construction: waste management, portable toilets	TBD/in dev.	ongoing
17	Enforce legal authority established for all its inventoried construction sites to achieve compliance.	Base	MS4 Permit, Section E.4.e	Construction: waste management, portable toilets	as necessary	ongoing
	update county ordinance related to construction; reference to existing grading ordinance	Base		Construction: waste management, portable toilets	one time	FY15
18	Conduct internal training on Construction Management	Base	MS4 Permit, Section E.7.a(3)	Construction: waste management, portable toilets	Annually	ongoing
Existing Development						
19	Maintain and update a watershed-based inventory of all existing development that may discharge a pollutant load to and from the MS4.	Base	MS4 Permit, Section E.5.a	ICMR	Annually	on going
	make improvements to tracking watershed based inventories via consolidated database	Optional committed		ICMR	one time	FY16
20	Designate a minimum set of BMPs required for all existing development inventories, including special event venues. The designated minimum BMPs must be specific to facility or area types and pollutant generating activities, as appropriate.	Base	MS4 Permit, Section E.5.b	ICMR	one time	on going
	Create an Equestrian BMP Handbook	Optional Committed	County Program	equestrian land uses	one time	FY16
21	Require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types and pollutant generating activities, as appropriate.	Base	MS4 Permit, Section E.5.c	ICMR	ongoing	ongoing
	facilitate pet waste management in County Parks through outreach or bag dispensers	Enhanced		municipal parks	ongoing	ongoing
22	Operate and maintain (inspect and clean) MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.).	Base	MS4 Permit, Section E.5.b.(1)(c)(ii)	MS4	Annually	ongoing
23	Operate and maintain (e.g., inspect, sweep) County maintained streets, unpaved roads, paved roads, and paved highways	Base	MS4 Permit, Section E.5.b.(1)(c)(iii)	transportation corridors	per JRMP	ongoing
24	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Base	MS4 Permit, Section E.5.b(1)(d)	ICMR	ongoing	ongoing
25	Promote and encourage implementation of designated BMPs at residential areas.	Base	MS4 Permit, Section E.5.b(2)	residential	ongoing	FY16
26	Conduct inspections of inventoried existing development to ensure compliance	Base	MS4 Permit, Section E.5.c	ICMR	20% per year, all within 5 years	FY16
	conduct focused residential inspections based on strategic assessments (modeling, MST, persistent flows, regulatory, monitoring data, SFR/MFR (112 RMAs based on HSA)	Enhanced		residential	20% per year, all within 5 years	FY16
	Investigate the feasibility of a residential inspections tracking program via mobile platform - miles, violations, etc.	Optional Committed		residential	ongoing with inspections	FY16
	Investigate the feasibility of improvements to inspections data tracking through mobile phone applications	Optional		ICRM		FY16
27	Enforce legal authority established for all inventoried existing development to achieve compliance	Base	MS4 Permit, Section E.5.d	ICMR	ongoing	ongoing
	update county ordinance related to existing development; reference to existing guidance documents	Enhanced		ICMR	one time	FY15
28	Develop a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Base	MS4 Permit, Section E.5.e(1)	municipal areas	internal and WMAA	FY15
	collaborate with partner agencies and groups to promote non-County sponsored incentive programs for BMP retrofits, including rain barrels, smart controllers, soil sensors, turf replacement, etc.	Enhanced		residential/ commercial	ongoing	ongoing
	Investigate the feasibility of developing and implementing an incentive program for BMP Retrofits (Public-Private Partnerships - a County sponsored program to offer incentives for rain barrel installation, downspout disconnects from the stormwater system, etc)	Optional committed				
29	Develop a strategy to identify candidate areas of existing development for stream, channel, and/or habitat rehabilitation projects and facilitate implementation of such projects.	Base	MS4 Permit, Section E.5.e(2)	municipal	internal and WMAA	FY15
	Outreach and Public Participation					

	Strategy	Program Type (see notes at bottom)	Permit Reference	Sources	Frequency	Schedule
	Develop Sustainable Landscapes Program based on available grant funding	Optional		residential/ commercial	ongoing	FY16
	develop, improve, distribute outreach materials for existing development	Enhanced		ICMR	ongoing	ongoing
	conduct outreach to mobile landscaping service providers	Enhanced		ICMR	ongoing	ongoing
	Conduct large residential property pet waste management outreach	Optional committed		rural residential	ongoing	ongoing
	Consider expanding Homeowners Associations Outreach and Coordination (pilot project considered for San Luis Rey, San Dieguito and San Diego River) as needed and as funding is identified	Optional				TBD
	Sponsor Trash Collection Events	Enhanced	County Program	existing land use	TBD	ongoing
	Conduct Educational Workshops (e.g., IPM, manure management)	Enhanced	County Program	residential	ongoing	ongoing
	Conduct Education & Outreach Effectiveness Survey	Enhanced	County Program	ICMR	annual	ongoing
Enforcement Response Plan						
30	Implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.	Base	MS4 Permit, Section E.6	all MS4 related sources	ongoing	ongoing
31	Notify the SDWB by email (Nonfilers_R9waterboards.ca.gov) within five (5) calendar days of issuing escalated enforcement to a construction site that poses a significant threat to water quality as a result of violations or other noncompliance	Base	MS4 Permit E.6.e.(1)	construction	ongoing	FY16
32	Notify the SDWB by email (Nonfilers_R9waterboards.ca.gov) any persons required to obtain coverage under the statewide Industrial General Permit and Construction General Permit and failing to do so, within five (5) calendar days from the time the Copermittee become aware of the circumstances.	Base	MS4 Permit E.6.e.(2)	industrial	ongoing	FY16
Public Education and Participation						
33	Implement a public education and participation program to promote and encourage development of programs, management practices and behaviors that reduce the discharge of pollutants in storm water prioritized by high risk behaviors, pollutants of concern, and target audiences.	Base	MS4 Permit, Section E.7	MS4 sources	ongoing	ongoing
Physical Strategies						
	Investigate feasibility of Land Acquisitions for habitat restoration or preservation	Optional	WURMP WQ	ICMR	ongoing	
34	Investigate feasibility of planning for Structural BMPs	Optional	MS4 Permit, Section B.2.e	TBD	TBD	land development programs
39	Investigate feasibility of Retrofitting projects in areas of existing development	Optional	MS4 Permit, Section B.2.e	TBD	TBD	potential for implementation via alternative compliance program
40	Investigate feasibility of Stream, channel, and/or habitat rehabilitation projects	Optional	MS4 Permit, Section B.2.e	TBD	TBD	potential for implementation via alternative compliance program
Optional PlanningStrategies developed during WQIP process						
42	Consider development of incentive programs for water conservation (turf replacement, smart irrigation controllers, irrigation modifications, sustainable landscapes, rain barrels), in collaboration with water agencies and others, to reduce priority pollutants.	Optional				
43	Consider development of incentive programs, in collaboration with DEH, for pumping septic systems in high risk areas adjacent to waterways (within 600 ft) or stormwater system; subject to grant funding	Optional				
44	Consider partnerships with Master Gardeners to provide education opportunities on water use and practices for gardening	Optional				
45	Consider collaboration with community groups to provide “boots on the ground” local information to focus implementation efforts on reducing bacteria and other pollutants, close to the source	Optional				

	Strategy	Program Type (see notes at bottom)	Permit Reference	Sources	Frequency	Schedule
46	Consider collaboration with COSD internal departments to leverage mutually beneficial projects to promote retrofits to include installation of controls to address priority pollutants, if feasible.	Optional				
47	Consider collaboration with watershed partners to encourage consistent messaging to specific targeted audiences (commercial, residents, and others) to conserve water and mitigate dry weather flows	Optional				
48	Consider collaboration with watershed partners on Round 4 of Proposition 84 IRWM grant opportunities to fund targeted educational programs, building of structural controls (brick and mortar projects), or incentive programs to reduce runoff	Optional				
49	Consider collaboration with watershed partners and Regional Water Quality Control Board on effective measures to reduce potential impact of pollutant loads to waterways from unauthorized encampments	Optional				
50	Consider collaboration with wastewater agencies to identify where sewer and stormwater infrastructure are in close proximity and confirm the absence of flow at nearby stormwater MS4 outfall during dry weather	Optional				
52	Consider collaboration with watershed partners to remove invasive non-native plants (Arundo) upstream areas rivers or tributaries to increase flood and fire protection and reduce the number of unauthorized encampments on the river bottom	Optional				
53	In collaboration with DEH, consider developing program for on-site wastewater treatment (septic) systems. May include mapping and risk assessment, inspection, or maintenance practices.	Optional				
54	Implement full scale residential pet waste projects (commitments, large property, urban)	Optional				
56	Consider investigating diverting persistent dry weather flows from storm drains to sanitary sewer, where feasible	Optional				
57	Consider the design of structural controls for persistent unpermitted dry weather flows where outreach has been unsuccessful and groundwater or other non-MS4 sources has been ruled out	Optional				
58	Consider developing a strategy to evaluate opportunities to naturalize concrete stormwater conveyances, and identify potential funding sources (such as grants) for design and implementation	Optional				
59	Consider evaluation and reprioritization of the AWM stormwater program to determine inspection priorities for agricultural and related facilities.	Optional				
60	*Consider collaboration with Caltrans on their implementation of TMDLs at stream reaches on the Caltrans TMDL Prioritization List that are within the County's jurisdiction.*	Optional				

Program Type Notes:
Base - Indicates requirements of the MS4 Permit that the County will implement.
Enhanced - Base program that has been enhanced beyond the MS4 Permit requirements. The enhanced portions of these strategies would be implemented if needed and if funding is available.
Optional - Strategies that are not required by the MS4 Permit. These strategies would be implemented if needed and if funding is available. Those that are "**committed**" are currently funded this fiscal year (FY14-15) and/or being undertaken or planned for undertaking

Responsible party notes:
WPP = DPW Watershed Protection Program
ED = WPP, Existing Development
PS = WPP, Planning and Science
DC = WPP, Development and Construction
FC = DPW Flood Control
CIP = DPW Capital Improvement Projects
DEH = Department of Environmental Health
AWM = Department of Agriculture, Weights and Measures

APPENDIX J

Strategy Selection and Compliance Analysis

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APPENDIX J. STRATEGY SELECTION AND COMPLIANCE ANALYSIS

This appendix details the basis for strategy selection and prioritization, implementation assumptions used to estimate strategy effectiveness within the simulation models, and the results of the modeling efforts including anticipated load reductions by strategy, subwatershed, jurisdiction, and pollutant. Figure J-1 provides a conceptual model of the quantification of benefits from the strategies represented in the model and discussed within this appendix. Section 4 of the Water Quality Improvement Plan provides a summary by jurisdiction of selected strategies, and Appendix I provides the schedule for implementation by jurisdiction.

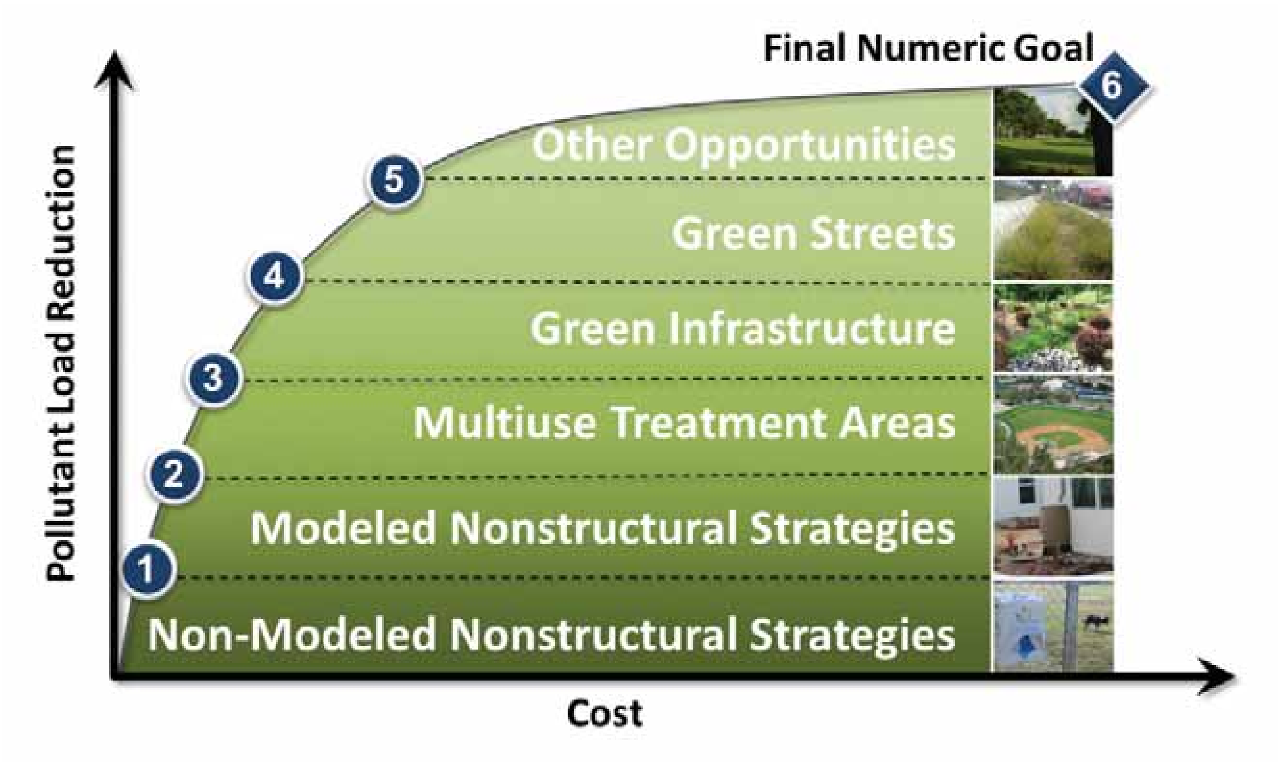

Figure J-1
Conceptual Diagram Illustrating Strategy Implementation
(Not to Scale)

Strategies were selected based on their ability to effectively and efficiently eliminate non-storm water discharges to the MS4, reduce pollutants in storm water discharges in the MS4 to the maximum extent practicable (MEP), and achieve the interim and final numeric goals. Efficiency in pollutant reduction is based on identifying the known and suspected areas or sources likely contributing to the highest priority water quality condition and targeting those sources. To assist in the geographical identification of sources, watershed modeling and GIS tools were used to estimate the relative sediment and bacteria loading within the Los Peñasquitos WMA, land ownership and availability of public land for implementation, and physical watershed characters such as slope and soil types for BMP selection.

Section J.1 presents the relative, estimated sediment and bacteria loading by drainage area in the Los Peñasquitos WMA. The relative loading results can assist Responsible Agencies in selecting locations to focus nonstructural and structural strategies within subwatersheds. Section J.2 provides additional detail on nonstructural strategy selection and implementation. Many of the nonstructural strategies overlap with administrative programs. Responsible Agencies may utilize the relative loading results to target application of administrative programs, such as street sweeping, rebate programs or education and outreach programs, in high priority areas. Specific load reductions for select nonstructural programs or activities that had a sufficient amount of data collected to estimate load reductions were modeled. Modeling assumptions for those activities are also presented in Section J.2. Section J.3 provides additional detail on structural strategy (BMP) selection and implementation. Additional factors to the relative loading analysis were considered in the selection of structural BMPs, such as parcel ownership, slope, and soil type. These additional factors generally have a greater influence on site selection for structural BMPs than just the relative loading by area. They also play an important role in determining the costs for implementation of structural BMPs and affect the cost-efficiency results. The structural BMP modeling assumptions are also provided in this section. Finally, Section J.4 provides a summary of the expected, cumulative load reductions estimated from the suite of strategies selected. A summary of the modeling assumptions used in the projection and the cost-effectiveness assessments are provided.

J.1 Prioritization of Sediment- and Bacteria-Loading Areas

The MS4 Permit requires the identification of known and suspected areas or sources causing or contributing to the highest priority water quality condition within the following Responsible Agency inventories: MS4 outfall, priority development project, construction site, and existing development. The sediment- and bacteria-generating activities within the WMA were identified in Section 3. To identify potential geographic areas where sediment- and bacteria-generating activities are contributing to watershed load, subwatersheds delineated in a recent modeling effort were prioritized based on modeled sediment and bacteria loading results (City of San Diego, 2012).

Modeling was conducted using the Loading Simulation Program in C++ (LSPC) watershed model (Shen et al. 2004; Tetra Tech and USEPA 2002), which estimated pollutant loading based on physical watershed characteristics (e.g., slope, soil types, precipitation zones) and land use-based runoff parameters. LSPC was calibrated to available flow and water quality data measurements in the receiving waters, which incorporate the effects of existing pollutant sources and current management actions upstream of the calibration points. The final calibrated model represents a simulation of baseline existing conditions for Water Year 2003 (which represents typical wet and dry weather conditions, based on an analysis of rainfall data over a 20-year time period) and recent land use data (using the San Diego Association of Governments 2009 data) in the Los Peñasquitos WMA; any pollutant load reductions resulting from jurisdictional strategies will be subsequently subtracted from the baseline conditions in the following sections to demonstrate progress towards meeting watershed load reduction goals. Watershed modeling is explained in detail in Appendix K.

The calibrated watershed models were used to prioritize subwatersheds within the Los Peñasquitos WMA using a relative estimate of sediment and bacteria loading. All modeled bacteria results were averaged for dry weather and quintiles were established for each subwatershed and assigned to each pollutant. The individual quintile scores (1–5) for *Enterococcus*, fecal coliform, and total coliform were averaged to create a dry composite bacteria pollutant loading score (Figure J-2). The same procedure was performed for wet composite bacteria pollutant loading score, found in Figure J-3. A score of 5 indicates that the subwatershed pollutant loading was in the top 20th percentile (high pollutant loading), whereas a score of 1 represents a subwatershed loading in the bottom 20th percentile (low pollutant loading). The wet weather composite score was the average of the wet composite bacteria score and the wet sediment score, because both constituents are high priority water quality conditions (see Section 4.1 for more detail). The overall wet weather water quality composite score (2–10) is the summation of the wet composite bacteria score (Figure J-3) and wet composite sediment score (Figure J-4), which is shown in Figure J-5.

Areas that are expected to contribute the highest loading, and therefore suspected to have more sources, are darker, and areas that are less likely to contribute are lightly shaded. Subwatersheds with more development are expected to contribute more sediment and bacteria than less developed, open space. The model simulates pollutant loading based on land use. Sources identified in Section 3 of the Water Quality Improvement Plan are generally associated with land use types, but are not explicitly represented in this prioritization. For example, sources such as episodic sanitary sewer overflows are not explicitly included in the model; however, residential areas or areas with general development do have a higher bacteria load associated than undeveloped areas. This prioritization is meant as a guideline for identification of geographic areas within which to investigate sources. Each responsible Agency may have additional information to inform jurisdictional strategy implementation. Further analysis to determine the site suitability for structural strategies is discussed in Section J.3.

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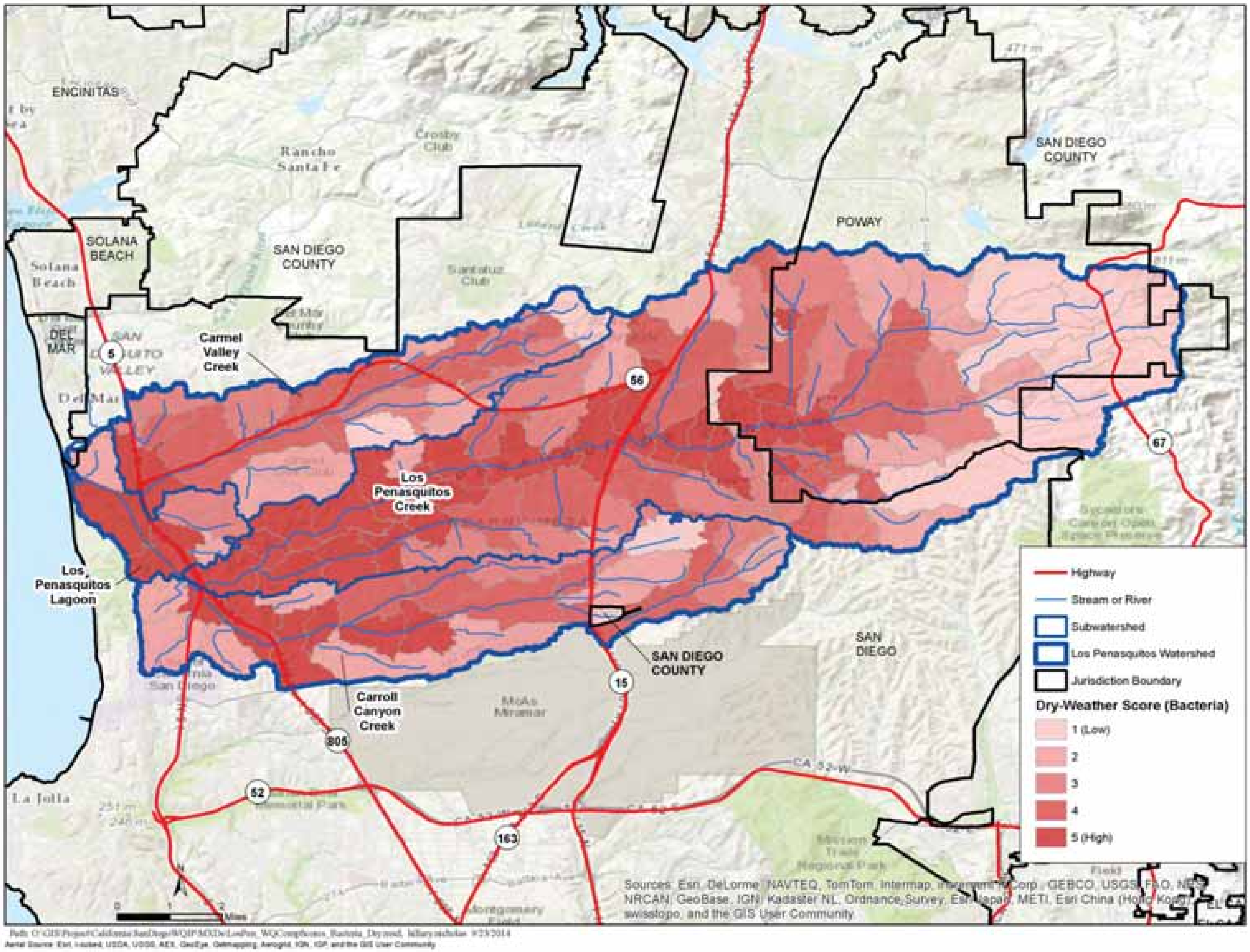

Figure J-2
Water Quality Dry-Weather Composite Score for Bacteria

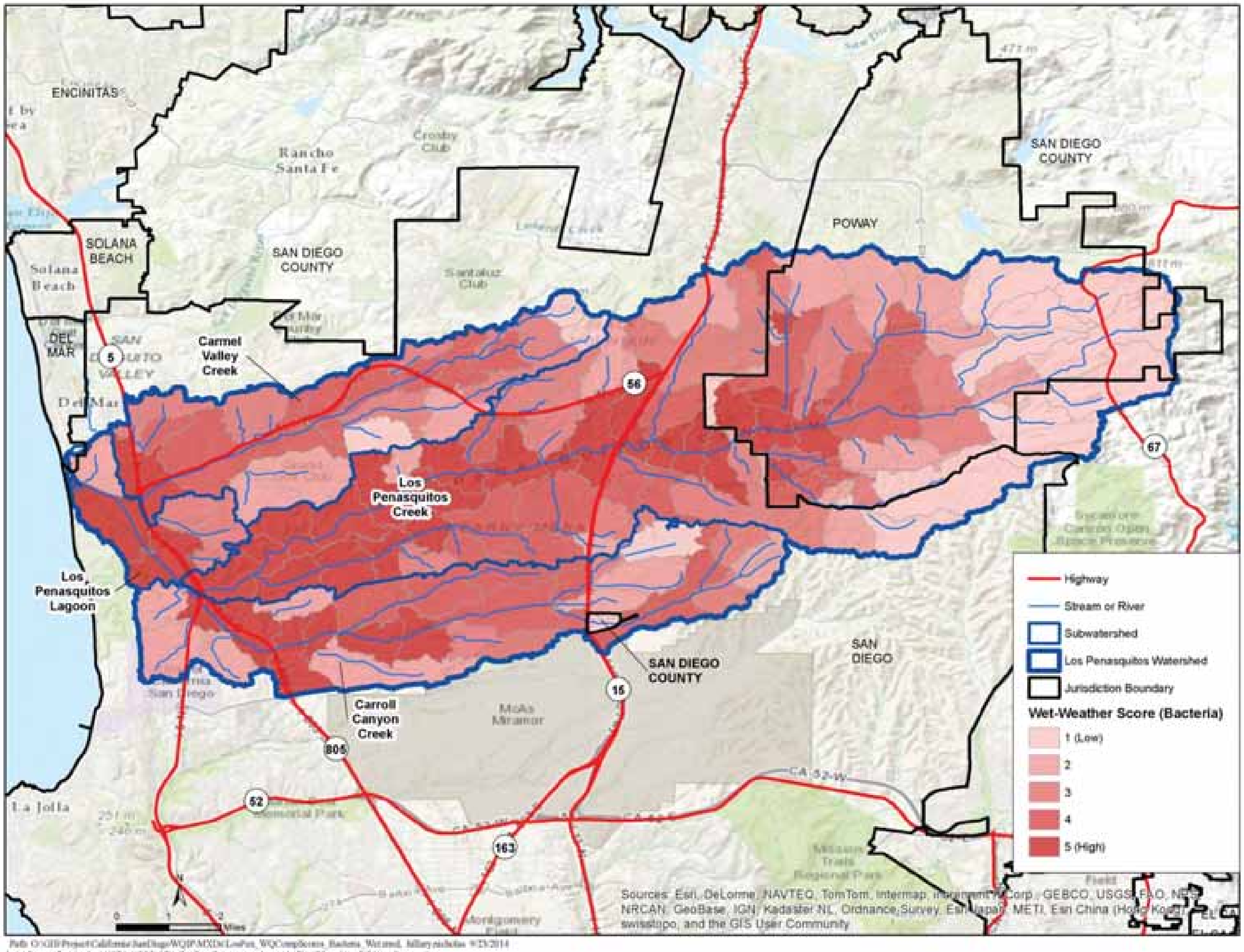

Figure J-3
Water Quality Wet-Weather Composite Score for Bacteria

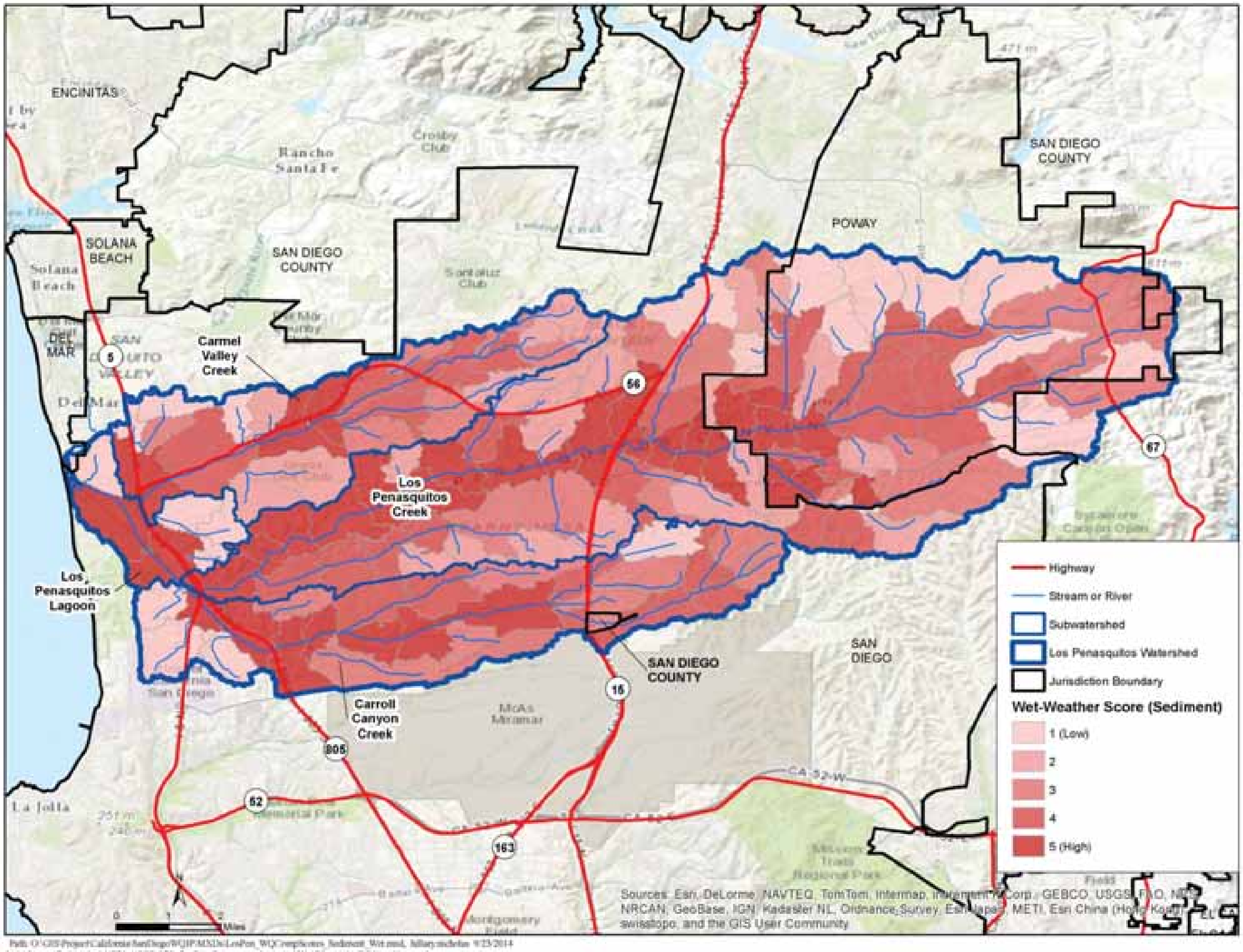

Figure J-4
Water Quality Wet-Weather Composite Score for Sediment

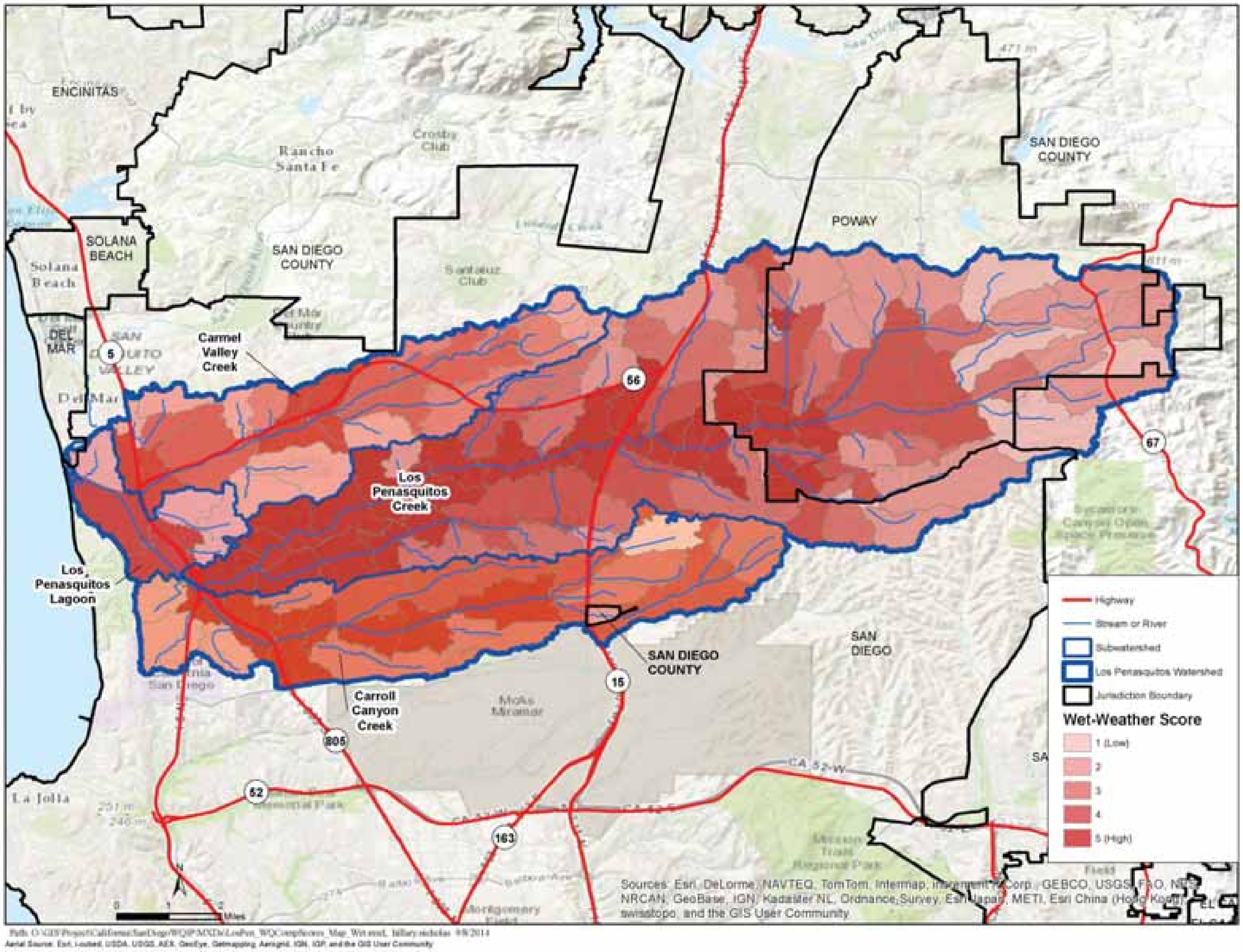

Figure J-5
Total Water Quality Wet-Weather Composite Score for Bacteria and Sediment

J.2 Nonstructural Strategies

To assist in the phased reduction of pollutant loads, various nonstructural strategies have been identified for implementation. Nonstructural reduction strategies are defined as those actions and activities that are intended to reduce storm water pollution and that do not involve construction or implementation of a physical structure to filter and treat storm water. These strategies are improvements of existing nonstructural programs, as well as implementation of new nonstructural best management practices (BMPs). Administrative policies, creation and enforcement of municipal ordinances, education and outreach programs, rebate and other incentive programs, and cooperation and collaboration with other WMA or regional partners are several examples of nonstructural strategies.

It is challenging to accurately quantify most nonstructural BMP benefits in terms of pollutant load reductions because it generally requires extensive survey and monitoring information. In addition, nonstructural BMPs may target pollutants, land uses, or populations, resulting in different load reductions depending on the implementation technique. The nonstructural strategies with sufficient data were modeled using LSPC to determine the pollutant load reductions from implementing these strategies. Pollutant load reductions from all strategies in this appendix are subtracted from loads simulated in the baseline model (discussed in the previous subsection) to quantify progress towards meeting the watershed numeric goals.

Estimated pollutant and flow reduction benefits from the non-modeled and modeled nonstructural BMPs provide the baseline from which additional reductions from structural BMPs will be achieved. Nonstructural BMPs are effective at reducing pollutant loads before they enter the storm drain and are generally cost-effective and require a shorter planning period; therefore, most nonstructural strategies are planned for implementation before or upon approval of the Water Quality Improvement Plan.

A summary of modeling assumptions used to quantify the load reduction potential from nonstructural strategies is provided in this section.

J.2.1 Non-Modeled, Nonstructural Strategy Assumptions

As previously stated, not all nonstructural strategies can be effectively modeled for load reductions due to their variable implementation, so these strategies are referred to as non-modeled nonstructural strategies. Since their benefits are not individually quantifiable, these strategies were assigned a conservative cumulative pollutant load reduction value of 10%, as shown in Figure J-6. Each of these non-modeled nonstructural strategies is described in further detail in the jurisdictional strategy tables in Appendix I.

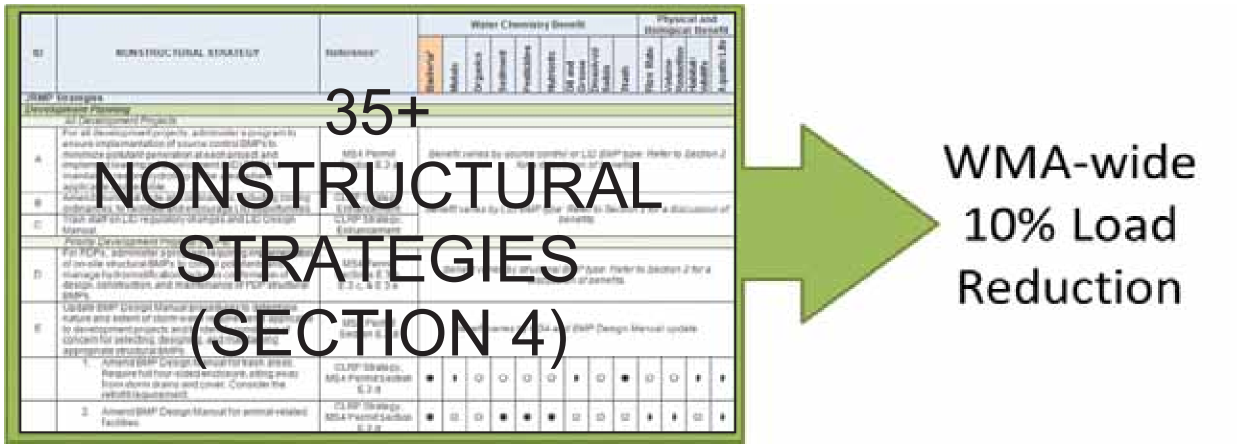

Figure J-6
Non-Modeled Nonstructural Strategies Load Reduction

As described in section 4.2.2.1 of the report, the 10 percent load reduction for non-modeled, nonstructural activities was estimated by averaging the range of measured and anticipated pollutant removal from the list of City of San Diego nonstructural strategies. Strategies were categorized as "high" percent removal, those with greater City control (operation and maintenance of MS4 infrastructure) or "low" percent removal, those requiring public behavior changes. The range of pollutant load reduction was as low as approximately 2 percent and as high as 72%. The overall average percent removal for all constituents and all activities is 10.1%. The average sediment and bacteria removal from the list of strategies was 17.9% and 11.7%, respectively (HDR, 2014).

J.2.2 Modeled Nonstructural Strategy Assumptions

Five of the nonstructural strategies selected for implementation in the Los Peñasquitos WMA were modeled: street sweeping, catch basin cleaning, Rain Barrels Incentive Program, Downspout Disconnection Incentive Program, and Irrigation Runoff Reduction Program. The following sections outline the nonstructural strategies that were modeled for the Responsible Agencies. Most of these strategies generally target residential or commercial land uses; therefore, not all are applicable to Caltrans' jurisdiction.

J.2.2.1 Street Sweeping

Enhanced street and median sweeping technology can provide wet weather pollutant load reductions by removing pollutants from the land surface before washoff can occur during storm events. Increasing the sweeping frequency, increasing the area of impervious cover swept, or upgrading the sweeping equipment can result in an increase in pollutant load removal. Note that while street sweeping can significantly reduce pollutant loads, the practice is not associated with runoff volume reduction. Established street sweeping programs currently implemented by the Responsible Agencies are characterized in the baseline model. At this time, the City of San Diego, City of Poway, and San Diego County have committed to enhanced sweeping efforts above.

Treatment Process Model Overview

The LSPC model's street sweeping BMP process for pollutant removal is illustrated in Figure J-7. This BMP is explicitly represented in the model to simulate pollutant removal at the street level. Parameters of the street sweeping module can be adjusted to account for variable removal efficiencies (based on equipment type), sweeping frequency, and sweeping area coverage.

Ultimately, the total load of pollutants that are programmed to build up in the modeled watershed over time are re-programmed to be removed or reduced based on the assumed street sweeping practices occurring in the watershed. While the sweeping effectiveness parameters are best determined by scientific study, it is critical to document the following key variables relevant to street sweeping programs:

- Sweeping Equipment –Designed specifically to capture fine sediments in addition to coarse sediment and other solids, vacuum sweeping machines achieve greater sediment, nutrient, and metals removal as compared to mechanical broom sweepers, which are designed to capture coarse particles.
- Sweeping Frequency – More frequent sweeping activities can result in greater pollutant removal.
- Sweeping Routes – Increased treatment area can also result in greater pollutant removal.

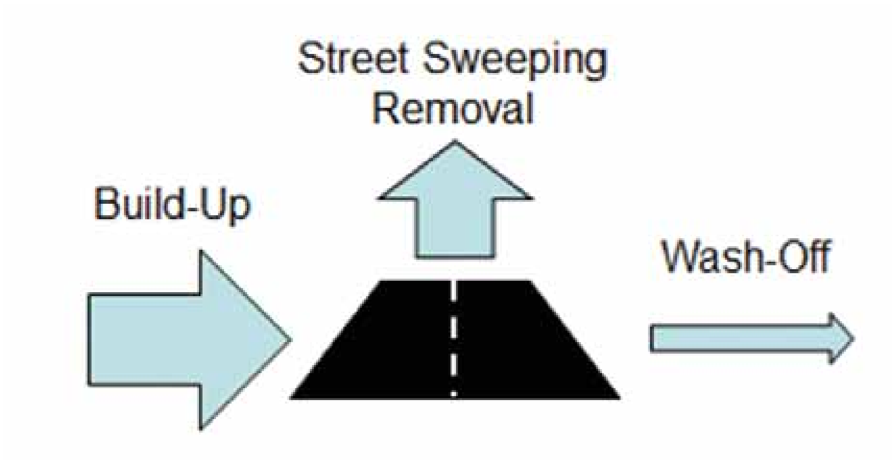

Figure J-7
Street and Median Sweeping Treatment Process

To develop a better understanding of the implications of assumptions associated with the proposed street sweeping program, an optimization analysis was performed. The optimization was set up to determine the optimal combination of enhancements to the street sweeping program to maximize sediment removal. Results from this optimization analysis were used to inform implementation decisions for individual watersheds.

The results of this analysis suggested that increasing the frequency and/or using enhanced sweeping equipment is more cost effective for sediment removal, and that extremely infrequent sweeping (i.e. every other month) is the least cost-effective for reducing sediment delivery in runoff. The interaction between street sweeping and the other pollutants varies by pollutant.

The modeled results suggested that:

- ❖ Street sweeping is cost effective for particulate matter like sediment and sediment-associated pollutants like metals, but not as cost effective for bacteria and nutrients. The metals removal cost-effectiveness gradient mirrors that of sediment removal.
- ❖ It is more cost-effective to sweep more frequently in watersheds with more rainfall.
- ❖ Because bacteria grow so quickly, increasing street-sweeping frequency provides little benefit for bacteria removal. In fact, the results suggest not sweeping as a means for controlling bacteria. Other BMPs may be more effective at bacteria management than sweeping; particularly those that are designed to reduce runoff volume.
- ❖ Similar to bacteria, more frequent street sweeping is also less cost-effective for nutrient removal. Direct source controls or practices that reduce runoff are likely more effective for nutrient removal than street sweeping.
- ❖ The “knee” of the cost-effectiveness curves, or where the slope of the curve begins to flatten and effectiveness begins to diminish, suggest that a frequency of bi-weekly, e.g. twice per month (third point from left), is the most cost effective frequency for street sweeping in Los Peñasquitos WMA.

Program Enhancements

Program enhancements are recommended based on a combination of optimization analysis results and findings gleaned from interviews with City of San Diego representatives (details regarding the interview process were presented in CLRP Phase II; City of San Diego 2013). The key findings of this analysis are:

- ❖ Enhancements of the street sweeping program should only be considered when sediment or metals load reduction is a concern (i.e. the effectiveness for reducing bacteria counts is minimal).
- ❖ Proposed and most cost-effective street sweeping frequency to implement in Los Peñasquitos WMA as part of the enhanced program is bi-weekly (or every other week) in all swept areas.

In summary, the enhanced street sweeping program in Los Peñasquitos WMA entails sweeping bi-weekly of all routes and the conversion of mechanical sweepers to regenerative-air sweepers. The current street sweeping program and proposed enhancements are summarized in Table J-1. Summaries of street sweeping program enhancements and modeling parameters are included in Table J-2.

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Table J-1
Summary of Current Street Sweeping Program for the City of San Diego in the Los Peñasquitos WMA

Machine	Total Linear Miles Swept		Detailed Distribution of Swept Roads				Annual Miles Swept	
	Road Miles	Curb Miles	Residential, bi-monthly (road miles)	Commercial, 1x week (road miles)	Commercial, 2x week (road miles)	Recommended Frequency, bi-weekly (road miles)	Road Miles Swept per Year	Curb Miles Swept per Year
Current Program								
Mechanical	457	914	339	107	11		8,742	17,484
Regen-Air*	27	54	7	20	0		1,082	2,164
Enhanced Program								
Mechanical	-	-	-	-	-	-	-	-
Regen-Air*	484	968	-	-	-	484	12,584	25,168

<u>Note:</u>
*Regen-Air = Regenerative Air
Current program assumes that Route 5c roads are swept by Regen-Air sweepers and 2% of remaining swept roads are also currently swept by Regen-Air.

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Table J-2
Summary of Model Parameters for Street Sweeping Program Enhancements

Parameter	Value	Source
Start month of sweeping practices	Continuous program	City of San Diego
End month of sweeping practices	Continuous program	City of San Diego
Typical days between HIGH frequency route sweeping	3-7	City of San Diego
Typical days between MEDIUM frequency route sweeping	30	City of San Diego
Typical days between LOW frequency route sweeping	60	City of San Diego
Fraction of land surface available for street sweeping	Provided at subwatershed level	GIS
Mechanical broom machine, weekly sweeping TS removal	13%	CWP 2008
Vacuum machine, weekly sweeping TS removal	31%	CWP 2008
Mechanical broom machine, monthly sweeping TS removal	9%	CWP 2008
Vacuum machine, monthly sweeping TS removal	22%	CWP 2008
Fraction of sand in solids storage available for removal by sweeping practices	78%	City of San Diego street sweeping pilot studies
Fraction of silt/clay in solids storage available for removal by sweeping practices	6%	City of San Diego street sweeping pilot studies
Fraction of gravel in solids storage available for removal by sweeping practices	16%	City of San Diego street sweeping pilot studies
Concentration of copper in the removed sediment	93 mg/kg	City of San Diego street sweeping pilot studies
Concentration of zinc in the removed sediment	136 mg/kg	City of San Diego street sweeping pilot studies
Concentration of lead in the removed sediment	23 mg/kg	City of San Diego street sweeping pilot studies
Concentration of TKN in the removed sediment	495 mg/kg	City of San Diego street sweeping pilot studies
Concentration of total phosphorus in the removed sediment	199 mg/kg	City of San Diego street sweeping pilot studies

Parameter	Value	Source
Concentration of bacteria in the removed sediment	0.00000521 x10^12 colonies per pound of street sediment	Pitt 1986

Note:
The location of existing sweeping activities will be used to spatially identify subwatersheds that will receive enhanced sweeping applications.
Proposed levels of enhanced sweeping activities will be distributed to the subwatershed level of the LSPC model.

J.2.2.2 Catch Basin Cleaning

Enhanced catch basin cleaning activities will contribute to watershed-scale pollutant load reductions. Note that while enhanced catch basin cleaning can significantly reduce pollutant loads, this BMP is not associated with runoff volume reduction. This section summarizes the findings of a study focused on optimizing the City of San Diego's catch basin cleaning program.

Treatment Process Overview

A representation of the catch basin cleaning process and associated pollutant removal is provided in Figure J-8. As the catch basin cleaning program improves effectiveness, pollutant loading to receiving waters through wash-off decreases. The primary method for improving pollutant reduction from catch basin cleaning activities is increased frequency of cleaning operations.

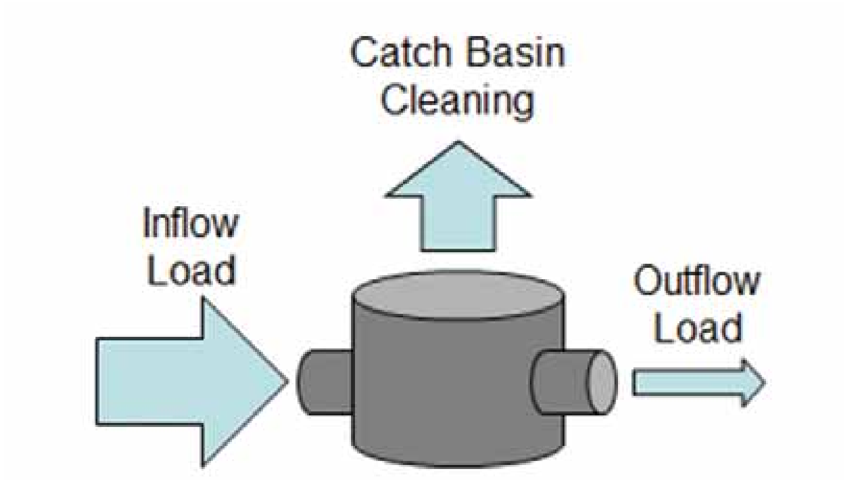


Figure J-8
Catch Basin Cleaning Treatment Process

To determine the maximum program enhancement scenario, manual clean-out data from 2009-2012 along with findings from the City of San Diego Catch Basin Cleaning Program Pilot Study (Tetra Tech, Inc. 2012, 2013a, and 2013b) were analyzed. As part of the pilot study, a detailed assessment was performed to categorize catch basins according to their tendency to yield high, medium, or low debris weights per cleaning event. The pilot study characterized typical pollutant loads per unit dry weight of debris. By combining these two pieces of information, estimates can be made regarding the effectiveness of the current program at reducing pollutant loads. In order to assess different possible scenarios for program enhancement, these data were used to perform an optimization analysis. Ultimately this information can be used to recommend the extent to which program enhancement is needed.

The pilot study findings suggested that catch basins tend to fill up with debris quickly during storm events and remain at their capacity for debris storage until they are cleaned. Since current catch basin cleaning activities are typically performed only once annually, there is ample opportunity to substantially increase pollutant load removal by increasing the number of cleanings per basin. Several different scenarios were developed for possible future increases in catch basin cleanings (Table J-3) and the associated pollutant load reductions were calculated based on concentrations of typical debris removal found in previous studies (Table J-4). The results of this analysis are presented in Figure J-9, which illustrates the cost-effectiveness of the increased cleaning activities relative to a 20-year implementation cost. It is important to note that catch basin cleaning activities achieve cost efficiency for certain pollutants (copper in particular) that is comparable to the implementation of green streets (City of San Diego 2013). However, cleaning activities can be implemented on a faster timescale and has less of an administrative burden than the construction of structural BMPs. It is also important to note that catch basin cleaning activities are not efficient for bacteria removal, as can be deduced from Figure J-9.

Table J-3
Enhancement Scenarios

Enhancement Scenario	Number of Additional Cleanings per Year		
	High Yield Grids	Medium Yield Grids	Low Yield Grids
(1)	1	--	--
(2)	2	--	--
(3)	3	--	--
(4)	3	1	--
(5)	3	2	--
(6)	3	3	--
(7)	3	3	1
(8)	3	3	2
(9)	3	3	3

Table J-4
Pollutant Concentrations Used to Calculate Reductions

Pollutant	Concentration (per kg of dry debris)	Source
Copper	75 mg/kg	Tetra Tech 2012
Zinc	232 mg/kg	
Lead	36 mg/kg	
Total Nitrogen	2,629 mg/kg	
Total Phosphorous	551 mg/kg	
Fecal Coliform	6.13 MPN/kg	

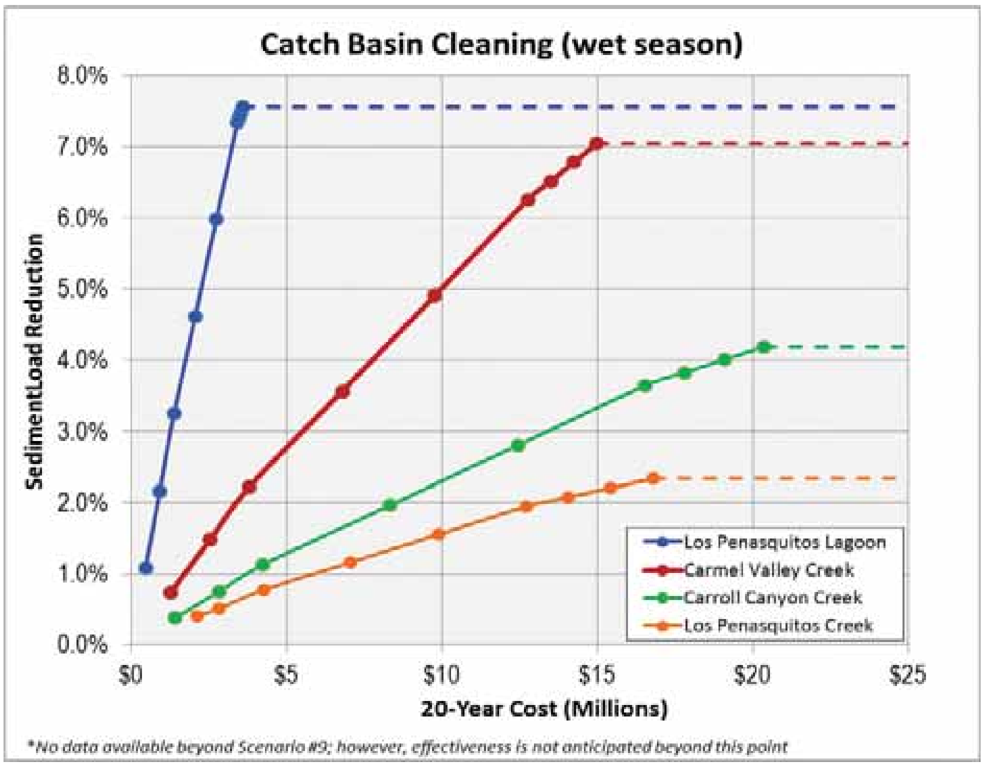


Figure J-9
Catch Basin Cleaning Program Enhancement Scenarios (Wet Season)

Program Enhancements

Program enhancements are recommended based on a combination of optimization analysis results and findings gleaned from interviews the City (details regarding the interview process were presented in CLRP Phase II; City of San Diego 2013). Because the critical pollutant for wet weather conditions is sediment in the Los Peñasquitos WMA, and because this BMP is sufficiently efficient, the City of San Diego's program was recommended to be implemented to the optimal extent. Recommended program enhancements are summarized in Table J-5.

Table J-5
Summary of Catch Basin Cleaning Program Enhancements in Los Peñasquitos WMA

Cleaning Metric	City of San Diego
Estimated # of Catch Basins in WMA	6,033
Total number of cleaning per year recommended	4
Number of Additional Catch Basin Cleanings per Year	18.099

Note:
Number of catch basins presented is based on catch basins in the City Grids within Los Peñasquitos WMA for which historic cleaning data is available. Based on historic data, CSD currently performs catch basin cleanings once per year on average.

J.2.2.3 Rain Barrels Incentive Program

The City of San Diego Public Utilities Department currently operates a rebate program for customers who harvest rainwater, including with rain barrels and cistern-type devices. The goal of this program is to minimize pollutant loads to receiving waters by reducing the runoff volume and peak flow originating from rooftops. Rooftop runoff can be collected in rain barrels and retained for irrigation reuse or slowly released after a period of storage. Pollutant load is reduced by releasing captured runoff onto landscaped areas, where pollutants are removed by the natural processes of infiltration and evapotranspiration.

The City's rain barrel rebate program is part of a larger landscape-based rebate program to promote and encourage implementation of specific BMPs for residential and commercial areas. The rain barrel rebate aspect of the program currently focuses on single-family residential landscapes, but it is intended to expand the program to multifamily and commercial areas. The landscape-based rebate program has a budget of $250,000 of annual funding to support rebate costs for all aspects of the program including rain barrels, downspout disconnects, micro-irrigation, and grass replacement. Of this rebate budget, it is anticipated that 10% of funds will support rain barrel rebates. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

Figure J-10 depicts rain barrel use to reduce runoff volume. As implementation of the rain barrel program grows, more rooftop runoff will be intercepted and temporarily stored in rain barrels. As a result, runoff volume and associated pollutant loads to receiving waters will also decrease. The effectiveness of a rain barrel program in reducing runoff volume is a function of the number of rain barrels installed. As the program encourages more rain barrel installations, reducing runoff volume further can be expected.

Simulating long-term rainfall and runoff processes in the LSPC will help determine the average rain barrel capture performance (runoff reduction) per rooftop drainage acre. Rain barrel modeling parameters are summarized in Table J-6.

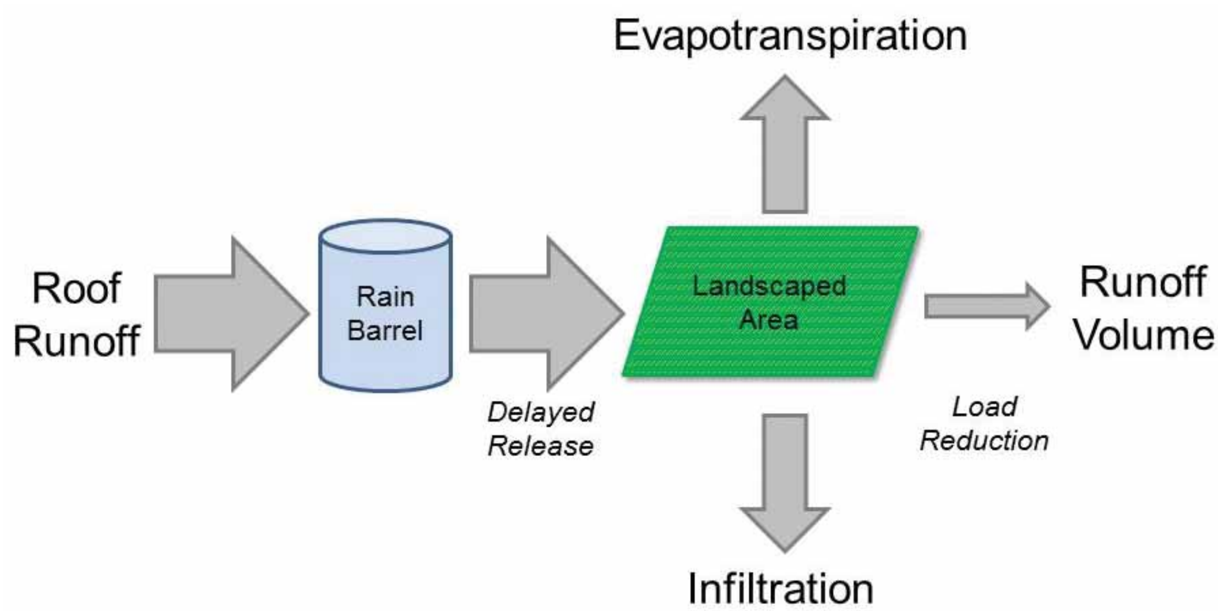


Figure J-10
Rain Barrel Treatment Process

Table J-6
Model Parameters for Rain Barrel Program Enhancements

Parameter	Value	Source
Contributing rooftop area to rain barrel in residential areas	500 square feet	City of San Diego
Rain barrel size (average)	65 gallons	City of San Diego
Primary outlet diameter (minimum)	0.5 inches	City of San Diego
Outlet pipe invert location	< 6 inches above bottom of barrel	City of San Diego
Overflow pipe diameter (minimum)	2 inches	City of San Diego
Maximum rain barrel outflow via 0.5-inch primary outlet	0.010 cubic feet per second	Orifice equation with depth = 2.5 feet
Rain barrel dewatering time	18 minutes	Typical value

Parameter	Value	Source
Assumed soil infiltration rate at rain barrel discharge	0.03 inches per hour	Type D soil infiltration parameter range
Assumed potential evapotranspiration rate	1.43 inches per month	Minimum monthly value in San Diego region in 2012
Assumed potential evapotranspiration rate	0.002 inches per hour	Typical regional value
Assumed allowable ponding depth in landscaping area	0.75 inches	Typical regional value
Required landscaped area downstream of rain barrel discharge location to prevent rain barrel runoff	144 square feet	Typical regional value
Landscaped area dewatering time	23 hours	Typical regional value

Program Enhancements

To maximize the benefit of implementation and to improve the effectiveness of the current program, program enhancements are recommended. As presented in the CLRP Phase I and II reports (City of San Diego 2012 and City of San Diego 2013), the recommended enhancements were determined based on rain barrel capture volumes and costs, potentially available single-family zoned parcels, available program budget, and discussions with City staff. Based on this information, it was estimated that 72 households per year will take advantage of rain barrel rebates in the Los Peñasquitos WMA. These figures are based on the single-family zoned parcels potentially available for implementation as well as input from City staff; see Table J-7.

Table J-7
Rain Barrel Program Enhancements*

Implementation Metric	City of San Diego
Single-family zoned parcels (SFZP) within watershed	71,750
SFZP percentage within Jurisdiction	18.7%
Rain barrel installations per year (based on number of rebates per year)	72

Note:
Only the City of San Diego elected to participate in the rain barrel enhancements.

J.2.2.4 Downspout Disconnection Incentive Program

Downspout disconnections are a BMP alternative to reduce runoff volumes in highly impervious watersheds. The purpose of this cost-effective BMP is to disconnect downspouts from rooftop surfaces and reroute downspout runoff to pervious areas where natural processes such as storage, infiltration, and evapotranspiration can remove pollutants.

The City of San Diego has recently initiated a pilot downspout disconnection program in the Newport Avenue area of the Ocean Beach community. The pilot program has demonstrated the effectiveness of downspout disconnections in reducing pollutant loads in highly impervious areas. As part of the City's larger landscape based rebate program, implementation of downspout disconnections are encouraged in residential and commercial areas. The landscape-based rebate program has an annual budget of $250,000 to support rebate costs for all aspects of the program. Of this rebate budget, it is anticipated that 10% of funds will support downspout disconnections in residential areas and 10% of funds will support downspout disconnections in commercial areas. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

Downspout disconnection is modeled by routing roof runoff to pervious land surfaces where overland flow over a typical lawn can be simulated. As roof runoff flows over a pervious surface, such as a lawn, natural infiltrative and evapotranspiration processes occur, reducing runoff volume and removing pollutants.

An overview of downspout disconnection represented in LSPC is shown in Figure J-11.

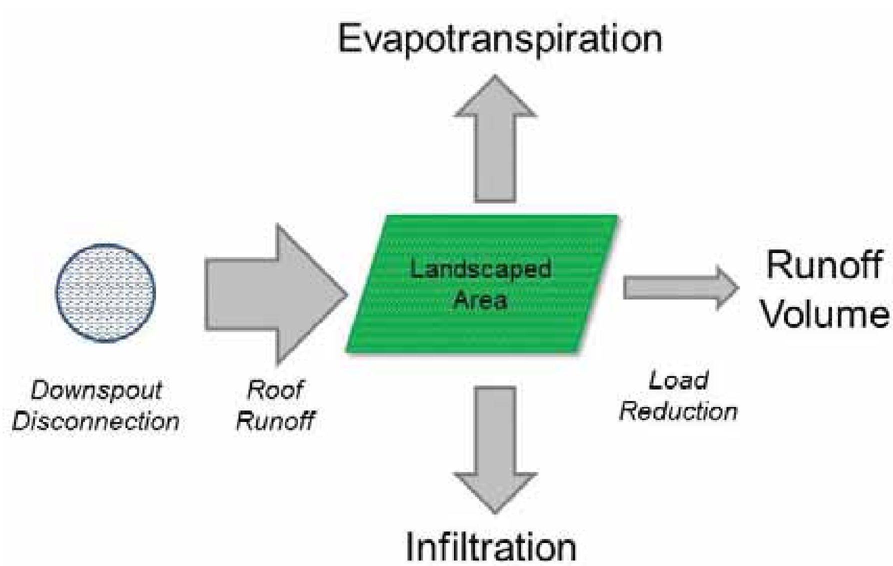


Figure J-11
Downspout Disconnection Treatment Process

Since the downspout disconnection program has recently been initiated, methods for improving runoff volume reduction through downspout disconnections are primarily additional facility installations. To estimate the number of anticipated downspout disconnection rebates in Los Peñasquitos WMA and throughout the City of San Diego, single-family zoned parcels was used as a metric to determine the relative distribution of rebates. Assumptions regarding modeling parameters for downspout disconnections are summarized in Table J-8.

Table J-8
Model Parameters for Downspout Disconnection Program Enhancements

Parameter	Value	Source
Contributing rooftop area to rain barrel (residential areas/commercial areas)	500 square feet/ 3,600 square ft.	Typical area
85th percentile flow to disconnection	0.001 cubic feet per second	Rainfall intensity = 0.2 inches/hour
85th percentile runoff volume to disconnections	10 cubic feet	P = 0.6 inches
Assumed soil infiltration rate at rain barrel discharge	0.03 inches per hour	Type D soil infiltration parameter range
Assumed potential evapotranspiration rate	1.43 inches per month	Minimum monthly value in San Diego region in 2012
Assumed potential evapotranspiration rate	0.002 inches per hour	Typical regional value
Assumed allowable ponding depth in landscaping area	0.75 inches	Typical regional value
Landscaped area dewatering time	23 hours	Typical regional value

Program Enhancements

Based on the available City budget for the program, the cost of installation, and discussion with City staff, it is estimated that 147 downspout disconnections in residential areas and 147 downspout disconnections in commercial areas would be anticipated to occur in Los Peñasquitos WMA. A total of 294 downspout disconnection rebates is anticipated for this watershed, and the remaining downspout disconnection rebate budget is expected to support rebates in other WMAs. Estimated program enhancements and potential single-family parcels for implementation are summarized in Table J-9.

Table J-9
Downspout Disconnection Program Enhancements

Implementation Metric	City of San Diego
Single-family zoned parcels (SFZP) within watershed	71,750
SFZP percentage within watershed	18.67%
Downspout disconnection installations per year in residential areas (based on number of rebates/year)	117

Note:
Only the City of San Diego elected to participate in the rain barrel enhancements.

J.2.2.5 Irrigation Runoff Reduction Program

Reductions of irrigation runoff help meet reduction goals for runoff volume and associated pollutant loads. This nonstructural strategy, which doubles as a water conservation initiative, incorporates good landscaping practices to limit irrigation runoff. Measures to reduce irrigation runoff can be implemented wherever landscapes are irrigated. Residential, commercial, recreational, and industrial land uses can be targeted by incentive policies and programs.

The City of San Diego Public Utilities Department currently operates a rebate program for various landscape-based practices. As part of this program, implementation of irrigation reduction runoff measures, such as micro-irrigation and grass replacement, are encouraged in residential and commercial areas. The landscape-based rebate program has an annual budget of $250,000 to support rebate costs for all aspects of the program. Of this rebate budget, it is anticipated that 15% of funds will support micro-irrigation rebates in residential areas, 15% will support micro-irrigation rebates in commercial areas, 20% will support grass replacement rebates in residential, and 20% will support grass replacement rebates in commercial areas. In addition to staffing, the City anticipates an annual 4% increase to the annual rebate budget for this program to accommodate program expansion.

Treatment Process Model Overview

The irrigation runoff reduction program encourages three types of practices—grass replacement projects, micro-irrigation system conversions, and weather-based irrigation controllers—to reduce irrigation runoff. These practices reduce runoff by increasing the capacity of runoff infiltration, conserving water, and/or irrigating only as needed, based on weather and soil inputs. These practices, collectively, are modeled by adjusting (reducing) irrigation inputs to urban grass land uses and adjusting how irrigation overspray is allocated between impervious and pervious land uses. To reduce irrigated runoff, the model simulates a combination of 25% less irrigated area and elimination of overspray to impervious areas. As implementation of irrigation runoff reduction measures increase, runoff volume and associated pollutant loads to receiving waters decrease.

Figure J-12 illustrates the irrigation reduction treatment process as represented in the LSPC model.

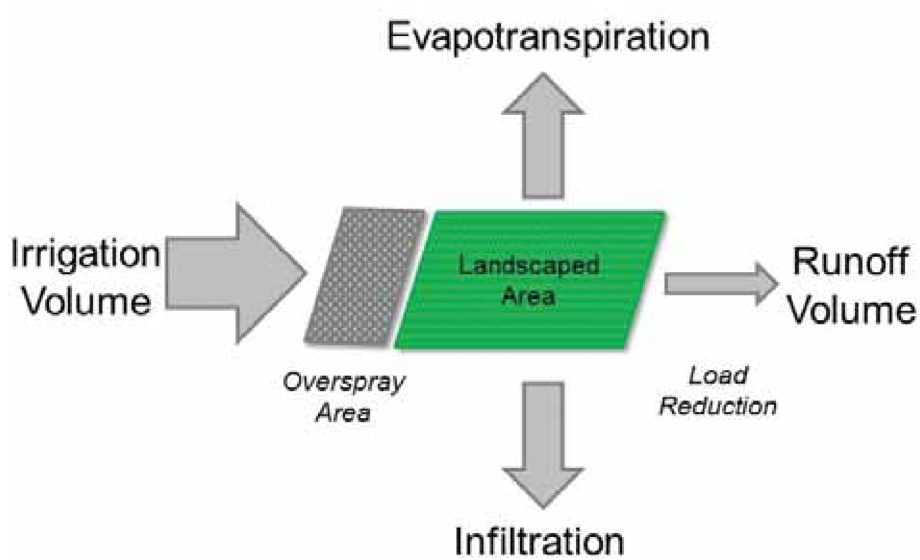


Figure J-12
Irrigation Reduction Treatment Process

Irrigation changes the normal water balance and influences all the components of hydrology. Most of the irrigated water is evaporated or transpired by the vegetation, but some of the irrigated water is added to baseflow. In semi-arid environments, the increase in baseflow can be substantial since natural baseflow is very low. There is also an increase in surface runoff. The soil is already saturated prior to rainfall events, so less rainfall soaks into the soil and more flows off the surface. Furthermore, urban landscapes often receive more irrigation than is needed to sustain the health of vegetation. Therefore, a reduction in irrigation leads to decreases in all components of hydrology. However, the response of the various components is not linear. For example, a small decrease in irrigation can prompt a large decrease in dry weather baseflow due to evapotranspiration. Since evapotranspiration demand is high in semi-arid environments, a greater proportion of the inputs (i.e. rainfall and irrigation) are lost through evapotranspiration.

Program Enhancements

Based on interviews with City of San Diego staff and the diverse options and means of implementation in the irrigation runoff reduction program, the recommendation to enhance this program is not a specific action or strategy, but a targeted outcome of 25% irrigation runoff reduction. Regardless of the reduction method, it is recommended that the Responsible Agencies reduce runoff from irrigation practices by 25%. The Responsible Agencies that elected to participate in an irrigation reduction program are listed in Table J-10.

Table J-10
Participation in Irrigation Reduction Program

	City of San Diego	County of San Diego	City of Poway	Caltrans	City of Del Mar
Participation for 25% reduction	Yes	Yes	Yes	No	Yes

J.3 Structural Strategies

Structural strategies (BMPs) provide the opportunity to intercept runoff and filter, infiltrate, and treat storm water. These structures tend to be more expensive than nonstructural strategies, but they also tend to have predictable and reliable effectiveness in removing pollutant loads. Additionally, structural BMPs provide other multiuse benefits to the community, such as habitat, aesthetics, and recreational opportunities.

Four major categories of potential structural BMPs were modeled in the Los Peñasquitos WMA using the LSPC and the System for Urban Stormwater Treatment and Analysis Integration model (SUSTAIN):

- Multiuse treatment areas,
- Green infrastructure,
- Water quality improvement BMPs, and
- Additional Watershed Opportunities

Section 4 describes these structural BMPs in detail, and this appendix summarizes representative BMP information for the four types of structural BMPs evaluated as part of this analysis.

J.3.1 Structural Strategy Modeling Assumptions

Structural BMPs will be an important element of the overall Water Quality Improvement Plan compliance strategy. The following subsections describe the assumptions that were applied to model the structural BMPs.

J.3.1.1 Multiuse Treatment Areas

Large treatment structural BMPs (referred to as multiuse treatment areas) are regional facilities that receive flows from neighborhoods or larger areas, which often serve dual purposes—flood control and groundwater recharge. These BMPs are often located in public spaces and can be collocated within parks or green spaces; these BMPs can provide excellent ecosystem services and aesthetic value to stakeholders. The first steps in evaluating potential multiuse treatment areas were primary site-selection screening and prioritization analysis, as shown in Figure J-13.

Figure J-13
Screening and Prioritization Methodology Concept

This analysis began by assessing parcels to screen out unsuitable site parameters for structural BMPs, such as steep slopes. These screened sites were then assessed for landscape characteristics, jurisdictional attributes, water quality needs, and general site sustainability to systematically evaluate and prioritize potential sites in each municipality throughout the WMA. Field investigations determined BMP feasibility and potential configuration; then the water quality and hydrology of the multiuse treatment areas were dynamically modeled. This subsection provides the process details and assumptions.

Screening and Prioritization Methodology

In 2009, the City of San Diego performed the *Parcel Evaluation for BMP Implementation Study* that provided a geographical information system (GIS) analysis and decision criteria for selecting parcels for BMP implementation in the City's jurisdiction. The study methodology was a starting point in developing the prioritization and screening process.

The process was further refined based on the experience of the Responsible Agencies and Tetra Tech, and based on CLRP Task 2 Pollutant Source Characterization data (City of San Diego 2012). The site-selection process identified parcels potentially suitable for BMP implementation using GIS-based analyses and the best available landscape and water quality data, as shown conceptually in Figure J-14.

Figure J-14
Parcel Screening Results

Site selection consisted of two major steps, including:

1. A primary screening to eliminate unsuitable parcels on the basis of physical and zoning characteristics; and

2. A separate site prioritization process for green infrastructure and multiuse treatment areas, to rank the suitability of the remaining parcels.

The primary screening for potential BMP opportunities was based on two parameters:

- **Parcel Zoning:** Parcels classified as single-family residential, based on the Nucleus Use Code attribute (a description of the use of the property provided by the county assessor), were not considered because of their average small size and the typically low cost-benefit ratio of implementing BMPs on single-family residential parcels. Research and experience nationally indicate that the runoff impacts of single-family parcels can be addressed more cost-effectively through outreach and education, or incentives for practices such as harvesting rainwater, improving irrigation, and converting turf and landscape.

- **Slope:** Parcels with a slope greater than 15 percent were not considered for BMP opportunities, other than parcels located in canyons. The screening was expanded to include areas in and around canyons for multiuse treatment areas. For this analysis, slope was determined on the basis of digital elevation maps or other available topographic data sets. In areas where the overall slope of the parcel was in question, slope was verified through review of aerial imagery.

The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation. A GIS analysis was performed on the remaining parcels to identify the potential sites for optional multiuse treatment area placement and to rank their potential suitability.

Potential sites were then prioritized on the basis of the parcel characteristics, plus additional considerations and different numerical criteria for multiuse treatment areas that were developed and reviewed in discussions with the Responsible Agencies. The additional considerations for identifying potential sites for multiuse treatment areas mainly regarded the use of open space and contributing watershed characteristics; see the following list.

- **Hydrologic Soil Group:** The mapped hydrologic soils groups are used as an initial estimate for the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs receive higher priority.
- **Proximity to Wells and Contaminated Soils:** Areas near contaminated sites received lower priority because of their potential for increased costs and complications during implementation.
- **Proximity to Environmentally Sensitive Areas (ESAs):** Areas where runoff can be treated before draining to an ESA were given a higher priority.
- **Parcel Percent Impervious:** Parcels with a large extent of existing open space tend to be more cost effective for BMP retrofits. Additionally, multiuse treatment areas can commonly be incorporated into existing recreational facilities to provide enhanced community benefits. Sites with a lower impervious coverage therefore received higher priority.
- **Parcel Size:** The size of the parcel was used to prioritize sites for multiuse treatment areas, with larger parcels receiving higher priority.
- **Proximity to Existing BMPs:** To distribute treatment opportunities effectively throughout the watershed, areas close to existing or planned future BMPs were given a lower priority.
- **Proximity to Parks and Schools:** Parks typically have the largest available open area and the lowest percentage of impervious area, and are well suited for multiuse treatment area implementation. Schools also tend to have large open areas, providing opportunities for BMP implementation. Areas classified as parks were given the highest priority, followed by schools. Other areas were given higher priority because of their opportunity for public outreach and education.

- **Proximity to the Storm Drainage Network:** Because multiuse treatment areas are especially effective where runoff can be diverted from the existing drainage network for treatment and control, areas close to the storm drainage network received higher priority.
- **Contributing Area:** The size of the drainage area that could be diverted and treated at each potential site was evaluated, and areas that capture and effectively treat runoff from the largest drainage areas were given higher priority.
- **Impervious Coverage of Contributing Area:** During storms, contributing drainage areas with a higher percentage of imperviousness produce increased runoff relative to the watershed size. Drainage areas with higher imperviousness were targeted for greater potential volume reduction and water quality improvements
- **Proximity to Corrugated Metal Pipe Systems:** To incorporate future upgrades to the storm drainage network in the City of San Diego, the proximity to a corrugated metal pipe system is to be considered and ranked on the basis of the necessity for rehabilitation.

The advantage of this prioritization process is the ability to select BMP locations that are best suited for maximum cost-effectiveness, resulting in the greatest pollutant load reductions per dollar. Because structural BMPs at any scale involve identifying and setting aside land for stormwater treatment, assessing opportunities on existing publicly owned lands is especially important. Structural treatment often can be integrated into parks, playing fields, street rights-of-way, and medians without compromising function, so opportunities for incorporating BMPs in recreation areas, streets, and other public open spaces are typically prioritized and used as a first step in evaluating sites.

The agreed-upon weightings for each factor are listed in Table J-11.

As part of CLRP Phase I efforts, multiple desktop and field-screening exercises were completed to develop a full understanding of the opportunities that exist for multiuse treatment area implementation in this WMA (City of San Diego, 2012). The sites were pared down and prioritized, based on feasibility, potential for pollutant load reduction, and other physical characteristics. The top-ranked sites in each hydrologic area for each Responsible Agency jurisdiction were identified, then each was reviewed using aerial photography to assess the validity of the site. Sites that were potentially feasible per the aerial photography review were used to target parcels where field investigations would be conducted. On the basis of the field evaluations, the sites were ranked by implementation feasibility. Fact sheets were then composed to convey the design intent and potential configuration of each site.

Table J-11
Prioritization Criteria for Multiuse Treatment Area BMP Implementation

Factor	Score (1 = Worst; 5 = Best)				
	1	2	3	4	5
Parcel Type	All Others	All Private Commercial or Industrial Parcels	—	Other-Owned Public Parcels (Assigned a Priority Score of 8)	City or County Public Parcels (Assigned a Priority score of 10)
Hydrologic Soil Group	D	—	C	—	A, B
Proximity to Wells and Water Supplies, and Contaminated Soils (Feet)	< 100	—	> 100	—	—
Proximity to Environmental Sensitive Areas (ESAs)	—	—	—	Drains to	Adjacent
Parcel Percent Impervious	> 40	—	—	30–40	≤ 30
Parcel Size (Acres)	< 1	1–100	100–150	150–200	≥ 200
Proximity to Existing and Proposed BMP Site (Miles)	< 2	2–3	3–4	4–5	> 5
Proximity to Parks and Schools (Feet)	—	—	< 1,000	School	Park
Proximity to Storm Drainage Network (Feet)	> 300	< 300	< 100	—	—
Contributing Area (Acres)	< 50	> 50	> 100	> 150	> 250
Impervious Coverage of Contributing Area (%)	< 40	> 40	> 50	> 60	> 70
Proximity to Corrugated Metal Pipe (CMP) Systems	CMP requiring no action	—	CMP needing rehabilitation	—	CMP needing replacement

Note:
1. Schools and universities, state and federal facilities, and utilities

Model Representation

Each of the multiuse treatment area BMPs was represented directly in the LSPC using a storage-discharge relationship to simulate outflow and a background infiltration rate reflective of the underlying soils (as shown in Figure J-15). By incorporating these features directly into the LSPC, the dynamic effect on volume and water quality incorporates all of the spatial variability (land use distribution and precipitation time series) within the model.

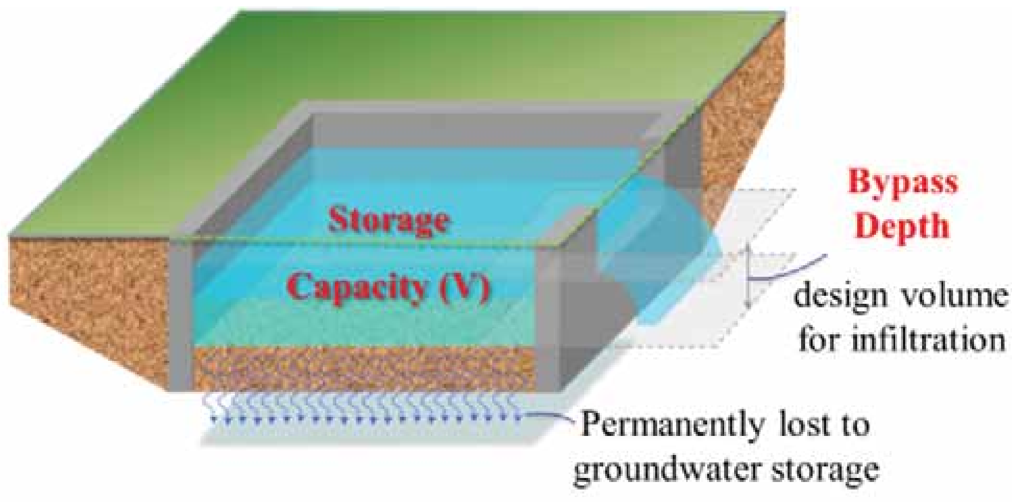


Figure J-15
Multiuse Treatment Area BMP Representation

The static storage volume of each optional multiuse treatment area was initially calculated as the required volume corresponding to the 85th percentile runoff depth, based on the average percent imperviousness in the upstream contributing drainage area (City of San Diego, 2008). The 85th percentile runoff depth was calculated uniquely for each multiuse treatment area, using the weather station assigned to the model subwatershed that includes each BMP. The storage volume and BMP dimensions were then verified and refined based on field reconnaissance to reflect realistic dimensions of the BMPs implemented at each unique location. Additionally, planned or already-implemented multiuse treatment areas with known dimensions and drainage areas were also represented modeled.

Modeling Results

From previous site selection optimization analyses, approximately 2,235 parcels were screened for BMP opportunities in the Los Peñasquitos WMA, resulting in 312 public parcels among the five Responsible Agencies. Eleven newly identified and nine known multiuse treatment area projects were identified during the screening and prioritization process, as listed in Table J-12 and displayed in Figure J-16. As shown it the table, most BMPs were modeled in SUSTAIN, but several BMPs were included explicitly in the LSPC baseline model to improve calibration.

Table J-12
Tabulation of Identified Potential Multiuse Treatment Areas in the Los Peñasquitos WMA

Name of Multiuse Treatment Area	Responsible Agency	Subwatershed	Type of Best Management Practice (BMP)	Modeled Total Drainage Area (acres)
Modeled with SUSTAIN				
Los Peñasquitos Lagoon Sediment Basin	City of San Diego	Los Peñasquitos Creek	Sediment Detention Basin	36,375
Ashley Falls	City of San Diego	Carmel Valley Creek	Retention Basin	30
Carroll Canyon Road Extension - Flintkote Sediment Detention Basin (Project ID 1007)	City of San Diego	Los Peñasquitos Lagoon	Sediment Detention Basin	35
Carroll Canyon Road Extension - Upper Sorrento Valley Road Sediment Detention Basin (Project ID 1007)	City of San Diego	Carroll Canyon Creek	Sediment Detention Basin	9,306
Carmel Creek Neighborhood Park and Elementary School	City of San Diego	Carmel Valley Creek	Infiltration Basin	66
Del Mar Trails Park	City of San Diego	Carmel Valley Creek	Detention Basin	19
Open Space adjacent to Carmel Knolls Drive	City of San Diego	Carmel Valley Creek	Infiltration Basin	301
Sage Canyon Park	City of San Diego	Los Peñasquitos Creek	Detention Basin	14.4
Open Space next to Canyonside Park Driveway	City of San Diego	Los Peñasquitos Creek	Detention Basin	181
Dingeman Elementary School and Spring Canyon Park	City of San Diego	Los Peñasquitos Creek	Detention Basin	559
Sandburg Park	City of San Diego	Los Peñasquitos Creek	Detention Basin	268
Maddox Park	City of San Diego	Carroll Canyon Creek	Detention Basin	570
Mira Mesa High School	City of San Diego	Carroll Canyon Creek	Detention Basin	261
Open Space adjacent to Carriage Road	City of Poway	Los Peñasquitos Creek	Stormwater Wetland	9,567
Hilleary Park - 01/23/14 - request has come in for a dog park	City of Poway	Los Peñasquitos Creek	Detention Basin	138
Included in Baseline Model				

Name of Multiuse Treatment Area	Responsible Agency	Subwatershed	Type of Best Management Practice (BMP)	Modeled Total Drainage Area (acres)
Community Detention Basin	City of Poway	Los Peñasquitos Creek	Detention Basin	9.5
Gate Detention Basin	City of Poway	Los Peñasquitos Creek	Detention Basin	206
Kirkham Detention Basin	City of Poway	Los Peñasquitos Creek	Detention Basin	150
Stotler Detention Basin	City of Poway	Los Peñasquitos Creek	Detention Basin	32
Stowe Detention Basin	City of Poway	Los Peñasquitos Creek	Detention Basin	200

The multiuse treatment area BMPs on public parcels incorporated in the model were mostly detention facilities (see Table J-12) because sites were largely located on soils with low infiltration capacities. All sites should be analyzed in detail to optimize their design and to maximize the subwatershed-wide load reductions.

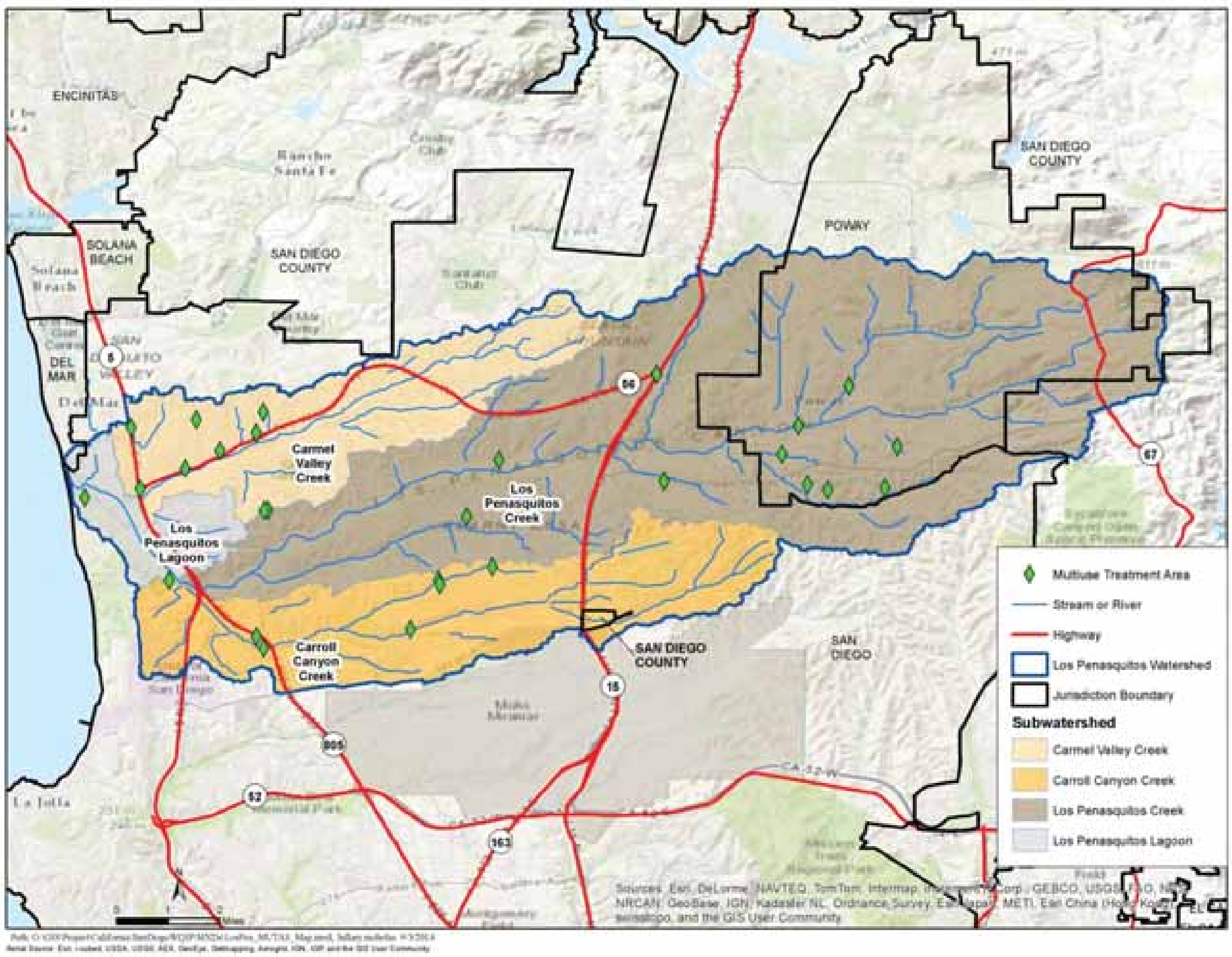


Figure J-16
Locations of Multiuse Treatment Area BMPs in the Los Peñasquitos WMA

J.3.1.2 Green Infrastructure

As with multiuse treatment areas, the first step in selecting the best potential new locations for green infrastructure BMPs was a site-selection and prioritization analysis. This analysis follows the concept presented in Section J.3.1.1, with some modifications specific to green infrastructure practices.

Screening and Prioritization Methodology

The same primary screening criteria presented in Section J.3.1.1 for multiuse treatment areas were used to initially screen out potentially unsuitable parcels for green infrastructure, based on slopes and land ownership. The results of the primary screening provided a base list of parcels potentially suitable for BMP implementation. Then a GIS analysis was performed on the remaining parcels to identify the potential sites for green infrastructure BMP placement and to rank their potential suitability. The following characteristics were used in this ranking:

- **Pollutant Loading:** Parcels where estimated pollutant loadings are greatest were given a higher priority. Land-based pollutant loadings were obtained from the CLRP Task 2 Pollutant Source Characterization modeling results. Pollutant loading percentiles were determined on a watershed basis, and represent the average pollutant loading scores. A composite wet- and dry-weather areal loading score was developed for each applicable TMDL pollutant in each watershed.
- **Parcel Zoning and Ownership:** Land costs generally are minimized by using existing public lands; therefore, a higher priority was placed on publicly-owned parcels.
- **Hydrologic Soil Groups:** The mapped hydrologic soils groups were used as an initial estimate of the infiltration rate and storage capacity of the soils. Sites where mapped hydrologic soils groups have infiltration rates suitable for infiltration BMPs received higher priority.
- **Wells, Water Supplies, and Contaminated Sites:** Areas near contaminated sites received lower priority because of their potential for increased costs and complications during implementation.
- **Environmentally Sensitive Areas:** Areas where runoff can be treated before draining to an ESA were given a higher priority.
- **Total Impervious Area:** Parcels with a larger total impervious area typically generate more runoff and greater pollutant loads, and so were given a higher priority. Where impervious data were not available, the impervious area was estimated using aerial imagery.
- **Percent Impervious:** Parcels with a higher percentage of impervious area also typically produce more runoff, and so were targeted on the basis of their greater potential to reduce volume and improve water quality.
- **Proximity to Existing BMPs:** To distribute treatment opportunities effectively throughout the watershed, areas close to existing or planned future BMPs were given a lower priority.
- **Proximity to Parks and Schools**: Areas closest to parks and schools were given a higher priority, in part to provide a greater opportunity for public outreach and education.
- **Proximity to the Storm Drainage Network:** Areas close to the storm drain network were given a higher priority. Green infrastructure BMPs on poorly draining soils require underdrain systems that tap into existing infrastructure, and siting these near the storm drain network can minimize cost.

Potential sites were prioritized using a scoring methodology developed in conjunction with the Responsible Agencies and presented in Table J-13. This scoring methodology puts an equally high emphasis on municipal or public ownership and areas most affected by land-based pollutant loadings (combined wet and dry weather loading). Ownership and pollutant loading can achieve a maximum score of 10; the remaining scoring criteria can achieve a maximum score of 5. Therefore, this methodology not only prioritizes locations where green infrastructure BMPs are practicably feasible but allows for selecting BMPs in public parcels where the load reduction would be potentially most effective.

The top-ranked sites in each hydrologic or subwatershed area for each Responsible Agency were also identified.

Table J-13
Prioritization Criteria for Potential Green Infrastructure BMP Locations

Factor	Score (1 = Worst; 5 = Best)				
	1	2	3	4	5
Wet Weather Areal Pollutant Loading	<20th percentile	40-20th percentile	60-40th percentile	80-60th percentile	>80th percentile
Dry Weather Areal Pollutant Loading	<20th percentile	40-20th percentile	60-40th percentile	80-60th percentile	>80th percentile
Parcel Zoning and Ownership	All Other Parcels	All Private Commercial or Industrial Parcels	—	Other-Owned Public Parcels: Priority Score of 8	City- or County-Owned Public Parcels and Rights-of-Way: Priority Score of 10
Hydrologic Soil Group	D	—	C	—	A, B
Proximity to Wells, Water Supplies, and Contaminated Soils (Feet)	< 100	—	> 100	—	—
Proximity to ESA (Optional)	—	—	—	Drains to	Adjacent to
Impervious Area (Acres)	—	> 0.1	> 0.25	> 0.5	> 1
Percentage Impervious	< 50	—	—	80–90	60–80
Proximity to Existing or Proposed BMP Site (Miles)	< 2	2–3	3–4	4–5	> 5
Proximity to Parks and Schools (Feet)	> 1,000	—	< 1,000	—	—
Proximity to Storm Drainage Network (Feet)	> 300	< 300	< 100	—	—

Note:
1. Schools and universities, state and federal facilities, utilities, etc.

Model Representation

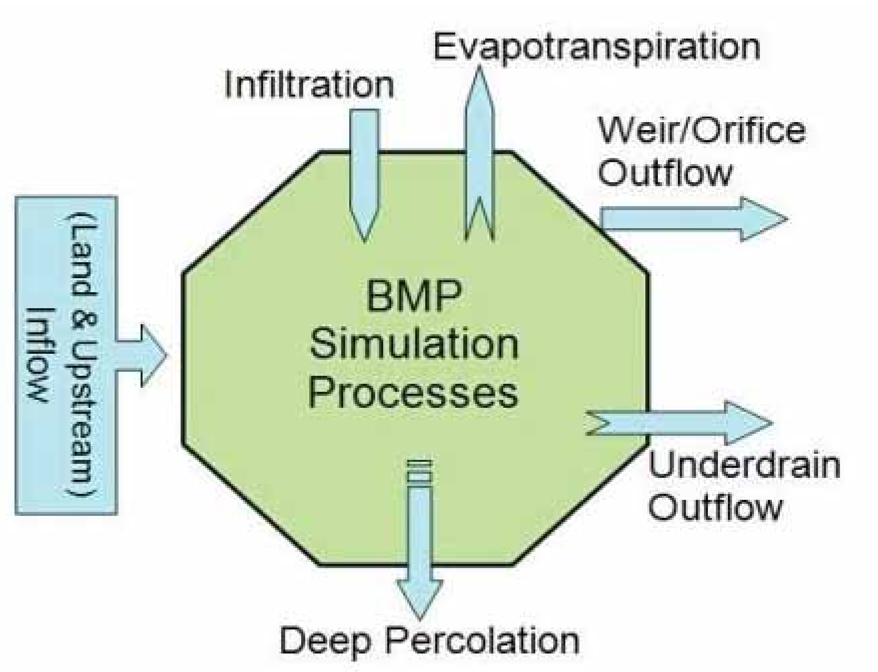
Green infrastructure BMPs were simulated in the LSPC, using bioretention or permeable pavement features. These BMPs' runoff and pollutant loading boundary conditions were generated for the modeling framework and were selected for evaluation in consideration of their suitability in various site configurations and their multiuse benefits. The model represented green infrastructure BMPs using a set of (a) physical characteristics that describe the feature geometry and (b) process-based parameters that describe the mechanisms related to flow and pollutant transport, such as evapotranspiration, infiltration, and pollutant loss. Physically, both bioretention and pervious pavement were conceptualized as having three compartments: (a) surface storage, which provides volume for ponding, (b) soil media or aggregate substrate, and (c) an optional underdrain reservoir when required by background soil conditions. Both bioretention and permeable pavement options were configured with and without underdrains, depending on the underlying soils. For instance, HSG B areas were modeled without underdrains and HSG C and D areas were modeled with underdrains. These modeling parameters are outlined in Table J-14.

Table J-14
Detailed Model Representation for Green Infrastructure BMPs

Parameter	Bioretention	Permeable Pavement
Surface Parameters		
Unit size (square feet) *(Varies with 85th percentile rainfall depth)*	808–1,520	1,388–2,610
Design drainage area (acres)*	1	1
Substrate depth (feet)	3	2
Underdrain depth (feet)	None for B Soil; 1.5 for C, D Soil	None for B Soil; 1.5 for C, D Soil
Ponding depth (feet)	0.75	0.01
Subsurface Parameters		
Substrate layer porosity	0.4	0.4
Substrate layer field capacity	0.25	0.1
Substrate layer wilting point	0.1	0.05
Underdrain gravel layer porosity	0.4	0.4
Vegetative parameter, A	1	0
Monthly growth index	1	0
Background soil infiltration rate (in./hr.), f_c	B–0.8; C–0.2; D–0.01	B–0.8; C–0.2; D–0.01
Media final constant infiltration rate (inches per hour), f_c	2	2

The modeled BMPs incorporated a variety of pathways through which water and pollutants travel through the BMP (e.g., infiltration, evapotranspiration, weir overflow, and underdrain outflow). Figure J-17 is a schematic diagram of the soil media and underdrain components illustrating the related physical and process-based parameters. As discussed above, inflow from the land was represented using the time series from the LSPC.

While the model representation of permeable pavement is similar to that of bioretention, the two features are distinguished by a different set of physical and process-based parameters that describe the function of infiltration, both through the aggregate media and into background soils. For example, the ponding depth of pervious pavement is physically much shallower than that of bioretention, because, in practice, stormwater would not be allowed to accumulate on the paved surface. Also, because permeable pavement is not vegetated, its potential for evapotranspiration is also greatly diminished as compared to that of bioretention.



Source: Lee et al., 2012

Figure J-17
Conceptual Diagram of Selected Processes Associated with Structural BMPs

Green infrastructure BMPs were modeled in CLRP Phase II by assuming that BMPs were sized to capture the 85th percentile runoff volume from the impervious cover of each suitable public parcel in each subwatershed (City of San Diego 2013). Additionally, the City of San Diego is demonstrating progress towards reducing pollutant loads through a number of green infrastructure BMP projects that have already been implemented. Those green infrastructure projects (identified in Table J-15) were modeled with project-specific details to consider the water quality benefits provided by these practices.

Table J-15
Tabulation of Identified Los Peñasquitos Green Infrastructure Projects

Green Infrastructure	Responsible Agency	Subwatershed	Best Management Practice Type	Modeled Impervious Drainage Area (acres)[1]
Miramar Water Treatment Plant	City of San Diego	Carroll Canyon Creek	Grass/Vegetated Swales	5.07
Del Mar Mesa Neighborhood Park	City of San Diego	Los Peñasquitos Creek	Inserts and buffers	0.83
Carroll Canyon Road Extension - added 4/11, under construction	City of San Diego	Carroll Canyon Creek	Grass/Vegetated Swale	5.30
Mira Mesa Library Green Lot	City of San Diego	Los Peñasquitos Creek	Bioretention, Permeable pavement	0.34
Camino Ruiz Neighborhood Park	City of San Diego	Los Peñasquitos Creek	Grass/Vegetated Swale	1.49
Breen Park Site - Development	City of San Diego	Los Peñasquitos Creek	Grass/Vegetated Swale	0.60
Rancho Peñasquitos Skate park	City of San Diego	Los Peñasquitos Creek	Infiltration Basin or Trench (2)	0.57
Fire Station #47	City of San Diego	Carmel Valley Creek	Grass/Vegetated Swale	0.28
Torrey Del Mar Neighborhood Park	City of San Diego	Carmel Valley Creek	Grass/Vegetated Filter Strips (2) AND Grass/Vegetated Swales (2)	1.02

[1] Impervious drainage areas, for modeling purposes, were estimated based on assumed percent imperviousness of the total drainage area in Los Peñasquitos WMA.

Modeling Results

The screening and prioritization process identified the potentially suitable parcels for optional green infrastructure implementation in the Los Peñasquitos WMA, as shown in Figure J-18. These prioritized parcels provide a basis for selecting project sites throughout the WMA and should be cross-referenced with already-planned projects (e.g. parking lot improvements, utility work, landscaping enhancements, etc.) to ensure cost-effective scheduling and implementation. All projects should be sized to capture and treat the 85th percentile runoff volume from the contributing impervious parcel area.

The modeled quantities of green infrastructure that were predicted (in addition to other nonstructural strategies and structural BMPs) to meet the sediment wet weather load reductions are shown in Figure J-18 and listed in Table J-16. These BMPs should be applied throughout each modeled subwatershed, based on the list of prioritized parcels during CLRP I efforts (City of San Diego 2012) and shown in Figure J-18.

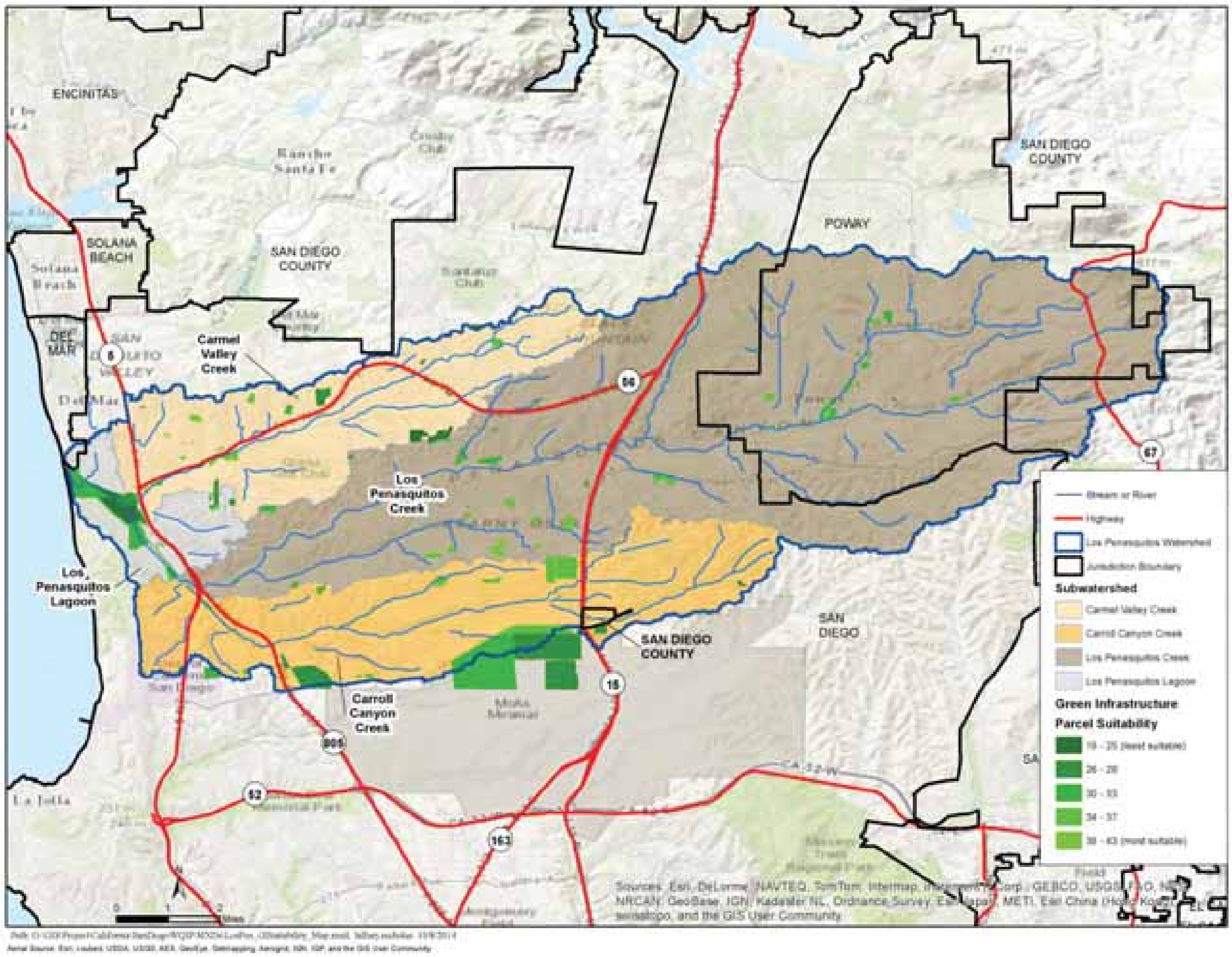


Figure J-18
High-Ranked Locations
of Optional Green Infrastructure Best Management Practices

J.3.1.3 Green Streets

Green streets provide an additional opportunity for locating BMPs in a publically owned location. To evaluate the extent to which green streets can help achieve compliance with reduction goals, an assessment was performed to identify green streets opportunities on a WMA-wide basis.

Screening and Prioritization Methodology for Potential Sites

Available green street implementation and contributing areas were determined using existing GIS information, sample roads, and existing project designs. The process began with identifying streets appropriate for green street retrofits and estimating the typical contributing area from surrounding parcels. Using the County roads information available on SANGIS, the roads were screened based on their functional class attribute so only roads with suitable characteristics were selected. These initial screening steps are illustrated in Figure J-19.

Figure J-19
Street Screening Results

Model Representation

The City of San Diego provided data that measures the street width from curb-to-curb and the right-of-way width allowing for a calculation of the space between the curb and edge of the right-of-way known as the parkway width. The parkway width information was combined with the selected function class roads and the median parkway width was identified for each of the function classes. An associated bioretention width was then assigned based on the available parkway width. The typical available length of BMP was estimated based on engineering judgment from designing green streets, such as the City of San Diego's Bannock Avenue. The length of the bioretention cells was measured and compared to the length of each road segment to give an overall percentage of the roadway length that is available for BMP implementation. It was assumed that permeable parking lanes can also be installed in conjunction with each bioretention segment.

The contributing areas to the BMPs were found using random road sampling and identifying the surrounding drainage patterns. Using a random number generator, road segments of the identified function classes and surrounding land use were selected and the contributing area draining to the right-of-way was outlined based on a desktop analysis of topography, aerial imagery, and drainage infrastructure. Using the multiple samples for each function class and land use, the average contributing area of the surrounding parcels was identified. The roads deemed appropriate for BMP classification in the first step were tallied in each subwatershed and compared to the total roadway length within each subwatershed. This reduction percentage was assumed to be the available roads for BMP implementation across each subwatershed. The land uses in each subwatershed were multiplied by these two reducing factors to identify contributing areas to implementable roads. The areas were summed by subwatershed for the model input. Ultimately, the BMPs were represented in the modeling framework in the same way that they are described in J-3.1.2 of this appendix, except that the BMP-to-drainage area ratio was allowed to vary such that optimum solutions could be determined. Additionally, results were compared for both 18” and 24” depth bioretention areas in order to determine which was most cost-effective. It was found that 18” of substrate depth provided enough depth for effective pollutant load reduction for the Highest Priority Water Quality Condition in this case, sediment. Thus 18” was used for the bioretention areas substrate depths in the model.

Green street optimization was performed for each subwatershed in the WMA so that modeled implementation was dependent upon the loading and hydrologic conditions unique to each subwatershed.

Modeling Results

The screening process classified the percentage of suitable roads for green street implementation in each modeled drainage area, as shown in Figure J-20. The extents of suitable roads displayed in Figure J-20 and tabulated in Table J-16 represent the planning-level extent of green street retrofits in the Los Peñasquitos WMA. The table also tabulates the proportion of BMPs requiring underdrains to allow functionality in areas with poor draining soils. Implementation of all green street opportunities is needed to meet the Water Quality Improvement Plan sediment targets, and thus the locations for implementation were not optimized. Street-scale analysis is required to determine the most cost effective green street locations and drainage area ratios.

Table J-16
Modeled Green Street Sizes to Meet Subwatershed Goals

Subwatershed	Jurisdiction	Total Green Street BMP Footprint (acres)	Percentage of BMPs Requiring Underdrains
Carmel Valley Creek	City of San Diego	53.20	68%
Carroll Canyon Creek	County of San Diego	0.13	100%
	City of San Diego	55.92	98%
Los Peñasquitos Creek	City of Poway	64.64	73%
	County of San Diego	0.41	94%
	City of San Diego	121.42	96%
Los Peñasquitos Lagoon	City of Del Mar	0.06	0%
	City of San Diego	9.06	68%

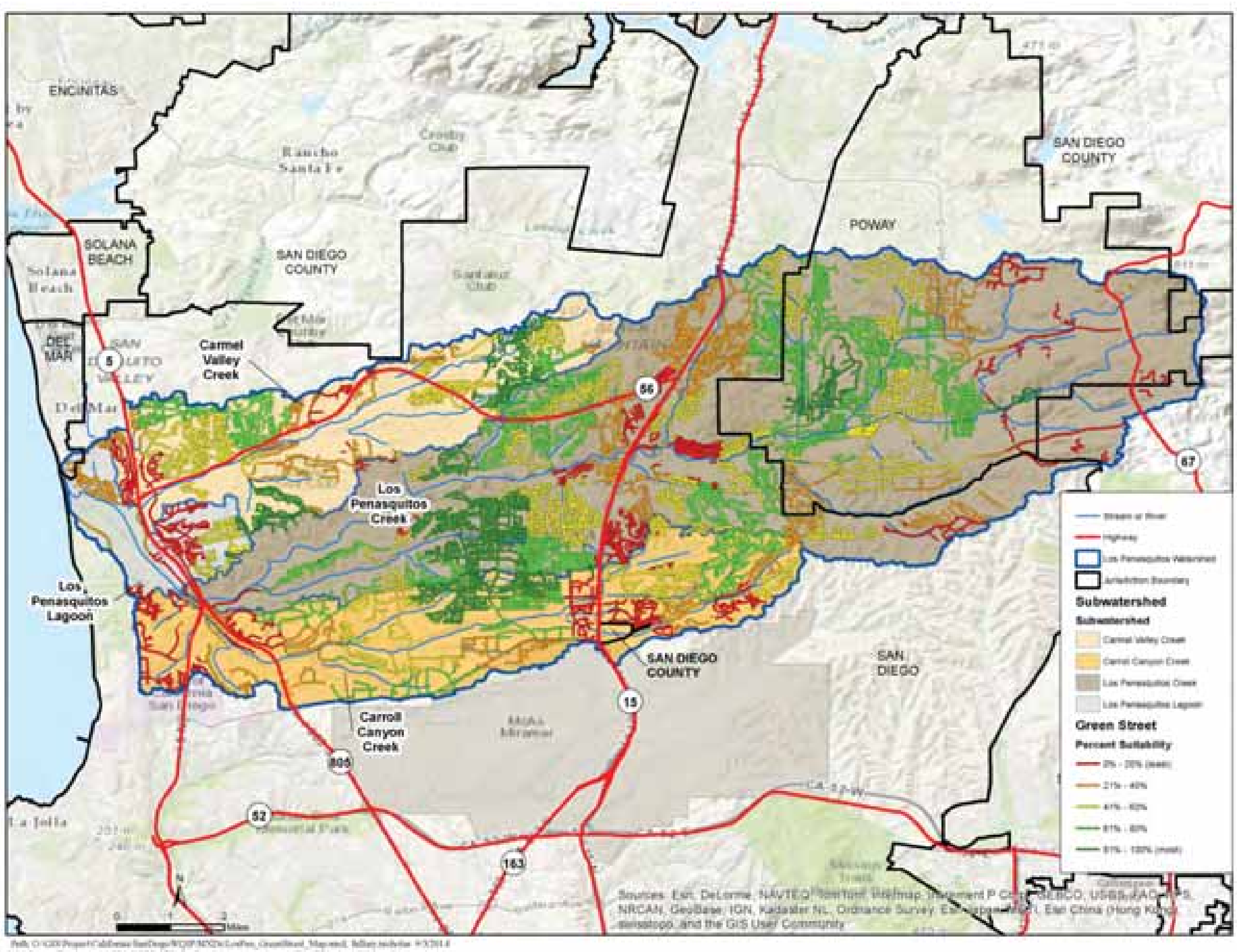


Figure J-20
Green Street Opportunity Screening Results (Potential Retrofit Suitability by Subwatershed) Water Quality Improvement BMPs

Water quality improvement BMPs include strategies such as low-flow diversions and proprietary BMPs. These BMPs can be useful where green infrastructure is not suitable because of design constraints. No water quality improvement BMPs were explicitly modeled within the Los Peñasquitos WMA.

J.3.1.4 Additional Opportunities

In the event that the combination of structural and nonstructural BMPs discussed above are not sufficient to meet reduction goals, additional strategies exist that can be identified and implemented through adaptive management to achieve interim and final numeric goals. In general, additional opportunities may include the creation of additional sediment detention basins, stream and canyon restoration, Lagoon restoration, new strategies not yet identified, phased implementation, operation, and maintenance of the additional required acreage of multiuse treatment area projects, or increased implementation of nonstructural and/or green infrastructure BMPs that would be equivalent to the storage volume required for treatment. Activities particularly relevant within the Los Peñasquitos WMA that target water quality improvement include upgrades to existing MS4 outfalls along canyon slopes to reduce scouring, low impact development measures in the developed mesas, restoration or enhanced sediment management of reaches affected by mining operations, and stabilization of various sections of Carroll Canyon Creek. In addition, development of a comprehensive Los Peñasquitos Lagoon Restoration strategy will provide an opportunity to reassess the watershed sediment load reduction needs and further refine the overall direction of the Water Quality Improvement Plan.

Because of limited restoration component details currently available, load reductions for additional opportunities were estimated as the implementation of two additional sediment detention bases, similar to the existing basin in Los Peñasquitos Creek subwatershed, restoration of five creek segments including repair or replacement of MS4 outfalls, and restoration of the Lagoon as discussed further in Section 4.2.5.1. Detailed modeling or technical analyses will need to be performed to quantitatively assess the water quality benefits as a result of the restoration and to identify other regional structural BMPs, if needed, to meet the Water Quality Improvement Plan numeric goals. As discussed in Section J.4, where additional opportunities beyond the sediment basins, outfall repair and stream restoration, and Lagoon restoration are needed, the additional opportunities were modeled as additional multiuse treatment areas in non-publicly owned areas.

Screening and Prioritization Methodology for Potential Additional Multiuse Treatment Areas

Modeling of additional watershed opportunities was considered only at a conceptual level as it is not feasible to consider all factors needed to locate specific multiuse treatment areas due to unknown locations and land availability. As such, private parcels were considered as viable options for additional watershed opportunities; this assumption can be refined once detailed implementation strategies (including stream, channel, and habitat restoration projects and public private partnerships) are proposed and analyzed.

Model Representation of Additional Multiuse Treatment Areas

Individual SUSTAIN models were developed for each subwatershed to characterize the unit response of a hypothetical BMP. Unlike the green streets optimization, which was based upon a detailed desktop analysis of BMP opportunities, the optimization of additional watershed opportunities was founded on a higher level planning analysis due to the unknown locations and availability of private land acquisition. Specific spatial and climatic characteristics of each individual subwatershed were loaded into SUSTAIN and hypothetical BMPs were simulated with a fixed drainage area necessary to capture the design storm. Each BMP was represented by fixing the depth at 2 feet and allowing the footprint to vary based on the required volume. In few cases, some special BMP configurations were made. To meet targets, BMP depths were increased to 3 feet and orifices were raised 8 inches in City of San Diego jurisdiction in Carmel Valley Creek Watershed. To ensure equity of treatment BMPs in San Diego County in Carroll Canyon Creek, orifices were raised to 8 inches and depths remained at 2 feet. It is important to note that for these areas, special design considerations such as drawdown time, vector control, signage, and fencing may be necessary for these deeper sized BMPs. Modeling each individual subwatershed separately allowed quantification of a unique BMP response which is a function of both variation in precipitation and a unique land use distribution.

The optimization analysis included numerous combinations of BMP location and size scenarios. Construction costs were incorporated as a function of both BMP footprint and volume based on previous construction line item cost estimates completed for similar BMPs.

Model Results for Additional Multiuse Treatment Areas

The optimization system selected the most cost effective combinations of additional watershed opportunities in each subwatershed to attain the wet weather load reduction goal. Because specific project locations and configurations have not been identified for additional watershed opportunities, the modeling results represent a planning-level quantity of BMPs that must be implemented to achieve compliance. Adaptive management and more detailed analysis will be used to identify specific projects to achieve the load reduction goals.

J.4 Comprehensive Strategy Results

Nonstructural and structural strategies were modeled to demonstrate progress toward attaining the numeric goals outlined in the main body of this document. The focus of the optimization analysis is to consider the cost-effectiveness of subwatershed-wide implementation of BMPs. Optimization incrementally considers costs of BMP implementation and accounts for progress toward achieving the load reduction goals. The targets for optimization are the jurisdictional goals, the percent load reduction goal equitably distributed among jurisdictions, presented in Section 4.1. An equitable percent load reduction goal ensures an overall net load reduction for the entire subwatershed with the ability for each Responsible Agency to achieve the load reduction appropriately and effectively for each jurisdiction. A relative percent load reduction goal also ensures equitable distribution of the pollutant mass to be reduced—requiring the City of San Diego (with higher existing loads) to implement more BMPs to reach the reduction goal, but still achieve the same percent reduction as other Responsible Agencies.

Strategies were prioritized by order of those that are most cost-effective. For instance, nonstructural strategies are effective in reducing pollutant loads before they enter the storm drain and are generally cost-effective and require a shorter planning period. Therefore, most nonstructural strategies are planned for implementation before or upon approval of the Water Quality Improvement Plan. Structural BMPs can be cost-effective when greater load reductions are needed and treatment must occur after the pollutants enter the storm drain system, particularly when benefits other than water quality improvements are considered. However, planning for structural BMPs requires more time to secure resources, design BMPs, and obtain permits. Most of the structural BMPs are planned for later in the compliance period to allow more time to ensure that the implementation is necessary to meet numeric goals and is designed to achieve the load reductions required, and that alternatives to these BMPs have been evaluated. The following sections summarize the combined load reductions predicted for all modeled strategies for each Responsible Agency.

J.4.1 Caltrans Results

Caltrans will voluntarily implement the strategies outlined in Section 4.2 of the Water Quality Improvement Plan, as resources are available, per the schedule provided in Appendix I. Attachment IV to the Caltrans MS4 permit, outlines a methodology for prioritizing stream segments included in TMDLs in which Caltrans is subject to. The permit establishes BMP implementation requirements evaluated in terms of compliance units, as opposed to load reduction targets. Caltrans is expected to achieve 1650 compliance units per year through the implementation of retrofit BMPs, cooperative implementation, and post construction treatment beyond permit requirements.

For Bacteria TMDLs, Caltrans is expected to eliminate dry weather flows by implementing control measures to ensure effective prohibition (Provision B.2 of the Permit). For wet weather flows, Caltrans is expected to implement control measures/BMPs to prevent discharge of bacteria from the ROW; this can be source control and preemptive activities such as street sweeping, clean-up of illegal dumping and public education on littering. Implementation of these controls is per the TMDL prioritization list currently under development. The Sediment TMDL has not been incorporated into the Caltrans MS4 Permit.

J.4.2 City of Del Mar Results

Table J-17 and Table J-18 summarize pollutant load reductions for wet and dry weather conditions for the City of Del Mar. These tables present the load reductions predicted for all modeled strategies within the WMA and demonstrate that the strategies presented in the Water Quality Improvement Plan will reach the dry and wet weather subwatershed percent load reduction goals. Mass of sediment removed in terms of tonnage is presented in Table J-19 for wet weather conditions.

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Table J-17
Predicted Wet Weather Load Reduction Summary for the City of Del Mar

Strategy and Level of Implementation[1]	City of Del Mar – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Los Peñasquitos Lagoon Subwatershed										
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	3.2%	0.1%	4.4%	0.6%	1.4%	0.2%	2.3%	4.0%	<0.1%	<0.1%
Green Infrastructure 0.001 acre BMP to treat an impervious drainage area of 0.06 acre with a total storage volume of 0.002 acre-foot	0.1%	0.4%	0.2%	<0.1%	0.1%	0.1%	0.3%	0.2%	0.3%	0.1%
Green Streets[3] 0.06 acre BMP to treat a total drainage area of 2.59 acres with a total storage volume of 0.05 acre-foot	6.9%	9.1%	5.4%	11.6%	9.3%	11.7%	7.9%	5.9%	8.9%	8.7%
Additional Opportunities[3] 0.18 acre with a total storage volume of 0.35 acre-foot	14.6%	21.2%	18.3%	17.6%	16.5%	17.6%	19.7%	17.4%	21.3%	21.1%

Strategy and Level of Implementation[1]	City of Del Mar – Wet Weather Percentage Reductions								
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Total	34.8% Goal = 34.8%	40.7% Goal = 2.0%	38.3%	39.8%	37.3%	39.7%	40.1%	37.4%	40.5% Goal = 1.9%	39.9% Goal = 1.6%

Note:

1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Strategy has been identified as potential based on results of a model that may not be reflective of the small drainage area that leads from Del Mar to the lagoon. The strategy is presented until further analysis (including monitoring data) can confirm or revise the needs and strategies.

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-18
Predicted Dry Weather Load Reduction Summary for the City of Del Mar

Strategy and Level of Implementation[1]	City of Del Mar – Dry Weather Percentage Reductions									
	Total Sediment	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Los Peñasquitos Lagoon Subwatershed										
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	32%	99%	32%	26%	37%	59%	65%	86%	99%	99%
Total	42%	100%[3] Goal = 96.6%	42%	36%	47%	69%	75%	96%	100%[3] Goal = 99.4%	100%[3] Goal = 96.5%

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

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Table J-19
Predicted Wet Weather Load Sediment Mass Reduction Summary for the City of Del Mar (Tonnage)

Strategy	City of Del Mar – Wet Weather Sediment Tonnage Reduction[1,2,3]
	Los Peñasquitos Lagoon
Nonstructural, non-modeled	0.13
Nonstructural, modeled	0.04
Irrigation Reduction	
Structural, modeled	<0.01
Green Infrastructure	
Green Streets	0.09
Additional Opportunities	0.20

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Sediment masses are land-based removals and do not account for in-stream processes.
3. The mass of sediment reduction is, in part, related to rainfall, which varies by year. Tonnage presented represents the estimated mass removed based on rainfall data during the wet period October 1, 2002– April 30, 2003.

J.4.3 City of Poway Results

Table J-20 and Table J-21 summarize pollutant load reductions for wet and dry weather conditions for the City of Poway. These tables present the load reductions predicted for all modeled strategies within the WMA and demonstrate that the strategies presented in the Water Quality Improvement Plan will reach the dry and wet weather subwatershed percent load reduction goals. Mass of sediment removed in terms of tonnage is presented in Table J-22 for wet weather conditions.

Table J-20
Predicted Wet Weather Load Reduction Summary for the City of Poway

Strategy and Level of Implementation[1]	City of Poway – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Los Peñasquitos Creek Subwatershed										
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	4.0%	0.1%	3.5%	0.9%	1.9%	0.3%	2.0%	2.5%	<0.1%	<0.1%
Street Sweeping[3] See Section 2.2.1	3.3%	<0.1%	<0.1%	9.5%	5.2%	8.3%	<0.1%	<0.1%	<0.1%	<0.1%
Multiuse Treatment Areas 3.3 acre BMP to treat a total drainage area of 9,705 acres with a total storage volume of 4.9 acre-feet	0.6%	2.7%	6.6%	0.5%	0.4%	0.4%	3.8%	1.9%	3.5%	3.1%
Green Infrastructure 0.26 acre BMP to treat an impervious drainage area of 74.58 acres with a total storage volume of 3.64 acre-feet	0.04%	0.22%	0.08%	0.02%	0.04%	0.04%	0.14%	0.09%	0.19%	0.05%
Green Streets 64.64 acre BMP to treat a total drainage area of 2,908.84 acres with a total storage volume of 90.13 acre-feet	26.5%	32.3%	10.4%	40.9%	29.7%	40.8%	22.9%	21.9%	33.6%	31.7%

Strategy and Level of Implementation[1]	City of Poway – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Additional Opportunities										
Lagoon restoration, outfall repair/replacement, stream restoration, and other opportunities	7.5%	Load Reductions from pollutants not assessed, but are anticipated.								
Total	51.9% Goal = 47.2%	45.3% Goal = 2.0%	30.6%	61.8%	47.3%	59.8%	38.9%	36.4%	47.3% Goal = 1.9%	44.9% Goal = 1.6%

Note:

1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Nonstructural, modeling load reductions do not yet include street sweeping enhancements.

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-21
Predicted Dry Weather Load Reduction Summary for the City of Poway

Strategy and Level of Implementation[1]	City of Poway – Dry Weather Percentage Reductions									
	Total Sediment	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Los Peñasquitos Creek Subwatershed										
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	37%	99%	33%	32%	43%	57%	64%	75%	99%	99%
Total	47%	100%[3] Goal = 96.6%	43%	42%	53%	67%	74%	85%	100%[3] Goal = 99.4%	100%[3] Goal = 96.5%

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

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Table J-22
Predicted Wet Weather Load Sediment Mass Reduction Summary for the City of Poway (Tonnage)

Strategy	City of Poway – Wet Weather Sediment Tonnage Reduction
	Los Peñasquitos Creek[1,2,3]
Nonstructural, non-modeled	61.5
Nonstructural, modeled	20.4
Street Sweeping	
Irrigation Reduction	24.89
Structural, modeled	3.4
Multiuse Treatment Areas	
Green Infrastructure	0.2
Green Streets	163
Additional Opportunities	45.8

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Sediment masses are land-based removals and do not account for in-stream processes.
3. The mass of sediment reduction is, in part, related to rainfall, which varies by year. Tonnage presented represents the estimated mass removed based on rainfall data during the wet period October 1, 2002– April 30, 2003.

J.4.4 City of San Diego Results

Table J-23 and Table J-24 summarize pollutant load reductions for wet and dry weather conditions for the City of San Diego. These tables present the load reductions predicted for all modeled strategies within the WMA and demonstrate that the strategies presented in the Water Quality Improvement Plan will reach the dry and wet weather subwatershed percent load reduction goals. Mass of sediment removed in terms of tonnage is presented in Table J-25 for wet weather conditions. In compliance with the Settlement Agreement and Release (Settlement) made with San Diegans for Open Government (SDOG) and Coastal Environmental Rights Foundation (CERF), City of San Diego will conduct either increased street sweeping or additional catch basin inspection and cleaning efforts near channel facilities as they are cleared.

Table J-23
Predicted Wet Weather Load Reduction Summary for the City of San Diego

Strategy and Level of Implementation[1]	City of San Diego – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Street Sweeping See Section J.2.2.1	4.5%	<0.1%	<0.1%	13.2%	7.1%	11.6%	<0.1%	<0.1%	0.1%	<0.1%
Catch Basin Cleaning See Section J.2.2.2	3.5%	<0.1%	<0.1%	1.3%	0.8%	0.3%	0.7%	0.8%	<0.1%	<0.1%
Rain barrel installations See Section J.2.2.3	<0.01%	0.07%	0.04%	0.01%	0.02%	0.02%	0.04%	0.01%	0.10%	0.11%
Downspout Disconnect See Section J.2.2.4	0.03%	0.14%	0.04%	0.07%	0.06%	0.12%	0.05%	<0.01%	0.02%	0.02%
Irrigation reduction[3] Eliminate irrigation overspray and reduce irrigation by 25%	4.4%	0.1%	3.3%	0.9%	2.1%	0.4%	1.7%	2.5%	<0.1%	<0.1%
Multiuse Treatment Areas 20.5 acre BMP to treat a total drainage area of 2,239.4 acres with a total storage volume of 47.1 acre-feet	2.9%	5.7%	1.1%	1.7%	1.7%	1.7%	2.8%	2.1%	7.4%	6.3%
Green Infrastructure 21.87 acre BMP to treat an impervious drainage area of 815.28 acres with a total storage volume of 37.91 acre-feet	1.0%	4.7%	0.8%	0.6%	0.9%	1.1%	2.5%	2.1%	3.9%	1.0%

Strategy and Level of Implementation[1]	City of San Diego – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Green Streets										
239.60 acre BMP to treat a total drainage area of 8,482.86 acres with a total storage volume of 357.18 acre-feet	20.9%	26.9%	7.7%	29.5%	22.2%	30.0%	18.9%	19.5%	28.9%	27.5%
Additional Opportunities										
Lagoon restoration, outfall repair/replacement, stream restoration, and other opportunities	8.6%	Load Reductions from pollutants not assessed, but are anticipated.								
Total[4]	55.8%	47.6%	22.9%	57.2%	44.8%	55.1%	36.6%	37.1%	50.5%	45.0%
	Goal = 53.1%	Goal = 2.0%							Goal = 1.9%	Goal = 1.6%

Note:
1. Note that these numbers are planning-level calculated at a watershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Irrigation reduction strategies include the implementation of grass replacement projects, micro-irrigation system conversions, weather-based irrigation controllers, downspout disconnections, education and outreach and enforcement of regulations that prohibit runoff.
4. Load reduction totals that exceed the goals reflect coarseness in the model that can be improved with finer physical data at the parcel and/or street scale.

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-24
Predicted Dry Weather Load Reduction Summary for the City of San Diego

Strategy and Level of Implementation[1]	City of San Diego – Dry Weather Percentage Reductions									
	Total Sediment	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	47%	100%	39%	41%	54%	80%	68%	86%	99%	99%
Total	57%	100%[3] Goal = 96.6%	49%	51%	64%	90%	78%	96%	100%[3] Goal = 99.4%	100%[3] Goal = 96.5%

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Orange-shaded cells indicate highest priority water quality conditions for the Los Peñasquitos WMA.
3. Mechanistic, process-based assumptions were not applied to non-modeled, nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100%.

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-25
Predicted Wet Weather Load Sediment Mass Reduction Summary for the City of San Diego (Tonnage)

Strategy	City of San Diego – Wet Weather Sediment Tonnage Reduction[1,2,3]
	Los Peñasquitos WMA
Nonstructural, non-modeled	315.1
Nonstructural, modeled	110.8
Catch Basin Cleaning	
Street Sweeping	143.2
Rain Barrels[4]	<0.1
Downspout Disconnect	1.0
Irrigation Reduction	138.8
Structural, modeled	90.8
Multiuse Treatment Areas	
Green Infrastructure	32.0
Green Streets	657.1
Additional Opportunities	269.6

Note:
1. Sediment masses are land-based removals and do not account for in-stream processes.
2. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
3. The mass of sediment reduction is, in part, related to rainfall, which varies by year. Tonnage presented represents the estimated mass removed based on rainfall data during the wet period October 1, 2002– April 30, 2003.
4. Load reduction through rain barrel implementation in Los Peñasquitos WMA, as modeled, results in negligible sediment removed.

J.4.5 County of San Diego Results

Table J-26 and Table J-27 summarize pollutant load reductions for wet and dry weather conditions for the County of San Diego. These tables present the load reductions predicted for all modeled strategies within the WMA and demonstrate that the strategies presented in the Water Quality Improvement Plan will reach the dry and wet weather subwatershed percent load reduction goals. Mass of sediment removed in terms of tonnage is presented in Table J-28 for wet weather conditions.

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Table J-26
Predicted Wet Weather Load Reduction Summary for the County of San Diego

Strategy and Level of Implementation[1]	County of San Diego – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Street Sweeping See Section 2.2.1	2.4%	<0.1%	<0.1%	19.6%	9.0%	24.8%	<0.1%	<0.1%	0.2%	<0.1%
Irrigation Reduction Eliminate irrigation overspray and reduce irrigation by 25%	2.2%	0.3%	2.2%	1.3%	2.4%	0.7%	2.2%	1.0%	0.2%	0.2%
Green Infrastructure 0.034 acre BMP to treat an impervious drainage area of 6.49 acres with a total storage volume of 0.30 acre-foot	0.1%	5.0%	0.4%	0.2%	0.3%	0.6%	1.1%	0.2%	9.0%	2.7%
Green Streets 0.54 acre BMP to treat a total drainage area of 11.8 acres with a total storage volume of 0.82 acre-foot	3.0%	4.3%	1.1%	4.9%	4.4%	5.5%	2.1%	2.4%	4.6%	4.4%

Strategy and Level of Implementation[1]	County of San Diego – Wet Weather Percentage Reductions									
	Total Sediment[2]	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Additional Opportunities										
Lagoon restoration, outfall repair/replacement, stream restoration, and other opportunities	7.2%	Load Reductions from pollutants not assessed, but are anticipated.								
16.4 acres of additional structural BMPs or other BMPs with equivalent load reductions	22.3%	33.2%	22.9%	18.7%	19.4%	32.0%	22.4%	19.1%	33.6%	32.4%
Total	47.3%	52.9%	36.5%	54.8%	45.5%	73.5%	37.7%	32.6%	57.6%	49.7%
	Goal = 47.3%	Goal = 2.0%							Goal = 1.9%	Goal = 1.6%

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Highest priority water quality conditions

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-27
Predicted Dry Weather Load Reduction Summary for the County of San Diego

Strategy and Level of Implementation[1]	County of San Diego – Dry Weather Percentage Reductions									
	Total Sediment	Fecal Coliform[2]	Flow	Total Cu	Total Pb	Total Zn	Total N	Total P	Entero[2]	Total Coliform[2]
Nonstructural, non-modeled See Section 4.2.4	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Irrigation reduction Eliminate irrigation overspray and reduce irrigation by 25%	43%	99%	33%	38%	50%	79%	66%	87%	99%	99%
Total	53%	100%[3] Goal = 96.6%	43%	48%	60%	89%	76%	97%	100%[3] Goal = 99.4%	100%[3] Goal = 96.5%

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Highest priority water quality conditions
3. Mechanistic, process-based assumptions were not applied to non-modeled nonstructural BMPs, resulting in the cumulative dry weather load reductions exceeding 100% (this implies that the combination of strategies will be more than sufficient to achieve dry weather load reduction goals).

% = percent; Cu = copper; Pb = lead; Zn = zinc; N = nitrogen; P = phosphorus; FY = fiscal year

Table J-28
Predicted Wet Weather Load Sediment Mass Reduction Summary for the County of San Diego (Tonnage)

Strategy	County of San Diego – Wet Weather Sediment Tonnage Reduction[1,2,3]
	Los Peñasquitos WMA
Nonstructural, non-modeled	2.5
Nonstructural, modeled	0.6
Street Sweeping	
Irrigation Reduction	0.6
Structural, modeled	<0.1
Green Infrastructure	
Green Streets	0.8
Additional Watershed Opportunities	7.5

Note:
1. Note that these numbers are planning-level calculated at a subwatershed scale; structural BMPs should be designed to meet both jurisdictional standards and the numeric goals outlined above at each respective project site. Reported BMP sizes include projects that have already been implemented.
2. Sediment masses are land-based removals and do not account for in-stream processes.
3. The mass of sediment reduction is, in part, related to rainfall, which varies by year. Tonnage presented represents the estimated mass removed based on rainfall data during the wet period October 1, 2002– April 30, 2003.

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APPENDIX K

Model Calibration Report

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APPENDIX K. MODEL CALIBRATION REPORT

K.1 Introduction

The Los Peñasquitos WMA is in central San Diego County and drains into the Los Peñasquitos Lagoon (lagoon) before emptying into the Pacific Ocean (Figure K-1). Both the WMA and lagoon are included in the Los Peñasquitos Hydrologic Unit (906), which also includes Mission Bay and several coastal tributaries. The WMA is approximately 93 square miles (mi^2) and includes portions of the cities of San Diego, Poway, and Del Mar. In addition, a small portion of San Diego County is in the eastern headwaters area. There are also several major road corridors that Caltrans maintains within the WMA (City of San Diego 2010a).

Three major tributaries drain the WMA and flow into the tidal lagoon. Los Peñasquitos Creek is the largest subwatershed, draining 59 mi^2 through its central portion. Carroll Canyon Creek is the second largest subwatershed, draining 18 mi^2 through its southern portion. The Carmel Creek subwatershed is along the northern portion and drains the remaining 16 mi^2. While the Los Peñasquitos Lagoon is included in the Carmel Creek subwatershed, load reduction calculations were generated by separating out areas draining directly to the lagoon. There is one major dam in the Carroll Canyon Creek subwatershed, which drains 1 square mile. This dam forms Miramar Reservoir, which retains imported drinking water and does not discharge downstream. The WMA elevation rises from sea level at the outlet to 2,600 feet in the headwaters (City of San Diego 2010a).

The lagoon was included in the Clean Water Act (CWA) section 303(d) list for sediment/siltation. Increasing urban development has altered hydrology within the WMA and modified the geomorphic conditions of the three main tributaries that feed into the lagoon. These conditions have caused sedimentation and excess freshwater in the lagoon that have altered the natural habitat (City of San Diego 2009).

Watershed models have been used to support total maximum daily load (TMDL) development for bacteria and other water quality constituents in the San Diego region over the past decade. The Loading Simulation Program in C++ (LSPC) was the model of choice while developing the recently approved sediment TMDL for the Los Peñasquitos Lagoon. This model was updated to support pollutant source characterization and identification of High-priority management areas for the Comprehensive Load Reduction Plans (CLRPs) and implementation planning efforts associated with current development of the Water Quality Improvement Plan for the Los Peñasquitos WMA. The Water Quality Improvement Plan planning effort will include linkage to best management practice (BMP) simulation and optimization processes that require additional spatial resolution and representation of key land characteristics that influence BMP selection (e.g., imperviousness, soil infiltration, and slope). Therefore, significant updates of the previously developed LSPC models primarily focused on hydrology, which will have the largest impact on many of the structural BMP functions planned in the Water Quality

Improvement Plan. Additional refinements of water quality constituent calibrations were also performed.

This report describes the approach used to develop and refine the Los Peñasquitos WMA model for use in the Water Quality Improvement Plan. This report also presents and describes the model calibration/validation results.

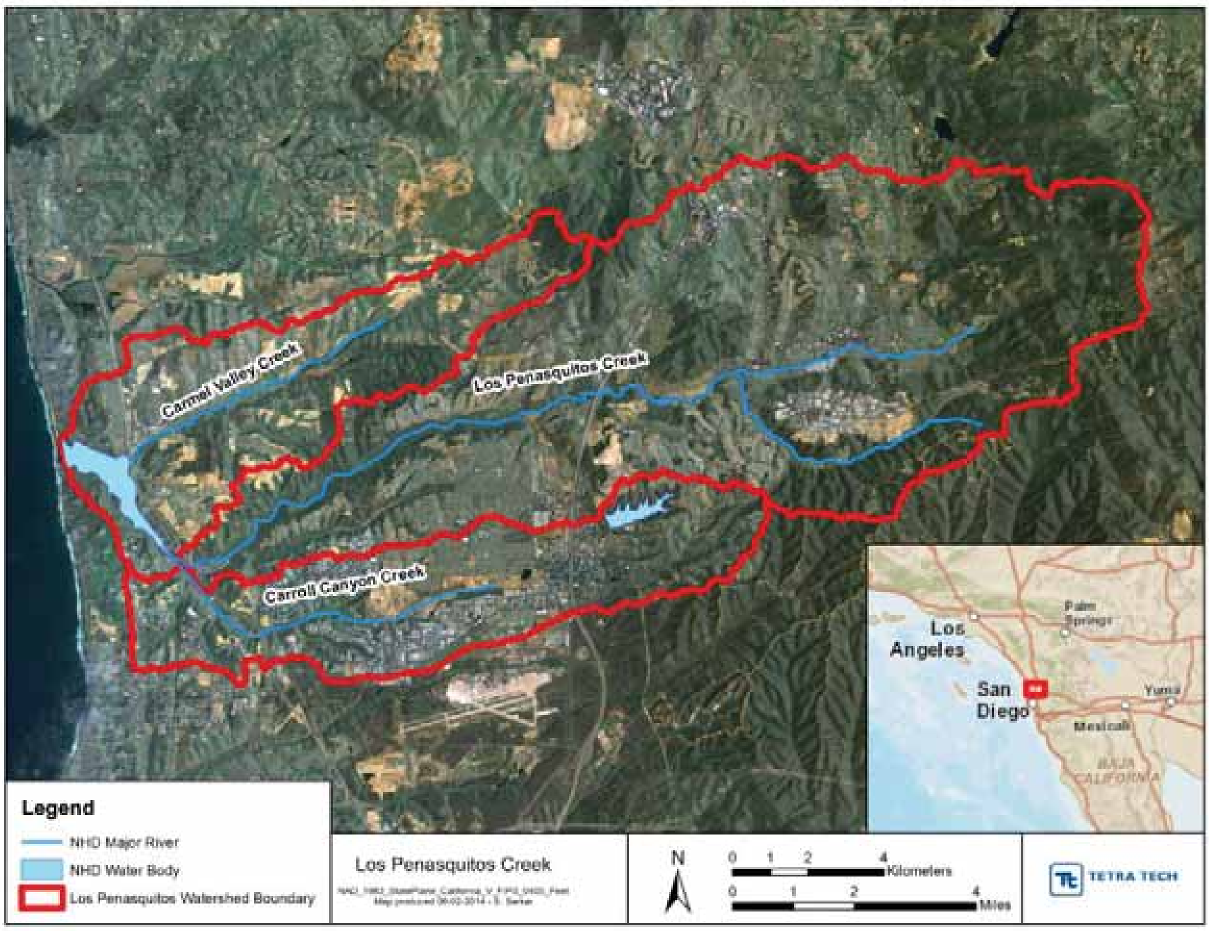

Figure K-1 Location of the Los Peñasquitos WMA

K.2 Model Selection

A watershed model is necessary to address the generation of pollutant loads over the land surface and through groundwater contributions and to predict the resulting water quality impact on receiving waters. A watershed model is comprised of a series of algorithms applied to watershed characteristics and meteorological data to simulate land- and stream-based processes over an extended period of time. Once a model has been adequately set up and calibrated, it can be used to quantify the existing loading of pollutants from subwatersheds or from land use categories, quantify pollutant loading from ungaged tributaries and diffuse overland flow sources, and assess the impacts of a variety of management scenarios.

The modeling analysis to support Water Quality Improvement Plan development builds on previous models developed in the region. TMDLs for indicator bacteria were developed to address 19 of the 38 bacteria-impaired water bodies in the San Diego region, as identified on the 2002 CWA section 303(d) List of Water Quality Limited Segments. This project is referred to as *Project I – Beaches and Creeks in the San Diego Region* or Bacti-I (SDRWQCB 2007b). An expansion of the regional modeling approach used in Bacti-I was conducted under *Bacteria-Impaired Waters TMDL Project II – Bays and Lagoons* (Bacti-II) and included representation of watersheds draining to impaired lagoons (SDRWQCB and USEPA 2005). Using Bacti-I and II as a foundation, additional modeling was conducted to support San Diego region lagoon TMDLs (SDRWQCB and USEPA 2008). This effort added a number of additional parameters to the modeling framework (SDRWQCB 2007a, 2010). In addition to this previous work, Los Peñasquitos was the subject of more recent LSPC modeling for hydrology and sediment to support the Los Peñasquitos Lagoon sediment TMDL (SDRWQCB 2012).

K.2.1 LSPC Watershed Model

LSPC is a watershed modeling system that excels at simulating hydrology, sediment and pollutant generation, transformation, and transport on land, as well as fate and transport within streams (Shen et al. 2004; Tetra Tech and USEPA 2002; USEPA 2003). The LSPC model has been successfully applied and calibrated for a large number of watersheds in Southern California including, but not limited to, the Los Angeles River, San Gabriel River, San Jacinto River, Lake Mathews, Chollas Creek, Los Peñasquitos, B Street/Downtown Anchorage, and multiple watersheds that drain to impaired beaches in the San Diego region (City of San Diego 2010c; USEPA 2011). The current effort builds on the results of previous modeling studies through the incorporation of recent monitoring data and key modeling enhancements.

The LSPC watershed modeling system includes Hydrologic Simulation Program FORTRAN (HSPF) algorithms for simulating watershed hydrology, erosion, and water quality processes, as well as in-stream transport processes. LSPC integrates a geographical information system (GIS), comprehensive data storage and management capabilities, the original HSPF algorithms, and a data analysis/post-processing system into a convenient, PC-based, Windows interface. LSPC's algorithms are identical to a subset of those in the HSPF model. LSPC is freely distributed by the U.S. Environmental Protection Agency (EPA) Office of Research and Development in Athens, Georgia, and is a component of EPA's National TMDL Toolbox (www.epa.gov/athens/wwqtsc/index.html).

A key advantage of LSPC over HSPF and other watershed models is a data management feature that uses a Microsoft Access database to manage model data and weather files for driving the simulation. This provides great flexibility for data transfer and manipulation, which is critical for complex watershed studies. LSPC was designed specifically to handle very large-scale watershed and receiving water modeling applications at a high resolution. The model has been successfully used to model watershed systems composed of well over 1,000 subwatersheds and at least as many individual stream elements.

K.3 Watershed Model Development

K.3.1 Overview

This section provides a description of LSPC model configuration used for the Los Peñasquitos WMA. The watershed model represented the variability of sediment source contributions through dynamic representation of hydrology and land practices. A long-term simulation was developed spanning the period from 1/1/1988 to 9/30/2012. One year and ten months was used for model spin-up (allowing sufficient time for primarily stabilization of soil moisture). The hydrology model was calibrated to the 11-year period from 10/1/2001 to 9/30/2012 and validated to the 12-year period from 10/1/1989 to 9/30/2001. The water quality model was calibrated from 1/1/2001 to 9/30/2012 and was not validated because of limited available monitoring data. The following were key components of the watershed modeling:

- Watershed Segmentation (Section K.3.2)
- Meteorological Data (Section K.3.3)
- Land Use and Cover Representation (Section K.3.4)
- Hydrologic Representation (Section K.4.1)
- Observed Flow Data (Section K.4.2)
- Hydrology Model Calibration (Section K.4.3)
- Hydrology Model Validation (Section K.4.4)
- Hydrology Observations and Conclusions (Section K.4.5)
- Water Quality Model Overview (Section K.5.1)
- Modeled Constituents (Section K.5.2)
- Reach Group Representation (Section K.5.3)
- Sediment Representation (Section K.5.4)
- Nutrients, Metals, and Bacteria Representation (Section K.5.5)
- Water Quality Calibration (Section K.5.6)
- Observed Water Quality Data Calibration and Validation (Section K.5.7)
- Water Quality Observations and Conclusions (Section K.5.8)

K.3.2 Watershed Segmentation

Watershed segmentation refers to the subdivision of the entire model area into smaller, discrete subwatersheds and reaches for modeling and analysis. This subdivision was based primarily on existing hydrologic boundaries and engineered storm drain networks, and secondarily on topography and the locations of flow and water quality monitoring stations. A combination of 3-meter and 10-meter resolution digital elevation models (DEM) from the National Elevation Dataset (NED) were merged and then used to define the elevation throughout the WMA and assist with determining subwatershed boundaries. Figure K-2 shows the 10-meter resolution NED. Streams were defined primarily using National Hydrography Dataset (NHD) High-resolution GIS data. Where available, local storm drain networks augmented or replaced NHD data. Each subwatershed was configured with a single representative stream reach, with reach connectivity from headwaters to outlets.

Based on some of the previous work and the intended use of the CLRP models, the target for average subwatershed size was set at approximately 300 acres. This size tended to increase in the more rural, less developed areas. The subwatershed sizing was deemed appropriate for characterizing existing pollutant loading and facilitating the analysis of management strategies for future phases of the Water Quality Improvement Plan development. Figure K-3 presents the final subwatershed delineations and representative stream reaches.

Model reaches were derived via the watershed delineation process. Many of the reaches were defined using storm drain network GIS data from the City of San Diego (obtained from www.sangis.org) where available. Additional GIS coverage from other municipalities (San Diego County, City of Del Mar, and City of Poway) augmented those data. Within the LSPC models, reaches were aggregated in cases where a reach length was less than 1,000 meters to prevent the possibility of short travel times (relative to the 1-hour time step used in the modeling), leading to numeric instability.

Because of potential hydromodification impacts in the watersheds, the substrate of each reach was identified. The model reaches were defined as natural channel, concrete channel, or reinforced concrete pipe based on storm drain attributes from the GIS data, supplemented by visual investigation of model reaches as needed. Where storm drain networks were not available, natural reaches were assumed.

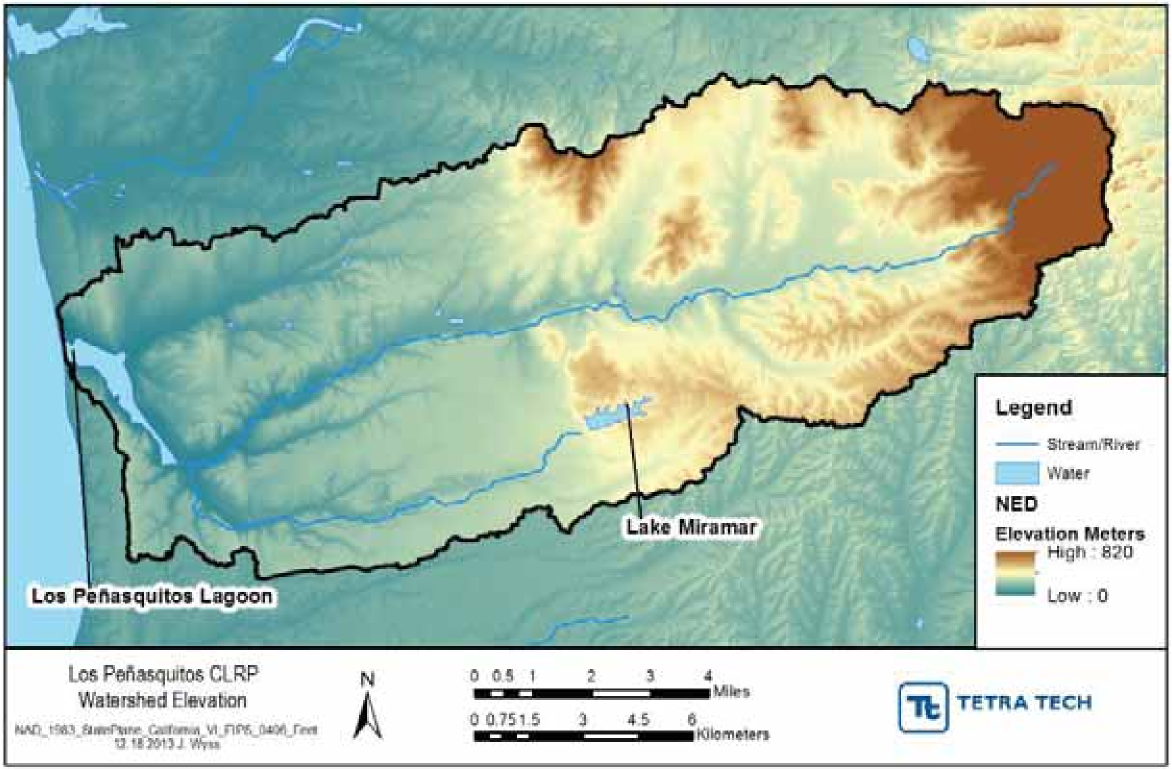

Figure K-2 Los Peñasquitos WMA NED 10-Meter DEM

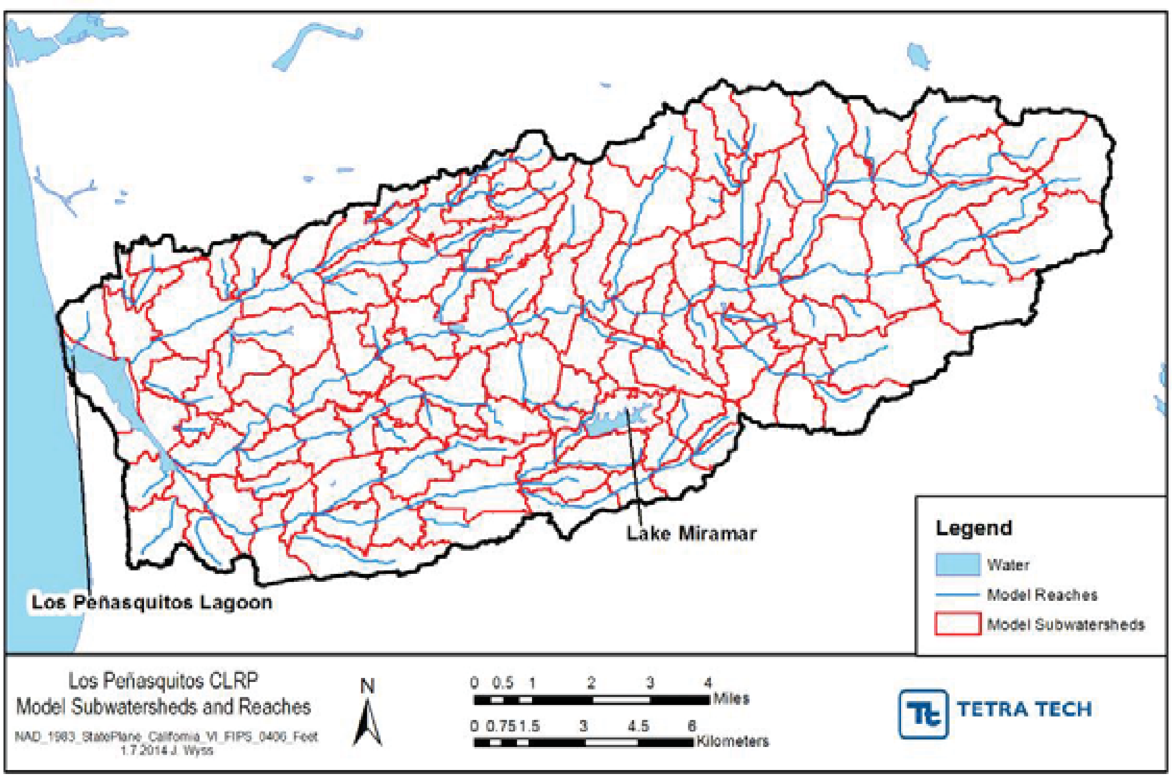

Figure K-3. Los Peñasquitos WMA Delineation and Representative Reaches

K.3.3 Meteorological Data

Meteorological data are a critical component of the watershed model. Models require appropriate representation of precipitation and potential evapotranspiration (PET). In general, hourly precipitation (or finer resolution) data are recommended for nonpoint source modeling and therefore are preferred, since daily flows tend to average out high peaks events. Precipitation data from the most representative station drove rainfall-runoff processes for each subwatershed. Those data provide necessary input to LSPC algorithms for hydrologic and water quality representation.

Successful hydrologic modeling depends on an accurate representation of the overall water balance. The two largest terms in the water balance are typically precipitation input and actual evapotranspiration (ET) output. Precipitation is specified from direct observations, while PET is either derived as a function of observed pan evaporation, or computed as a function of other weather data such as wind speed, air temperature, dew point temperature, and solar radiation. Together, these constitute the external meteorological time series needed to drive the model. This section focuses on the precipitation and evaporation/ET data, which were rigorously evaluated and processed for modeling purposes.

The accuracy of a hydrologic model is dependent on the accuracy of the meteorological time series. In most cases, precipitation and evaporation data are the most hydrologically sensitive and spatially variable data sets used in watershed modeling; therefore, having a complete quality-controlled continuous set of the data benefits the modeling effort. A major and crucial early effort for model development is thus assembly and processing of meteorology, which presents several challenges. First, precipitation data has historically been available as point-in-space measurements, rather than integrated totals over subwatershed areas. Second, precipitation, temperature, and other meteorological series typically show strong spatial gradients in response to elevation (orographic effects) and aspect.

K.3.3.1 Precipitation

Multiple sources of precipitation data were evaluated for model input, including National Climatic Data Center (NCDC) hourly precipitation and surface airways stations, NCDC Summary of Day (SOD) precipitation stations, San Diego County ALERT hourly rainfall gages, and California Irrigation Management Information System (CIMIS) stations. Data were screened for two purposes:

- Best representation of daily total precipitation
- Best representation of hourly precipitation, used as a pattern to disaggregate daily totals into hourly values

Experience has repeatedly demonstrated that precipitation collected on a daily basis from SOD stations provides a more accurate measure of total rainfall volume than accumulated volume from stations that monitor hourly. However, the spatial coverage was not adequate to capture rainfall variability, especially given the strong orographic influence along the coast; therefore, ALERT stations were used to address the gaps. CIMIS stations were initially included as well, but were removed after a quality review revealed large annual discrepancies in rainfall total compared to nearby locations. A few ALERT stations were also excluded for similar reasons.

ALERT hourly values were aggregated to daily totals because of quality issues in hourly rainfall reporting. There were numerous instances where a large rainfall value (in excess of 1 inch) was reported for a single hour, and no rainfall was reported during the remaining hours of the day. To address gaps in the observed data, the accumulated, missing, and impaired data records were repaired based on rainfall patterns at other proximal stations with unimpaired data using the normal ratio method (Dunne and Leopold 1978), which estimates a missing rainfall record with a weighted average from surrounding index stations (assigned based both on proximity and similar elevation). Once gaps in daily totals were patched for all of the SOD and ALERT stations in the CLRP study area, annual and monthly rainfall totals were screened according to an increasing gradient of elevation. Daily SOD and ALERT totals were then disaggregated to hourly using surface airways and hourly precipitation data sites. For the Los Peñasquitos WMA model, five stations were selected as providing the best spatial coverage, unimpaired period of record, and consistency across yearly totals—two SOD stations and three ALERT stations (Table K-1). Model subwatersheds were assigned to precipitation stations based on a combination of proximity, elevation, and annual average precipitation reported by San Diego County (Figure K-4).

For each station a unique model input file was created which included the hourly rainfall time series from 1/1/1998 – 11/31/2012.

Table K-1
Summary of Precipitation Station for the Los Peñasquitos WMA Model

Station ID	Station Name	Elevation (ft.)	State	County	Latitude	Longitude
SOD 047111	Poway Valley	648	California	San Diego	33.018	117.029
SOD 047228	Ramona Fire Dept.	1,470	California	San Diego	33.011	-116.908
ALERT22	Encinitas	242	California	San Diego	33.044	-117.278
ALERT24	Poway	440	California	San Diego	32.949	-117.064
ALERT28	Kearny Mesa	455	California	San Diego	32.837	-117.130

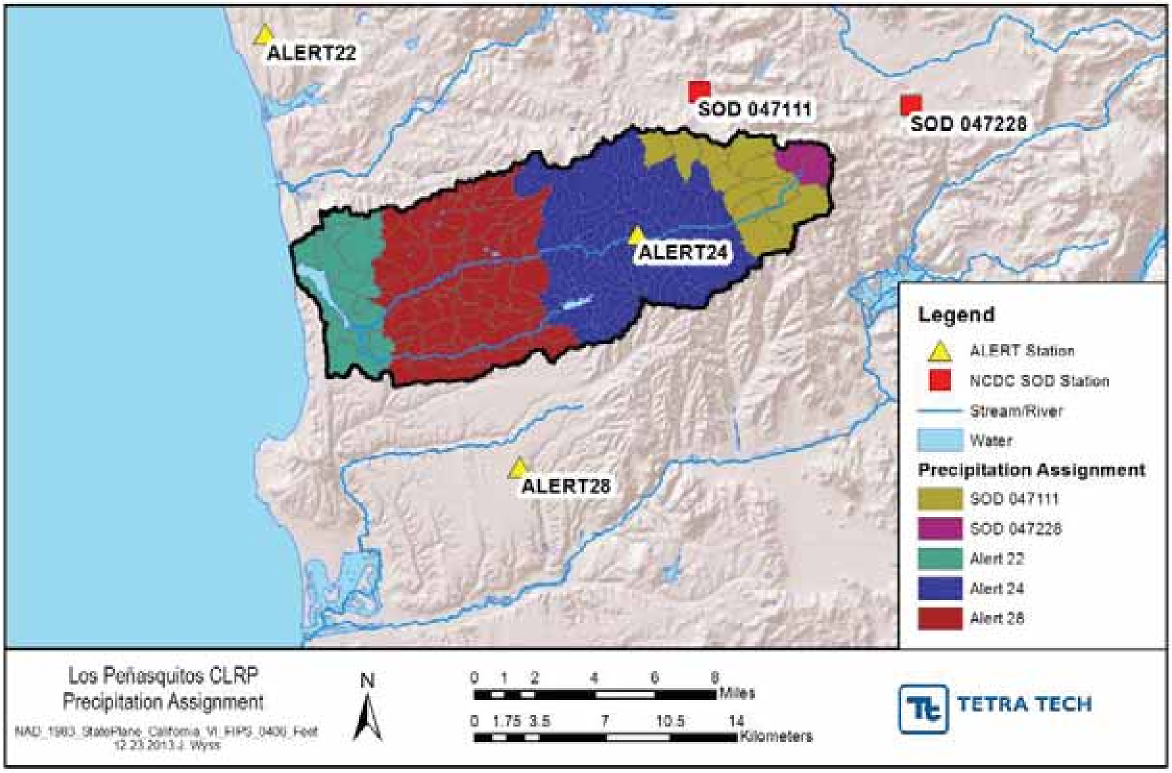

Figure K-4
Spatial Coverage and Assignment of Precipitation Stations used in the Los Peñasquitos WMA Model

The precipitation time series for both Encinitas (Alert 22) and Ramona Fire Department (SOD 047228) were summarized to provide insight into the orographic effects for the Los Peñasquitos WMA. Figure K-5 shows the yearly total precipitation for Encinitas and Figure K-6 shows the yearly total precipitation for Ramona Fire Department. Ramona experiences approximately 33 percent more rainfall than Encinitas but both locations experience extremely wet or extremely dry conditions during the same years. Figure K-7 shows the monthly average precipitation for Encinitas and Figure K-8 shows the monthly average precipitation for Ramona Fire Department. These figures also show that Ramona experiences approximately 33 percent more rainfall than Encinitas but both locations experience the same seasonal rainfall distribution. Figure K-9 shows the 24-hour total precipitation distribution for Encinitas and Figure K-10 shows the 24-hour total precipitation distribution for Ramona Fire Department. Approximately 84 percent of the rainfall in Encinitas falls in less than ½-inch 24-hour totals whereas approximately 74 percent of the rainfall in Ramona falls in less than ½-inch 24-hour totals. In addition, Ramona experiences much more intense rainfall, where approximately 5 percent of rainfall occurs in 1.5-inch or larger events, as compared to Encinitas, where approximately 2 percent of rainfall occurs in 1.5-inch or larger events.

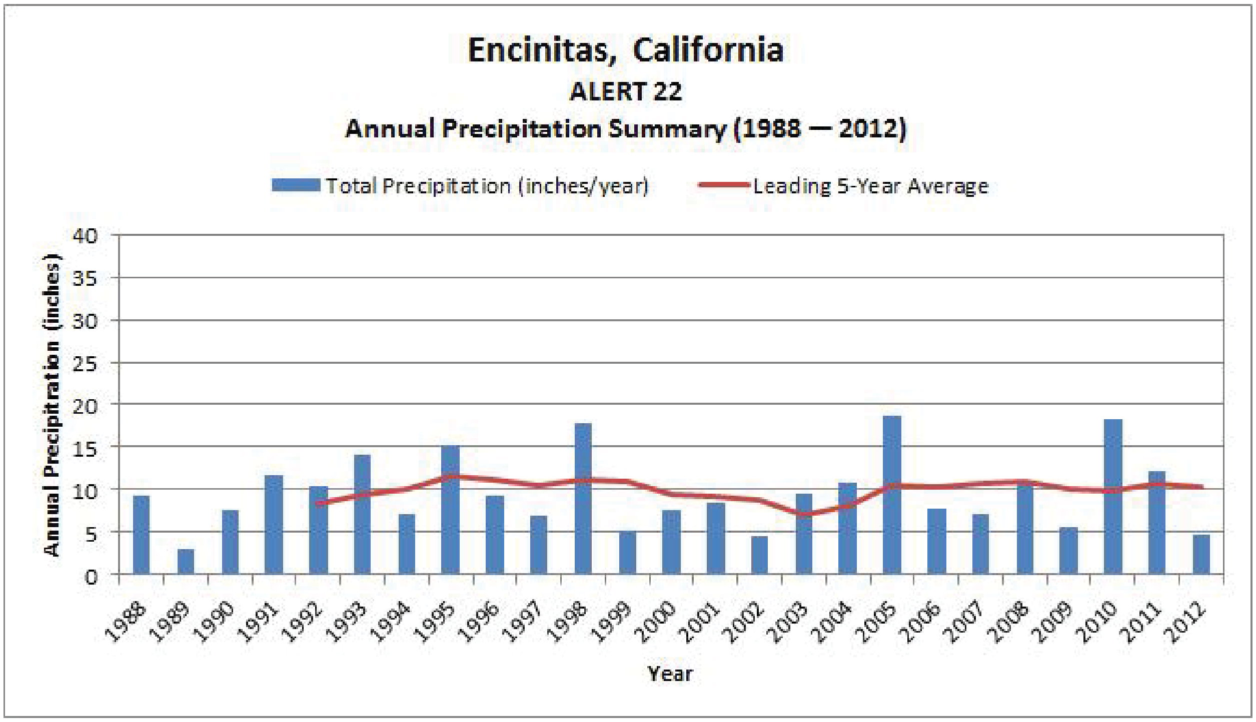

Figure K-5
Annual Precipitation Totals for Encinitas (ALERT 22)

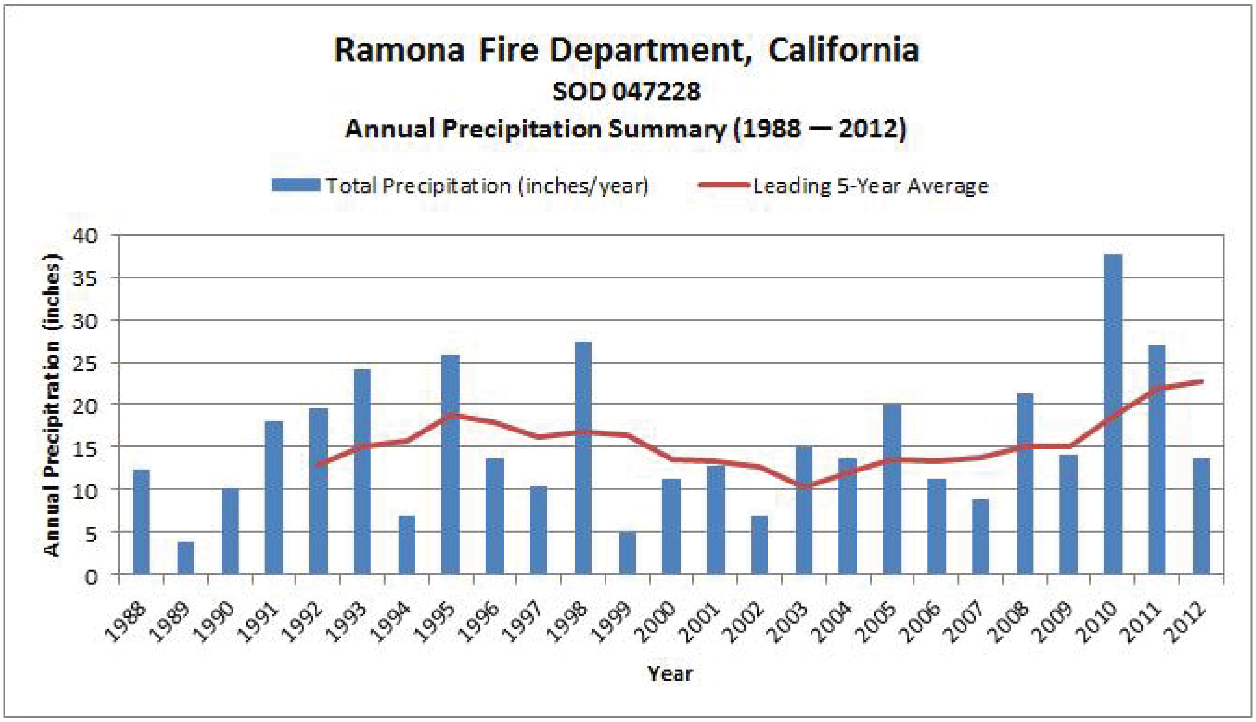

Figure K-6
Annual Precipitation Totals for Ramona Fire Department (SOD 047228)

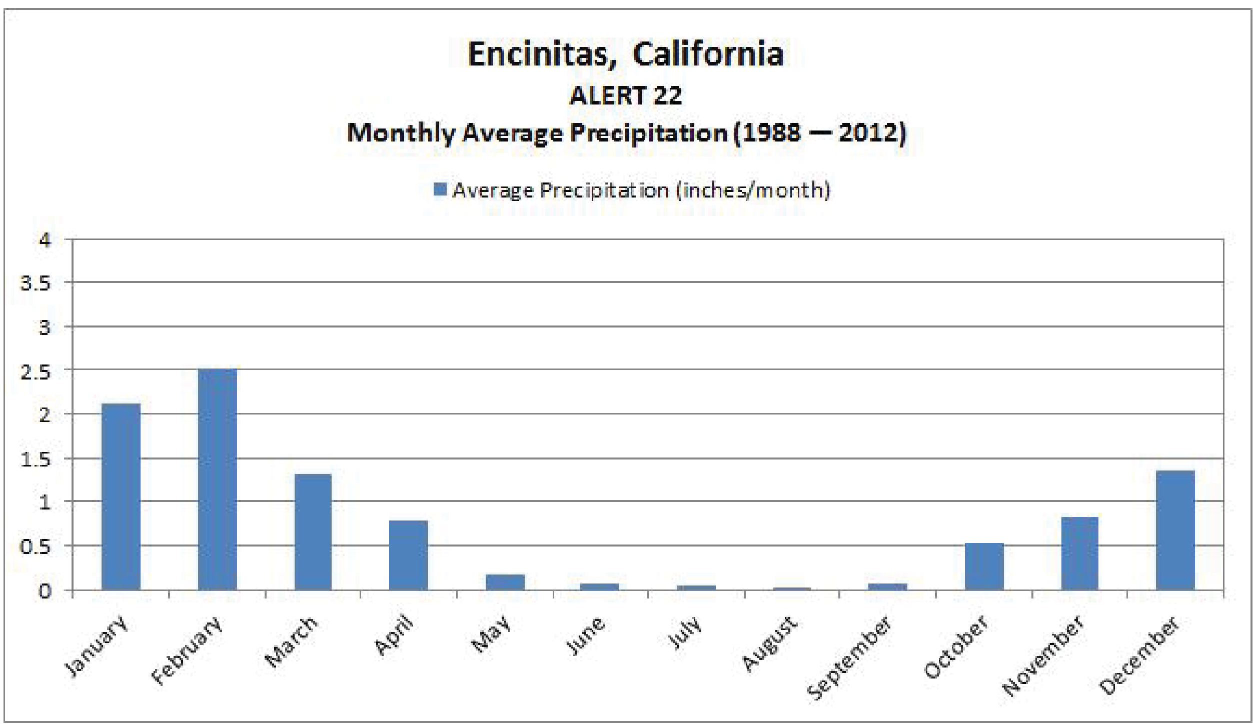

Figure K-7
Monthly Rainfall Summary for Encinitas (ALERT 22)

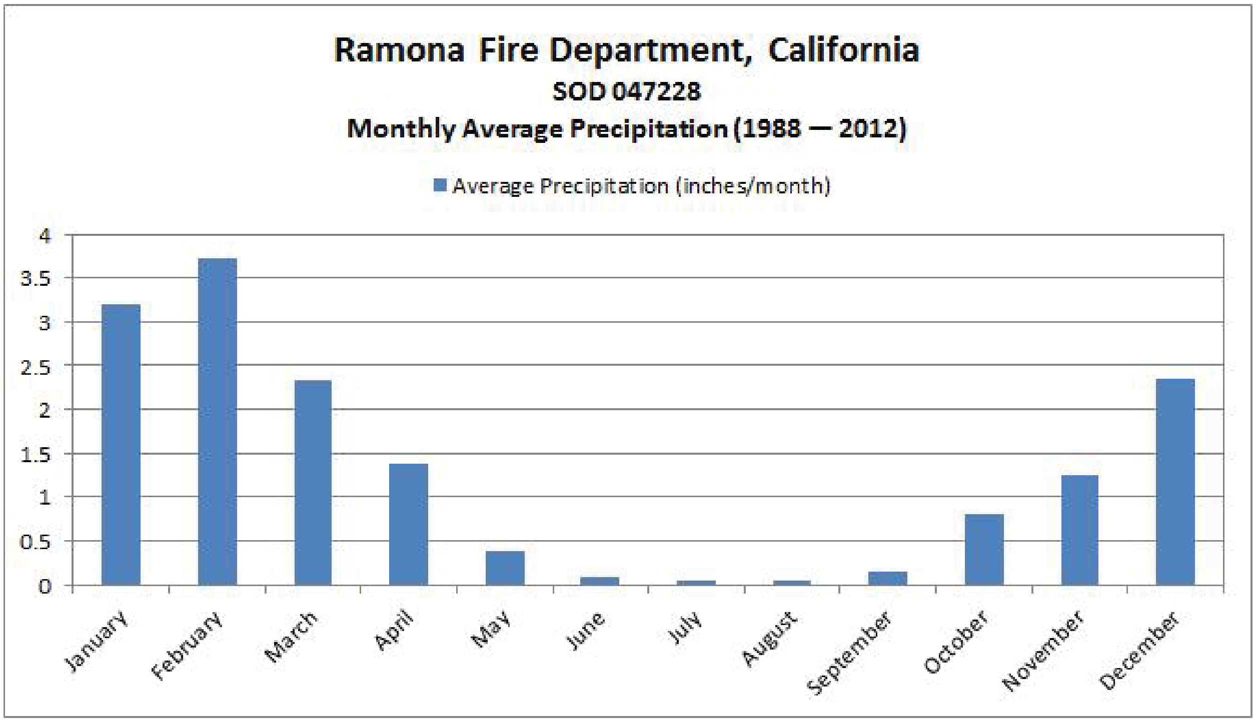

Figure K-8
Monthly Rainfall Summary for Ramona Fire Department (SOD 047228)

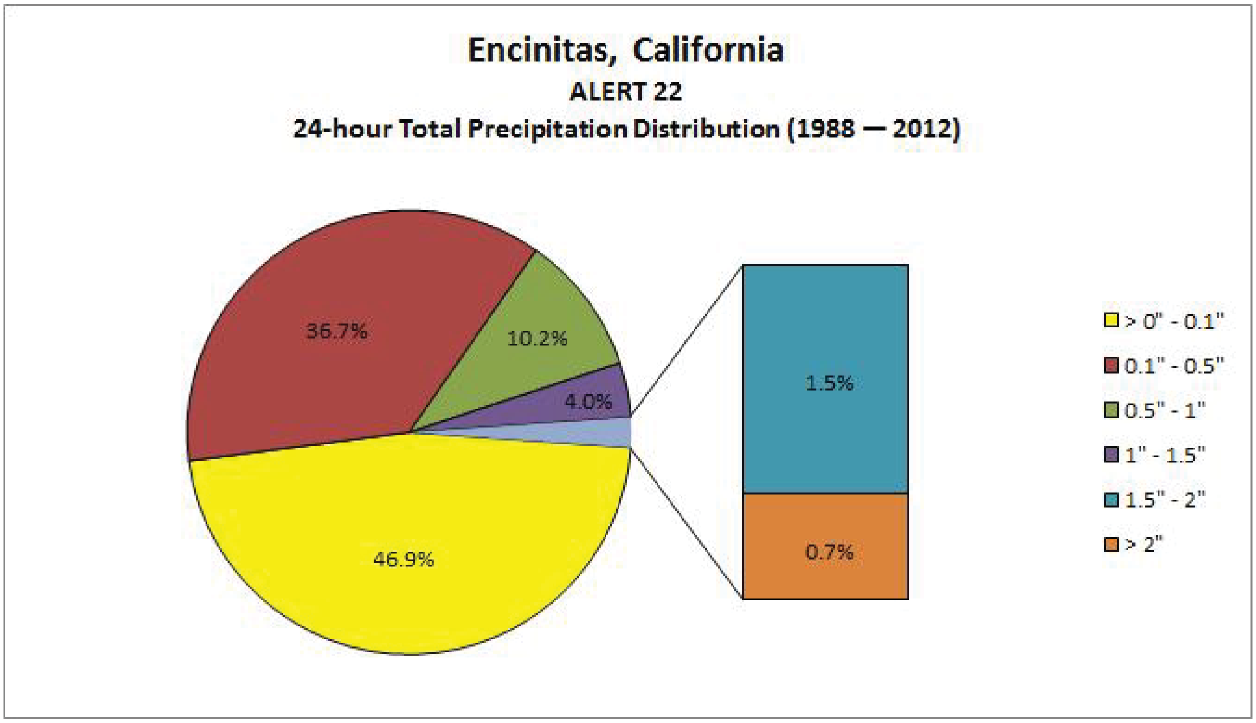

Figure K-9
Precipitation Distribution Summary for Encinitas (ALERT 22)

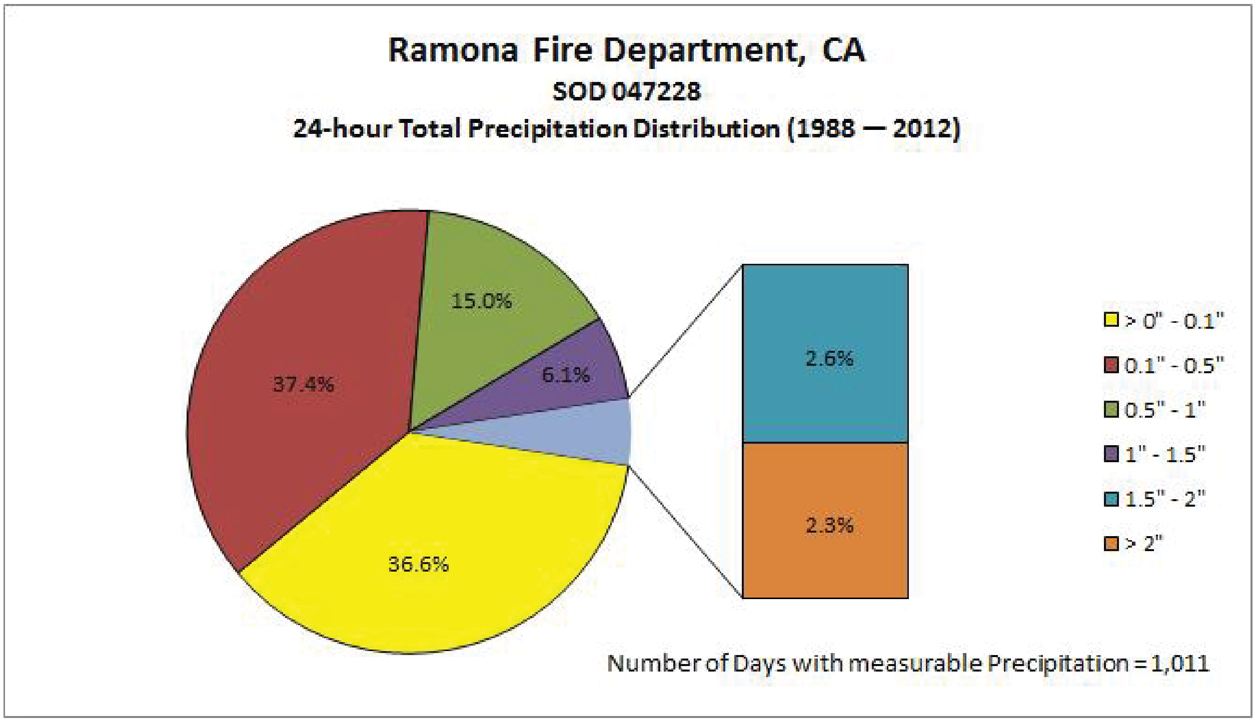

Figure K-10
Precipitation Distribution Summary for Ramona Fire Department (SOD 047228)

K.3.3.2 Potential Evapotranspiration

Evaporation in Southern California is typically limited by supply, rather than being capped by the potential. Observed pan evaporation data from San Diego (from reservoir sites) could not be utilized for a variety of reasons; notably, the data begin in 2004, and the data contain numerous gaps during the periods of record. On the other hand, CIMIS reference crop evaporation (ETo) data are available for a handful of locations in or near the WMA, with a nearly complete period of record for the 23 ¾-year simulation. CIMIS stations provide a United Nations Food and Agriculture Organization (FAO) standard estimate of ETo using the Penman-Monteith energy balance method, which is equivalent to actual ET from a standardized alfalfa crop without water limitation. As a result, CIMIS ETo was used to develop model PET.

The CIMIS data are not without gaps, both spatially and temporally. Based on the location of usable data, the following approach was adopted. Two CIMIS stations (184 and 153) had minor gaps in their period of record. PET was extracted from the EPA Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) meteorological data for two nearby NCDC surface airways stations. The BASINS daily PET (calculated using the Hamon method) was scaled to match the CIMIS ETo during periods of coincident data using fitted monthly adjustment factors. These monthly factors were then used to scale the calculated Hamon PET that was then subsequently used to fill the temporal gaps in the CIMIS data.

CIMIS 173 (at the coast) began reporting in 2000 and was deemed critical to retain in order to capture known differences in PET in the coastal fog zone. Using a similar procedure, as performed for patching CIMIS in the previous step, the coincident data from 173 was fitted to 184 using monthly factors. The monthly factors were then used to back-calculate the missing 12 years from 173 using 184 as the template.

The previous steps provided three patched PET data sets; however, the CLRP study area spans five CIMIS ETo zones, as seen in Figure K-11. The stations provide coverage for Zones 1, 4, and 9. Published CIMIS ETo zone monthly coefficients show measurable differences in seasonal ETo, especially for the high elevation (Zone 16). To address these gaps, the difference in monthly ETo coefficients between zones was used to calculate daily values for the lower elevation Zone 6 and the higher elevation Zone 16 using station 153 (Zone 9) as the template.

The four PET series associated with the Los Peñasquitos WMA (Zone 1, Zone 4, Zone 6, and Zone 9) were then associated with and assigned to each of the five rain stations, using the CIMIS ETo zones as guidance, but allowing variation based on elevation. The CIMIS ETo zones were developed and interpolated at a larger statewide scale and do not appear to account for local topography. A unique text file with an .air extension was created for each precipitation station, which included the hourly PET time series from 1/1/1998 to 11/31/2012. Table K-2 shows the precipitation station, PET zone assignment, and associated PET file used in the Los Peñasquitos WMA model. Attachment A provides tabular information pertaining to weather station assignments in the Los Peñasquitos WMA model.

Table K-2
Summary of Precipitation Station and PET Assignments for the Los Peñasquitos WMA Model

Model ID	Precipitation Station ID	PET Zone	PET File Name
1	SOD 047111	Zone 3	04711.air
2	SOD 047228	Zone 4	047228.air
3	ALERT0022	Zone 1	ALERT002.air
4	ALERT0024	Zone 3	ALERT0024.air
5	ALERT0028	Zone 2	ALERT0028.air

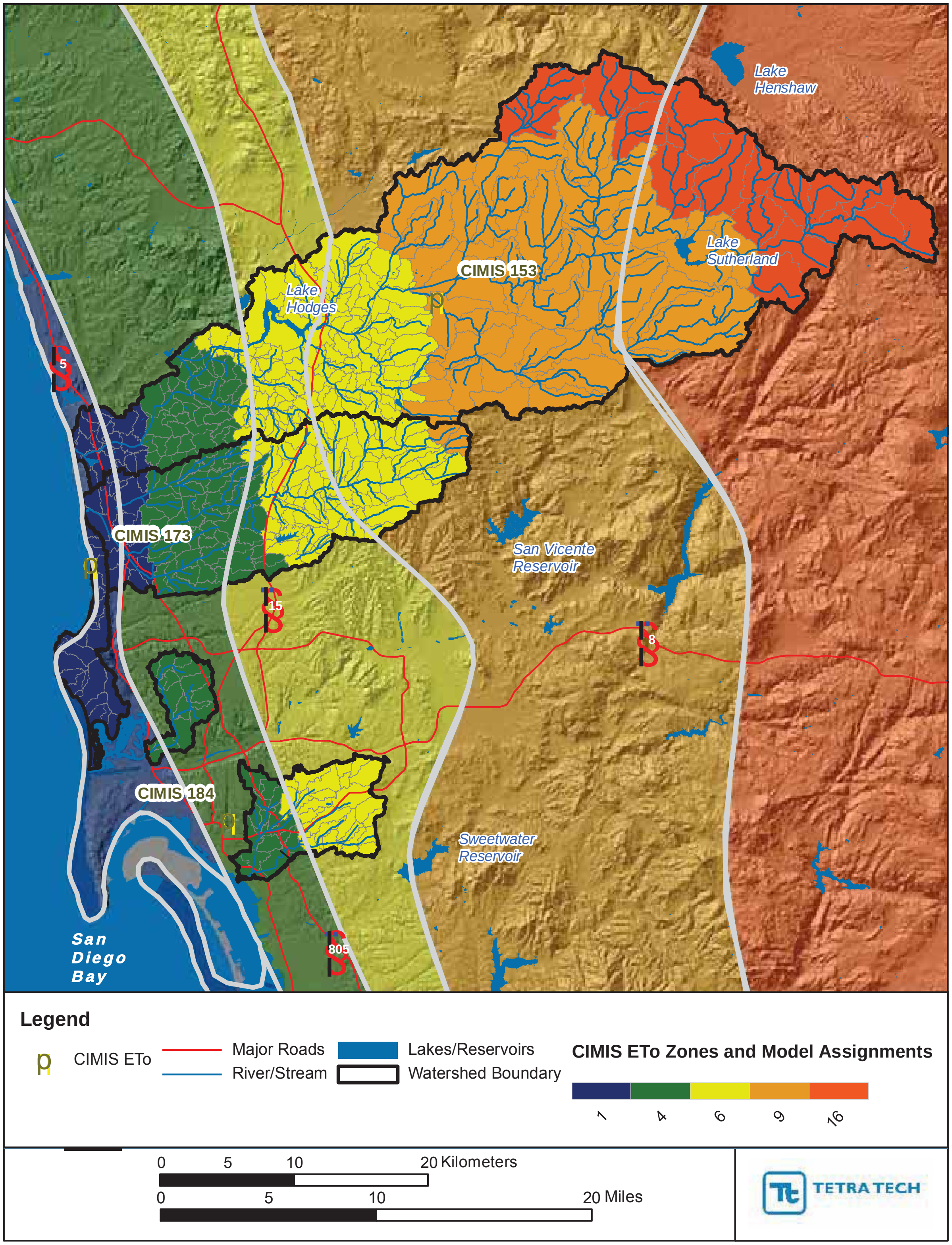

Figure K-11
CIMIS PET Stations and Zones in the CLRP Study Area

K.3.4 Land Use Representation

In a watershed model, land unit representation should be sensitive to the features of the landscape that most affect hydrology and pollutant transport, including land use (including impervious assumptions), soils, and slope. In urban areas, it is important to estimate the division of land use into pervious and impervious components. In rural areas, vegetative cover is more important. Depending on the goals of the model, if soil hydrologic groups are not homogenous in a watershed, it might be important to further divide pervious land cover by soil hydrologic group so that infiltration processes are better represented. Slope might also be an important factor, especially if steep slopes are prevalent; high slopes influence runoff and moisture storage processes. The combination of land use, soil hydrologic group, and slope were used to define the hydrologic response units (HRUs) for the Los Peñasquitos WMA model. The HRU approach provides certain advantages and efficiencies for model parameterization because it compartmentalizes the way process variables are assigned and insulates that exercise from spatially variable influences like meteorology, which will naturally manifest itself differently for the same HRU in different parts of the WMA. Although there are many similarities in the way HRUs in the current effort compare to previous work in the region, the current configuration utilizes the most recent and highest resolution data sources available.

The following are the main objectives for developing representative HRUs:

- To support representation of existing condition hydrology and pollutant loading processes generated from land areas for source characterization
- To support any potential future objectives of providing unit area hydrology and pollutographs in support of BMP optimization
- To capture sufficient variability in hydrology and pollutant loading as related to land uses and land covers
- To balance the need for capturing landscape variability with a goal of reducing model complexity

The following summarizes the HRU development approach:

1. Land use in urban areas was represented with a polygon layer developed by a regional planning authority, with polygon boundaries largely determined using parcel data.
2. The planning land use categories were simplified into broader model land use categories, as well as disaggregation of Single-Family Residential (SFR) planning categories into housing density groups.
3. Land cover in unmanaged land areas was represented with a grid data product based primarily on interpreted satellite imagery.

4. Unique percent impervious values were assigned to each urban area polygon, using best available data.

5. Each urban land use and unmanaged land cover (LULC) was classified by Hydrologic Soil Group (HSG).

6. Each LULC-HSG was further distinguished as a low or high slope class (SC).

7. The resulting over 100 potential HRU combinations of LULC-HSG-SC were simplified into a manageable number of model HRUs, using aggregation of classes with low contributing area or low importance to those with larger area or importance.

8. Irrigation assumptions were developed for urban land.

A detailed discussion of each step listed above is provided below.

K.3.4.1 Urban Land Use Coverage

The San Diego Association of Governments (SANDAG) 2009 land use polygon coverage was obtained and intersected with the study area boundary. Table K-3 presents unique SANDAG classes of modeled contributing land areas within the WMA boundary.

Table K-3
Water Quality Improvement Plan Model Land Uses

	Water Quality Improvement Plan Model Land Use	Notes
Residential	Unmanaged Land	Lot size > 10 acres
Residential	Rural Residential	Lot size 2.0–10.0 acres
Residential	LDR (Low-Density Residential)	Lot size 0.5–2.0 acres
Residential	MDR (Medium-Density Residential)	Lot size 0.17–0.5 acres
Residential	HDR (High-Density Residential)	Lot size 0.07–0.17 acres
Residential	Multifamily Residential	Includes SFR lot size < 0.07 acres
	Office/Institutional	Lower vehicle/foot traffic
	Commercial	Higher vehicle/foot traffic
	Industrial	Manufacturing, warehouses, storage
	Transportation	streets, roads, and right-of-way
	Freeway	Limited-access highway corridors
	Barren	Construction sites and quarries/mines
	Park Land (irrigated)	Developed, higher intensity parks
	Open Water	Lakes, ponds
	Unmanaged Land	Undeveloped, low-intensity park/recreation, agriculture

K.3.4.2 Assignment of SANDAG Classes to Model Land Uses

For identification of modeled urban land uses (Table K-3), a critical goal was to capture types of use that are known to generate differential pollutant loads. For instance, commercial use is distinguished from office/institutional use by intensity of vehicle and foot traffic; a higher intensity of use tends to result in more residues on impervious surfaces. Table K-4 provides the crosswalk between SANDAG categories and land uses in Table K-3. The Unmanaged Land category includes all land uses that have very low levels of developed use (open space and low-intensity parkland, residential uses with parcel area in excess of 10 acres) or no developed use (undeveloped polygons and agricultural land). SANDAG classification of agricultural use was poor in comparison to High-resolution aerial photos, and appeared to overestimate agricultural land. SANDAG documentation notes that the agricultural classification is a source of error, and is based on data from 20 years ago. It is important to note that the land use aggregation was performed in a manner to optimize land use groupings with similar hydrology and pollutant loading characteristics.

SANDAG polygon boundaries typically follow parcel boundaries; however, areas with identical class assignment were aggregated into single polygons, most notably the residential uses with IDs 1000–1190. On the other hand, many larger parcels were split into multiple SANDAG use polygons. To allow for classification of Single Family Residential (SFR) categories into housing density classes, a union coverage of current parcel boundaries (November 2011) and 2009 SANDAG land use was created. Polygon area was calculated to perform the modeled residential land use assignment. Parcel boundary disagreements between the two data sets were present, though not common, and were rectified to the extent possible using automated geoprocessing techniques.

Table K-4
SANDAG Land Uses and Water Quality Improvement Plan Model Land Use Class Assignment

SANDAG Code	SANDAG Land Use	Area in CLRP Watersheds (acres)	Water Quality Improvement Plan Model Land Use Class
1000	Spaced Rural Residential	26,719	SFR [1,3]
1110	Single-Family Detached	35,926	SFR [1]
1120	Single-Family Multiple Units	3,204	SFR [1]
1190	Single-Family Residential Without Units	164	SFR [1]
1200	Multifamily Residential	3,958	Multifamily
1290	Multifamily Residential Without Units	14	Multifamily
1300	Mobile Home Park	404	Multifamily
1402	Dormitory	44	Multifamily
1403	Military Barracks	27	Multifamily
1409	Other Group Quarters Facility	157	Multifamily

SANDAG Code	SANDAG Land Use	Area in CLRP Watersheds (acres)	Water Quality Improvement Plan Model Land Use Class
1501	Hotel/Motel (Low Rise)	130	Commercial
1502	Hotel/Motel (High Rise)	9	Commercial
1503	Resort	159	Commercial
2001	Heavy Industry	19	Industrial
2101	Industrial Park	3,018	Industrial
2103	Light Industry – General	1,357	Industrial
2104	Warehousing	216	Industrial
2105	Public Storage	129	Industrial
2201	Extractive Industry	640	Barren
2301	Junkyard/Dump/Landfill	116	Industrial
4103	General Aviation Airport	254	Commercial
4111	Rail Station/Transit Center	13	Transportation
4112	Freeway	3,242	Freeway
4113	Communications and Utilities	855	Office/Institutional
4114	Parking Lot – Surface	166	Transportation
4115	Parking Lot – Structure	23	Transportation
4116	Park and Ride Lot	16	Transportation
4117	Railroad Right-of-Way	256	Transportation
4118	Road Right-of-Way	17,839	Transportation
4119	Other Transportation	65	Transportation
5001	Wholesale Trade	16	Commercial
5002	Regional Shopping Center	136	Commercial
5003	Community Shopping Center	765	Commercial
5004	Neighborhood Shopping Center	727	Commercial
5005	Specialty Commercial	4	Commercial
5006	Automobile Dealership	74	Commercial
5007	Arterial Commercial	617	Commercial
5008	Service Station	86	Commercial
5009	Other Retail Trade and Strip	228	Commercial
6001	Office (High Rise)	22	Office/Institutional
6002	Office (Low Rise)	1,162	Office/Institutional
6003	Government Office/Civic Center	34	Office/Institutional
6101	Cemetery	437	Park Land (irrigated)
6102	Religious Facility	743	Office/Institutional

SANDAG Code	SANDAG Land Use	Area in CLRP Watersheds (acres)	Water Quality Improvement Plan Model Land Use Class
6103	Library	24	Office/Institutional
6104	Post Office	75	Office/Institutional
6105	Fire/Police Station	92	Office/Institutional
6109	Other Public Services	94	Office/Institutional
6501	UCSD/VA Hospital/Balboa Hospital	5	Office/Institutional
6502	Hospital – General	110	Office/Institutional
6509	Other Health Care	104	Office/Institutional
6701	Military Use	67	Office/Institutional
6702	Military Training	5	Office/Institutional
6801	SDSU/CSU San Marcos/UCSD	419	Office/Institutional
6802	Other University or College	192	Office/Institutional
6803	Junior College	180	Office/Institutional
6804	Senior High School	862	Office/Institutional
6805	Junior High School or Middle School	486	Office/Institutional
6806	Elementary School	1,245	Office/Institutional
6807	School District Office	48	Office/Institutional
6809	Other School	142	Office/Institutional
7201	Tourist Attraction	646	Park Land (irrigated)
7203	Racetrack	88	Commercial
7204	Golf Course	3,758	Park Land (irrigated)
7205	Golf Course Clubhouse	143	Commercial
7207	Marina	6	Commercial
7210	Other Recreation – High	559	Park Land (irrigated)
7211	Other Recreation – Low	360	Unmanaged Land [3]
7601	Park – Active	1,679	Park Land (irrigated)
7603	Open Space Park or Preserve	68,833	Unmanaged Land [3]
7604	Beach – Active	155	Unmanaged Land [3]
7605	Beach – Passive	6	Unmanaged Land [3]
7606	Landscape Open Space	1,272	Residential Other [2]
7607	Residential Recreation	184	Park Land (irrigated)
8001	Orchard or Vineyard	5,686	Unmanaged Land [3]
8002	Intensive Agriculture	3,448	Unmanaged Land [3]
8003	Field Crops	21,922	Unmanaged Land [3]
9101	Vacant and Undeveloped Land	94,421	Unmanaged Land [3]

SANDAG Code	SANDAG Land Use	Area in CLRP Watersheds (acres)	Water Quality Improvement Plan Model Land Use Class
9200	Water	1	Park Land (irrigated)
9201	Bay or Lagoon	114	Open Water
9202	Lake/Reservoir/Large Pond	1,749	Open Water
9501	Residential Under Construction	393	Barren
9502	Commercial Under Construction	23	Barren
9503	Industrial Under Construction	41	Barren
9505	School Under Construction	71	Barren
9506	Road Under Construction	20	Barren

Note:
1. All SFR categories were disaggregated to five residential densities, based on parcel area.
2. In aerial photos, nearly all of these areas are fringes or easement areas in SFR developments. Many overlap impervious surfaces. These were disaggregated to residential pervious and impervious areas later in the HRU development process.
3. Unmanaged Land was removed, and reclassified into Agriculture, Forest/Shrub, and Grassland using LANDFIRE EVT. SFR in excess of 10 acres was also classified as Unmanaged Land and reclassified with LANDFIRE.

K.3.4.3 Land Cover for Unmanaged Land Areas

Available land cover data were reviewed for providing the best representation of undeveloped land cover and vegetation type in areas assigned to the Unmanaged Land category. U.S. Forest Service and Department of Interior LANDFIRE, also known as the Landscape Fire and Resource Management Planning Tools Project, provides a high level of detail about vegetation for wildfire management, and consists of a series of raster-based data products including vegetation type, vegetation cover (percent canopy), vegetation height, and others. The Existing Vegetation Type (EVT) data set provides details about plant communities, as well as some spatial information indicating areas of development and agricultural use. The data set was determined to be the best resource for characterizing land cover during a comparison to High-resolution aerial photography. This finding is consistent with previous Tetra Tech experience in Southern California. Agricultural land shown in LANDFIRE EVT was more consistent with aerial photography than SANDAG; error was fairly high at a close spatial scale (i.e., hundreds of feet), but the relative proportions at a subwatershed scale matched reasonably well.

Three categories were selected to represent undeveloped land cover, which were sufficient to capture variation in vegetation and land use germane to hydrology and pollutant loading processes—Forest, Grassland/Shrubland (or chaparral), and Agriculture. Given the relatively small area of agricultural land use within the watersheds as a whole, multiple agricultural categories (e.g., orchards, vegetable production) were not needed.

K.3.4.4 Impervious Area

The National Land Cover Dataset (NLCD) is developed under a national program overseen by the Multi-Resolution Land Characteristics Consortium, a group of federal agencies that cooperate to create a consistent land cover GIS grid-based product for the entire United States. The 2006 data is based on interpretation of multiseasonal Landsat satellite images into 30-meter grid cells, and includes a grid with assignment of percent impervious cover. Spatial analysis and post-processing calculations were performed to assign unique percent impervious values to each SANDAG polygon (excluding polygons assigned to Unmanaged Land Area and Open Water).

K.3.4.5 Hydrologic Soil Group

EPA recommends classifying HSPF pervious land uses by Hydrologic Soil Group or HSG (USEPA 2000). HSG defines a soil's ability to infiltrate rainfall in four categories, ranging from A soils that support high infiltration rates to D soils that support low infiltration rates. County-level soil GIS data files were obtained (SSURGO) to develop HSG GIS coverage. The HSG coverage was spatially intersected with the land use/land cover coverage to allow for specification of HSG.

K.3.4.6 Slope Class

Slope is also an important factor for HRU development, especially if steep slopes are prevalent; high slopes influence runoff and moisture storage processes. Percent slope was calculated from the 10-meter DEM from NED, and the slope values were classified as Low (< 10 percent), and High (> 10 percent). Slope classes (SCs) were dichotomized at 10 percent because past experience has shown that this threshold value strongly influences land use patterns (i.e., most urban development occurs on land with slopes less than 10 percent). The Low/High slope grid was converted to a polygon coverage, and spatially intersected with the land use/land cover coverage to allow for specification of SC.

K.3.4.7 Final HRU Selection

To reduce model complexity, the pool of potential discrete HRU types was simplified using the following observations of tabular HRU area, balanced by project goals:

- Developed polygon areas were split into impervious and developed pervious model HRUs, based on the assigned percent impervious value.
- In urbanized area, runoff response and pollutant loading is driven primarily by impervious surfaces; the urban land use designation was therefore retained and carried forward into the impervious HRU assignment.
- HSG and slope were considered more important for characterizing hydrology and pollutant loading for developed pervious land; therefore, HSG and SC were retained.

- HSG A soils comprise approximately 3.2% of the WMA area; to reduce model complexity, HSG A soils were lumped with HSG B soils.
- The majority of Forest and Grassland/Shrubland land covers were classified as having high slopes (87 percent and 76 percent, respectively); however, HSG classes were more evenly distributed. Low slope land was lumped with High slope land for both land covers.
- Agriculture and Barren land were evenly distributed by slope, but tended to be dominated by a single HSG; therefore, Low and High slopes only were used for both land covers.
- Both SC and HSG were retained for developed pervious land, resulting in six separate classes.

K.3.4.8 Irrigation Assumptions

LSPC provides a module for simulating the impacts of irrigation, beginning with a dynamic estimation of irrigation volume based on PET and recent rainfall depth, followed by application of irrigation back to the landscape. Individual model HRUs can be selected by the user for receiving irrigation, with appropriate application factors for the HRU. Irrigation input is lumped with precipitation, so the influence of irrigation on hydrology (i.e., wetter soils that promote more runoff during storm events, irrigation return flow via groundwater, etc.) and pollutant loading is carried through the entire model. However, not all developed land is irrigated, and the degree of irrigation can vary spatially depending on many factors. A review was performed to characterize expected urban irrigation rates by urban land use individually within each of the five CLRP watersheds. The review took into account open space requirements, zoning, lot size, landscaping requirements, review of aerial photos, and socioeconomic factors. Based on the results of the review, developed pervious land was split into irrigated and nonirrigated fractions according to the percentages shown in Table K-5. Previous modeling experience in the San Diego region indicated that overspray of irrigation water onto impervious area is a significant component of the hydrologic response in the extremely dry summer months. As a result, a small portion of impervious area, equal to 10% of the irrigated pervious area, was converted into impervious area that could be subjected to irrigation. These impervious areas were grouped into two separate HRUs, called Overspray-Other and Overspray-Road, to create distinct water quality responses between road and non-road surfaces.

Table K-5
Fraction of Developed Pervious HRU Areas Subject to Irrigation in the Los Peñasquitos WMA

Land Use	Los Peñasquitos WMA
Rural Residential	10%
LDR	14%
MDR	31%
HDR	35%

Multifamily	45%
Commercial	50%
Industrial	45%
Office/Institutional	50%
Park Land (irrigated)	50%
Transportation	30%

K.3.4.9 Model HRUs

The list of final model HRUs and associated land area in the Los Peñasquitos WMA are shown in Table-K-6.

Table-K-6
List of Final Model HRUs

Land Use/Land Cover	HSG	Slope Class	Area (Acres)	Area (%)
Open Water	N/A		165.2	0.27%
Agriculture		Low	110.0	0.18%
		High	51.3	0.08%
Barren		Low	350.4	0.58%
		High	393.9	0.65%
Forest	B		798.9	1.32%
	C		659.8	1.09%
	D		8,429.4	13.93%
Grassland/Shrubland	B		1,632.5	2.70%
	C		1,326.3	2.19%
	D		13,915.4	22.99%
Developed Pervious, No Irrigation	B	Low	1,008.5	1.67%
	C	Low	375.6	0.62%
	D	Low	5,422.2	8.96%
	B	High	705.4	1.17%
	C	High	648.9	1.07%
	D	High	3,787.2	6.26%
Developed Pervious, With Irrigation	B	Low	416.6	0.69%
	C	Low	171.1	0.28%
	D	Low	2,882.6	4.76%
	B	High	209.9	0.35%
	C	High	176.7	0.29%
	D	High	1,574.5	2.60%
Low-Intensity Residential	Impervious		1,207.2	1.99%

Land Use/Land Cover	HSG	Slope Class	Area (Acres)	Area (%)
High-Intensity Residential			5,494.8	9.08%
Office/Institutional			1,211.6	2.00%
Commercial			727.2	1.20%
Industrial			2,313.4	3.82%
Transportation			3,091.0	5.11%
Freeway			716.4	1.18%
Overspray Other			271.8	0.45%
Overspray Road			271.0	0.45%

K.3.4.10 Parameter Groups

LSPC allows for the model to be further segmented by parameter groups. A parameter group is an additional set of model HRUs that are assigned to subwatersheds that the user selects. This allows for different parameterization for HRUs in parameter group 1 as opposed to those used for HRUs in parameter group 2. Parameter groups were implemented into the Los Peñasquitos WMA model (Figure K-12) to account for the extremely high sediment loading associated with the Carroll Canyon Creek drainage area. All parameters associated with parameter groups 1 and 2 were set equal to each other besides those associated with the production and removal of sediment for the land. Carroll Canyon comprises only 19 percent of the total Los Peñasquitos WMA area, but preliminary studies show that the Carroll Canyon contributing subwatershed accounts for up to 92 percent of the total suspended sediment load to the Los Peñasquitos Lagoon ("Preliminary Assessment of Sediment Reduction Opportunities for Los Peñasquitos Lagoon – Carroll Canyon Watershed," ESA-PWA, June 23, 2011). Table K-18 contains tabular information pertaining to parameter group assignments in the Los Peñasquitos WMA model. Additional details are provided in Section 5.6.

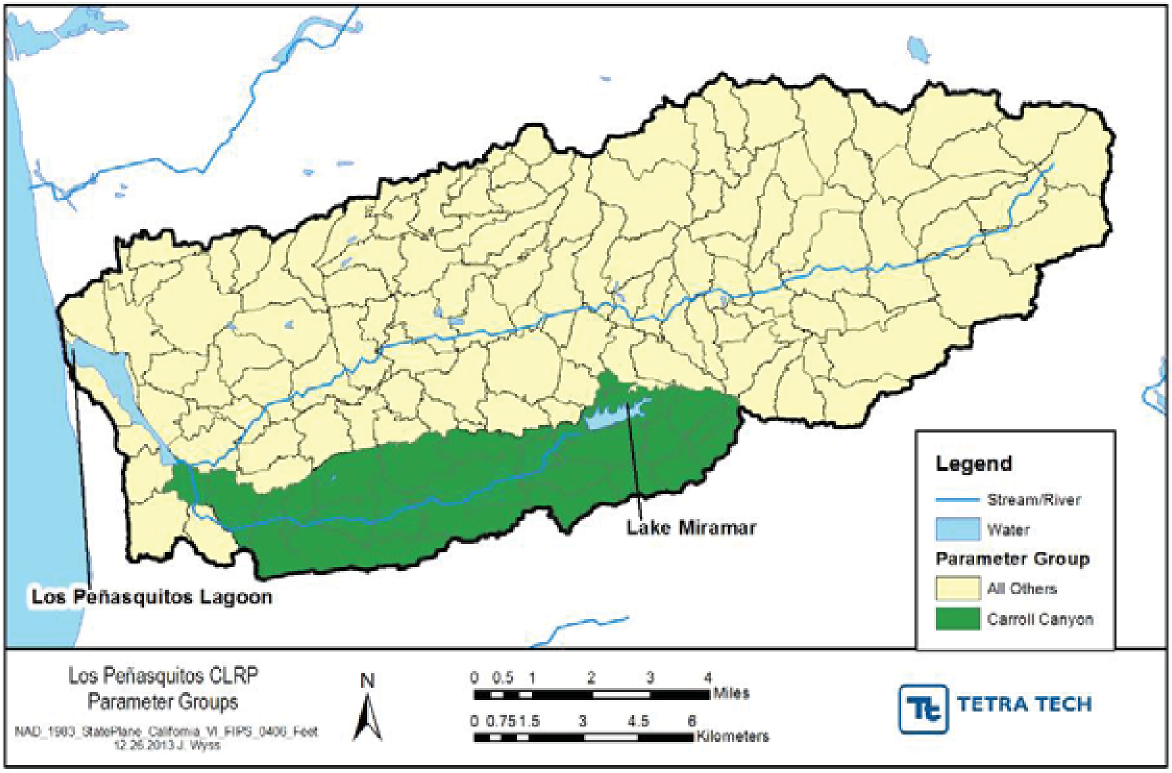

Figure K-12
Parameter Group Assignment used in the Los Peñasquitos WMA Model

K.4 Watershed Hydrology Model

K.4.1 Hydrologic Representation

Watershed hydrology plays an important role in the determination of flows and loadings to a water body. The watershed model must appropriately represent the spatial and temporal variability of hydrological characteristics within a watershed. Key hydrological characteristics include interception storage capacities, infiltration properties, evaporation and transpiration rates, and watershed slope and roughness. The LSPC/HSPF modules used to represent watershed hydrology include PWATER (water budget simulation for pervious land units) and IWATER (water budget simulation for impervious land units). The *HSPF Version 12 User's Manual* presents a detailed description of relevant hydrological algorithms (Bicknell et al. 2004).

Figure K-13 provides a schematic of the LSPC hydrology model. Rainfall first experiences interception storage (CEPSC). If there is space available in interception storage it is filled up and all remaining precipitation volume proceeds to the land surface. Once on the land, surface water is divided into subsurface flow and surface flow by infiltration (INFILT). Any water not being infiltrated is divided between upper zone storage (UZSN), interflow (INTFW) and overland flow. If space exists in upper zone storage it is filled first before becoming interflow or overland flow. Overland flow travels directly to the stream and timing is based on the slope, length, and Manning's *n* value of the overland flow plane. Interflow travels to the stream under the surface of the land and the timing of interflow outflow is dependent on the interflow recession constant (IRC). Water in the upper zone storage is either evaporated or moves deeper into the soil profile through percolation. Infiltrated water first fills the capacity of lower zone storage (LZSN) and water is lost from lower zone storage through evapotranspiration (LZETP). Any remaining water then enters one of two groundwater storage components. Inactive groundwater (water not having the ability to become streamflow) is supplied by a value for DEEPFR. Active groundwater storage is released to the stream through a groundwater recession constant (AGWRC). Water can be lost from both active groundwater storage and groundwater outflow by values supplied for AGWETP and BASETP, respectively. The model simulates total actual ET by trying to fulfill PET by first removing water from baseflow outflow, then interception storage, then upper zone storage, then groundwater storage and finally lower zone storage. Some of the parameter values for the hydrology model are considered constant and others are allowed to vary by month but no parameters are allowed to vary by year.

Table K-7 provides the list of hydrology parameters and the temporal variability that was used for the Los Peñasquitos WMA model. All parameters were allowed to vary by HRU.

In Southern California another important component of watershed hydrology is irrigation. LSPC includes an irrigation routine which is based on a calculation for irrigation demand. Irrigation demand is simply the difference between ET and precipitation. ET is calculated as the product of PET and a crop coefficient (ETc). If the calculation produces a positive number, then irrigation is not in demand because the precipitation volume is greater than the volume of water lost through ET. If the calculation produces a negative number, then irrigation is in demand because precipitation volume is less than the amount of water lost through ET. Essentially, the irrigation demand calculation is a water-deficit calculation. If there is a deficit, then irrigation occurs until the deficit has been made up. LSPC allows the user to specify how many days, or length of time to utilize in the deficit calculation.

*Irrigation Demand = (PET*ETc) - Precip* (evaluated over time *ET Days*)

Where:

PET = Potential Evapotranspiration (inches)

ETc = Crop coefficient to evaluate actual evapotranspiration (unitless)

Precip = Precipitation (inches)

ET Days = number of days to utilize in the irrigation demand calculation (days)

The irrigation module of LSPC was designed with flexibility in mind. The modeler can choose to either supply a constant PET or utilize PET from the atmospheric forcing file. The modeler can also choose either a constant crop coefficient or one that varies monthly. The irrigation water can be applied to different soil moisture storage zones in the model, including the following: applied over the canopy (i.e., like precipitation); applied directly to the soil surface (i.e., flood irrigation); applied to either the upper soil zone or lower soil zone (i.e., via buried systems); and applied directly into the local groundwater (i.e., seepage irrigation). The modeler designates the modeled reach from which the irrigation water is withdrawn. If a reach does not exist or is not supplied, then irrigation demand is assumed to be satisfied from an external source.

Table K-8 provides the list of irrigation parameters (only applied to land uses where irrigation application is occurring) and the basic setup used for the Los Peñasquitos WMA model.

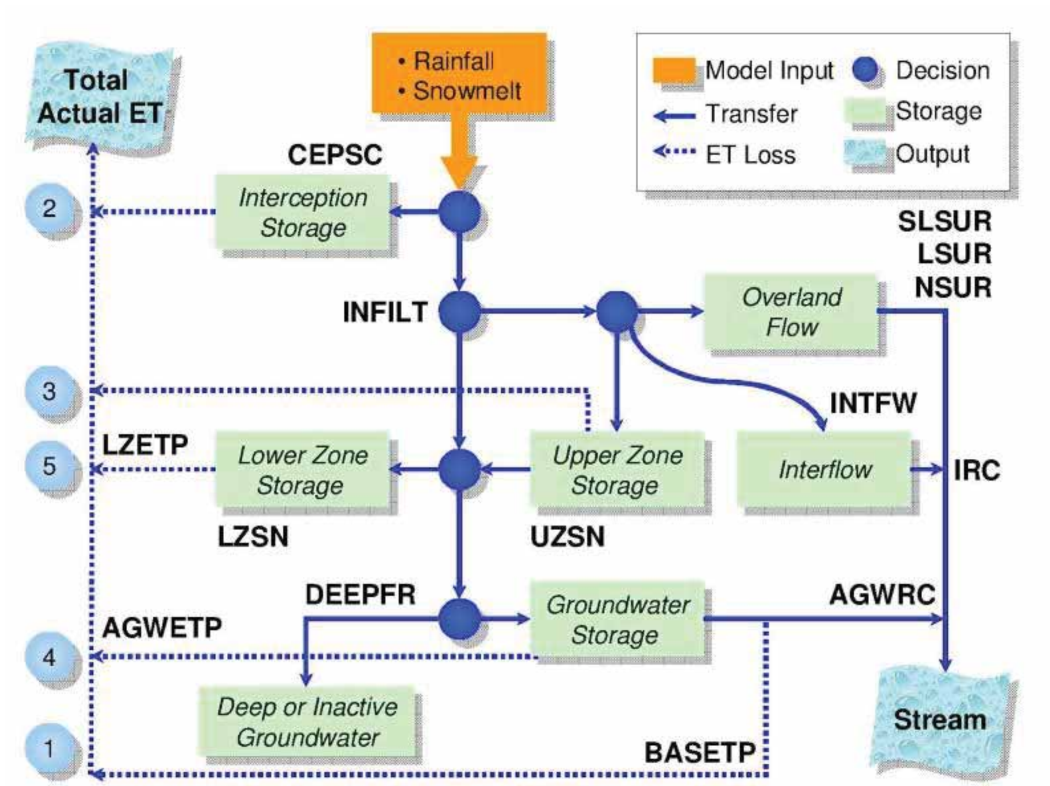

Figure K-13
Schematic of LSPC Hydrology Components and Pathways

Table K-7
Hydrology Parameters for the Los Peñasquitos WMA Model

Parameter	Definition	Units	Temporal Variability
LZSN	Lower zone nominal soil moisture storage	inches	Constant
INFILT	Index to the infiltration capacity of the soil	inches/hour	Constant
KVARY	Variable groundwater recession	1/inches	Constant
AGWRC	Base groundwater recession	none	Constant
PETMAX	Air temperature below which ET is reduced	deg F	Constant
PETMIN	Air temperature below which ET is set to zero	deg F	Constant
INFEXP	Exponent in the infiltration equation	none	Constant
INFILIF	Ratio between the maximum and mean infiltration capacities of the PLS	none	Constant
DEEPFR	Fraction of groundwater inflow that will enter deep groundwater	none	Constant
BASETP	Fraction of remaining potential ET that van be satisfied from baseflow	none	Constant
AGWETP	Fraction of remaining potential ET that van be satisfied from active groundwater	none	Constant
CEPSC	Interception storage capacity	inches	Monthly
UZSN	Upper zone nominal storage	inches	Constant
NSUR	Manning's *n* for the assumed overland flow plane	none	Constant
INTFW	Interflow inflow parameter	none	Constant
IRC	Interflow recession parameter	none	Constant
LZETP	Lower zone ET parameter	none	Monthly

Table K-8
Irrigation Parameters for the Los Peñasquitos WMA Model

Parameter	Definition	Units	Value
petfg	If = 1, use constant PET rather than time series from the air file	none	0
monVaryIrrig	If = 1, use monthly varying ET coefficient	none	1
startmonth	Startmonth of irrigation requirement	integer	1
endmonth	Endmonth of irrigation requirement	integer	12
fraction1	Fraction of irrigation requirement applied over the canopy	%	100%
fraction2	Fraction of irrigation water applied directly to the soil surface	%	0%
fraction3	Fraction of irrigation water applied to the upper soil zone via buried systems	%	0%
fraction4	Fraction of irrigation water likewise applied to the lower soil zone	%	0%
fraction5	Fraction of irrigation water entering directly into the local groundwater, such as seepage irrigation	%	0%
etcoeff	Coefficient to calculate actual ET, based on PET	%	Monthly Varying

Parameter	Definition	Units	Value
etdays	Number of threshold days to calculate irrigation demand	integer	2
rchid	Reach ID from where water is withdrawn (If reach does not exist then etdemand is assumed to be satisfied from an external source.)	none	0

K.4.2 Observed Flow Data

Available hydrologic data were reviewed and used for evaluating the predictive ability of the Los Peñasquitos WMA model. Hydrology monitoring stations were first georeferenced with both the subwatershed boundaries and reach layers to identify the associated model outflow points for comparison. Upstream drainage area characteristics, such as contributing land use distribution, were also summarized for each flow gage. Table K-9 provides a summary of the stations and Figure K-14 shows the in-stream hydrology stations in the Los Peñasquitos WMA available for use in hydrology calibration and validation.

The U.S. Geological Survey (USGS) maintains a long-term flow gage that had a complete period of record for the simulation period from 1/1/1988 to 9/30/2012. This gage, USGS11023340 – Los Peñasquitos Creek near Poway, California, was used as both a calibration and validation gage. Weston collected additional streamflow data at the Los Peñasquitos Creek Mass Loading Station (MLS) on lower Los Peñasquitos Creek as well as at two Temporary Watershed Assessment Stations (TWAS) on upper Los Peñasquitos Creek and on Carroll Canyon Creek. Data for the MLS and two TWAS gages were provided at a sub-daily interval, and therefore were converted to daily average flow values and utilized as additional model validation gages. Additional monitoring stations considered as part of the TMDL modeling effort included a Carmel Creek station and a USGS station near the mouth of Los Peñasquitos Creek.

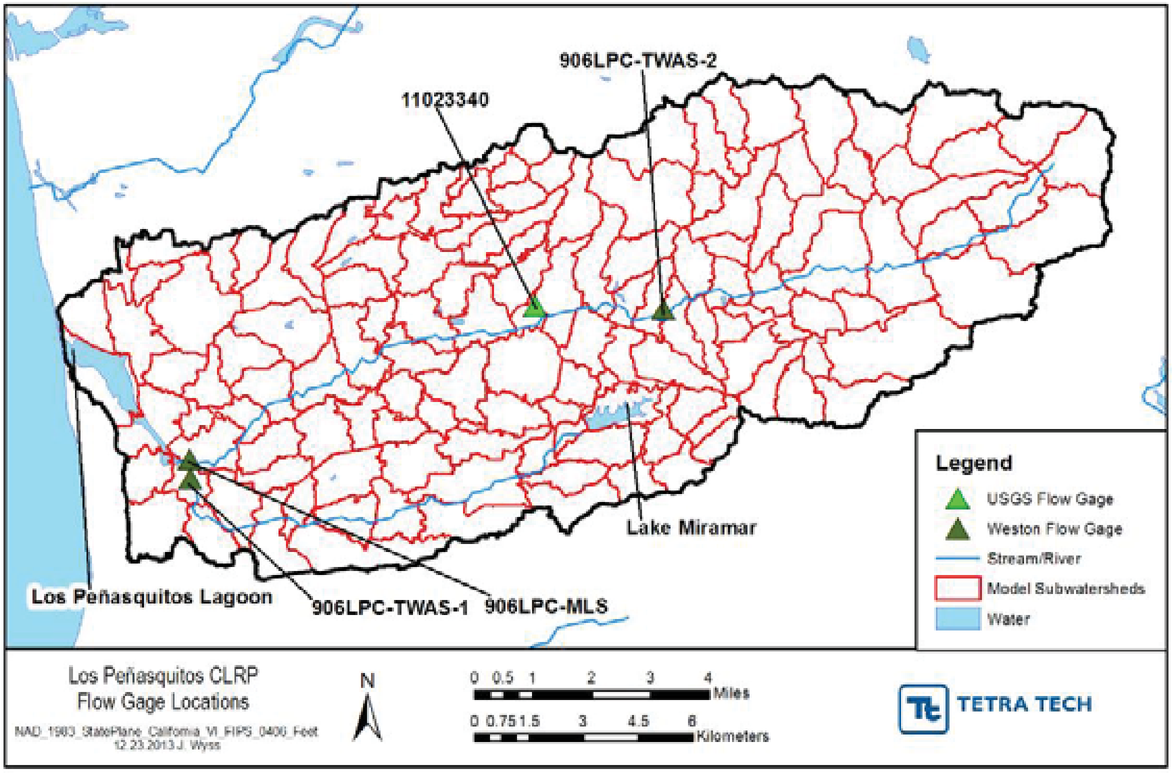

Figure K-14
Spatial Coverage of Calibration and Validation Stations used in the Hydrology Model

Table K-9
Flow Gages used for Calibration and Validation in the Los Peñasquitos WMA Model

Source	Gage ID	Site Name	USGS Drainage Area (acres)	LSPC Watershed	LSPC Drainage Area (acres)	Type	Period of Record Utilized
USGS	11023340	Los Peñasquitos Creek near Poway, CA	26,944	1146	26,988	Calibration/ Validation	10/1/1989–9/30/2012
Westo n	906LPC-MLS	Lower Los Peñasquitos Creek	N/A	1132	36,866	Validation	9/13/2007–6/15/2009 & 8/17/2010–6/22/2011
Westo n	906LPC-TWAS-1	Carroll Canyon Creek	N/A	1208	11,397	Validation	9/19/2007–8/11/2008 & 8/25/2010–6/22/2011
Westo n	906LPC-TWAS-2	Upper Los Peñasquitos Creek	N/A	1154	21,074	Validation	9/27/2007–8/11/2008 & 8/22/2010–6/22/2011

K.4.3 Hydrology Model Calibration

Hydrologic calibration followed the standard operating procedures for the model described in Donigian et al. (1984) and Lumb et al. (1994). Daily, monthly, seasonal, and total modeled flows were compared to observed data, and error statistics were calculated for the percent difference. The percent errors were then compared to recommended tolerance targets from Donigian et al. (1984) and Lumb et al. (1994). Targets are shown in Table K-10 and represent long-term averages for relative error. In general, meeting these targets indicates that a model calibration can be rated as "very good." In contrast, failure to achieve these targets does not indicate that the model is unusable, but rather indicates a need to consider the impacts of model uncertainty on decisions.

Model results were also visually compared to observed data using time series plots, and additional graphical and tabular monthly comparisons were performed. Less credence was placed in the seasonal summer and storm event summer statistics since runoff volumes are low (or nonexistent) during the dry seasons, and storms are rare.

Initial values for the hydrological parameters were taken from the shorter simulation period and regionally calibrated CLRP watershed model (Tetra Tech 2012). Values for hydrologic parameters were set in accordance with the ranges recommended in USEPA (2000) and adjusted during calibration. The key hydrologic parameters adjusted included infiltration, lower zone storage, lower zone evapotranspiration, and the irrigation component. The calibration of the hydrologic parameters was performed from 10/1/01 to 9/30/12.

Table K-10
Criteria for the Hydrology Calibration

Category	Recommended Criteria (%)
Error in total volume:	±10
Error in 50% lowest flows:	±10
Error in 10% highest flows:	±15
Seasonal volume error - Summer:	±30
Seasonal volume error - Fall:	±30
Seasonal volume error - Winter:	±30
Seasonal volume error - Spring:	±30
Error in storm volumes:	±20
Error in summer storm volumes:	±50

Source: Modified from Lumb et al. (1994) and Donigian et al. (1984).

K.4.4 Hydrology Model Validation

An important step of the modeling process is model validation. Model validation is the process of taking the hydrological parameters that have been calibrated, applying those parameters to other watersheds or a different period of time, and comparing the simulated flow to measured flow. Model validation is sometimes called model verification because essentially you are validating or verifying that hydrological parameters calibrated in one watershed will produce acceptable results in another watershed. It is important that when selecting watersheds to perform validations, those watersheds represent a wide variety of land uses and drainage areas. This will help to ensure that the hydrological parameters that were calibrated apply to a wide range of conditions. The validation of the hydrological parameters was performed from 10/1/1989 to 9/30/2001.

K.4.5 Hydrology Results, Observations and Conclusions

Statistics for the hydrologic calibration to the USGS gage on Los Peñasquitos Creek are shown in Table K-11 and compared to the targets discussed in the Calibration Approach section. All measures are within the pre-specified target tolerance ranges (with the exception of 50% lowest flow volumes, for which the percent error is slightly out of range and likely due to irrigation). Overall, the model performs very well, across a range of flow conditions and seasons.

A flow-duration plot (plot of flow versus percent of time exceeded, Figure K-15) shows excellent agreement for the highest flows, and overall good agreement for the rest of the flows. Mid-range flows are slightly over-predicted, and the lowest flows are slightly over. A plot of flow accumulation (Figure K-16) shows that the model tracks observed flow volume well over time, with little deviation.

Monthly observed and modeled flows at Los Peñasquitos Creek for the calibration period are plotted along with reported monthly rainfall (Figure K-17), and also show good agreement. When months are aggregated across the entire calibration period, both a scatterplot and time series show very little difference between simulated and observed average monthly values (Figure K-18).

Table K-11
Summary statistics: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek near Poway CA (Water Years 2002 through 2012 Daily Flow Calibration)

LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1146 11-Year Analysis Period: 10/1/2001 - 9/30/2012 Flow volumes are (inches/year) for upstream drainage area		USGS 11023340 LOS PENASQUITOS CREEK NEAR POWAY CA Hydrologic Unit Code: 18070304 Latitude: 32.9431013 Longitude: -117.1216999 Drainage Area (sq-mi): 42.1		
Total Simulated In-stream Flow:	**4.41**	Total Observed In-stream Flow:		**4.40**
Total of simulated highest 10% flows:	**3.58**	Total of Observed highest 10% flows:		**3.39**
Total of Simulated lowest 50% flows:	**0.27**	Total of Observed Lowest 50% flows:		**0.33**
Simulated Summer Flow Volume (months 7-9):	**0.17**	Observed Summer Flow Volume (7-9):		**0.17**
Simulated Fall Flow Volume (months 10-12):	**1.53**	Observed Fall Flow Volume (10-12):		**1.59**
Simulated Winter Flow Volume (months 1-3):	**2.26**	Observed Winter Flow Volume (1-3):		**2.14**
Simulated Spring Flow Volume (months 4-6):	**0.46**	Observed Spring Flow Volume (4-6):		**0.50**
Total Simulated Storm Volume:	**3.17**	Total Observed Storm Volume:		**3.00**
Simulated Summer Storm Volume (7-9):	**0.02**	Observed Summer Storm Volume (7-9):		**0.03**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	0.22	10		
Error in 50% lowest flows:	**-15.76**	**10**		
Error in 10% highest flows:	5.59	15		
Seasonal volume error - Summer:	-2.10	30		
Seasonal volume error - Fall:	-4.07	30		
Seasonal volume error - Winter:	5.98	30		
Seasonal volume error - Spring:	-9.81	30		
Error in storm volumes:	5.88	20		
Error in summer storm volumes:	-32.19	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.879	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.721	as E or E' approaches 1.0		

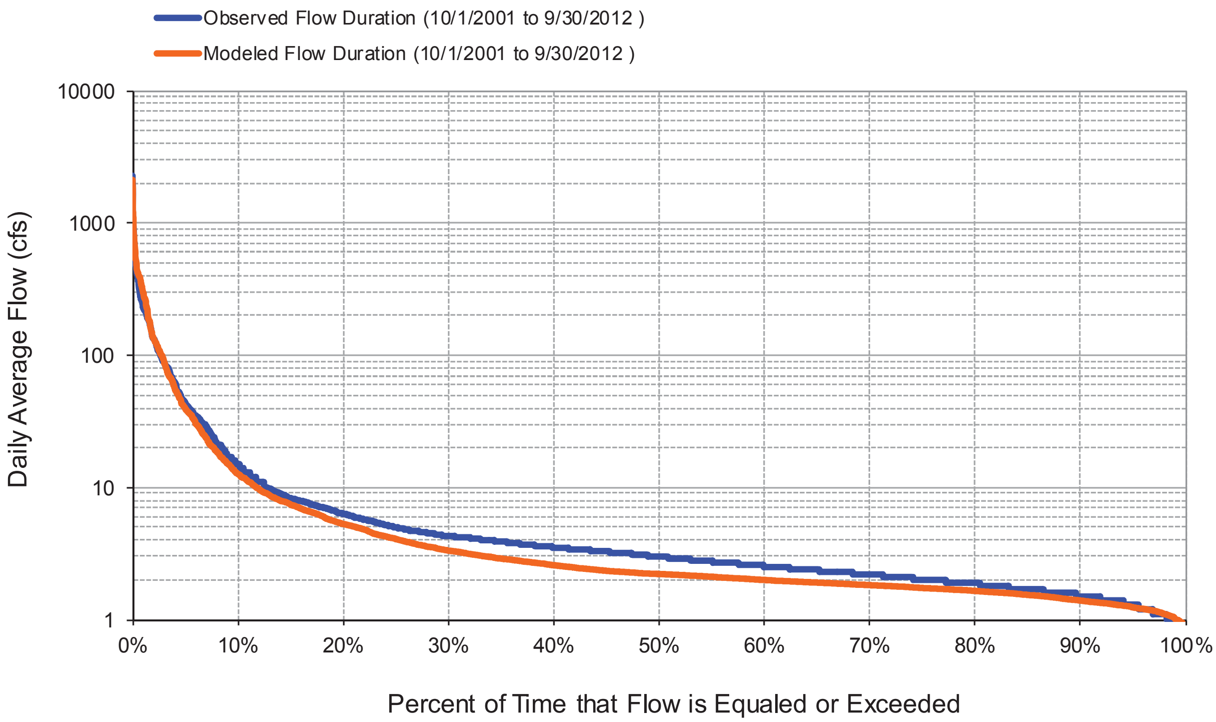

Figure K-15
Flow Exceedance: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek near Poway CA (Water Years 2002 through 2012 Calibration)

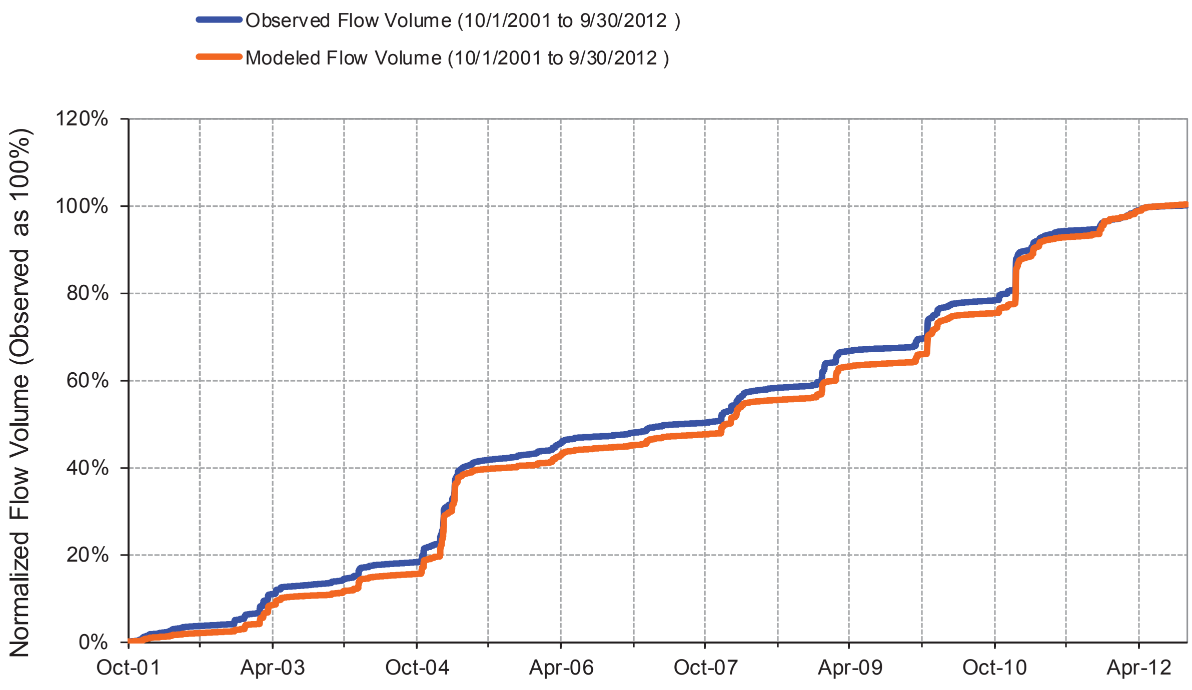

Figure K-16
Flow Accumulation: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek near Poway CA (Water Years 2002 through 2012 Calibration)

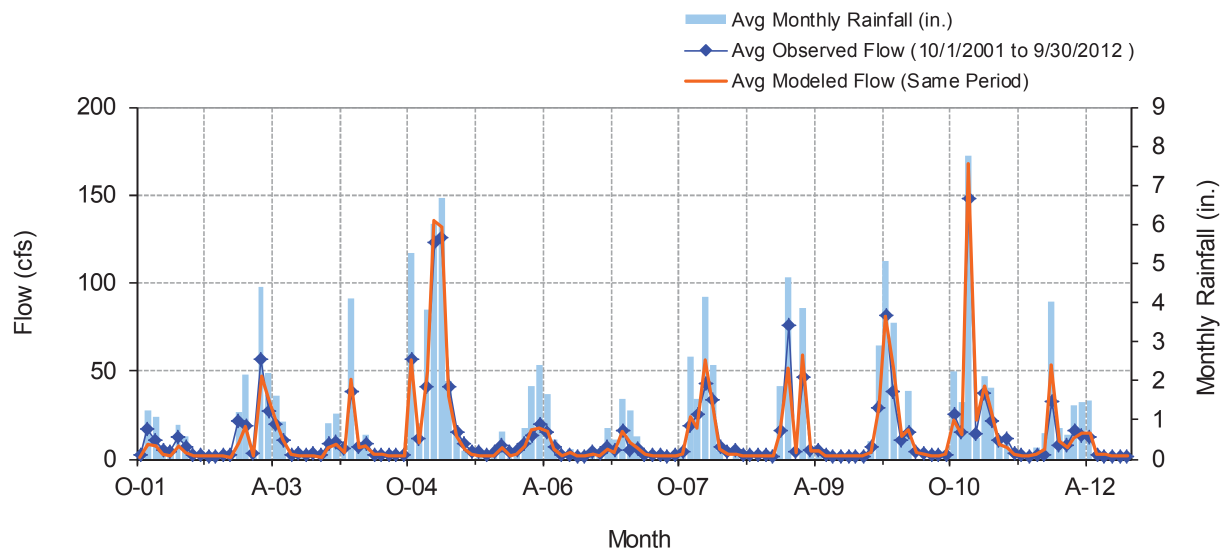

Figure K-17
Mean Monthly Flow: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 2002 through 2012 Calibration)

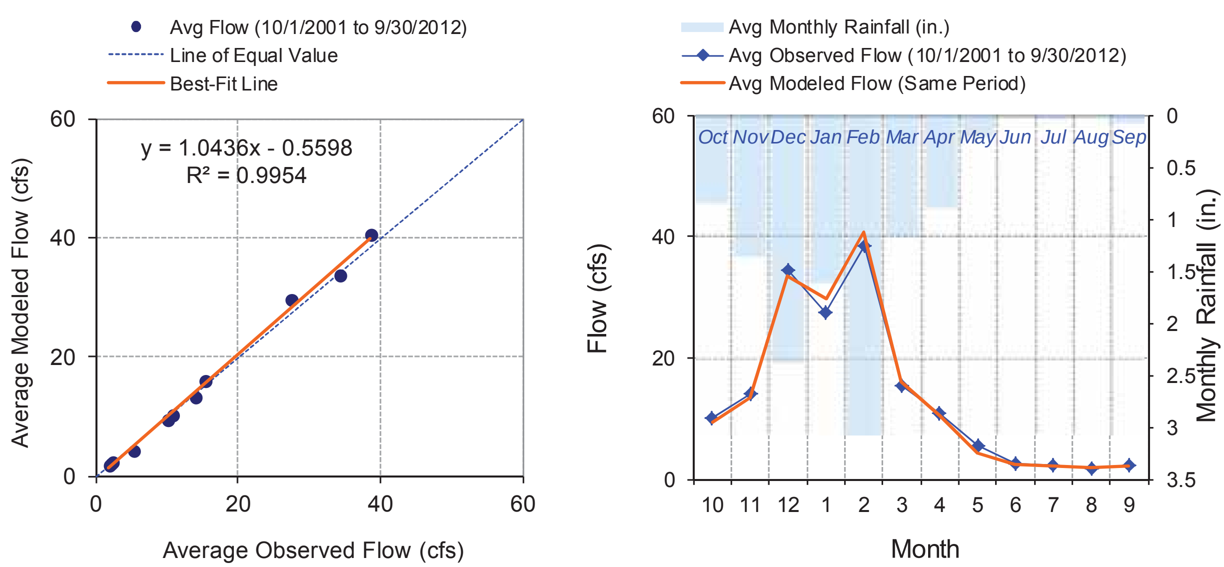

Figure K-18
Seasonal Regression and Temporal Aggregate: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 2002 through 2012 Calibration)

Validation results are presented in Table K-12 and Figure K-19, Figure K-20, Figure K-21, and Figure K-22. The model shows excellent agreement to observed conditions, arguably the results of the validation are better than the calibration largely due to the better match of simulated and observed flow duration curves but the Nash Sutcliffe Coefficient of Efficiency is not of as high a quality as compared to the calibration. The validation results are very good.

Table K-12
Summary Statistics: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek near Poway CA (Water Years 1990 through 2001 Daily Flow Validation)

LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 1146 12-Year Analysis Period: 10/1/1989 - 9/30/2001 Flow volumes are (inches/year) for upstream drainage area		USGS 11023340 LOS PENASQUITOS CREEK NEAR POWAY CA Hydrologic Unit Code: 18070304 Latitude: 32.9431013 Longitude: -117.1216999 Drainage Area (sq-mi): 42.1		
Total Simulated In-stream Flow:	**5.12**	Total Observed In-stream Flow:		**5.16**
Total of simulated highest 10% flows:	**4.19**	Total of Observed highest 10% flows:		**4.15**
Total of Simulated lowest 50% flows:	**0.28**	Total of Observed Lowest 50% flows:		**0.29**
Simulated Summer Flow Volume (months 7-9):	**0.22**	Observed Summer Flow Volume (7-9):		**0.20**
Simulated Fall Flow Volume (months 10-12):	**0.47**	Observed Fall Flow Volume (10-12):		**0.50**
Simulated Winter Flow Volume (months 1-3):	**3.81**	Observed Winter Flow Volume (1-3):		**3.84**
Simulated Spring Flow Volume (months 4-6):	**0.62**	Observed Spring Flow Volume (4-6):		**0.62**
Total Simulated Storm Volume:	**3.67**	Total Observed Storm Volume:		**3.46**
Simulated Summer Storm Volume (7-9):	**0.05**	Observed Summer Storm Volume (7-9):		**0.05**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*		
Error in total volume:	-0.69	10		
Error in 50% lowest flows:	-2.51	10		
Error in 10% highest flows:	0.95	15		
Seasonal volume error - Summer:	10.40	30		
Seasonal volume error - Fall:	-6.85	30		
Seasonal volume error - Winter:	-0.82	30		
Seasonal volume error - Spring:	1.53	30		
Error in storm volumes:	5.92	20		
Error in summer storm volumes:	-13.31	50		
Nash-Sutcliffe Coefficient of Efficiency, E:	0.397	Model accuracy increases		
Baseline adjusted coefficient (Garrick), E':	0.619	as E or E' approaches 1.0		

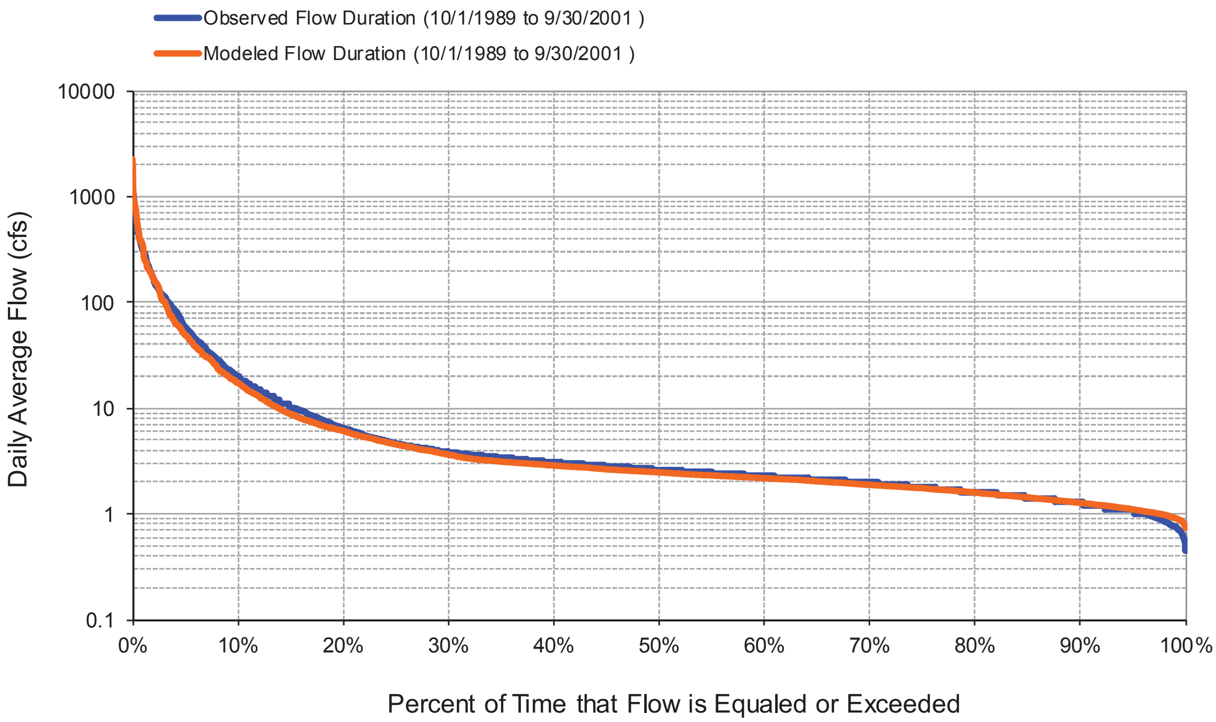

Figure K-19
Flow Exceedance: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 1990 through 2001 Validation)

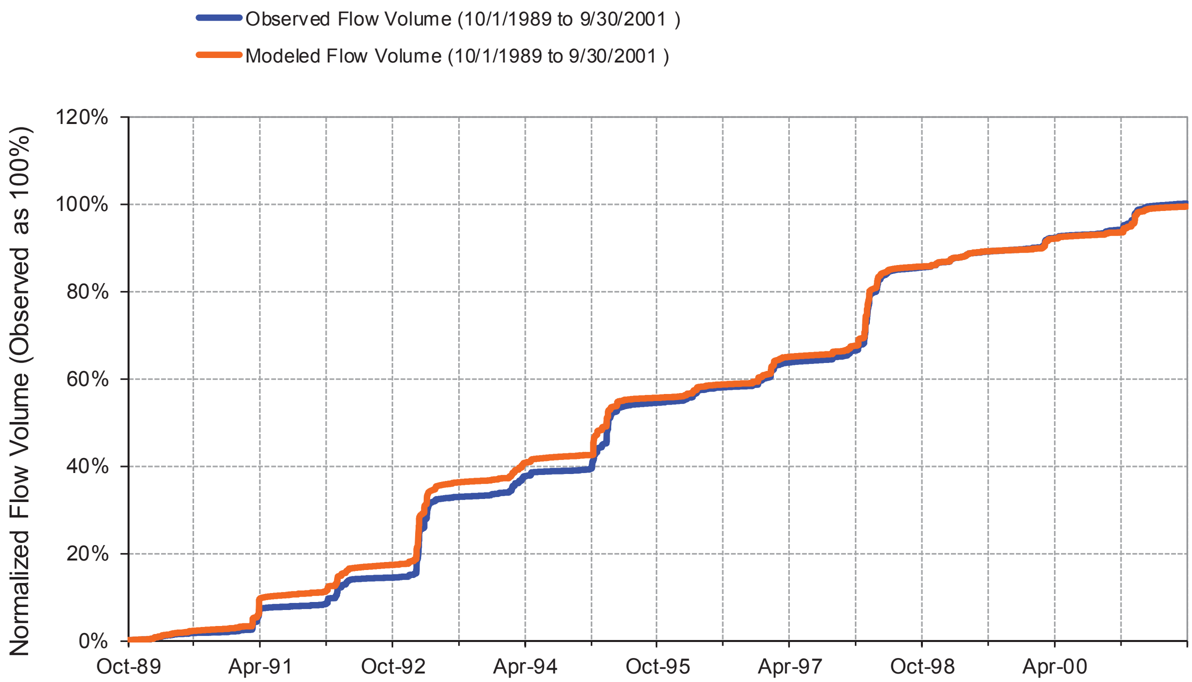

Figure K-20
Flow Accumulation: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 1990 through 2001 Validation)

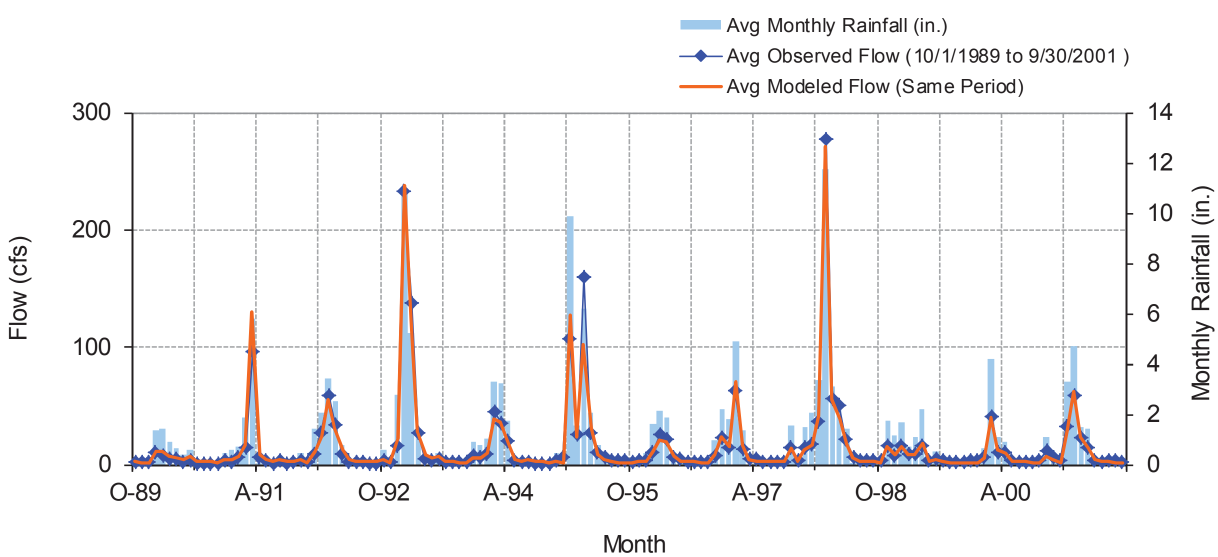

Figure K-21
Mean Monthly Flow: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 1990 through 2001 Validation)

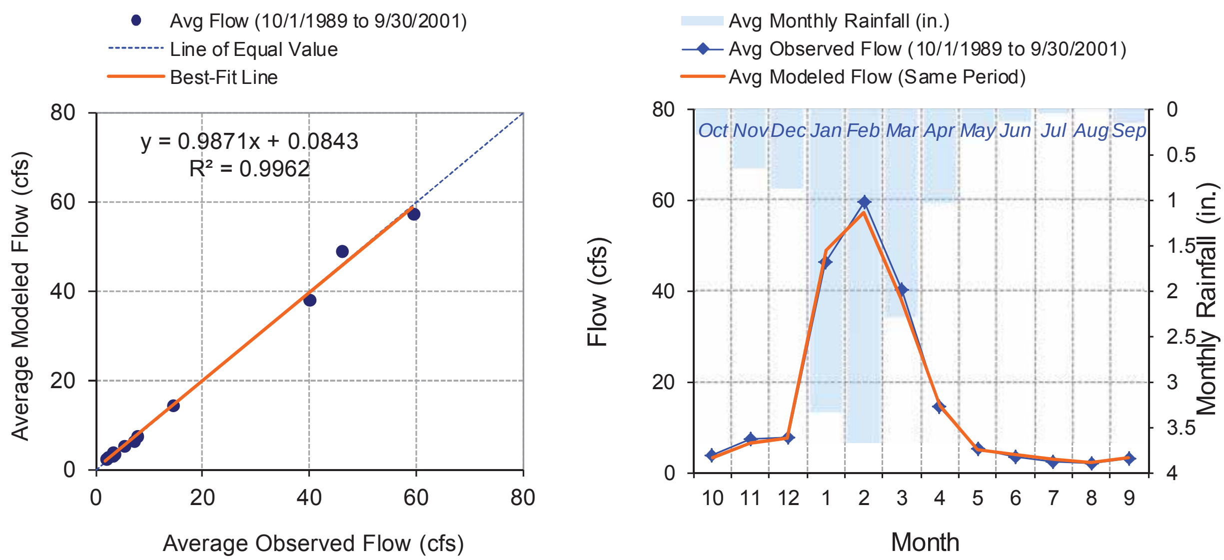

Figure K-22
Seasonal Regression and Temporal Aggregate: Model Outlet 1146 vs. USGS 11023340 Los Peñasquitos Creek Near Poway CA (Water Years 1990 through 2001 Validation)

During the calibration process it was observed that obtaining an acceptable hydrology calibration was largely dependent on the irrigation component of the model. The model was sensitive to all of the irrigation parameters (Table K-8) but extremely sensitive to the ETc (Crop coefficient to evaluate actual evapotranspiration parameter) and where the irrigation water was applied in the model.

For the irrigation component it was assumed that irrigation water could be applied in any month of the year and that the irrigation calculation would resolve the irrigation demand function over a period of 2 days (i.e. to calculate the irrigation demand function it would utilize rainfall and potential evapotranspiration from the previous 2 days). Additionally it was assumed that all irrigation water was supplied either over the canopy, which made irrigation water subject to interception losses, or to the soil surface (bypassing interception storage). Values for ETc ranged from 0.95 to 1.15, varying seasonally.

Research suggests a crop coefficient of 0.6 for lawns planted with warm season grasses and 0.65 for agricultural citrus production (University of California Cooperative Extensive 2000). To be able to use the suggested ranges all irrigation water would have needed to be supplied directly to the soil surface. This did not seem realistic with the types of irrigation systems being used in southern California. Therefore, the assumptions that all irrigation water was to be applied over the canopy and also using ETc as a calibration parameter were adopted. Further it was decided that the crop coefficients in the document were meant for use in irrigator’s actual calculations to determine their irrigation need and is not necessarily reflective of the amount of irrigation water that is actually utilized and applied to the landscape. Lastly, through the course of the calibration it was determined that supplying ETc as a monthly varying parameter resulted in a better comparison of simulated and observed flow values.

Due to the extreme sensitivity to ETc it was decided to perform and present the results of a sensitivity analysis. The model calibration was tuned to its final state and then monthly ETc was modified by adding 10% to the final calibrated values and subtracting 10% from the final calibrated values. Then Tetra Tech's hydrology calibration tool was used to analyze impacts between the final calibrated model (Baseline) and the simulation with the changed ETc values (Scenario) during the calibration period of the model.

Table K-13 presents the summary statistics comparing the two scenarios with the baseline calibrated model. The +10% scenario drastically increases the volumes in the summer and 50% lowest flows while the -10% scenario drastically decreases the volumes in the summer and 50% lowest flows. Figure K-23 shows the flow duration curve of the +10% scenario and graphically shows the increase in flow of the 50% lowest flows and Figure K-24 shows the flow duration curve of the -10% scenario and graphically shows the decrease in flow of the 50% lowest flows. The results of the sensitivity analysis indicate that the values used for ETc in the calibrated model are in an acceptable range when using the assumptions adopted during the course of model calibration.

Table K-13
Summary Statistics: Scenario +10% ETc (Modeled) vs. Baseline Calibration Outflow from Sub-Watershed 1146

Metric (Scenario-Baseline)	Scenario Comparison	
	ETc +10%	ETc -10%
Difference in total volume:	6.85	-6.23
Difference in 50% lowest flows:	42.22	-40.22
Difference in 10% highest flows:	2.73	-2.31
Seasonal volume difference - Summer:	37.33	-36.93
Seasonal volume difference - Fall:	5.91	-5.23
Seasonal volume difference - Winter:	3.51	-3.32
Seasonal volume difference - Spring:	15.52	-12.90
Difference in storm volumes:	2.98	-2.27
Difference in summer storm volumes:	13.48	-7.40

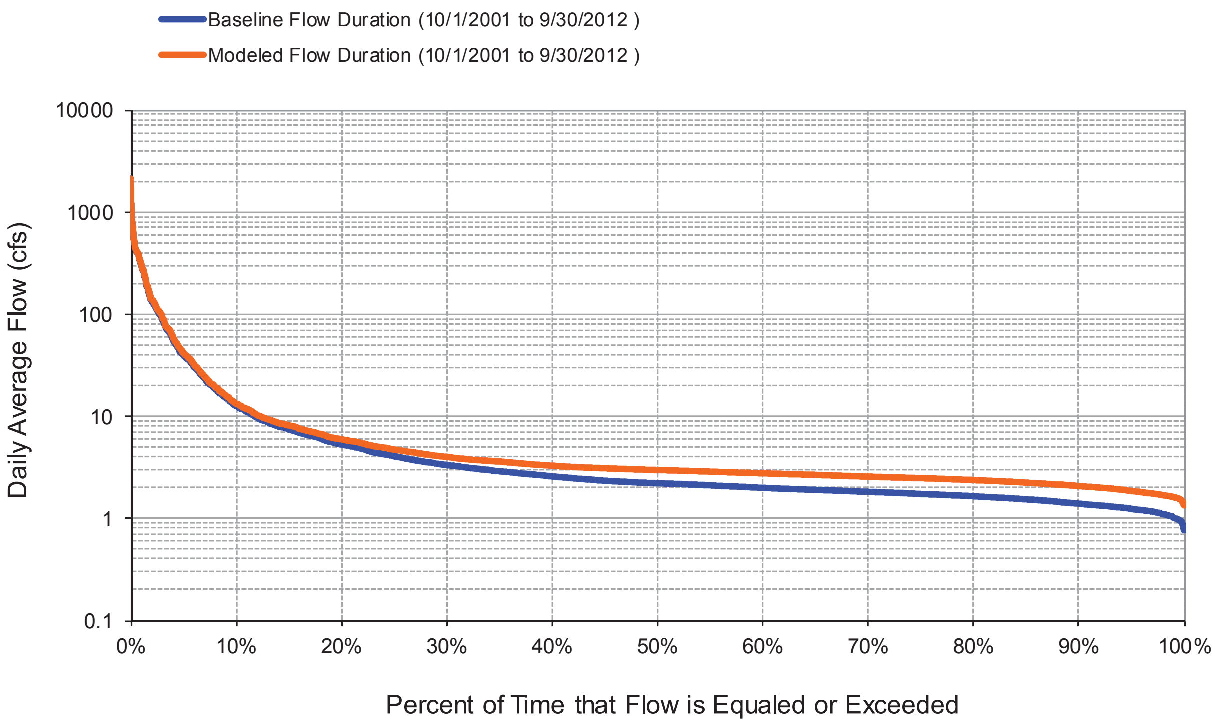

Figure K-23
Flow Exceedance: Scenario +10% ETc (Modeled) vs. Baseline Calibration Outflow from Sub-Watershed 1146

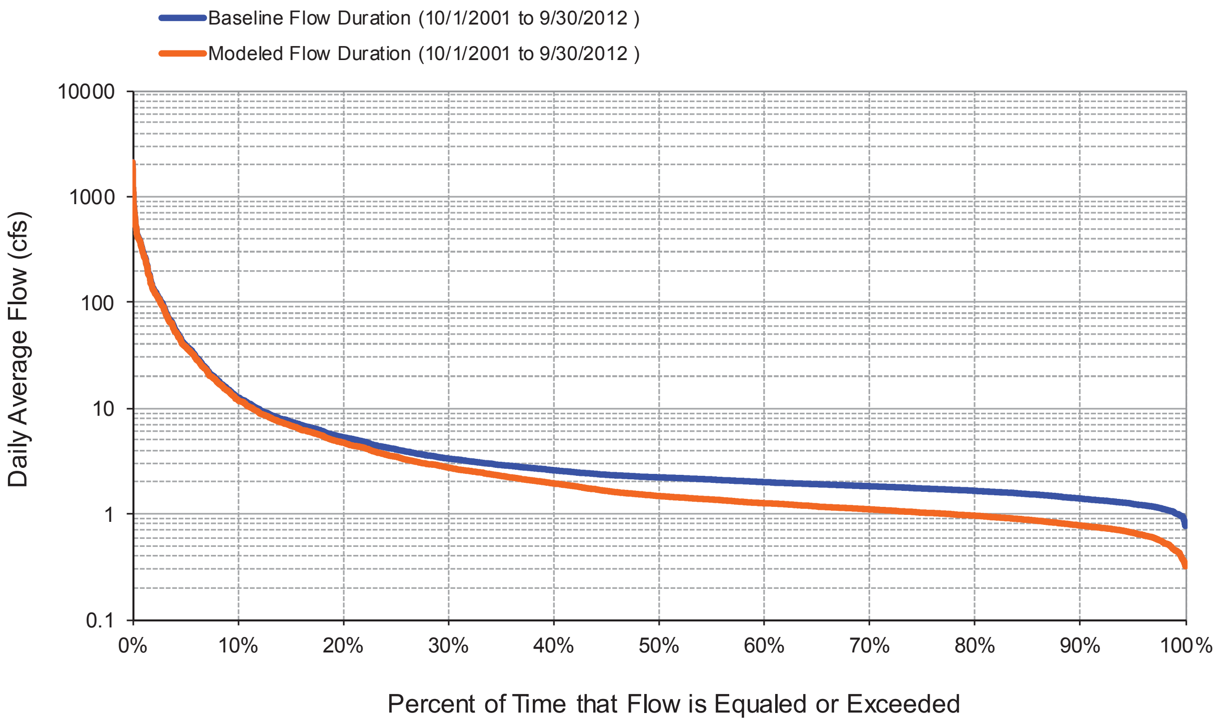

Figure K-24
Flow Exceedance: Scenario -10% ETc (Modeled) vs. Baseline Calibration Outflow from Sub-Watershed 1146

K.5 Watershed Water Quality Model

K.5.1 Water Quality Model Overview

Once the LSPC watershed hydrology model was calibrated, the model was used to create a water quality model of the Los Peñasquitos watershed. Many components of the water quality model were established during hydrology modeling. These components include watershed segmentation, meteorological data, and land use representation. The models simulate pollutant generation and accumulation on surfaces, and resulting pollutant runoff and delivery to receiving water bodies. Delivery of pollutants through subsurface pathways (i.e., interflow and groundwater) is also represented. Water quality parameters were determined to adequately represent the loading generation capabilities for the different modeled HRUs for a wide range of storm intensities and baseflows. Initial water quality parameterization was taken from the previous shorter simulation period and regionally calibrated CLRP watershed model (Tetra Tech 2012), and refined where appropriate to optimize the fit of simulated to observed concentration and load.

K.5.2 Modeled Constituents

The LSPC water quality model was set up to model Total Suspended Solids, Total Nitrogen (TN), Total Phosphorus (TP), Total Copper, Total Lead, Total Zinc, Fecal Coliform, Total Coliform, and *Enterococcus*.

K.5.3 Reach Group Representation

For in-stream water quality simulation, the user has the ability to model in-stream processes, for the modeled reaches, by assigning them to reach groups. Assigning reaches into groups allows for the assignment of unique values, for each reach group, for certain LSPC parameters. The parameters that can be assigned differently by reach group for the Los Peñasquitos WMA model include sediment bed storage parameters, cohesive and non-cohesive suspended sediment variables for in-stream transport, in-stream general quality constituent control, parameters for decay of contaminant adsorbed to sediment, and parameters for adsorption/desorption of contaminant adsorbed to sediment. In LSPC, reach group is analogous to the RCHRES block in HSPF. A detailed description of relevant in-stream and transport algorithms is presented in the *HSPF Version 12 User's Manual* (Bicknell et al. 2004).

For the Los Peñasquitos WMA model, each reach was assigned its own unique group. This was done primarily for the sediment transport component of the model. All of the values for stream group parameters that were not associated with sediment were set to the same value for each reach. The parameters that were associated with sediment transport were allowed to vary for each individual reach. Giving each reach its own reach group removed the phenomena where one reach in a particular group might always be accumulating silt and clay and scouring sand while another reach might always be scouring silt and clay and depositing sand. Additional details regarding parameters for specific reaches are provided in Section 5.6.

K.5.4 Sediment Representation

LSPC models sediment by using algorithms identical to those in the HSPF. The LSPC/HSPF modules used to represent sediment include SEDMNT (production and removal of sediment from a pervious land segment), SOLIDS (accumulation and removal of solids by runoff and other means from the impervious land segment), and SEDTRN (transport, deposition, and scour of inorganic sediment in free-flowing reaches and mixed reservoirs). A detailed description of relevant sediment algorithms is presented in the *HSPF Version 12 User's Manual* (Bicknell et al. 2004). In short, sediment is being removed from pervious lands via raindrop impact particle detachment and then subsequently the detached sediment is being carried to the stream via pervious land surface flow. For impervious land, buildup and removal rates are applied and solids are washed into the stream via impervious land surface flow during rain events. Once the sediment and solids are in the stream they either deposit or scour dependent on the conditions in the water column for each reach.

Sediment is one of the most difficult water quality parameters to accurately simulate with watershed models; therefore, the approach to modeling sediment in the Los Peñasquitos WMA model consisted of using the final calibrated parameter values from the previous shorter simulation period and regionally calibrated CLRP watershed model (Tetra Tech 2012) except the stream bank erosion component. The borrowed parameters were adjusted slightly in accordance with guidelines established in EPA *BASINS Technical Note 8: Sediment Parameter and Calibration Guidance for HSPF* (USEPA 2006) and *Sediment Calibration Procedures and Guidelines for Watershed Modeling* (Donigian and Love 2003). In addition, the in-stream transport component of sand, silt and clay were closely examined and calibrated for each reach to maintain a dynamic steady state during the long-term simulations.

Key processes for sediment include soil detachment, soil compaction, fraction of land use shielded from raindrop impact, sediment washoff rate, and in-stream transport which includes settling velocities and flow velocities that contribute to deposition and resuspension of sediment particles.

K.5.5 Nutrients, Metals, and Bacteria Representation

LSPC models nutrients, metals, and bacteria by using algorithms identical to those in the HSPF. The LSPC/HSPF modules used to represent nutrients, metals, and bacteria include PQUAL (water quality constituents or pollutants in the outflows from a pervious land segment using simple relationships with water and/or sediment yield); IQUAL (water quality constituents or pollutants in the outflows from an impervious land segment using simple relationships with water yield and/or solids); and GQUAL (simulate the in-stream behavior of a generalized constituent). A detailed description of relevant sediment algorithms is presented in The *HSPF Version 12 User's Manual* provides a detailed description of relevant sediment algorithms (Bicknell et al. 2004).

Accumulation and washoff rates play an important role in the determination of nonpoint source loadings to a water body. The watershed model must appropriately represent the spatial and temporal variability of hydrological characteristics within a watershed. It must also appropriately represent the rate at which constituent's build up between rain events and wash off during rain events. Key general water quality characteristics include initial storage, washoff and scour potency, accumulation rates, and asymptotic maximum storage amounts. The water supplied to a stream from groundwater and through interflow also plays an important role in loading to a water body. LSPC allows the user to supply groundwater and interflow concentrations by parameter group and RMU. The accumulation, washoff, and interflow strongly influence peak flow water quality while groundwater reflects baseflow water quality.

Nutrients and bacteria on pervious and impervious HRUs were simulated using the buildup/washoff and assignment of concentrations to the interflow and groundwater flow paths. Metals on pervious and impervious HRUs were simulated as sediment-associated constituents by assigning a washoff potency factor (mass/ton of sediment) and concentrations to the interflow and groundwater flow paths. As a result of using potency factors, metals are strongly correlated with the sediment simulation. Once in the stream, all constituents were simulated as dissolved and it was assumed that there was no adsorption/desorption with sediment. Nutrients and bacteria were assigned general first-order in-stream loss rates to account for uptake and decay, but metals were assumed to not decay.

K.5.6 Water Quality Calibration

Sediment was the first constituent calibrated after hydrology. The land-based parameters were adjusted until the simulated land-based export closely matched the sediment target export coefficients (Table K-14). After the land-based sediment was reasonably calibrated the in-stream transport simulation of sediment was closely examined. The parameters for in-stream transport were modified as necessary to maintain a dynamic steady state for each sediment class for the long-term simulation.

Additional calibration was pursued for mining areas in Carroll Canyon Creek. Two new land use categories, 73 and 76, were adopted to explicitly represent activity on lands with <10% slope and >= 10%, respectively.

While there is a general consensus that mining areas are a major source of sediment, there are no quantitative estimates of loading. As a result, the model was parameterized for mining areas based upon published data. The Georgia Department of Natural Resources (2005) reports an estimated sediment load of 3.19 tons/ac/yr. from quarries, strip mines and gravel pits in Headstall Creek in Georgia. Diaz-Ramirez et al. (2008) have modeled sediment generation from barren land (which includes quarries/strip mines/gravel pits) in an HSPF model for the Luxapallila Creek watershed in Alabama and Mississippi. They report a simulated annual sediment rate of 6.3 mt/ha/yr. (~2.8 tons/ac/yr.) compared to an observed rate of 4.0 - 9.0 mt/ha/yr. (~1.8 - 4.0 tons/ac/yr.). The Tt model adopted similar parameter values for mining land uses (Table K-15).

Table K-14
Export Coefficients for Total Suspended Solids for Different Land Uses Literature Review

Eco-region type or Land Use	Export Coefficient (kg/ha/year)	Reference
Foothills Parklands	18.07 – 42.90	Sosiak 2000
Foothills Fescue	24.02 – 100.99	Sosiak 2000
Forest	250	USEPA 1976
Forest	253	Reckhow et al. 1980
Agricultural non intensive pasture/range	400	USEPA 1976
Agricultural non intensive pasture/hay	514.5	Reckhow et al. 1980
Agricultural intensive mixed	4900	Van Vliet & Hall 1991
Agricultural intensive wheat	1440	Larney et al. 1995b
Nonnative land use		
Urban	2000	USEPA 1976
Urban, residential	208.6	Reckhow et al. 1980
Industrial	868.7	Reckhow et al. 1980

Extracted from (Tetra Tech 2011)

Table K-15
Sediment Parameter Values for Mining Land Uses

Parameter	Value
kser	10.0
jser	2.0
kger	10.0
jger	2.2

The model was also configured to generally represent the trends in sediment production and delivery observed in the ESA-PWA geomorphology/sedimentation reports. These included,

- Specifying the initial sediment fraction (by weight) of bed materials to 90% sand, 5% silt and 5% clay based upon particle size distribution of bed materials in the Carroll Canyon Creek subwatershed.
- The model generally has *ksand* and *expsand* set to 1.5 and 1, respectively, for all reaches in Carroll Canyon Creek subwatershed. These values were revised for some reaches (Table K-16), depending upon the erosive or depositional nature of the reach.

Table K-16
Values of ksand and expsand
in Carroll Canyon Creek

Reach	*ksand*	*expsand*
1211	1.5	1.2
1213	1.5	2.3
1214	1.5	2
1215	1.5	2
1216	1.5	1.2
1218	1.5	2
1225	1.5	2
1226	1.5	2
1227	1.5	2
1228	1.5	2

The parameterization for the three classes of bacteria (enterococcus, fecal coliform, total coliform) were obtained from the previous shorter simulation period and regionally calibrated CLRP watershed model (Tetra Tech 2012), and unmodified for the model extension effort.

K.5.7 Observed Water Quality Data for Calibration and Validation

Available in-stream water quality data were reviewed and used for evaluating the predictive ability of the Los Peñasquitos WMA model. Water quality monitoring stations were first georeferenced with both the subwatershed boundaries and reach layers to identify the associated model outflow points for comparison. Upstream drainage area characteristics, such as contributing land use distribution, were also summarized for each water quality station. Table K-17 provides a summary of the stations and Figure K-25 shows the in-stream water quality stations in the Los Peñasquitos WMA available for use in water quality calibration. Because of the limited number of samples available for water quality calibration, the water quality model was not validated.

Water quality data for many constituents were collected at the Los Peñasquitos Creek MLS on lower Los Peñasquitos Creek as well as at two TWAS on upper Los Peñasquitos Creek and on Carroll Canyon Creek. These three locations are at the same location as the Weston flow measurement stations used for Hydrology validation.

Table K-17
Water Quality Stations used for Calibration in the Los Peñasquitos WMA Model

Station	Site Name	Drainage Area (mi^2)	Drainage Area (acres)	LSPC Watershed	Parameters	Period of Record Utilized	# of Samples
906LPC-MLS	Lower Los Peñasquitos Creek	57.60	36,866	1132	Total Suspended Sediment *Enterococcus* Fecal Coliform Total Coliform	11/29/2001–5/12/2011	27
906LPC-TWAS-1	Carroll Canyon Creek	17.81	11,397	1208	Total Suspended Sediment *Enterococcus* Fecal Coliform Total Coliform	9/26/2007–5/12/2011	8
906LPC-TWAS-2	Upper Los Peñasquitos Creek	32.93	21,074	1154	Total Suspended Sediment *Enterococcus* Fecal Coliform Total Coliform	9/26/2007–5/12/2011	8

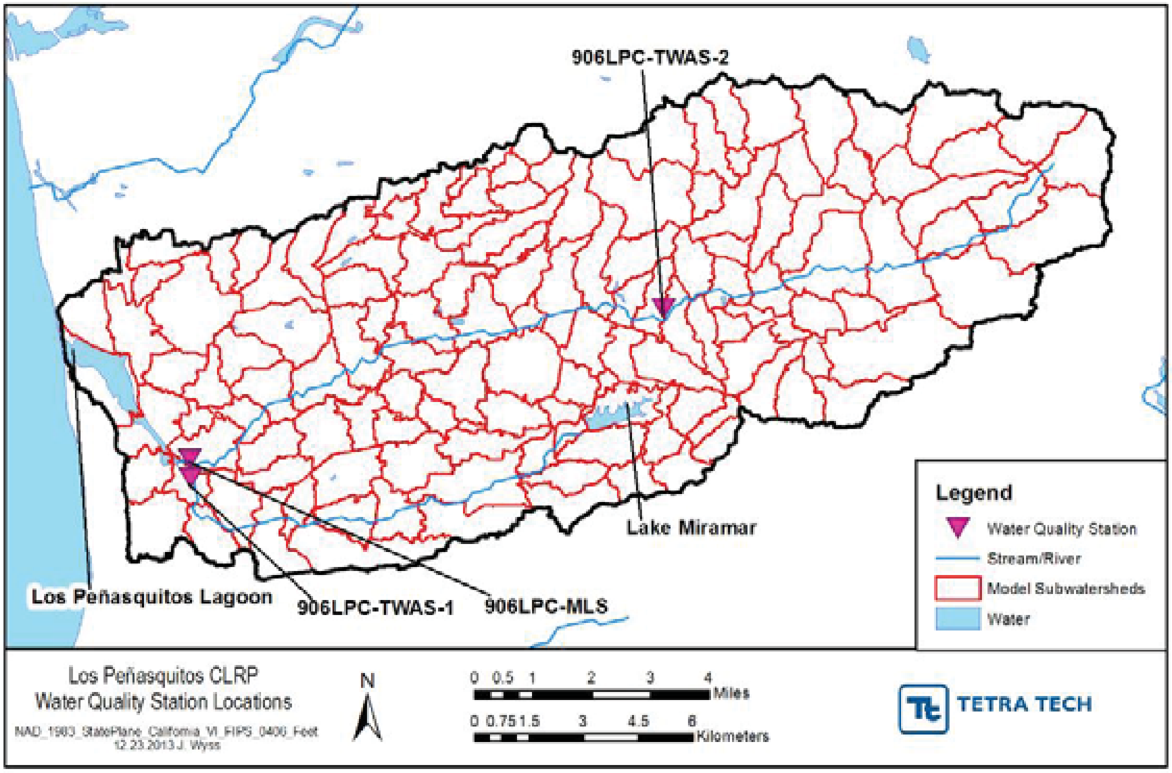

Figure K-25
Spatial Coverage of Calibration and Validation Stations used in the Water Quality Model

K.5.8 Water Quality Results, Observations and Conclusions

Presented below are the results of the water quality calibration at 906LPC-MLS on lower Peñasquitos Creek. Shown are time-series plots comparing continuous simulation concentration output to point in time grab sample measurements. Also shown are simulated and observed load/load regressions and simulated and observed load duration curves. In order to calculate observed load, long-term daily observed flow is needed. There is not long-term daily observed flow at the water quality gages so simulated flow has been used in its place. Therefore any difference in load between simulated and observed is entirely dependent on concentration since both simulated and observed loads are being calculated with the same flow time-series. Additionally, for the load calculations all concentrations were assumed to be in mg/L and calculated loads were assumed to be in pounds/day. Metals and bacteria are simulated in different units (µg/L and #/100ml respectively) so the loads are not actual masses and should only be used for comparative purposes.

K.5.8.1 Sediment

Table K-18 shows the simulated average sediment unit area loading by HRU for each parameter group. Time-series comparisons in standard and log format are shown in Figure K-26 and Figure K-27, respectively. Observed and simulated concentrations generally have similar distributions and magnitudes. The regression plot (Figure K-28) of simulated versus observed load shows little or no bias across the range of loads sans the line of five samples that have low observed load and high simulated load. These samples were measured as less than detection and the TSS value used for that sample was input at ½ the detection limit. In the load duration curve (Figure K-29), observed loads generally follow the distribution of simulated loads across the entire flow regime sans the five less than detection samples in the lower left hand corner of the plot. Overall the results of the sediment calibration are acceptable and the model should be useful for the CLRP and future implementation planning efforts.

Table K-18
Sediment Unit Area Land Use Export for Both Simulated Parameter Groups

Parameter Group		Carroll Canyon	All Others
DELUID	Land Use Name	Average Ton/Acre/Year	Average Ton/Acre/Year
3	Water	0.000	0.000
11	Agriculture Low Slope	0.000	0.029
15	Agriculture High Slope	0.250	0.210
23	Barren Low Slope	0.011	0.016
26	Barren High Slope	0.339	0.240
34	Forest/Shrub HSG B	0.001	0.001
35	Forest/Shrub HSG C	0.010	0.020
36	Forest/Shrub HSG D	0.114	0.111
44	Grassland HSG B	0.003	0.002
45	Grassland HSG C	0.017	0.056
46	Grassland HSG D	0.214	0.192
51	DevPerv HSG B Low Slope No Irrigation	0.012	0.014
52	DevPerv HSG C Low Slope No Irrigation	0.036	0.086
53	DevPerv HSG D Low Slope No Irrigation	0.183	0.157
54	DevPerv HSG B High Slope No Irrigation	0.012	0.014
55	DevPerv HSG C High Slope No Irrigation	0.040	0.083
56	DevPerv HSG D High Slope No Irrigation	0.189	0.164
61	DevPerv HSG B Low Slope Irrigation	0.062	0.104
62	DevPerv HSG C Low Slope Irrigation	0.185	0.305
63	DevPerv HSG D Low Slope Irrigation	0.502	0.434
64	DevPerv HSG B High Slope Irrigation	0.071	0.091

Parameter Group		Carroll Canyon	All Others
DELUID	Land Use Name	Average Ton/Acre/Year	Average Ton/Acre/Year
65	DevPerv HSG C High Slope Irrigation	0.181	0.278
66	DevPerv HSG D High Slope Irrigation	0.488	0.420
73	Mining, Low Slope (<10%)	0.078	0.000
76	Mining, High Slope (>10%)	2.185	0.000
91	Residential Low Slope Impervious	0.143	0.103
92	Residential High Slope Impervious	0.140	0.112
93	Institutional/Office Impervious	0.089	0.077
94	Commercial Impervious	0.521	0.413
95	Industrial Impervious	0.633	0.402
96	Road Impervious	0.278	0.231
97	Freeway Impervious	0.238	0.219
98	Overspray Residential Impervious	0.146	0.115
99	Overspray Road Impervious	0.280	0.238

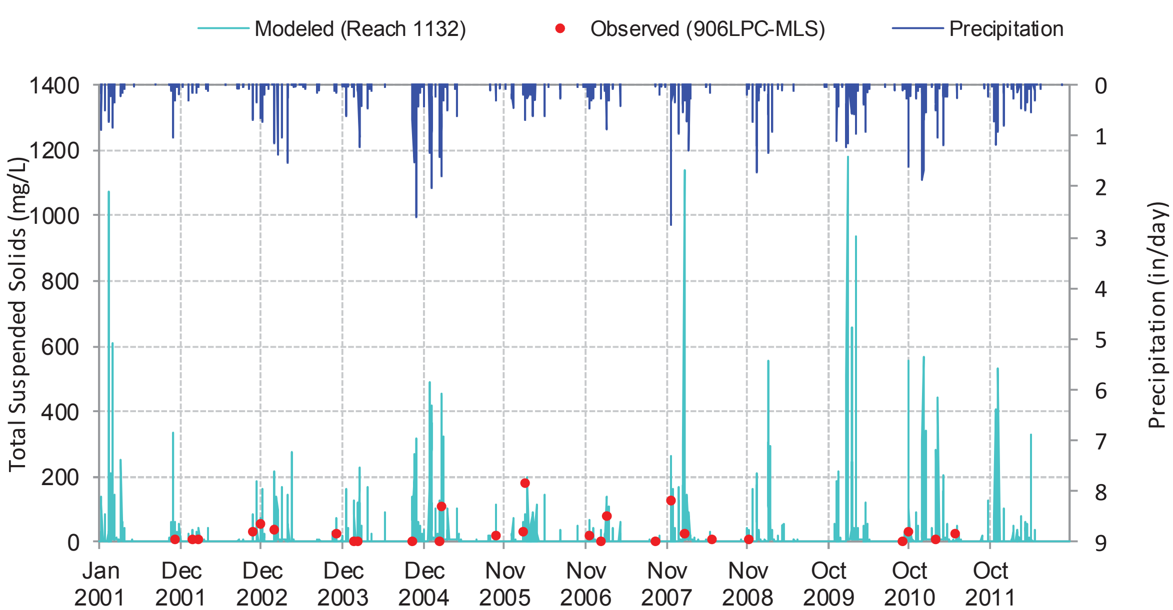

Figure K-26
Modeled vs. Observed Total Suspended Solids (mg/L) at 906LPC-MLS

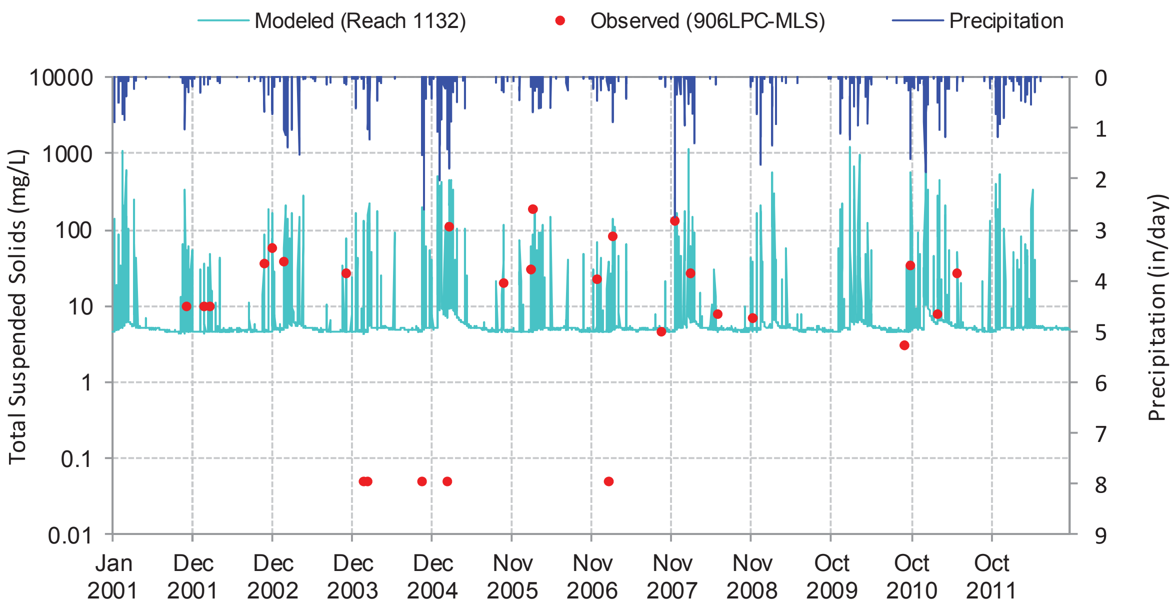

Figure K-27
Modeled vs. Observed Total Suspended Solids (mg/L) at 906LPC-MLS (log scale)

Figure K-28
Modeled vs. Observed Load Total Suspended Solids (pounds/day) at 906LPC-MLS

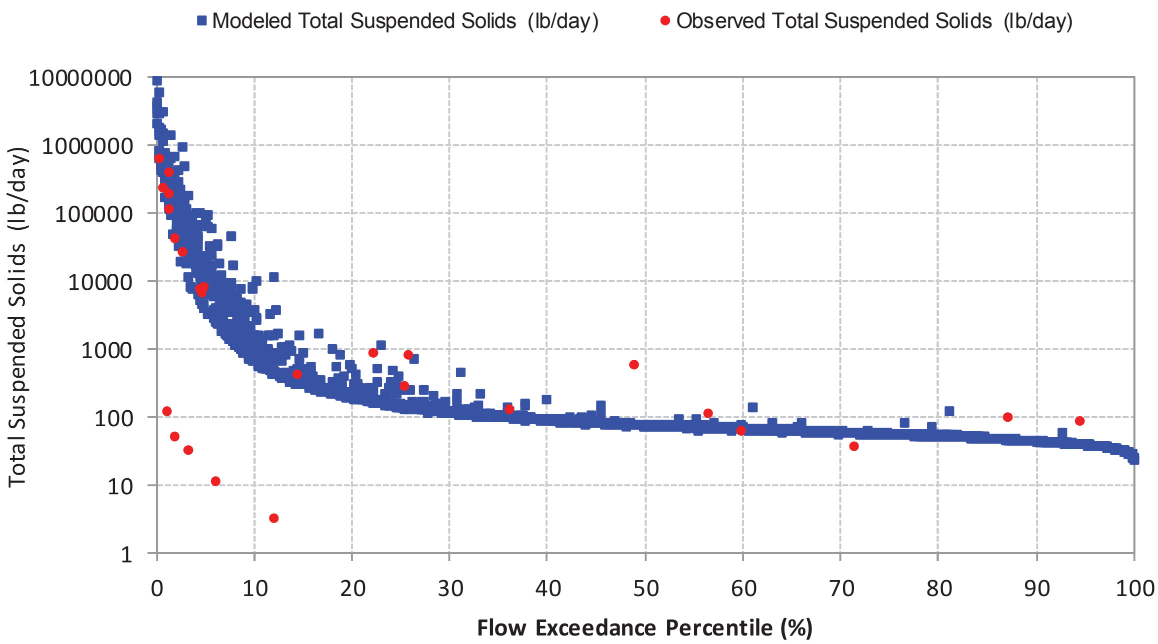

Figure K-29
Modeled vs. Observed Load Total Suspended Solids (pounds/day) at 906LPC-MLS

Results of the Tt LSPC model, with the mining land uses parameterized similar to the Diaz-Ramirez HSPF model (Diaz-Ramirez et al. 2008) are shown in Figure K-30.

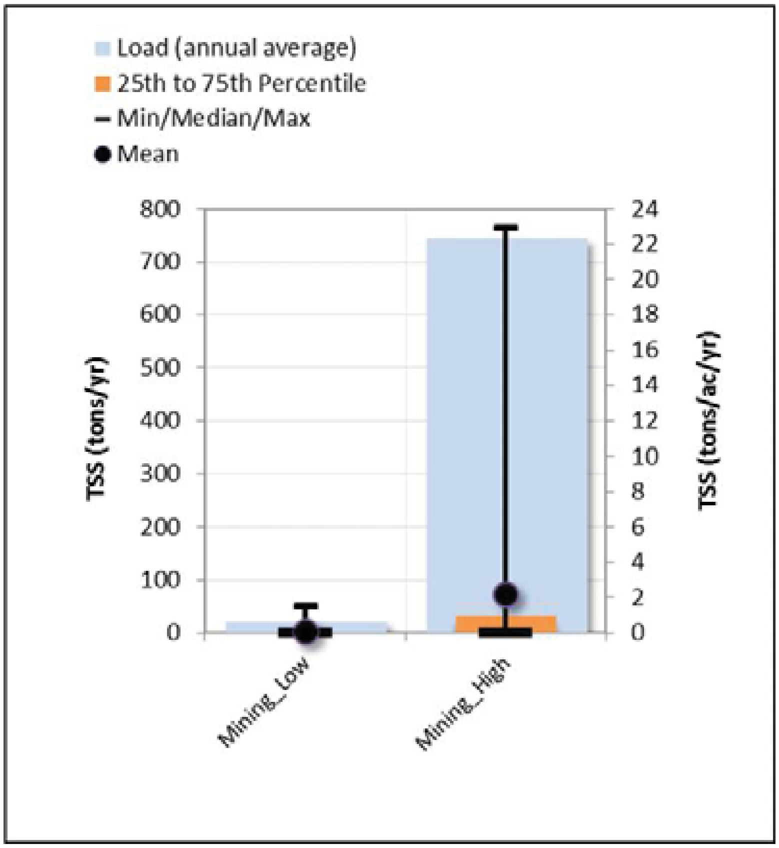

Figure K-30
Average Annual Sediment Load from Mining Land Uses
(for Water Years 1991 to 2012)

Figure K-31 shows the sediment loading from mining land uses in the Carroll Canyon Creek subwatershed in comparison to other land uses. It is evident that the unit area loading rate from mining land uses is noticeably higher than the other land use categories.

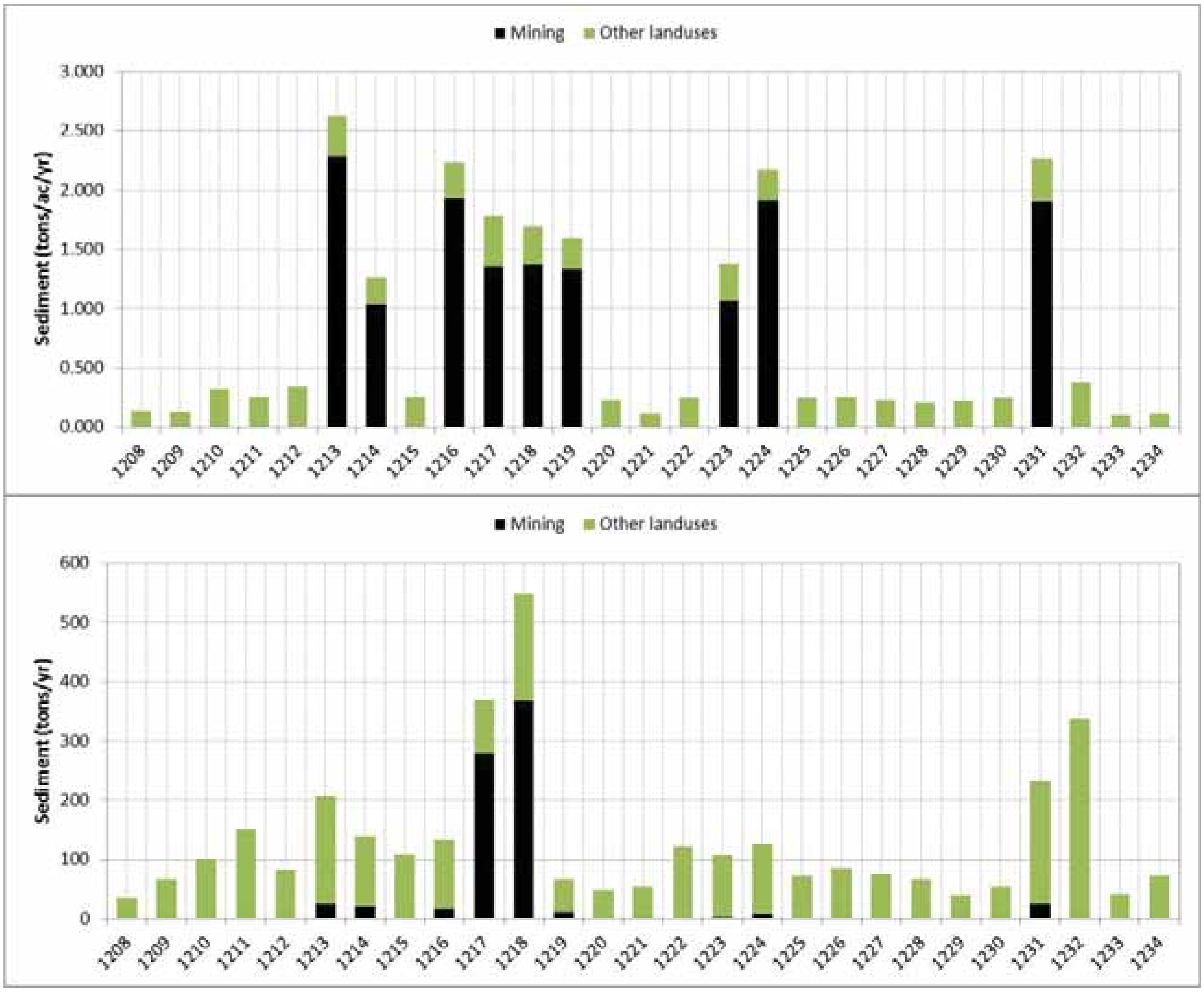

Figure K-31
Average Annual Sediment Load from Mining Land Uses Compared To Other Land Uses (for Water Years 1991 to 2012)

Figure K-32 shows the net scour and deposition for all the modeled reaches in Carroll Canyon Creek. While most of the reaches are depositional, some exhibit a net scour. Figure K-33 shows the total amount of sediment output by each modeled reach in Carroll Canyon Creek. These results are generally in agreement with the findings of the ESA-PWA report.

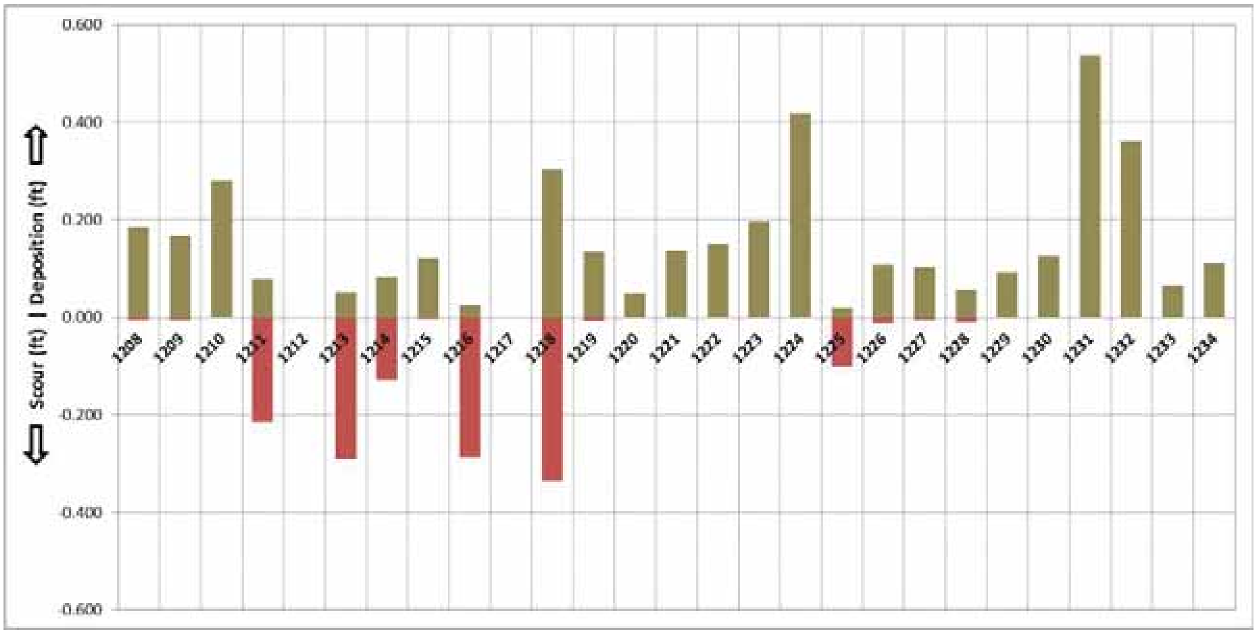

Figure K-32
Scour and Deposition for Each Modeled Reach (10/1/1990 to 9/30/2012)

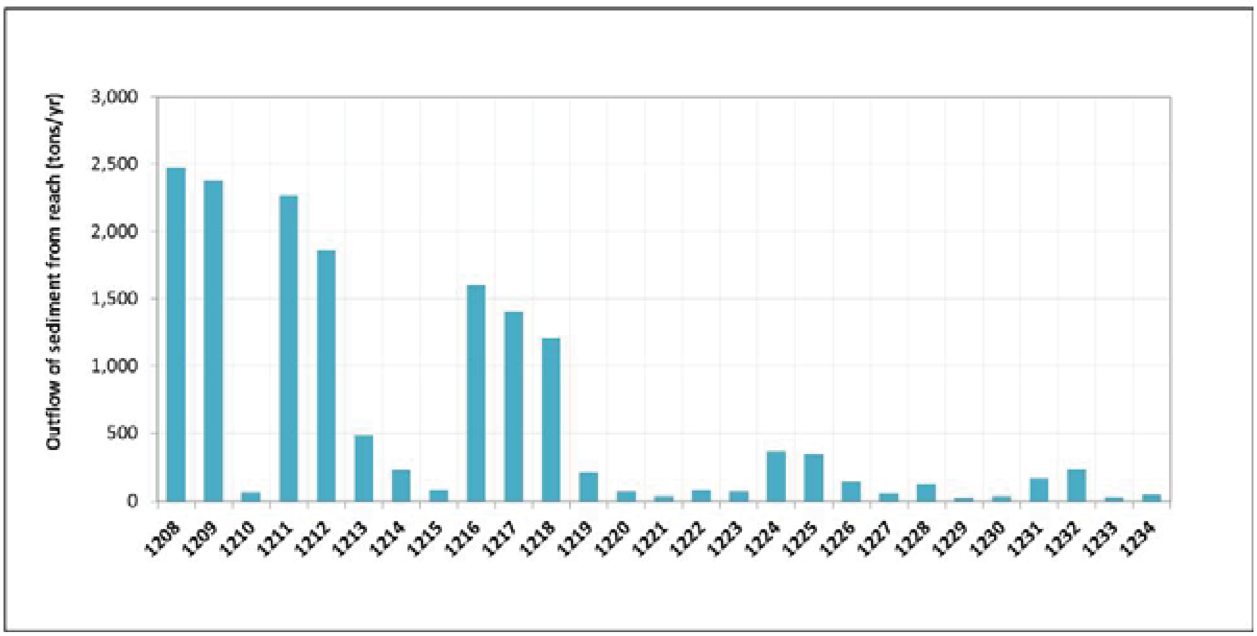

Figure K-33
Average Annual Outflow of Sediment from Modeled Reaches (10/1/1990 to 9/30/2012)

Figure K-34 and Figure K-35 show the amount of sediment generated and delivered by Carroll Canyon Creek in comparison with the other watersheds. It is important to note that the sediment rate generated by Carroll Canyon Creek is much higher than the other watersheds (Table K-19).

Table K-19
Sediment Load by Subwatershed

Subwatershed	Upland Load (tons/yr.)	Rate (tons/ac/yr.)	Delivered Load (tons/yr.)
Carmel Valley Creek	1,247	0.14	896
Carroll Canyon Creek	3,536	0.31	2,476
Los Peñasquitos Creek	5,438	0.15	3,938
Los Peñasquitos Lagoon	235	0.08	196

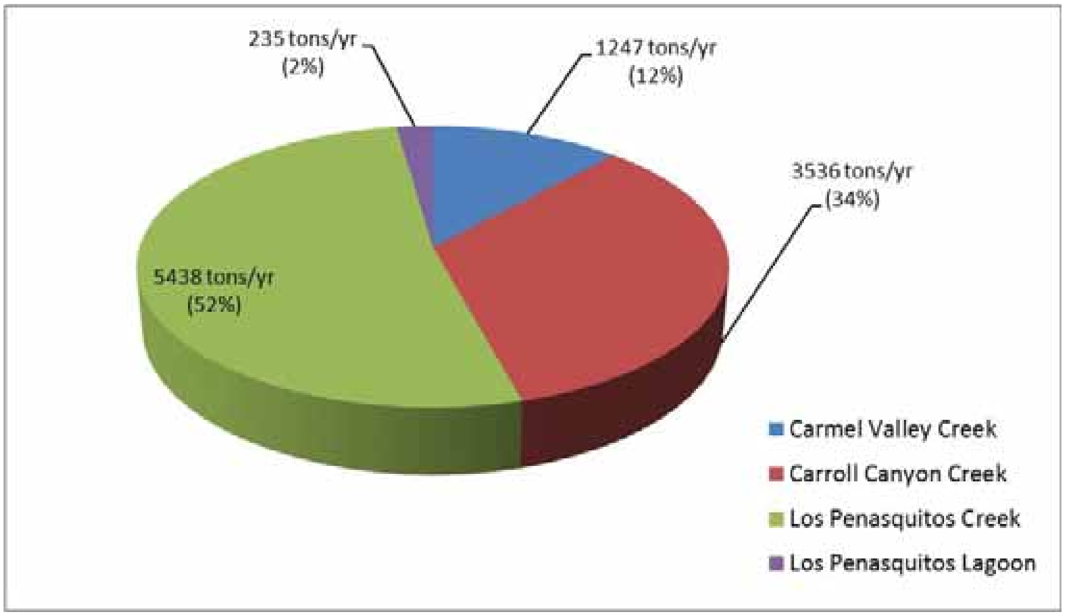

Figure K-34
Average Subwatershed Annual Upland Sediment Loads (10/1/1990 to 9/30/2012)

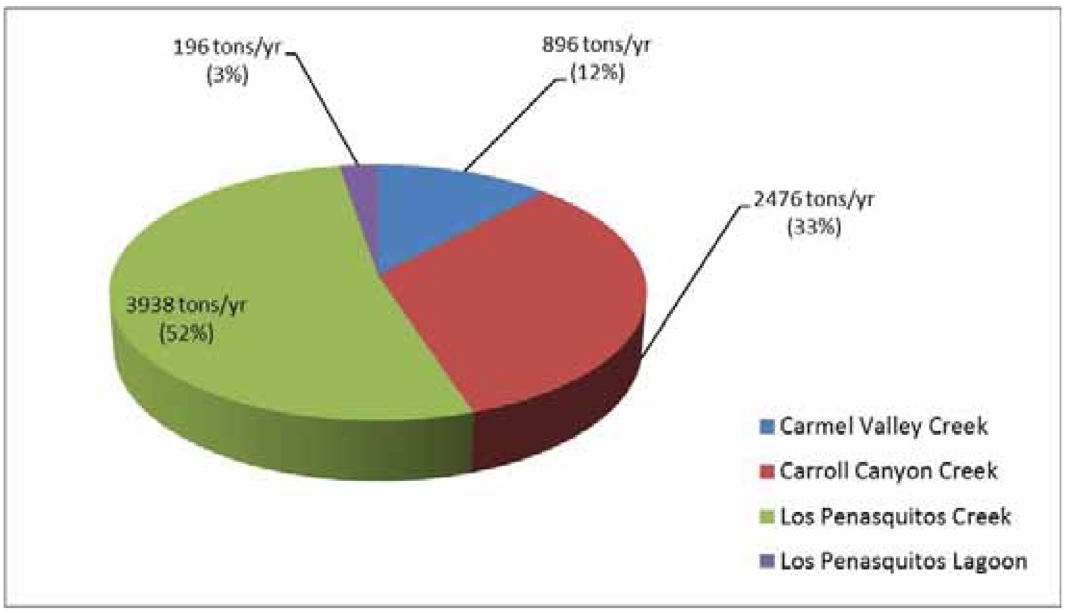

Figure K-35
Average Subwatershed Annual Sediment Output From Modeled Reaches (10/1/1990 to 9/30/2012)

K.5.8.2 Bacteria

The bacteria parameters were obtained from the previous shorter simulation period and regionally calibrated CLRP watershed model (Tetra Tech, 2012) and unmodified for the model extension effort. The results are included here for completeness.

Groundwater and interflow bacteria concentrations were updated as shown in Table K-20 to reflect the median value of observed monitoring data collected in the Poche Beach Bacterial Source Identification Study (Weston Solutions 2013).

Table K-20
Subsurface Bacteria Concentration

Land use group	Model land use name (group_soil_slope_irrigation)	Subsurface bacteria conc. (#/100 mL) fecal	total	entero
Water		0	0	0
Agriculture	Agri_Low	110	1,330	270
	Agri_High	110	1,330	270
Barren/Mining	Barren_Low	100	1,650	100
	Barren_High	100	1,650	100
Open Space	ForestShrub_B	10	167	150
	ForestShrub_C	10	167	150
	ForestShrub_D	10	167	150
	Grassland_B	10	167	150
	Grassland_C	10	167	150
	Grassland_D	10	167	150
Developed Pervious	Devperv_B_Low_NoIrg	100	1,650	700
	Devperv_C_Low_NoIrg	100	1,650	700
	Devperv_D_Low_NoIrg	100	1,650	700
	Devperv_B_High_NoIrg	100	1,650	700
	Devperv_C_High_NoIrg	100	1,650	700
	Devperv_D_High_NoIrg	100	1,650	700
	Devperv_B_Low_Irrg	100	1,650	700
	Devperv_C_Low_Irrg	100	1,650	700
	Devperv_D_Low_Irrg	100	1,650	700
	Devperv_B_High_Irrg	100	1,650	700
	Devperv_C_High_Irrg	100	1,650	700
	Devperv_D_High_Irrg	100	1,650	700

Enterococcus time-series comparisons in standard and log format are shown in Figure K-36 and Figure K-37, respectively. The regression plot (Figure K-38) of simulated versus observed load shows a slight high bias across the range of loads. The load duration curve (Figure K-39) shows a high bias across the entire flow regime.

Fecal Coliform time-series comparisons in standard and log format are shown in Figure K-40 and Figure K-41 respectively. The regression plot (Figure K-42) of simulated versus observed load shows a slight high bias across the range of loads. The load duration curve (Figure K-43) shows a high bias across the entire flow regime.

Total Coliform time-series comparisons in standard and log format are shown in Figure K-44 and Figure K-45 respectively. The regression plot (Figure K-46) of simulated versus observed load shows a slight high bias across the range of loads. The load duration curve (Figure K-47) shows a high bias across the entire flow regime.

Overall the results of the bacteria calibration are acceptable and the model should be useful for future planning and implementation efforts.

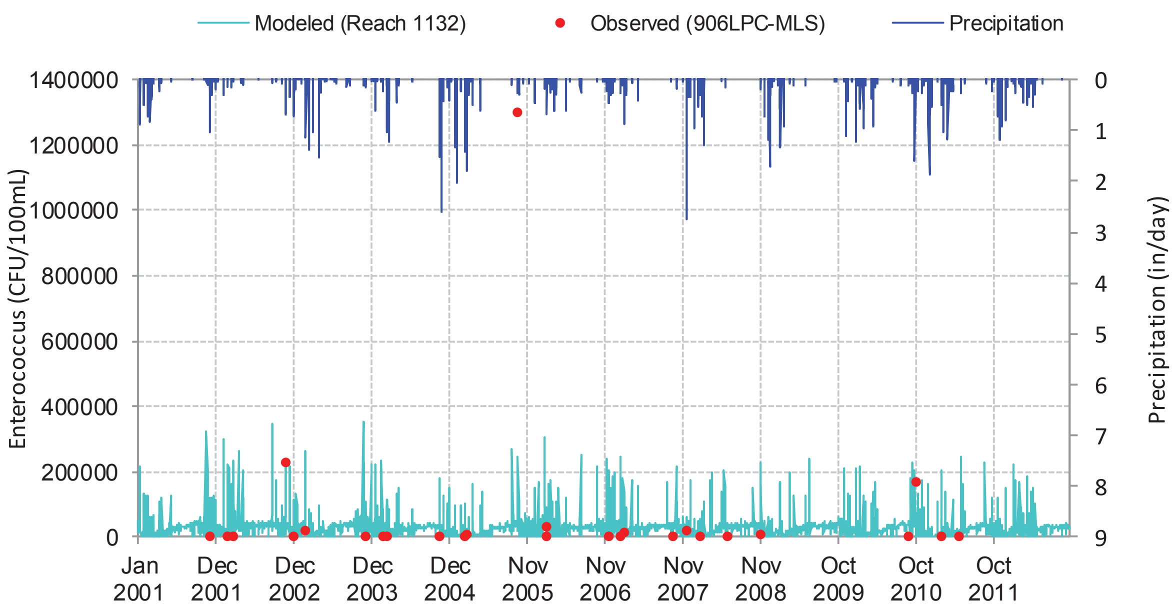

Figure K-36
Modeled vs. Observed Enterococcus (CFU/100mL) at 906LPC-MLS

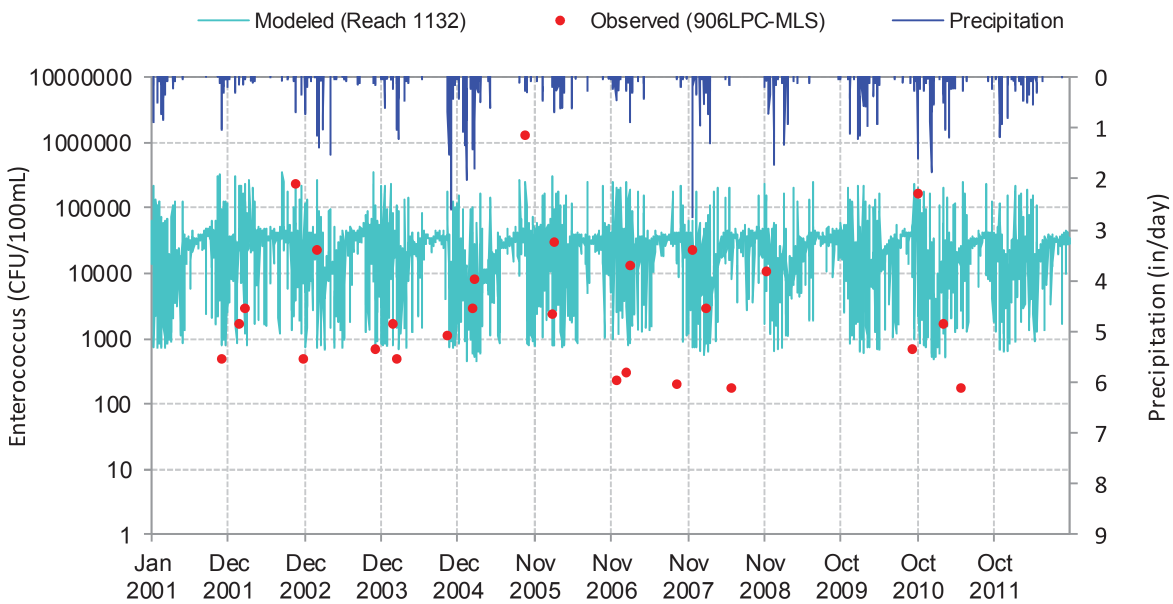

Figure K-37
Modeled vs. Observed Enterococcus (CFU/100mL) at 906LPC-MLS (log scale)

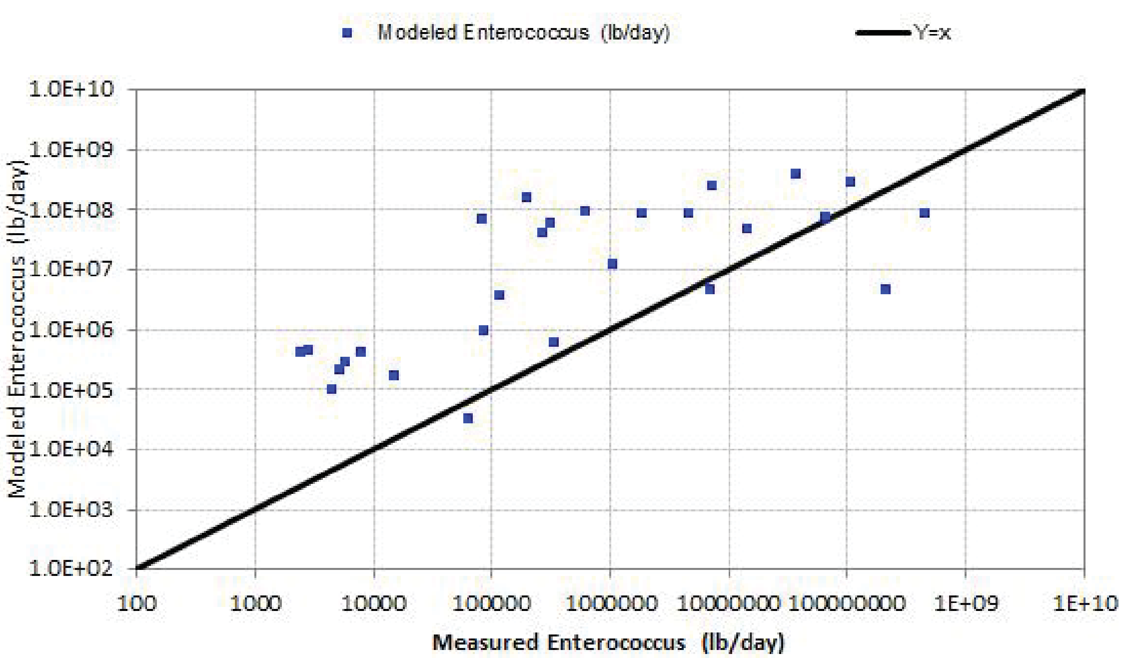

Figure K-38
Modeled vs. Observed Load Enterococcus (CFU/100mL) at 906LPC-MLS

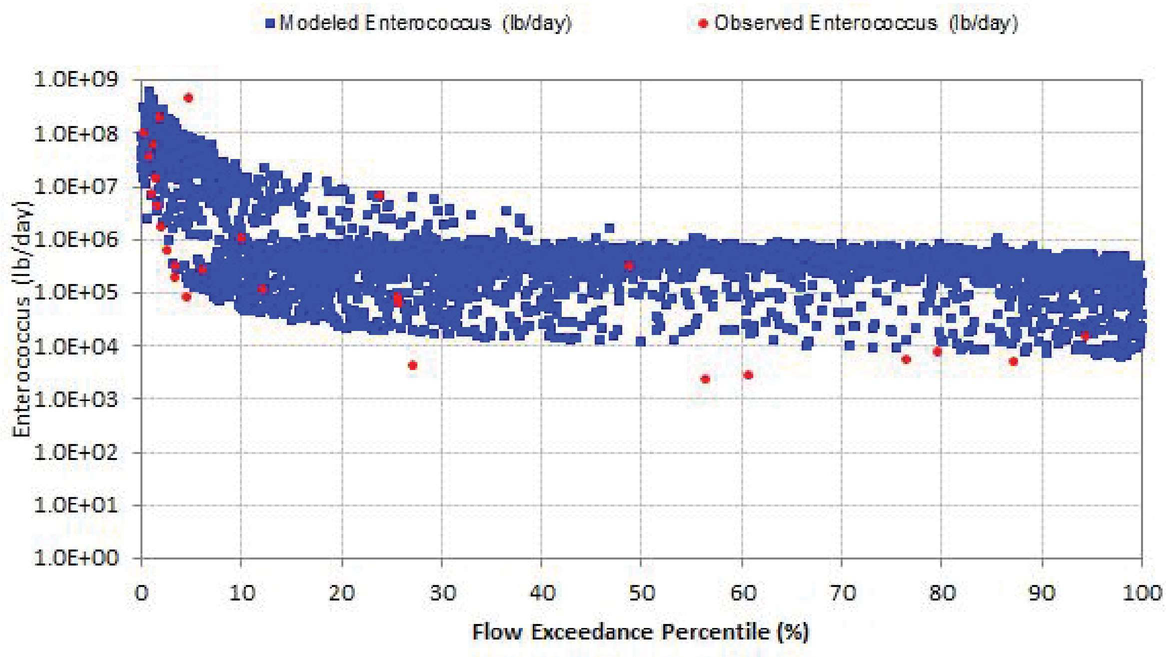

Figure K-39
Modeled vs. Observed Load Enterococcus (CFU/100mL) at 906LPC-MLS

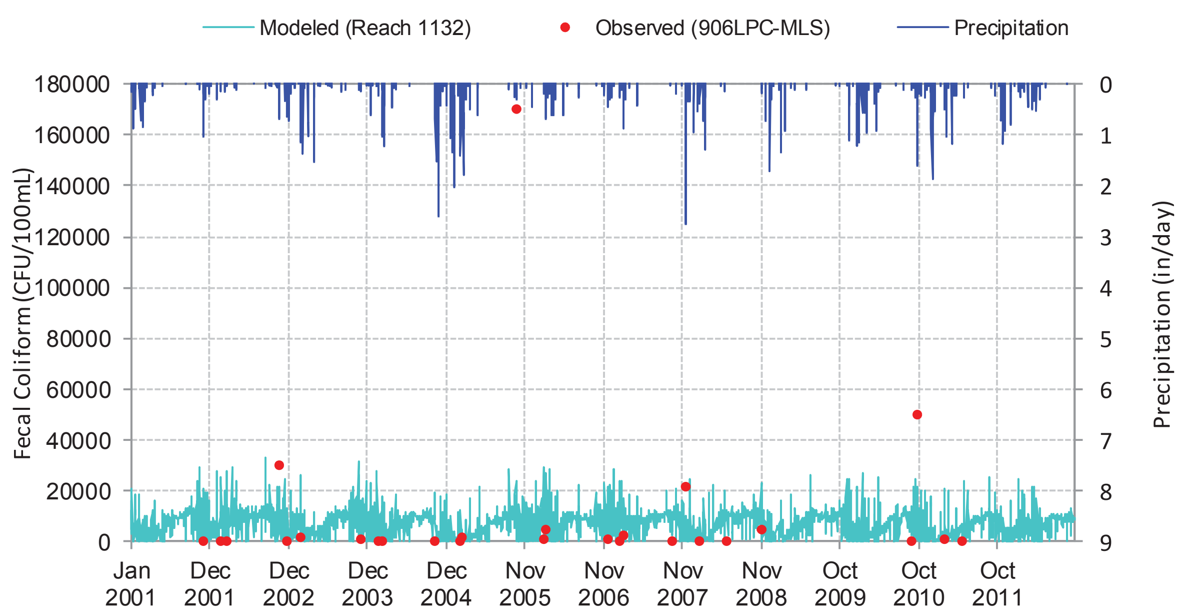

Figure K-40
Modeled vs. Observed Fecal Coliform (CFU/100mL) at 906LPC-MLS

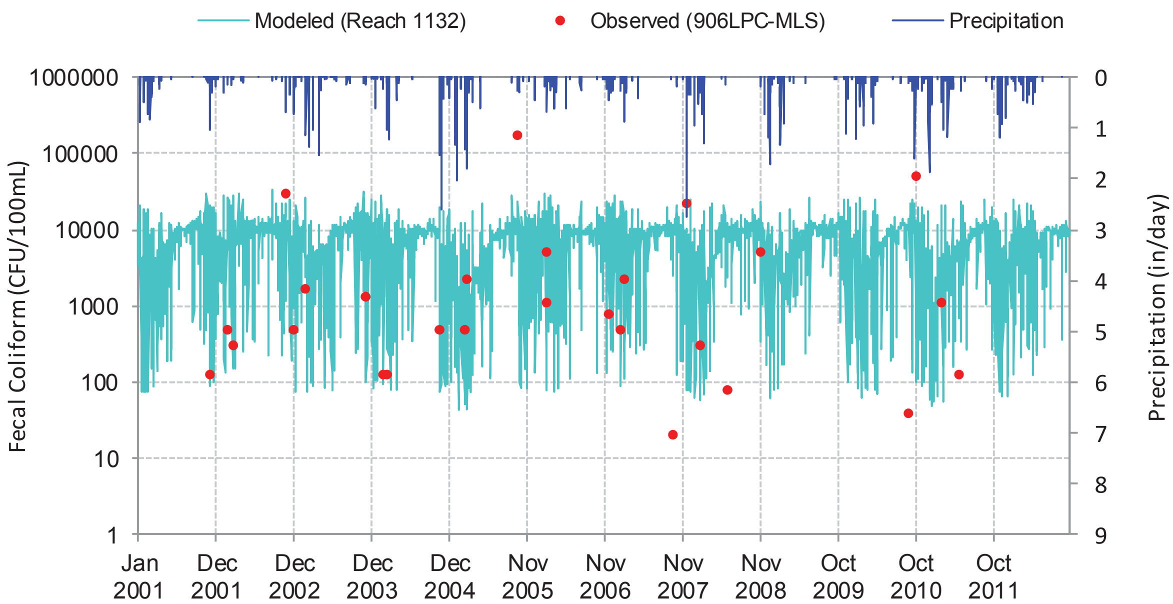

Figure K-41
Modeled vs. Observed Fecal Coliform (CFU/100mL)
at 906LPC-MLS (log scale)

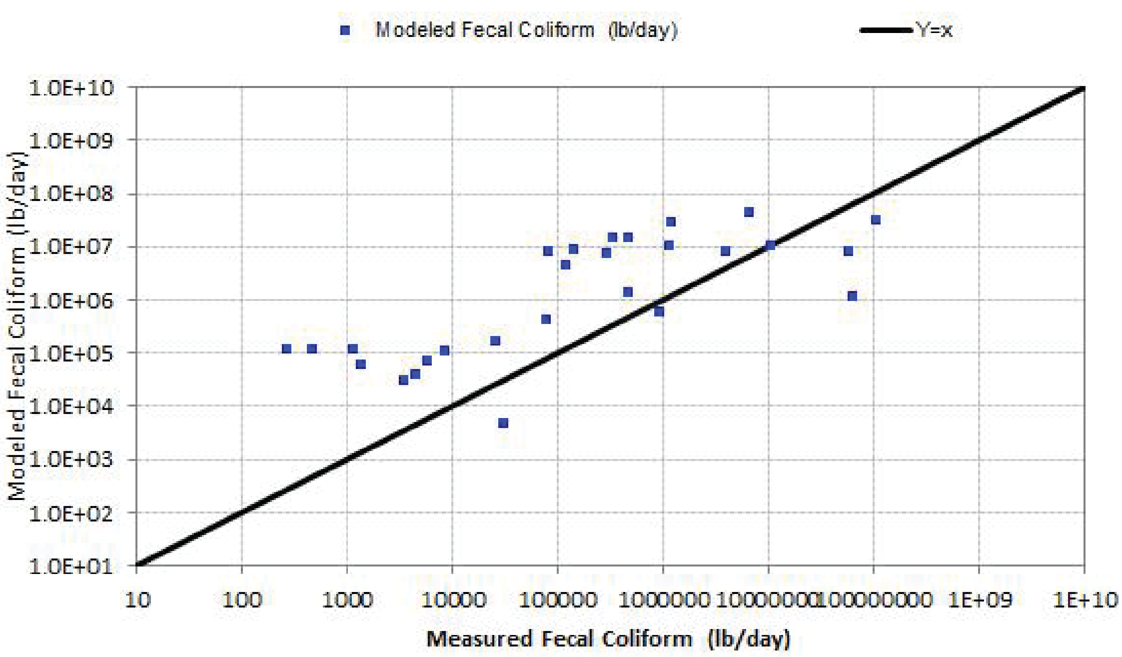

Figure K-42
Modeled vs. Observed Load Fecal Coliform (CFU/100mL)
at 906LPC-MLS

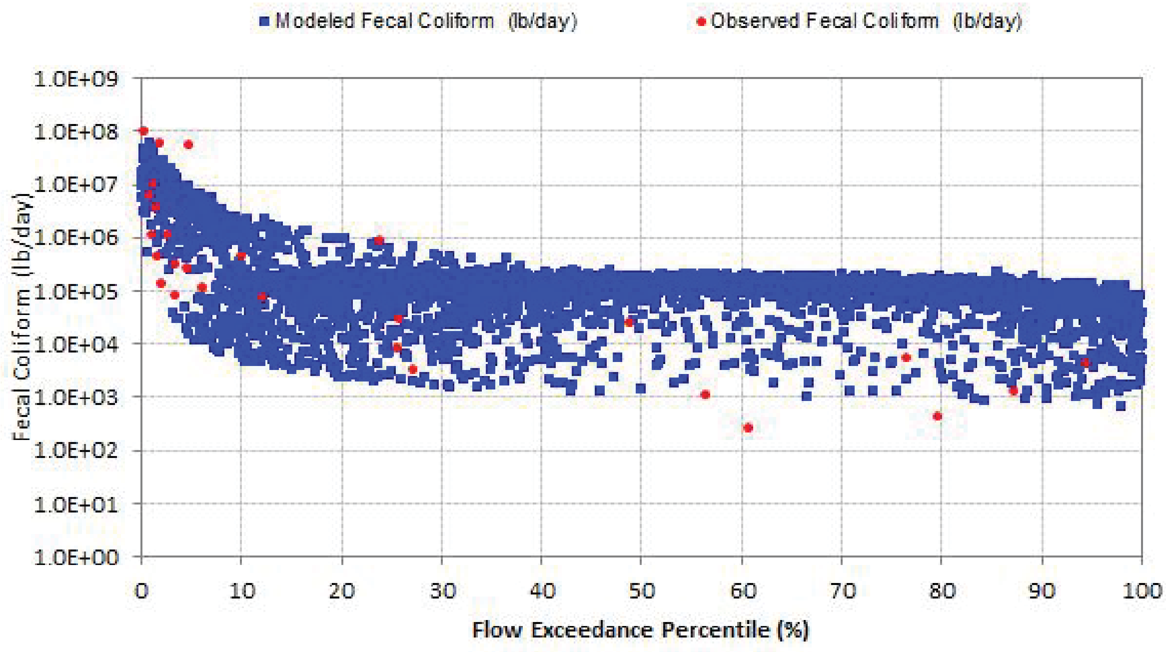

Figure K-43
Modeled vs. Observed Load Fecal Coliform (CFU/100mL) at 906LPC-MLS

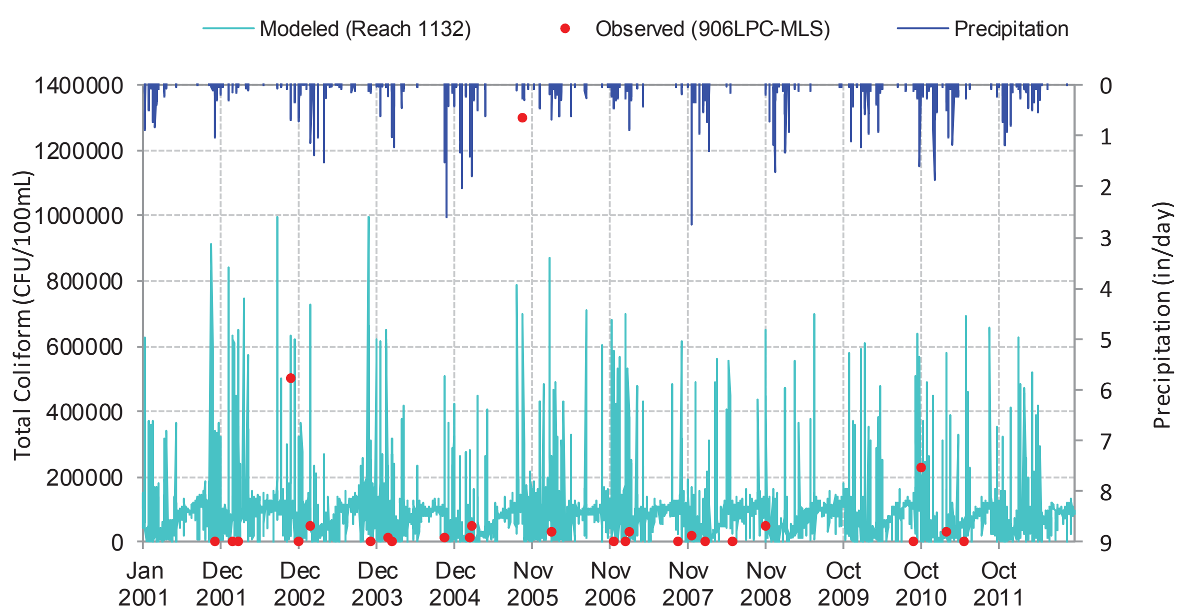

Figure K-44
Modeled vs. Observed Total Coliform (CFU/100mL) at 906LPC-MLS

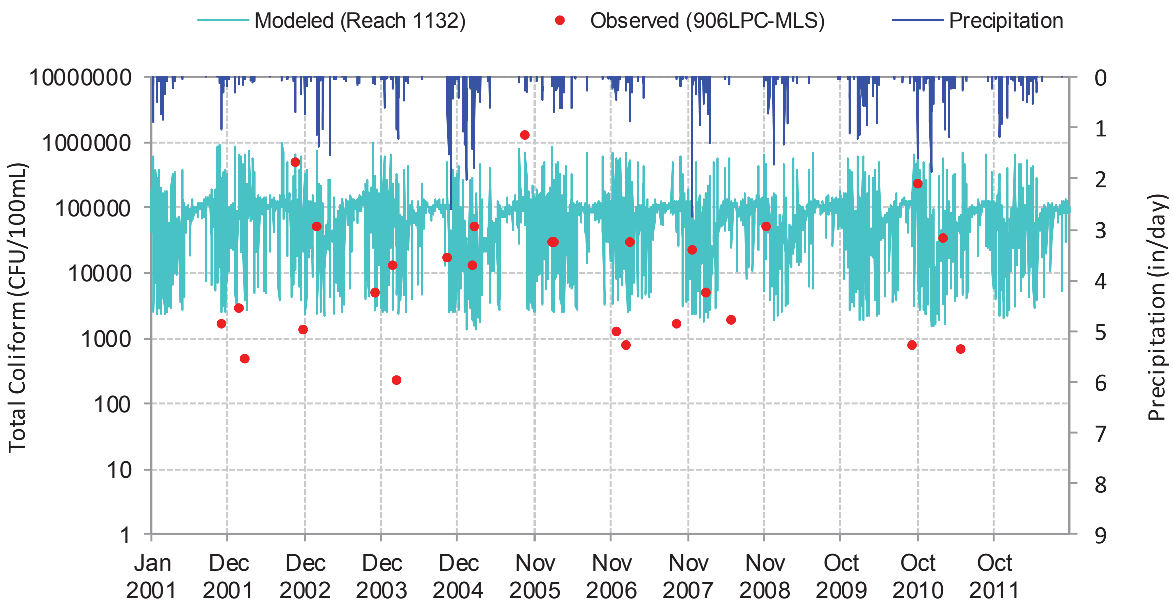

Figure K-45
Modeled vs. Observed Total Coliform (CFU/100mL) at 906LPC-MLS (log scale)

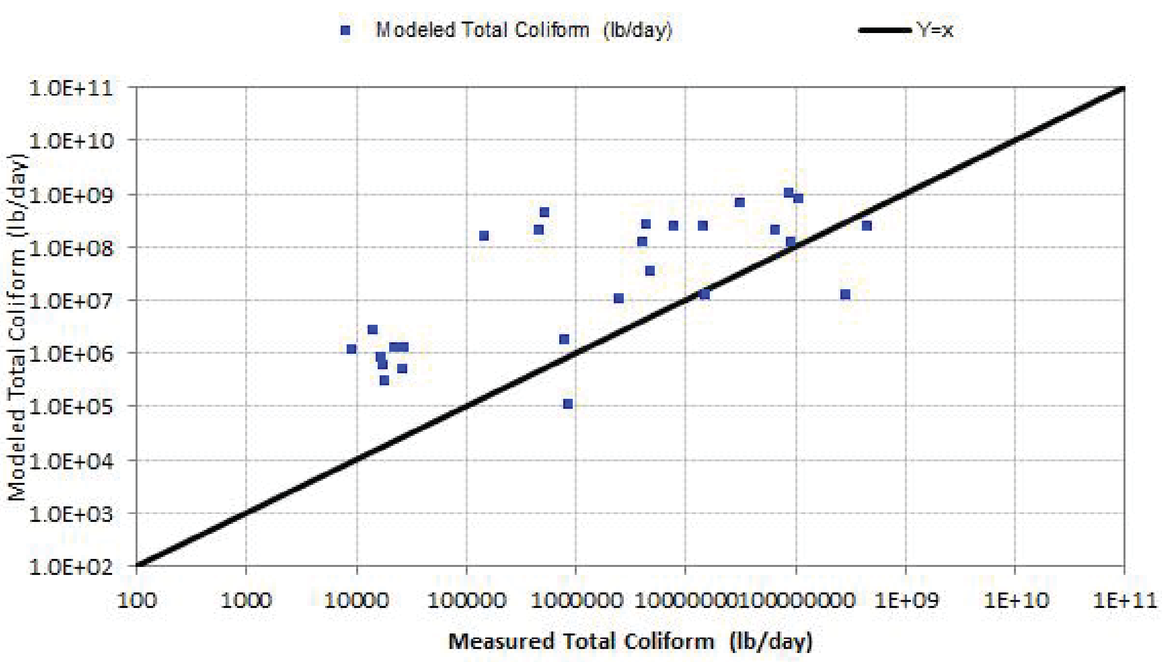

Figure K-46
Modeled vs. Observed Load Total Coliform (CFU/100mL) at 906LPC-MLS

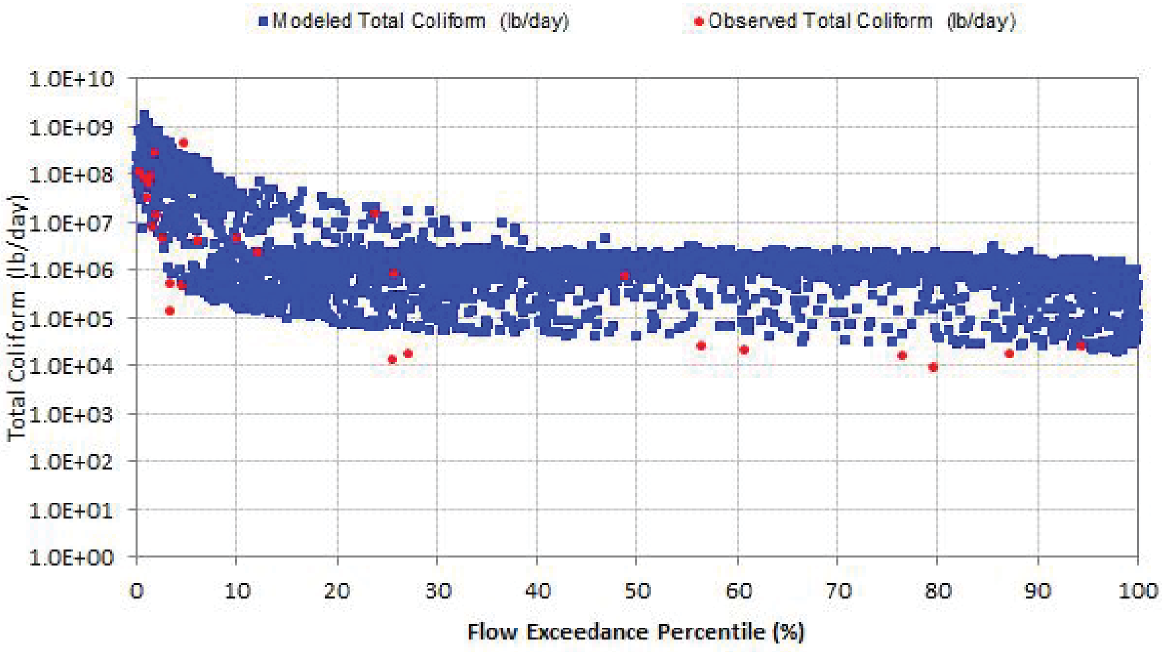

Figure K-47
Modeled vs. Observed Load Total Coliform (CFU/100mL)
at 906LPC-MLS

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APPENDIX L

Strategy Benefits and References

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APPENDIX L. STRATEGY BENEFITS AND REFERENCES

The following references provide supporting documentation for the water chemistry, physical, and biological benefits associated with strategy categories presented in the strategy benefit tables in Section 4.2.

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APPENDIX M

Comprehensive Benefits Analysis of Water Quality Improvement Plan Strategies

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Appendix M
Comprehensive Benefits Analysis of Water Quality Improvement Plan Strategies

Final Technical Memorandum

November 2014

Prepared for:

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Summary

The City of San Diego Storm Water Division ("Division") is developing Water Quality Improvement Plans (WQIPs) that consist of a range of structural and nonstructural strategies for meeting TMDL regulatory requirements in each watershed. However, the Division recognizes that these strategies differ with respect to their contribution to "additional" or "other" benefits to the local community, environment, and economy that are beyond specific water quality improvements in streams. This assessment has been implemented to provide the Division with supplemental information on these potential benefits. The Division aims to consider these other benefits in selecting strategies only in cases when strategies yield the same level of water quality improvements but which may produce markedly different levels of other benefits.

This document outlines a framework for assessing other benefits from these strategies. The framework assesses how each type of strategy could impact one or more types of other benefits. These additional benefits consist of various types of changes beyond water quality improvements in terms of environmental resources, quality of life, property values, business development, and others.

In the WQIPs, individual strategies are grouped into a series of categories that are defined as either 'Nonstructural' or 'Structural.' Over 20 categories of strategies have been defined based on their similarity in how they can improve water quality and include *Development Planning*, *Construction Management*, *Existing Development*, *Illicit Discharge*, *Detection, and Elimination (IDDE) Program*, *Public Education and Participation*, and *Enforcement Response Plan*.

The framework for assessing the potential for additional benefits from strategies has several dimensions including::

- *Strategy Categories* are defined by how they influence water quality improvements (see Section 2). There are three Structural and four Nonstructural types of strategy categories including.
    - *Structural Strategies*, as defined in the WQIP include: (a) Green infrastructure, (b) multi-use treatment areas, or (c) water quality improvement BMPs
    - *Nonstructural Strategies,* as defined in this assessment based on how these strategies aim to: (a) Improve Structural Systems Performance, (b) Increase the Number of Structural Systems, (c) Change Behavior; or (d) Reduce Pollutants Directly.
- *Benefit Categories* include a range of economic, social and environmental outcomes. This assessment determines the relevance and impact of each strategy category on a benefit category (see Section 3).

- *Impact Levels* of a strategy category in a benefit category is classified as either (a) monetizable, (b) measurable, (c) potential, or (d) not applicable. (See Section 3). These impact levels are indented to provide *order of magnitude* information about the potential impact of a strategy on each type of benefit.

- A scoring system is established for the magnitude of benefits evaluation to compare different strategies (see Section 3). In addition, the total number of applicable benefits is provided for additional information about the relative advantage of different strategies.

A discussion and rationale for assessing the level of impact for a given strategy on a benefit category is provided in Section 4. This assessment is intended to be an initial, order of magnitude of benefits of different strategies. It can only be an illustrative assessment since details on the design and location of any individual strategy is not available at this stage. The framework however is intended to indicate how and to what degree benefits could be estimated once a strategy is in place. As an order of magnitude assessment, strategies with measurable and monetizable would be expected to exhibit successively higher levels of estimable benefits compared to strategies that are classified as only having a potential connection to benefits.

The results, as presented in Section 5, indicate that structural strategies (especially, Green Infrastructure and Multiuse Treatment Areas) have the highest potential to generate sizable benefits. However, a number of nonstructural strategies (e.g. Initiatives to Change Behavior for Existing Development, Priority Development Projects, Construction Management, Public Education and Enforcement, among others) could also provide additional benefits. Many other non-structural strategies have the potential to generate a wide range of different benefits for the community.

A cross-cutting theme in this assessment is the impact of strategies on property values and business development. Some strategies, such as ones that foster on-site water retention and reduction of street debris, have the potential to provide tangible and intangible benefit to communities and local businesses by reducing water and clean-up costs and providing an overall improved aesthetic environment. Depending on where and how a strategy is implemented, benefits can be higher or lower. The literature review in Appendix 1 discusses cases where these benefits have measured.

A next step for this assessment would entail site-specific evaluations of strategies and potential additional benefits of WQIP at a planning level. As strategies become more defined and specific data becomes available on project conditions, this framework could be adapted further to create more detailed results for prioritizing strategies. This step would include applying current research to site specific projects to more direct monetize and quantify the outcomes of strategies in terms of cost savings and property value enhancements. Better still would be a pre- and post-monitoring program to assess the singular and combined effects of strategies to different stakeholders.

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Acronyms and Abbreviations

Acronym or Abbreviation	Definition
ac	Acres
BCA	Benefit Cost Analysis
BES	Bureau Of Environmental Services
BMP	Best Management Practice
Btu	British Thermal Unit
CAMX	California-Mexico Power Area
CEA	Cost-Effectiveness Analysis
CLRP	Comprehensive Load Reduction Plan
CNT	Center For Neighborhood Technology
CO2	Carbon Dioxide
CSO	Combined Sewer Overflow
DOT	Department Of Transportation
EIA	Economic Impact Analysis
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
GI	Green Infrastructure
HOA	Home Owner's Association
IDDE	Illicit Discharge, Detection, And Elimination
kWh	Kilowatt Hour
LACDPW	Los Angeles County Department Of Public Works
LID	Low Impact Development
M Wh	Mega Watt Hour
MMSD	Milwaukee Metropolitan Sewage District
MODA	Multi-Objective Decision Analysis
MS4	Municipal Separate Storm Sewer System
NOx	Nitric Oxide And Nitrogen Dioxide
NPV	Net Present Value
NRDC	Natural Resources Defense Council
O&M	Operations And Maintenance
O3	Oxide
PDP	Priority Development Projects
PFC	Permeable Friction Course
PGA	Pollutant Generating Activities

Acronyms and Abbreviations (continued)

Acronym or Abbreviation	Definition
PM	Particulate Matter
PWD	Philadelphia Water District
QMRA	Quantitative Microbial Risk Assessment
SO2	Sulfur Dioxide
SPU	Seattle Public Utilities
SROI	Sustainable Return On Investment
TBL	Triple Bottom Line
TIGER	Transportation Investment Generating Economic Recovery
TMDL	Total Maximum Daily Load
UTC	Urban Tree Canopy
WAMP	Watershed Asset Management Plan
WERF	Water Environment Research Foundation
WQIP	Water Quality Improvement Plan

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1 Introduction

The City of San Diego Storm Water Division (Division) has prepared many potential strategies as part of its Water Quality Improvement Plan (WQIP). These strategies have identified a range of structural best management practices (BMPs) (e.g., a constructed runoff reduction system, such as a bio-swale), and nonstructural BMP activities (e.g., programs that promote installation of constructed systems, or reduce pollutants directly through education and outreach). This memo seeks to assess the potential for strategies to generate “additional” or “other” benefits beyond water quality improvements. The Division seeks such information to contribute to prioritization of strategies that meets regulatory requirements and generates the best value for the community and local businesses.

The concept for evaluating the other benefits of proposed strategies has been under discussion since April 2014. A technical memo was developed as an initial task to classify additional benefits from the Division’s stormwater management strategies. That memo is contained in Appendix 1 and includes a literature review of potential benefit categories and case studies of green infrastructure program benefits. The economic framework was presented to stakeholders at a meeting on May 20, 2014. Feedback was elicited during and after that meeting, and has been incorporated into this document and to the Division’s current approach to evaluating strategies (see presentation, handout, and comments from workshop in Appendix 2).

The next several sections in this document present the approach and draft evaluation of additional benefits. The evaluation has been applied to a comprehensive list of strategies from the City’s three draft WQIPs (Mission Bay, Los Peñasquitos, and San Dieguito). The framework entails the characterization of strategy categories by type of impact (Section 2), definition of potential types of benefit categories (Section 3) and a classification of benefits for each strategy category (Section 4). Results of this evaluation are contained in Section 5.

This assessment of additional benefits of WQIP strategies is conducted for initial planning purposes only. As strategies become more defined and specific data becomes available on project conditions, this framework could be adapted further to create more detailed results for prioritizing strategies. This step would include applying current research to site specific projects to more directly monetize and quantify the outcomes of strategies areas such as recreational, property value and business development benefits.

2 Strategy Classifications

The WQIP identifies a number of strategy categories as either “Nonstructural” or “Structural”, and in terms of whether they are Jurisdictional Strategies or Optional Jurisdictional Strategies. Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." In the analysis of benefits, the main distinction is between Nonstructural or Structural types which are defined in the following ways.

Nonstructural Strategies include “those actions and activities intended to reduce storm water pollution, which do not involve construction of a physical component or structure to filter and treat storm water.” Individual strategies are grouped into over 25 different categories including: *Development Planning*, *Construction Management*, *Existing Development*, *Illicit Discharge, Detection, and Elimination (IDDE) Program*, *Public Education and Participation*, *Enforcement Response Plan*, and *Non-JRMP Strategies*. For each watershed, a list of potential nonstructural strategies has been developed that reflect the needs, opportunities and constraints in different locations. In general, many of these initiatives have been implemented by the Division for many years and are integral to regulatory compliance on a watershed-specific basis.

Nonstructural strategy categories are further defined in this assessment by *how* they improve water quality, which in turn indicates how they may generate other benefits. For example, four types of mechanisms include the ways in which strategies:

- ***Improve Structural Systems Performance:*** These include strategies that relate to new design standards and performance monitoring would be measured by the improvement in the performance of installed structural systems. The benefits of these nonstructural strategies would ultimately draw from the benefits of structural systems that are implemented.
- ***Increase the Number of Structural Systems*:** These strategies aim to increase the rate of BMP adoption is due to training in the community or general promotion of BMPs, lead to benefits whenever they are installed. The outcome of these strategies then depends on the number of *additional* systems that are installed.
- ***Change Behavior*:** These strategies target efforts to encourage improved environmental stewardship and storm water protection by residents and businesses throughout the community. Various types of actions that people may take who become more aware of environmental impacts through these strategies include adoption of rain barrels, reducing litter, and reducing unnecessary levels of pesticides, herbicides and fertilizers.

- ***Reduce Pollutants Directly:*** These strategies include those that aim to directly control pollution through actions that the Division and other public agencies can take independently, such as internal training, enforcement and administrative changes. These strategies can lead to behavior change by individuals but initially through a focus on public entities.

Structural Strategies, in contrast to Nonstructural strategies, are physical infrastructure that are designed for site-specific conditions and placed strategically across a watershed to improve water quality. The effectiveness and feasibility of implementing any of these BMPs varies depending on their design and site conditions. For example, the effectiveness of a BMP for enhanced infiltration capacity of a watershed depends on amenable soil types. Other site-specific considerations include the physical land area available for effective implementation and maintenance. Also, the capital and maintenance costs of a BMP influence its feasibility for the Division, especially in comparison to other BMPs which can be implemented more cost-effectively. The structural strategies that have been identified as potentially suitable for San Diego watersheds and have been classified as one of three types: (1) green infrastructure, (2) multiuse treatment areas, and (3) water quality improvement BMPs.

- ***Green Infrastructure*** covers a range of BMPs that are designed to be integrated in a broader site plan to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities. Green infrastructure is distinguished from other methods by making deliberate and effective use of vegetation and soil to manage storm water.

- ***Multiuse Treatment Areas*** in the Water Quality Improvement Plan are identified as large-scale treatment areas such as multiuse basins and stream, channel, and habitat rehabilitation projects. These systems are designed as regional facilities that can receive flows from neighborhoods or larger areas and become cost-effective solutions that provide multiple benefits. For example, such systems can be integrated in public spaces, such as soccer fields and parks, which provide recreational areas and flood control, ground water recharge, restoration, habitat enhancement, and recreation. In addition stream bank projects that reduce erosion can improve water quality and simultaneously improve habitat.

- ***Water Quality Improvement BMPS*** include systems that supplement the design performance of existing infrastructure. For example, systems that segregate trash includes inlet devices, such as trash guards or racks that capture debris before they enter surface waters. Another example are proprietary commercial products that often aim to use settling, filtration, absorptive/adsorptive materials, vortex separation, and sometimes vegetative components to remove pollutants from runoff. Finally, dry weather flow separation and treatment projects target non-storm water dry season flows and divert these flows for treatment either on-site or to sanitary sewer systems and ultimately wastewater treatment plants.

Overall, 30 different groups of strategies have been classified as either “Jurisdictional” (strategy types numbered 1-23, in Table 2 and Table 6 or “Optional Jurisdictional” (strategies types numbered 24-30, in Table 3 and Table 7). Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." The number ordering for these strategies follows from documents provided by the Division and reflects the most comprehensive list of current strategies under consideration. Specific strategies have also been identified by the Division within each strategy group.

3 Benefit Categories and Levels of Impact

Stormwater management strategies can generate various types of benefits and have different levels of impact. Economic research has shown that stormwater management strategies can generate a range of benefit categories with economic, environmental and social impacts for the local residents, businesses, and public agencies. The level of impact of a strategy can differ across benefit categories and depends on the design of the strategy, site conditions where the strategy is implemented, and characteristics in the community. Estimation of economic benefits from a strategy depends on the degree to which linkages can be quantified between strategy and a benefit category and then available economic literature to value this change. In some cases, only a part of the link between a strategy and a benefit category can be quantified (e.g. the volume of water retained by a green infrastructure system can be measured, but not its impact on stream bank stabilization).

3.1 Description of Benefit Categories

This section below discusses a number of benefit categories that are found in economic literature. They are grouped by financial, environmental and social dimensions. A broader discussion from the literature is contained in the Appendix 1.

Financial Benefits

- ***Water Cost Savings:*** This type of benefit could occur when potable water needed for landscaping, washing or other property maintenance is reduced. Green infrastructure strategies could enable such savings if water retention reduces water demand, or some part of the system improves irrigation efficiency. The reduction in demand lowers water costs. These savings could be quantified and monetized if the volumes of water retained at a site can be measured.

- ***Energy Cost Savings:*** Green infrastructure can generate energy cost savings in several ways. For example, buildings which are adjacent to trees or which install green roofs can benefit from lower the heating and cooling energy costs because of shading and insulation, respectively. Some research suggests that if such green infrastructure system were installed throughout a city, the overall ambient temperature would decline and which would in turn reduce cooling loads for other buildings. Finally, in cases when green infrastructure provides water storage that lowers pumping costs, there would be a corresponding reduction in energy costs.

Environmental Benefits

- ***Flood Risk Reduction:*** Reduced runoff in an urban watershed can reduce the frequency and severity of flooding in downstream neighborhoods in some cases. The magnitude of these benefits though depends on if such a neighborhood is downstream and on the design and scale of a strategy that reduces flooding. Other factors include rainfall conditions, soil characteristics, slope, elevation and watershed characteristics. A first step in quantifying the potential for flood risk reduction benefits requires an understanding how much water is retained.

- ***Air Particulate Entrapment:*** Some green infrastructure systems can trap airborne pollutants, such as particulate matter (e.g. PM10), directly from the environment on their leaves and in turn reduce adverse human health impacts.[1] The total amount of particulate trapping depends on the type of vegetation, and local climate conditions. For trees, the US Forest Service published a report that provides benchmark values for use in calculations.[2] This type of benefit can be quantified and potentially monetized based on the amount and type of plants.

- ***Climate Impacts:*** Carbon sequestration is a natural process in which plants store carbon in biomass and soils as they grow. When atmospheric carbon dioxide is taken up by trees, grasses, and other plants, it can reduce greenhouse gas effects on the planet. The amount of carbon that can be sequestered by a green infrastructure system depends on the above ground quantity of biomass of the tree, green roof or bio-swale. Economic valuation of climate change effects can be used to monetize carbon sequestration.

- ***Habitat Related Benefits:*** Green infrastructure that can provide habitat benefits include strategies that create new habitat areas, or improve existing ones. For example, vegetated infiltration systems can improve the habitat for flora and fauna, birds, and insect species. These different types of habitats are usually small in size and have limited impacts. Greater benefits may arise from large-scale strategies that enhance habitat connectivity in existing corridors. This type of benefit is readily quantified based on the acreage and plantings at a green infrastructure site, or stream bank stabilization effects, but more difficult to monetize because of limitations in economic research.

- ***Air Quality Emission Reduction:*** The total amount of reduction in criteria air contaminant emissions, such as particulate matter, from a power plant is directly tied to the reduction in energy use as discussed above. Energy savings are readily converted to its emission rate reductions by utilizing data from EPA and other public sources. Reduction in air pollution would generate health-related benefits for people. This benefit can be quantified and monetized if information is available on the amount of water and energy reduced at a treatment facility.

- ***GHG Emission Reduction:*** Similar to air quality emission reductions, energy demand reduction also reduces greenhouse gas emissions. The tons of greenhouse gas emissions are computed from the same data sources as criteria air contaminants. The economic damage caused by greenhouse gas emissions are broadly related to changes in productivity and damage costs.

[1] Center for Neighborhood Technology, The Value of Green Infrastructure. 2010

[2] http://www.fs.fed.us/psw/programs/uesd/uep/products.shtml

Social / Community Benefits

- ***Property Value Enhancement:*** Green infrastructure and other strategies can lead to enhanced property values under a variety of circumstances. For example, strategies that improve the overall visual appearance of a community simply by having planted material, street trees and bioswales among impervious surfaces have been shown to enhance value of nearby properties. In addition, some BMPs strategies aim to directly reduce litter or debris from public spaces to make it more visually appealing. These effects improve the overall quality of life in those neighborhoods. Benefits can be quantified by measuring the number of properties that are adjacent to the green infrastructure. Monetization of the effect would depend on the applicability of economic research on a site specific basis.

- ***Recreational Benefits:*** Certain green infrastructure strategies provide recreational benefits if they facilitate pedestrian, bicycle use, or connect to an existing recreational corridor or trails. Benefits would be monetized by the number of participants in a recreational activity at a site and their value per use. Other quantitative measures include the number and type of design features that offer recreational options.

- ***Business Development & Jobs:*** Green infrastructure, such as comprehensive green street designs, and initiatives to reduce street debris can lead to an enhanced sense of place, and increase in foot traffic that can support retail activity. Additionally, spending on capital investments and operations and maintenance (O&M) leads to job creation. This benefit can be measured by assessing the number of jobs created in an area where a green infrastructure strategy is implemented. In addition, these jobs can be associated with wider economic development benefits.

- ***Crime Reduction:*** Research suggests that fewer crimes occur near buildings with trees and non-invasive vegetation. Maintained areas of vegetation encourage informal social gatherings outdoors. Incidence of crime declines when with the presence of people and possibly by psychological precursors to crime.

- ***Public Education/ Environmental Stewardship:*** Promoting strategies that seek to change people's behaviors and make them more aware of their environmental impacts helps to cultivate a *stewardship perspective* in the community about its local natural resources. Quantification of this type of benefit may be measured in terms of how many people are reached with messages of programs aimed to enhance knowledge and ultimately actions towards to improve stormwater management.

- ***Heat Island Effect:*** Trees and other vegetation can reduce ambient temperatures in cities that have higher air temperatures. Lower temperatures can reduce health effects especially in populations that are at risk of heat stroke. Additionally, the overall lowering of temperatures can reduce cooling needs at properties located within the area. This type of benefit is only quantifiable in cases where the strategy is applied over a large scale.

- ***Noise Reduction:*** Some green infrastructure systems, such as wetlands or trees, are effective in reducing ambient noise because they can absorb it. This is also true for porous concrete and green roofs, but there is limited research in quantifying these benefits.

3.2 Characterization of the Benefit Level from a Strategy

The potential magnitude of benefits differs across strategy types. To account for these differences, four 'levels' are defined that represent a decreasing association between the impact of a strategy and a benefit category. These levels include:

Monetizable – The level of benefits indicates impacts that can be quantified and where economic research has been produced to determine a monetary value.

Measurable – There exists a connection for some measure of non-monetary impact can be identified and measured, even if economic research is not available to monetize the impacts.

Potential - A conceivable connection exists between a strategy and benefit category but it is not likely to be measurable.

Not Applicable - There is no discernible connection between a strategy and benefit category.

At this stage in program implementation and project design, the impact of each strategy on a benefit category can only be considered to be an order of magnitude assessment. An estimation of the actual impact would be highly uncertain since most strategies currently lack site-specific data about the design and implementation. Instead, these levels of impact are intended to provide separable categories that indicate the order of magnitude of benefits that a strategy may be able to generate. That is, it is only possible to assess the likelihood that a project can generate monetizable benefits, not the actual size of monetizable benefits.

At the same time, these four categories are intended to provide a broad degree of separation between strategies in terms of their measurable connection with each benefit category. For instance, if a strategy can be classified as having monetizable benefits, then its overall level of measurable benefits can be reasonably assumed to be higher than another strategy that is classified as being quantifiable, even if only in part. By the same rationale, these classifications would likely have more direct impact for a benefit category than a strategy whose impact can only be presumed

This assessment aims to achieve consistency in evaluations within a specific strategy outcome group, as well as across strategy outcome groups. While some strategies have design or location specifications (e.g., total acres of bioretention), or target certain groups (developers vs. residential), others entail broad descriptions. Due to this uncertainty, the evaluation has taken a conservative approach to drawing conclusions about the magnitude of benefits that could arise from a strategy.

3.3 Scoring System

A scoring system is established to support comparisons of strategies with respect to the potential benefits they can generate (see Table 1). Each benefit level is assigned a point value that has been established through discussions with the Division. The values are intended to provide an indication of the strategy's impact across all benefit categories. In this case, potentially monetizable benefits are assigned a higher score than one that is only quantifiable (and not monetizable). This approach is intended to separate the types of benefits that are likely to be larger in magnitude from others that cannot be monetized nor quantified.

Table 1. Overview of Benefit Scoring

Level	Description	Point Value
Monetizable	Strategy can realize quantifiable impacts, and sufficient economic evidence supports placing a dollar value on these impacts.	1
Measurable	Strategy can realize quantifiable impacts, but lacks sufficient economic evidence to support placing a dollar value on these impacts.	0.667
Potential	Strategy most likely provides a positive impact, but the magnitude of the impact is uncertain.	0.333
Not Applicable	Strategy will not impact the benefit category in any meaningful way.	0

This scoring system places higher weight on strategies which may generate benefits that can be monetized (3 times the weight of a potential benefit level). Accordingly, in some cases a strategy that influences many additional benefit categories at a "*Potential*" level could score lower than one with fewer categories but with "*Monetizable*" impacts. This scoring system is designed for that type of result to give greater emphasis on strategy impacts that can be measured and are thus more tangible. Potential impacts are circumstantial and small, as compared to more significant impacts that can be measured and monetized. Furthermore, the implications of this scoring system have been taken into account in a consistent approach in determining which impacts of strategy are classified as monetizable, measureable or potential.

This scoring system is applied to the strategies in Table 2 through Table 7. This scoring system is only relevant for comparing strategies with respect to additional benefits, not in ways that influence a ranking towards meeting permit requirements and/or encourages other program objectives such as habitat restoration.

In addition, the total number of applicable benefit categories is also shown in Table 2 through Table 7 for additional reference on the impact of these strategies.

4 Framework for Assessment of Strategies

Determination of the applicability of benefits for each strategy depends primarily on the assignment of a strategy to one of the structural or nonstructural categories (defined in Section 2). Consistency in the applicability of a benefit category (defined in Section 3) for a strategy is maintained by jointly evaluating all strategies of a specific type. This section discusses the framework for assessing potential additional benefits that can arise from the implementation of each strategy. The aim of this exercise is to apply a consistent and transparent rationale for each strategy. Since available evidence is limited with respect to each strategy, the application of a consistent set of assumptions to each strategy underlies the basis for determining (a) which benefit categories are applicable, and (b) the potential magnitude of benefits, if a category is applicable.

The approach to assigning a magnitude level began with an assessment of the strategy for which the most information is available about its potential impact: Green Infrastructure (Ref 19). This type of strategy is used as a benchmark for assigning benefit categories and potential magnitudes of benefits due to the availability of evidence from projects implemented elsewhere in the U.S. To illustrate this approach for Green Infrastructure (Ref 19), consider the rationale below:

- In some cases, sufficient information available about the specific strategies specifies the area of bioretention and permeable pavement to be installed and the location of the project. Due to the size of these initiatives, and knowing that the vegetation can improve air quality through the uptake of criteria pollutants and improve the climate through carbon sequestration, it is assumed that the total pollutant and CO2 removal from the atmosphere can be quantified. These quantified amounts of pollutant and CO2 can then be monetized using standard practices that are currently being used to value these impacts.
- Additionally, it is assumed that these projects will provide aesthetic improvements to the existing site, which can be quantified with information regarding the number of properties within a certain radius and the property value changes.
- These sites will also need to be maintained, which will require spending on jobs, and depending on the specific site location, the improved aesthetics can also improve businesses located near the site.
- The total land area of the bioretention and permeable pavement will allow for quantifying the amount of rain water which gets absorbed onsite, and does not cause localized flooding, where applicable.
- The remaining other benefit categories are assumed to see positive impacts. For example, GHG emission reductions may occur from the lifecycle CO2 emissions for permeable pavement being lower than the lifecycle CO2 emissions of asphalt or pavement. However, there is not enough information at this time to accurately quantify that impact.

- ❖ Similarly, permeable pavement absorbs less heat than conventional pavement, which is a benefit for Urban Heat Island reduction. The amount of heat, and how that will affect public health cannot be quantified.

The potential impacts of all other strategies have been evaluated relative to the benchmark as established by the above assumptions for green infrastructure. As an example, the first group of strategies evaluated below, All Development Projects (Ref 1). focuses on improving existing systems performance. It is assumed that specific actions, such as administrative training or increased monitoring, will have positive impacts for the same benefit categories as a green infrastructure project. But since there is no way to quantify any of those impacts, the magnitude of benefits is assumed to be lower.

The remainder of this section discusses the assessment of Jurisdictional and Optional Jurisdictional Strategies. Note that these strategies represent the latest consideration in an evolving process of identification, specification and assessment. Not all strategies have been implemented or have plans for immediate implementation. At the same time, the specification of the design standards also varies from strategy to strategy. This assessment takes into account the *potential* benefits that may occur, given the information available, and assumptions that are listed in each strategy.

4.1 Jurisdictional Strategies

This section discusses the rationale and methodology for assigning scoring categories to the Jurisdictional Strategies, based on the most recent description of the strategy. This list of individual strategies has been grouped according to the same categories that are proposed for the draft WQIPs and are presented in the same chronological order. The information found in the parenthesis next to the strategy group name (*Ref X*), refers to the number in the far left columns of Table 2 and Table 6. Note that in some cases (e.g., Commercial, Industrial, Municipal, and Residential Facilities and Areas) the strategies are separated into two types (i.e., Improve Structural Systems Performance and Initiatives to Change Behavior) based on the specific ways in which a strategy creates benefits.

4.1.1 All Development Projects (Ref 1)

Strategies in this group consist of administrative and other tasks that center on improving the structural system's performance. Many of these types of strategies focus on broad initiatives such as training or source control. The list of strategies includes the following:

- ❖ Administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement LID BMPs to maintain or restore hydrology of the area, where applicable and feasible.
- ❖ Investigation and research of emerging technology.
- ❖ Train staff on LID regulatory changes and LID practices.

- Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities. Ensure consistency with the City of San Diego's BMP Design Manual.
- Develop and implement Green Infrastructure Program and Guidelines.
- Develop Design Standards for Public LID BMPs.
- Create Right-of-Way Design Manual.

In scoring these strategies, it is assumed that the programs that target the administration or enforcement of BMPs would mostly affect the same benefit categories as a Green Infrastructure (GI) project which increases the acres of bioretention, but on a smaller scale. It is assumed that these projects would generate a positive impact but due to the uncertainty of the implementation and magnitude of the effect of these strategies, it cannot be measured.

Some of the broad initiatives are deemed to have too much uncertainty to reasonably assign a specific benefit level. It is however reasonable to assume that overall public awareness and knowledge of the issue will increase.

4.1.2 Priority Development Projects (PDPs) (Ref 2)

Similar to the strategies in the All Development Projects section, PDP initiatives are assumed to increase the number of structural systems and improve existing structural systems. These strategies include the following:

- For PDPs, administer a program requiring implementation of on-site structural BMPs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs.
- Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs.
  - Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.
  - Amend BMP Design Manual for animal-related facilities, such as such as animal shelters, "doggie day care" facilities, veterinary clinics, breeding, boarding and training facilities, groomers, and pet care stores.
  - Amend BMP Design Manual for nurseries and garden centers.
  - Amend BMP Design Manual for auto-related uses.
- Administer a program to inspect and enforce updated BMPs in BMP Design Manual

- ❖ Develop and administer an alternative compliance program to on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects).

Scoring the impact of programs that target the administration or enforcement of BMPs would mostly affect the same benefit categories as a green infrastructure project which increases the acres of bioretention, but on a smaller scale. Initiatives that focus on updating various components of the design manual are assumed to increase the efficiency of the already existing systems. However, the total magnitude of this improvement cannot be estimated without additional information, and thus other benefits for this group cannot be measured.

4.1.3 Construction Management (Ref 3)

There is one specific strategy under this group, and it is assumed it will improve structural system performance. Construction Management strategy is:

- ❖ Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.

The scoring for this strategy is assumed to be the same as previously discussed strategies that improve the performance of existing systems.

4.1.4 Commercial, Industrial, Municipal, and Residential Facilities and Areas – Improve Structural Systems Performance (Ref 4)

The specific initiatives under this strategy group focus on improving structural systems performance. These strategies differ from the strategies in the next group, which also are included under Commercial, Industrial, Municipal, and Residential Facilities and Areas in the Water Quality Improvement Plan, but target a different outcome. Administering programs which require minimum BMPs are assumed to affect the same benefit categories as a GI project which increases the acres of bioretention, but a smaller scale. These strategies include:

- ❖ Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspection of existing development at appropriate frequencies and using appropriate methods.
  - ➢ Update minimum BMPs for existing residential, commercial, and industrial development. Specific updates to BMPs include require sweeping, catch basin cleaning and maintenance of private roads and parking lots in targeted areas.
  - ➢ Power-washing minimum BMPs: Outreach to property managers and trash haulers to elevate the emphasis of washing as a pollutant source. Emphasize non-compliant washing as an enforceable violation.

  - Implement property based inspections.
  - Review policies and procedures to ensure discharges from swimming pools meet permit requirements.

Strategies that target pollutants directly, such as the power-washing minimum BMPs, can be assumed to reduce the amount of pollutants entering the environment. However, while these strategies protect habitats and improving aesthetics, the total amount of pollutants reduced cannot be measured until more information is known regarding the current level of pollutant discharges, and how many people are targeted as part of this initiative. These initiatives are assumed to require some level of public outreach or promotion, and public awareness of these issues will be raised.

4.1.5 Commercial, Industrial, Municipal, and Residential Facilities and Areas – Initiatives to Change Behavior (Ref 5)

While also focusing on Commercial, Industrial, Municipal, and Residential Areas, these strategies seek to initiate changes in behavior. This list includes:

- Implement pet waste program
- Consider installing trash bins, pet waste bag dispensers and pickup services on Rose Creek Bicycle Path and Rose Canyon Bicycle Path.
- Promote and encourage implementation of designated BMPs for residential and non-residential areas.
- Residential BMP: Rain Barrel.
- Residential and Commercial BMP: Grass Replacement.
- Residential and Commercial BMP: Downspout Disconnect.
- Residential and Commercial BMP: Microirrigation.
- Onsite Water Conservation Survey.

These types of initiatives can also lead to measurable impacts. Specifically, initiatives which encourage water conservation allow for quantification if a simple number of variables are known, such as the number of Rain Barrels, and average annual rainfall.

4.1.6 MS4 Infrastructure (Ref 6)

The specific strategy initiatives for MS4 Infrastructure focus on improving the structural systems performance. The list of MS4 Infrastructure Strategies includes:

- Implementation of operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.) for water quality improvement and for flood control risk management.
  - Optimize catch basin cleaning to maximize pollutant removal (4 times per year for metals and sediment TMDLs, elsewhere 1 per year).

- Increased frequency of catch basin inspection and as-needed cleaning (Settlement Agreement).
- Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.

- Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.
- Identify sewer leaks and areas for sewer pipe replacement prioritization.

Since these projects specifically focus on sub-surface activities, it is assumed that other benefits associated with changes above ground are not affected. Due to the specificity of these initiatives, it is reasonable to assume they will have a positive impact on local flood risk reduction, which in turn could potentially affect habitat related benefits, and possibly aesthetics.

4.1.7 Roads, Street, and Parking Lots (Ref 7)

These strategies specifically target street litter or debris will create aesthetic improvements. These strategies include:

- Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.
- Outreach to street sweeping enhancement-targeted areas.
- Enhance street sweeping through equipment replacement (replace every 4 years) and route optimization (sweep all areas twice a month).
- Initiate sweeping of medians on high-volume arterial roadways.
- Implement additional street sweeping near commercial routes adjacent to maintained MS4 channels..

The impact of these strategies can be quantified by estimating the volume of litter and street pollutants removed. Also, depending on the local land-use for the streets targeted, it is conceivable that a cleaner environment can lead to business development and investment. Jobs then would be supported by the money spent on operation and maintenance activities.

4.1.8 Pesticide, Herbicides, and Fertilizer BMP Program (Ref 8)

This category includes a broad initiative to reduce pollutant loads. The strategy entails:

- Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.

While there is too much uncertainty at this time to be able to assign specific measurable benefits, this reduction in pollutants entering the environment will benefit habitats, and aesthetics. It is assumed that overall public awareness and knowledge of the issue will increase.

4.1.9 Retrofit and Rehabilitation in Areas of Existing Development – Improve Structural Systems Performance (Ref 9)

The goal of this strategy is to improve existing systems, specifically:

- ❖ Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.

As this strategy focuses on retrofitting, is assumed to follow the same methodology for scoring other projects which increase the number of structural systems.

4.1.10 Retrofit and Rehabilitation in Areas of Existing Development – Increase the Number of Structural Systems (Ref 10)

This strategy was separated from the previous as it focuses on rehabbing existing ecological areas.

- ❖ Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.

Specific improvements in streams and other systems will improve habitats and aesthetics and can be measured using the area of each project.

4.1.11 Illicit Discharge, Detection, and Elimination (IDDE) Program (Ref 11)

This program is assumed to change behavior, specifically, reduce pollutants entering the environment through illegal discharges and disposal. The strategy is defined as:

- ❖ Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMP. Requirements include: maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for public reporting of illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.

While broad strategies cannot be measured, it is assumed that the targeting of pollutants will improve the environment and benefit habitats and aesthetics. It is also assumed that overall public awareness and knowledge of the issue will increase.

4.1.12 Public Education and Participation: Initiatives to Change Behavior (Ref 12)

Strategies under Public Education and Participation are grouped under two categories, those which seek to change behavior, and are targeted at the community at large, and those which seek to reduce pollutants directly, by targeting business and industries. The strategies in this grouping target changing behavior, and are listed below:

- ❖ Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.
- ❖ Expand outreach to homeowners' association (HOA) common lands and HOA incentives.
- ❖ Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.
- ❖ Enhance and expand trash cleanups through community-based organizations involving target audiences.
- ❖ Improve consistency and content of websites to highlight enforceable conditions and reporting methods.
- ❖ Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.
- ❖ Enhance school and recreation-based education and outreach.
- ❖ Develop education and outreach to reduce over-irrigation.
- ❖ Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.

4.1.13 Public Education and Participation: Initiatives to Reduce Pollutants Directly (Ref 13)

These strategies differ from the previous group, it that they aim to reduce pollutants directly by targeting business and industries. This list includes:

- ❖ Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.
- ❖ Develop regional training for water-using mobile businesses.
- ❖ Promote and encourage implementation of designated BMPs in commercial and industrial areas.
- ❖ Outreach to impacted industry regarding minimum BMP requirement updates. Affects commercial, industrial, residential development.

While the total effect of the strategies cannot be determined at this time, it is assumed that the targeting of pollutants will improve the environment and benefit habitats and aesthetics.

The strategies which target commercial areas are assumed to effect more benefit categories, consistent benefit category scoring for other strategies which require minimum BMPs.

4.1.14 Enforcement Response Plan: Initiatives to Change Behavior (Ref 14)

The Enforcement Response Plan strategies can be categorized by 3 separate desired outcomes, and have been grouped separately. These strategies are focused at changing behavior.

It can be assumed that irrigation cost savings will occur as one strategy specifically targets over-irrigation. Where irrigation cost savings occur, there can potentially be emission savings. This is due to the reduced energy needed to provide the water, which in turn reduces the emissions generated from energy production. More information would be needed about these projects to determine the extent to which irrigation cost savings are realized.

List of Enforcement Response Plan Strategies to Change Behavior:

- ❖ Continue to implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.
- ❖ Increase enforcement of over-irrigation.

4.1.15 Enforcement Response Plan: Initiatives to Reduce Pollutants Directly (Ref 15)

This strategy differs from the previous, in that its outcome creates initiatives to reduce pollutants directly.

List of Enforcement Response Plan Strategies to Reduce Pollutants Directly:

- ❖ Increase enforcement associated with property-based inspections.
- ❖ Increase enforcement of sweeping and maintenance of private roads and parking lots in targeted areas.
- ❖ Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.
- ❖ Increase enforcement of water-using mobile businesses.

4.1.16 Enforcement Response Plan - Improve Structural Systems Performance (Ref 16)

This strategy in the Enforcement Response Plan is assumed to improve structural systems performance through minimum BMP enforcement, which is different from the targeted outcome of the other strategies:

- Increase enforcement of minimum BMPs for existing residential, commercial, and industrial development, including power washing.

As this strategy targets commercial and industrial areas, consistent benefit category scoring for other strategies which require minimum BMPs is used.

4.1.17 Additional Nonstructural Strategies- Reduce Pollutants Directly (Ref 17)

The remaining Nonstructural strategies related to pollutant reduction are grouped together, and separated from the additional strategies which improve structural systems performance. They are assumed to see habitat related benefits, but due to the broad nature and lack of specific details, that is the only benefit category affected. Additional outreach is assumed to provide Public Education benefits.

List of Additional Nonstructural Strategies which Reduce Pollutants Directly:

- Address and clean up pollutants from homeless encampments through Homeless Outreach Team
- Continue participating in source reduction initiatives
- Coordinate with other City of San Diego Departments to replace City-owned vehicle brake pads with copper-free brake pads as they become commercially available
- Pesticide Use Reduction
- Zinc Reduction Program
- San Dieguito Source Identification and Prioritization Process

4.1.18 Additional Nonstructural Strategies - Improve Structural Systems Performance (Ref 18)

These strategies differ from those which seek to reduce pollutants directly, as these target outcomes to improve structural systems and have specific tasks such as ‘actively monitor erosion’ are expected to positively impact habitat and flooding benefits. All the strategies which are research studies are assumed to provide public education benefits.

List of Additional Nonstructural Strategies which Improve Structural Systems Performance:

- Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property
- Using adaptive management, delist the beach segment from the TMDL and Attachment E of the MS4 Permit
- Los Peñasquitos Watershed Special Study
- Reference watershed study
- Reference beach study
- Tecolote Creek Quantitative Microbial Risk Assessment (QMRA)
- Implement ASBS Compliance Plan
- Collaborate with City of San Diego PUD and other watershed stakeholders in the Lake Hodges Water Quality Concentration Study. Study will characterize conditions and identify sources.
- Develop and implement targeted roof replacement incentive program for Chollas

4.1.19 Green Infrastructure (Ref 19)

These strategies produce a large amount of quantifiable benefits due to the research that exists demonstrating the effectiveness of green infrastructure. This means that in most cases, at a minimum, the benefits can be measured. In certain cases, they can be monetized when enough information is available. As the specific strategies vary by watershed, a high level summary is provided.

Several BMPs involve increasing the total area (acres) of bioretention and permeable pavement on public parcels. Other strategies focus on specific target sites such as parks on green lots.

Strategies with specific design features (such as size of bioretention, etc.) allow for the ability to calculate the amount of storm water runoff retained, which can be used in to quantify Flood Risk Reduction, where applicable.

Less information is known about how these systems will fully operate, so it is possible that there could be irrigation cost savings, but such benefits cannot be accurately quantified without additional information. Where instances of irrigation cost savings could occur, some level of emission savings could also occur because of reduced energy use for delivering water.

Changes in biomass at a site (due to green streets plantings, or bioretention) can have quantifiable impacts on air quality and climate. The quantified amount depends on the specific properties of the new vegetation. Assuming that changes in biomass can be quantified, it is possible to suggest that noise reduction is a potential benefit, and local aesthetics would be improved. Local aesthetics would be quantified by the area of improved land.

An increase in biomass could reduce ambient temperatures, but the scale would be localized and small overall. Thus, we scored this other benefit category as ‘potential.’’

In instances where aesthetics are realized, business development can be quantified if enough information is available about the local characteristics of a green Infrastructure site (i.e., the proximity of the site to existing retail businesses).

Projects which provide pedestrian or bike access such as a green street or open space are assumed to provide quantifiable recreational benefits, such as additional miles of walkable or livable streets. The amount of these benefits will depend on data on size of the local population, the area of the site, and site usage.

4.1.20 Green Infrastructure: Green Streets (Ref 20)

Due to the information available regarding bioretention and the size of implementation, it can be assumed green streets will have the same scoring as the green infrastructure projects. As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve increasing the total area (acres) of green streets on specific avenues or subwatersheds.

4.1.21 Multiuse Treatment Areas: Infiltration and Detention Basins (Ref 21)

This section describes the process for scoring the structural strategies consisting of infiltration and detention basins.

It is assumed that the strategies for both golf courses involve similar wetland system projects, which are assumed to increase total biomass and provide entrainment and sequestration. If the total biomass change can be quantified, air and climate benefits can be measured and monetized.

While underground systems will be able to provide flood risk reduction, which in turn protects local habitats and ecological systems, any benefit categories that depend on changes in the above ground environment (such as habitat benefits) will not be affected, and are indicated as ‘Not Applicable.’ Projects that occur on public land, such as schools, provide the opportunity for educating the public or students about the strategy, and can be quantified by the number of people who learn about the strategy. These benefits depend on the number of students enrolled at the school, or the population of a neighboring community where public outreach about the project occurs.

Where instances of irrigation cost savings are thought to occur, emission savings could occur, but more information would be needed about these projects to determine the extent to which irrigation cost savings are realized.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve the installation of a subsurface detention galley on public parcels. Other options include dry detention systems, sediment basins, infiltration basins, and hyrdomodification BMPs.

4.1.22 Multiuse Treatment Areas: Stream, Channel and Habitat Rehabilitation Projects (Ref 22)

As these strategies target streams and other ecological areas, it is assumed habitats and aesthetics will improve, and can be measured using the area of the project. This strategy is assumed to be similar to the MS4 and Retrofit and Rehabilitation in Areas of Existing Development strategies.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve either wetlands or the Chollas Creek.

4.1.23 Water Quality Improvement BMPs: Proprietary BMPs (Ref 23)

Due to the nature of these projects, a basic assumption is the projects will improve water flow, and flood control and habitat benefits can occur. However, no other benefit categories can reasonably be expected to be impacted until more specific details about the sites and projects are known.

As the specific strategies vary by watershed, a high level summary is provided. Several BMPs involve drainage inserts on public parcels. Others involve hydrodynamic separation systems, dry-weather, or low flow diversions. Some are broader in nature, and provide direction on implementing a certain amount of acres of multiuse treatment area projects on private parcels and/or through public-private partnerships with various total storage sizes.

4.2 Optional Jurisdictional Strategies

This section provides a discussion of the methodology for assigning scoring categories to the Optional Jurisdictional Strategies, as well as sub-categories. Optional strategies are those strategies that may be triggered in the future to achieve the interim and final numeric goals." Many of these strategies are assumed to have a similar outcome and thus a similar other benefit category scoring as their Jurisdictional counterpart. The scores take into account the *potential* benefits that may occur, given the information available, and assumptions that are listed in each strategy. The scoring for these strategies is presented in Section 5, in Table 3 and Table 7. These strategies represent the latest consideration in an evolving process of identification, specification and assessment. Not all strategies have been implemented or have plans for immediate implementation. At the same time, the specification of the design standards also varies from strategy to strategy.

This list of individual strategies has been grouped according to the same categories that are contained in the Water Quality Improvement Plan and are presented in the same chronological order. The information found in the parenthesis next to the strategy group name (*Ref X*), refers to the number in the far left columns of Table 3 and Table 7.

4.2.1 Additional Nonstructural Strategies (Ref 24)

Many of these strategies are studies, which until they are completed, and the recommendations are implemented, cannot produce any benefits other than public education at the moment. Additionally, initiatives that involve participating or collaborating with other agencies or organizations are not applicable to other benefit categories at this time. The removal of invasive plants should protect existing habitats.

Additonal Nonstructural Strategies include:

Project	Location
Conduct Sustainable Return on Investment (SROI) analysis to estimate strategies' co-benefits and impacts to the public and the private sector on a common scale.	City-wide
Collaborate with the County, if a County-led regional social services effort is established, to provide sanitation and trash management for person experiencing homelessness and determine if the program is suitable and appropriate for jurisdictional needs to meet goals.	City-wide
Identify strategy resources and funding to support mapping and assessment of agricultural operations.	SDG above Lake Hodges
Coordinate with County of San Diego and identify resources and funding to implement a program to target on-site wastewater treatment (septic) systems. May include mapping and risk assessment, inspection, or maintenance practices.	SDG
Participate in an assessment to determine if implementation of an urban tree canopy (UTC) program would benefit water quality and other City goals.	City-wide
Conduct a feasibility study to test Permeable Friction Course (PFC), porous asphalt that overlays impermeable asphalt.	City-wide
As opportunities arise and funding sources are identified, protect areas that are functioning naturally by avoiding impervious development and degradation on unpaved open space areas, creating permanent open space protections on undeveloped city-owned land, and accepting privately-owned undeveloped open areas.	City-wide MB-Rose Canyon
Add permanent open spaces protections to underdeveloped city-owned land in and on the rim of Rose canyon and San Clemente Canyon.	MB, Rose Canyon
Forming a linear "park" from the southern end of Marian Bear Natural Park to the mouth of Rose Creek.	MB, Rose Canyon
Lake Hodges Natural Treatment System Project	SDG: Lake Hodges

Project	Location
If a regional collaboration is established for the Los Peñasquitos Lagoon, participate in restorative efforts in collaboration with TMDL Responsible Parties and TMDL responsible parties and other stakeholders.	Los Peñasquitos Lagoon Subwatershed
Participate in a watershed council or group and support the establishment of a watershed coordinator if one is established.	City-wide
Participate in a watershed council or group and support the establishment of a watershed coordinator if one is established. Includes participation in Rose Creek Watershed Team.	MB, Rose Canyon
Removal of invasive plants.	MB, Rose Canyon

4.2.2 Green Infrastructure – Optional Jurisdictional Strategies (Ref 25)

These strategies follow the same scoring as Jurisdictional Green Infrastructure projects. Under certain circumstances, these Green Infrastructure Strategies could be implemented.

4.2.3 Green Infrastructure: Green Streets – Optional Jurisdictional Strategies (Ref 26)

This strategy follows the same scoring as Jurisdictional Green Streets projects. Green Streets Strategies could be implemented if:

- If interim load reduction goals are not met and additional green infrastructure is required, the additional acreage of bioretention and permeable pavement can be implemented through green streets if potential opportunities for green infrastructure implementation on public parcels are not available.

4.2.4 Multiuse Treatment Areas: Infiltration and Detention Basins – Optional Jurisdictional Strategies (Ref 27)

These strategies follow the same scoring as Jurisdictional Multiuse Treatment Areas: Infiltration and Detention Basins projects.

4.2.5 Multiuse Treatment Areas: Stream, Channel, and Habitat Rehabilitation Projects – Optional Jurisdictional Strategies (Ref 28)

These strategies follow the same scoring as Jurisdictional Multiuse Treatment Areas: Stream, Channel, and Habitat Rehabilitation projects. List of Stream, Channel, and Habitat Rehabilitation Project includes:

- If interim load reduction goals are not met and additional stream, channel, and habitat rehabilitation projects are required, implement as needed.

- Day lighting Cudahy Creek implementation.
- An example of this would be to lengthen the Genesee Avenue Bridge in Rose Canyon in order to eliminate the berm that bisects the riparian corridor. This would restore the natural riparian corridor and promote wildlife and recreational passage under Genesee.

4.2.6 Multiuse Treatment Areas: Other Opportunities – Optional Jurisdictional Strategies (Ref 29)

This strategy follows the same scoring as Jurisdictional Multiuse Treatment Areas: Other Opportunities projects. Other Opportunity Strategy is defined as:

- If interim load reduction goals are not met and additional multiuse treatment area projects are required, implement, as needed, on private parcels and/or through public-private partnerships.

4.2.7 Water Quality Improvement BMPs: Trash Segregation – Optional Jurisdictional Strategies (Ref 30)

These projects specifically target street litter or debris, and are assumed to create an aesthetic improvement, and can be quantified with estimates on the volume of litter removed. Depending on the local land-use for the streets targeted, business development could potentially increase. Jobs can also be supported by the money spent on operation and maintenance activities. Trash Segregation Strategies would be implemented under conditions defined as:

- If interim load reduction goals are not met and additional trash segregation projects are required, implement as needed.
- If interim load reduction goals are not met and additional proprietary projects are required, implement as needed.
- If interim load reduction goals are not met and additional dry weather flow separation and treatment projects are required, implement as needed.

5 Results of Assessment

An overview of all the strategies, with the number of benefits, by benefit level, shown in descending order is presented in Table 2 and Table 3. Additionally, the total point value across the other benefit categories is presented in the far right column, with the header 'Total Point Value.' For example, green infrastructure has the greatest benefit score for both the jurisdictional and optional jurisdictional strategies. It is located at the top of Table 2, with a 'Total Point Value' of 7.3. This is calculated by:

- Multiplying the number of monetizable benefits (2), by their benefit scoring value (1);
- Multiplying the number of measurable benefits (3), by their benefit scoring value (0.667),
- Multiplying the number of potential benefits (10), by their benefit scoring value (0.333),
- Multiplying the number of not applicable benefits (0), by their benefit scoring value (0),
- Adding the subtotals together results in a total score of (2 + 2 + 3.3 + 0 = 7.3).

A detailed summary of the potential level of impact for each strategy and benefit category is presented in Table 6 and Table 7. For convenience, the number in the far left column, with the header 'Ref,' corresponds to the number next to the strategy group descriptions in the previous sections, and is consistent across all tables. Using Green Infrastructure as an example, the number in the first column of Table 2, (19) can be found in Table 6, and corresponds to the discussion of green infrastructure in the previous section, *Green Infrastructure (Ref 19)*

Table 2: Overview of Jurisdictional Strategies in Descending Order

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
19	Green Infrastructure	Structural	Green Infrastructure	2	3	10	0	7.33	15
20	Green Streets	Structural	Green Infrastructure	2	3	10	0	7.33	15
5	Commercial, Industrial, Municipal, and Residential Facilities and Areas[2]	Non-Structural	Initiatives to Change Behavior	0	5	6	4	5.33	11
21	Multiuse Treatment Areas - Infiltration and Detention Basins	Structural	Multiuse Treatment Areas	2	1	6	6	4.67	9
1	All Development Projects	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	14	1	4.67	14
2	Priority Development Projects (PDPs)	Non-Structural	Increase # Of Structural Systems	0	0	14	1	4.67	14
3	Construction Management	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
4	Commercial, Industrial, Municipal, and Residential Facilities and Areas[1]	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
9	Retrofit and Rehabilitation in Areas of Existing Development - Structures	Non-Structural	Increase # Of Structural Systems	0	0	14	1	4.67	14

Table 2: Overview of Jurisdictional Strategies in Descending Order (continued)

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
13	Public Education and Participation: Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	14	1	4.67	14
15	Enforcement Response Plan: Improve Structural Systems Performance	Non-Structural	Improve Structural Systems Performance	0	0	14	1	4.67	14
22	Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects	Structural	Multiuse Treatment Areas	0	2	8	5	4.00	10
14	Enforcement Response Plan: Initiatives to Change Behavior	Non-Structural	Initiatives to Change Behavior	0	1	6	8	2.67	7
10	Retrofit and Rehabilitation in Areas of Existing Development	Non-Structural	Improve Structural Systems Performance	0	2	3	10	2.33	5
16	Enforcement Response Plan: Initiatives to Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	2	3	10	2.33	4
12	Public Education and Participation: Initiatives to Change Behavior	Non-Structural	Initiatives to Change Behavior	0	1	4	10	2.00	4
11	Illicit Discharge, Detection, and Elimination (IDDE) Program	Non-Structural	Initiatives to Change Behavior	0	1	3	11	1.67	4
7	Roads, Street, and Parking Lots - Cleaning Maintaining, etc	Non-Structural	Improve Structural Systems Performance	0	1	2	12	1.33	3

Table 2: Overview of Jurisdictional Strategies in Descending Order (continued)

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
8	Pesticide, Herbicides, and Fertilizer BMP Program	Non-Structural	Initiatives to Reduce Pollutants Directly	0	1	2	12	1.33	3
6	MS4 Infrastructure	Non-Structural	Improve Structural Systems Performance	0	0	3	12	1.00	3
18	Additional Nonstructural Strategies: Improve Structural Systems Performance	Non-Structural	Improve Structural Systems Performance	0	0	3	12	1.00	3
17	Additional Nonstructural Strategies: Initiatives to Reduce Pollutants Directly	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	2	13	0.67	2
23	Water Quality Improvement BMPs - Proprietary BMPs	Structural	Water Quality Improvement	0	0	2	13	0.67	2

1. The reference number refers to strategy groups presented in pages 9-28.

Table 3: Overview of Optional Jurisdictional Strategies by Descending Order

Ref.[1]	Description of Strategy Group	Category	Strategy Outcome	Monetizable	Measurable	Potential	Not Applicable	Total Point Value	Number of Applicable Benefits
25	Green Infrastructure – Optional Strategies	Structural	Green Infrastructure	2	3	10	0	7.33	15
26	Green Streets – Optional Strategies	Structural	Green Infrastructure	2	3	10	0	7.33	15
27	Multiuse Treatment Areas-Infiltration and Detention Basins – Optional Strategies	Structural	Multiuse Treatment Areas	2	1	6	6	4.67	9
28	Multiuse Treatment Areas-Stream, Channel and Habitat Rehabilitation Projects – Optional Jurisdictional Strategies	Structural	Multiuse Treatment Areas	0	2	8	5	4.00	9
29	Multiuse Treatment Areas- Other Opportunities – Optional Strategies	Structural	Multiuse Treatment Areas	0	1	8	6	3.33	9
30	Water Quality Improvement BMPs-Trash Segregation – Optional Strategies	Structural	Water Quality Improvement	0	0	3	12	1.00	2
24	Additional Nonstructural Strategies – Optional Jurisdictional Strategies	Non-Structural	Initiatives to Reduce Pollutants Directly	0	0	2	13	0.67	2

1. The reference number refers to strategy groups presented in pages 9-29.

In Table 6 and Table 7, a detailed summary of the potential level of impact for each strategy and benefit category is presented. For these tables, a key to symbols and point value is presented for each level of impact in Table 4. In some cases, the strategy group includes individual strategies that are classified by different types of strategy outcomes. Table 5 shows the numerical key used in Table 6 and Table 7. To make the evaluation process more transparent, a discussion about the assumptions and rationale for the assignment of a benefit category level to a specific strategy is briefly discussed for each type of Water Quality Improvement Plan strategy following the summary tables. The reference for the discussion below for each strategy is listed in column 1 of Table 6 and Table 7. In addition to presenting point values, the total number of potentially applicable benefits is also shown.

Table 4: Key to Symbols

Symbol	Level of Impact	Point Value
●	Monetizable	1
⦿	Measurable	0.67
○	Potential	0.33
⊗	Not Applicable	0

Table 5 provides a key to the number in the column with the header 'Strategy Outcome.' For example, the first strategy group listed, All Development Projects, has the number 6 in the 'Strategy Outcome' column. The number 6 in Table 5 indicates that All Development Projects are Nonstructural Strategies comprised of Initiatives to Reduce Pollutants Directly.

Table 5: Key to Strategy Outcome

ID	Category of Strategy	Type of Strategy Outcome
1	Structural	Green Infrastructure
2	Structural	Multi Use Treatment
3	Structural	Water Quality Improvement
4	Nonstructural	Improve Structural Systems Performance
5	Nonstructural	Increase the Number of Structural Systems
6	Nonstructural	Initiatives to Reduce Pollutants Directly
7	Nonstructural	Initiatives to Change Behavior

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
1	All Development Projects	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	4.7	14
2	Priority Development Projects (PDPs)	5	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	4.7	14
3	Construction Management	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	4.7	14
4	Commercial, Industrial, Municipal, and Residential Facilities and Areas	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	4.7	14

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
5	Commercial, Industrial, Municipal, and Residential Facilities and Areas	7	◉ [0.67]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	◉ [0.67]	◉ [0.67]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	◉ [0.67]	⊗ [0]	○ [0.33]	5.3	11
6	MS4 Infrastructure	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	1.0	3
7	Roads, Street, and Parking Lots	4	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	1.3	3
8	Pesticide, Herbicides, and Fertilizer BMP Program	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	◉ [0.67]	⊗ [0]	⊗ [0]	1.3	3

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
9	Retrofit and Rehabilitation in Areas of Existing Development - Improve Structural Systems Performance	5	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	4.7	14
10	Retrofit and Rehabilitation in Areas of Existing Development - Increase the Number of Structural Systems	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⦿ [0.67]	⊗ [0]	⊗ [0]	⦿ [0.67]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	2.3	5

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
11	Illicit Discharge, Detection, and Elimination (IDDE) Program	7	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	1.7	4
12	Public Education and Participation: Initiatives to Change Behavior	7	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	2.0	4

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
13	**Public Education and Participation: Initiatives to Reduce Pollutants Directly**	6	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**
14	**Enforcement Response Plan: Initiatives to Change Behavior**	7	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	**2.7**	**9**
15	**Enforcement Response Plan: Improve Structural Systems Performance**	4	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**4.7**	**14**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
16	**Enforcement Response Plan: Initiatives to Reduce Pollutants Directly**	6	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊙ [0.67]	⊗ [0]	○ [0.33]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	**2.3**	**4**
17	**Additional Nonstructural Strategies: Initiatives to Reduce Pollutants Directly**	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**0.7**	**2**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
18	**Additional Nonstructural Strategies: Improve Structural Systems Performance**	4	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**1.0**	**3**
19	**Green Infrastructure**	1	○ [0.33]	○ [0.33]	⊙ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊙ [0.67]	○ [0.33]	⊙ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
20	**Green Streets**	1	○ [0.33]	○ [0.33]	⊙ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊙ [0.67]	○ [0.33]	⊙ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
21	**Multiuse Treatment Areas - Infiltration and Detention Basins**	2	○ [0.33]	○ [0.33]	○ [0.33]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	**4.7**	**9**

Table 6: Overview of Potential Other Benefits of Water Quality Improvement Plan Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
22	**Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**4.0**	**10**
23	**Water Quality Improvement BMPs**	3	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**0.7**	**2**

1. The reference number refers to strategy groups presented in pages 9-29.
2. Strategy Outcome as described in Table 5.

Table 7: Overview of Potential Other Benefits of Water Quality Improvement Plan – Optional Jurisdictional Strategies

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
24	**Additional Nonstructural Strategies**	6	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**0.7**	**2**
25	**Green Infrastructure**	1	○ [0.33]	○ [0.33]	⊙ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊙ [0.67]	○ [0.33]	⊙ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
26	**Green Streets**	1	○ [0.33]	○ [0.33]	⊙ [0.67]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊙ [0.67]	○ [0.33]	⊙ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	**7.3**	**15**
27	**Multiuse Treatment Areas - Infiltration and Detention Basins**	2	○ [0.33]	○ [0.33]	○ [0.33]	● [1]	● [1]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊙ [0.67]	⊗ [0]	⊗ [0]	**4.7**	**9**

Table 7: Overview of Potential Other Benefits of Water Quality Improvement Plan – Optional Jurisdictional Strategies (continued)

			Financial		Environmental						Social								
Ref[1]	Strategy Group	Strategy Outcome[2]	Water Cost Savings	Energy Cost Savings	Flood Risk Reduction	Air Particulate Entrainment	Climate Impacts	Habitat Related Benefits	Air Quality Emission Reduction	GHG Emission Reduction	Property Value Enhancement	Recreational Benefits	Business Development & Jobs	Crime Reduction	Public Education/ Environmental Stewardship	Noise Reduction	Heat Island Effect	Total Point Value	Number of Applicable Benefits
28	**Multiuse Treatment Areas - Stream, Channel and Habitat Rehabilitation Projects**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	◉ [0.67]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**4.0**	**9**
29	**Multiuse Treatment Areas - Other Opportunities**	2	○ [0.33]	○ [0.33]	◉ [0.67]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	**3.3**	**9**
30	**Water Quality Improvement BMPs - Trash Segregation**	3	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	○ [0.33]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	⊗ [0]	**1.0**	**2**

1. The reference number refers to strategy groups presented in pages 9-29.
2. Strategy Outcome as described in Table 5.

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Appendix 1: Sustainable Return on Investment Assessment of Water Quality Improvement Strategies. Draft Report. June 2014

Note to reader: This appendix is a re-print of the Phase 1 Draft Report from this project. Some aspects of the strategies and framework differ from what is included in the main report. The literature review in the following Phase 1 report provides a foundation for all subsequent analysis.

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SUSTAINABLE RETURN ON INVESTMENT ASSESSMENT OF WATER QUALITY IMPROVEMENT STRATEGIES

Draft Report

June 2014

Prepared for:

City of San Diego, Storm Water Division

Prepared by:

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Executive Summary

The aim of this project is to help the City of San Diego Storm Water Division account for the costs and benefits of storm water management strategies. Benefits (sometimes called "co-benefits") include a variety of outcomes beyond improved water quality that some storm water strategies may achieve. The Division has identified a range of structural best management practices (BMPs (e.g., a constructed runoff reduction system such as a bio-swale), and nonstructural BMP activities (i.e. programs that promote installations of constructed systems, or reduce pollutants directly through education and outreach, for example). The Division now seeks to incorporate information on benefits of strategies into a prioritization approach so that as the Division selects strategies to meet its regulatory requirements, it is generating the best value for the community and local businesses.

This report summarizes the findings of a literature review on storm water management benefits and costs and a programmatic assessment of the Division's strategies and associated benefits. The purpose of the assessment is to determine which types of benefits, beyond water quality improvements, might arise from the Division's different storm water management strategies and to determine if and how these benefits can be quantified, and included in a decision making framework.

Our findings in this report indicate that many types of benefits can accrue to local residents, businesses, and the general public. Common types of benefits that have been evaluated in a number of cities around the U.S. include flood risk reduction, reduced energy consumption (and associated air quality emissions), and improved aesthetics. Computing benefits of BMPs has been standardized to some extent in the Center for Neighborhood Technology (CNT) report which outlines the data and calculations for a number of benefits (CNT, 2010). For the Division, a similar calculation process could be implemented and it would be consistent with efforts implemented in other cities. However, a significant level of uncertainty would arise in preparing such estimates without specific data on BMP designs and activities for each strategy as well as site specific information about where they would be implemented.

The City developed several dozen storm water management strategies ranging from types of structural BMPs to projects designed to affect public or municipal employee polluting behavior. Some of the strategies listed are assessment projects that provide information necessary to make decisions or to implement a subsequent non-structural strategy. To initiate this study, we grouped the strategies into specific categories:

- Structural
    - Green Infrastructure
    - Multiuse Treatment Areas
    - Water Quality Improvements

- Non Structural
    - Results in increases in the number of structural systems
    - Results in improved performance of existing structural systems
    - Results in changes in behavior that reduced pollutant loads
    - Results in direct removal of pollutants from watersheds

The next best evaluation strategy for the Division at present would entail a simplified assessment of the likely *existence* of quantifiable net benefits for each strategy. In this report, we have evaluated the degree to which benefits can be quantified (and potentially monetized) for each type of strategy. A net result of benefits exceeding negative attributes has been qualitatively assessed based on findings in the literature. This is not to say that the benefit would be greater than implementation costs, but that co-benefits would likely exceed negative impacts to the community of implementing the strategy.

The results of this assessment are shown in Table 1. A “Yes” in one of the table cells indicates that there would be sufficient evidence to quantifiably determine the value of a strategy, provided that information about the strategy and implementation location is better understood. In this high-level summary, it may be assumed that if a quantifiable benefit exists, they would be large enough to generate observable public value and influence decisions accordingly.

These initial findings however must be developed in more detail to provide practical use in prioritizing strategies for the Division. In particular, the feasibility of estimating benefits must assessed for each individually identified strategy (see Appendix 2), not its strategy group as shown in Table 1. With this information, the Division can establish an initial indication of specific strategies that provide the best value. This effort is planned for phase two of this project.

Table 1: Summary of Evidence for Estimating Benefits for Structural and Nonstructural Strategies

Strategy	Structural			Nonstructural			
	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives To Change Behavior	Initiatives To Reduce Pollutants Directly
Flood Control	YES	YES	YES	YES	YES	YES	
Irrigation Cost Savings	YES			YES	YES	YES	
Energy Cost Savings	YES			YES		YES	YES
Air Particulate Entrainment	YES			YES		YES	YES
Climate Impacts	YES			YES		YES	YES
Habitat Related Benefits							
Air Quality Emission Reduction	YES			YES		YES	YES
GHG Emission Reduction	YES			YES		YES	YES
Heat Island Effect	YES	YES		YES	YES	YES	
Aesthetics	YES	YES		YES	YES	YES	YES
Recreational Benefits	YES	YES		YES	YES	YES	YES
Noise Reduction							
Business Development & Jobs	YES			YES	YES	YES	YES
Crime Reduction							
Public Education/ Environmental Stewardship							

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Acronyms

BCA – Benefit Cost Analysis
BES – Bureau of Environmental Services
BMP – Best Management Practice
Btu – British Thermal Unit

CAMX - California-Mexico Power Area
CEA – Cost-Effectiveness Analysis
CLRP – Comprehensive Load Reduction Plans
CNT – Center for Neighborhood Technology
CO_2 – Carbon Dioxide
CSO – Combined Sewer Overflow

DOT – Department of Transportation

EIA – Economic Impact Analysis
EPA –Environmental Protection Agency

IDDE – Illicit Discharge, Detection, and Elimination

kWh – Kilowatt Hour

LACDPW – Los Angeles County Department of Public Works
LID – Low Impact Development

MMSD – Milwaukee Metropolitan Sewage District
MODA – Multi-Objective Decision Analysis
M Wh – Mega Watt Hour

NRDC – Natural Resources Defense Council
NO_x - Nitric oxide and nitrogen dioxide
NPV – Net Present Value

O_3 – Oxide

PFC – Permeable Friction Course
PM – Particulate Matter
PWD – Philadelphia Water District

SO_2 – Sulfur Dioxide
SPU – Seattle Public Utilities
SROI – Sustainable Return on Investment

TBL – Triple Bottom Line
TIGER – Transportation Investment Generating Economic Recovery
TMDL – Total Maximum Daily Load

UTC – Urban Tree Canopy

WAMP – Watershed Asset Management Plan
WERF – Water Environment Research Foundation
WQIP – Water Quality Improvement Plan

1 Introduction

The City of San Diego Storm Water Division (Division) seeks a framework for prioritizing storm water management strategies that have been identified as part of the Water Quality Improvement Plans for each watershed. These strategies include a range of best management practices (BMPs) in structural systems (i.e., a constructed runoff reduction system, such as a bio-swale), and nonstructural activities (i.e. programs that promote installations of constructed systems, or reduce pollutants directly through education and outreach, for example). Each of the identified strategies is intended to contribute to meeting Total Maximum Daily Load (TMDL) regulatory requirements.

At the same time, each strategy can also provide *additional* benefits (sometimes called "Co-benefits") to the community. Depending on the type of strategy, such benefits can include flood risk reduction, reduced energy consumption and associated air quality emissions, improved aesthetics and habitat creation. Of course, not all BMPs generate positive benefits – property damage can occur if infiltration systems are poorly performing or additional street sweeping miles would increase air pollution costs. [3] Whatever the case, accounting for such benefits is challenging because each one is measured in different units and data is rarely available to quantify existing conditions and predicting changed conditions. Even so, estimating benefits can contribute to decision making. WERF (2014) notes that while a number of studies have shown storm water BMPs to be cost-effective and efficient at achieving water quality goals, traditional engineering costing methods fail to adequately value the multiple benefits and improved life-cycle costs that storm water BMPs provide.

The Division has contracted HDR to apply its *Sustainable Return on Investment (SROI)* process to develop a sound prioritization framework that accounts for storm water management benefits. SROI is an economics-based approach to evaluating and communicating the economic benefits and expenditure-based impacts across a *triple bottom line* – the financial, environmental and societal outcomes of a project. The process includes: (a) transparent review of evidence; (b) economic framework for evaluation; (c) workshop-based discussion of evidence; and (d) accounting for risk and uncertainty in key drivers of outcomes. SROI is a proven process, having been implemented in billions of dollars in capital projects over the last 8 years. In this project, we apply SROI to evaluate key economic benefits and use this to develop a sound framework for prioritizing strategies.

This document discusses our initial tasks in this effort. We report on findings from a literature review for substantiating the existence of such benefits, and an evaluation of strategies, to assess how different benefit categories may apply. We also discuss an initial assessment of the applicability of different types of benefits for individual BMP strategies. In addition, we report on an introductory workshop with stakeholders on the concept of storm water management benefits and frameworks to include estimated benefits in decision making. In addition, this phase will also determine the methods to account for co-benefits in qualitative, quantitative or monetized metrics.

[3] To make the discussion more concise, "Benefits" refer to both positive and negative outcomes.

2 Literature Review on Storm water Management Benefits

Conceptual frameworks and empirical evidence on economic benefits of storm water management have been developed in a number of studies. This chapter characterizes this evidence to establish a foundation for understanding the types of benefits from storm water management that are included in project evaluations in a SROI process. The findings of this literature also indicate that the estimation of benefits beyond water quality improvements is an emerging field. The potential for life cycle cost savings of green infrastructure in suitable locations has been fairly well established. Yet, it has been more difficult to establish standards for estimating the benefits from other aspects of BMPs that affect environmental and societal outcomes. Significant uncertainties remain over the degree to which a BMP can generate tangible benefits. In most cases, benefits depend largely on the design and site conditions.

2.1 What are Economic Benefits and Impacts?

Economic benefits are the fundamental measure of a project's overall worth to society.[4] Storm water management benefits,[5] whether they relate to avoided flood damage, improved air quality, or energy cost savings are evaluated in the same theoretical framework. Economic researchers assess the value for products and services from data on people's expenditures and their preferences for goods that are not sold (e.g. air quality).[6] Research can provide a basis for understanding how people value storm water benefits in terms of financial, environmental and societal benefits. Moreover, this evidence can support agency staff in developing strategies to manage environmental investments to maximize environmental benefits per dollar spent (WERF, 2014, Ecosystem Valuation, 2007).

A complementary measure of the worthiness of a project reflects the expenditures to build and maintain it. These expenditures and their connection to the broader economy are defined as *economic impacts*. The expenditures on materials, labor, land, and monitoring over the project lifecycle are implementation costs that are measureable and tangible. Economic impacts of storm water management spending are straightforward to

[4] Benefits are a somewhat esoteric theoretical economic construct of how people value a product or service. The benefit of a product or service is derived from the premise that some people gain greater *value* from the use of a product or service, especially its initial use, than the price they paid for it. For example, the first glass of water to a thirsty person would be much more highly valued and than the last one consumed, even if the price is the same for each glass. It is further assumed that they would be *willing to pay* some amount to gain that value from it, even if it is above the market price. The idea that a person's willingness to pay can be greater than a market price is a fundamental principal of the value gained by consumers.

[5] In standard economic terminology, benefits can be *positive* or *negative* depending on whether they are desirable or undesirable. A negative storm water management benefit can arise if flood control measures that entail infiltration cause damage to neighboring properties.

[6] Goods that are not sold in markets, such as the recreational value from natural areas, can be derived from the expenditures of persons who visit these areas, or the responses of people to responses to structured surveys which to determine a willingness to pay for the hypothetical avoidance of some undesirable impact to such areas.

estimate since expenditures are readily estimable and the wider economic impacts can be assessed using economic impact multipliers. Results from economic impact analysis, such as the numbers of jobs created from storm water management strategies reflect the impact on the overall economy and can be estimated at the local, regional and even national levels.

2.2 What are the Key Economic Benefits of Storm water Management?

A growing number of researchers have evaluated the economic benefits and impacts of storm water BMPs in addition to cost savings (See: EPA, 2013; WERF, 2014; and CNT, 2010). Some of the most commonly cited benefits stem from the functional ability of BMPs to reduce the risk of flood damage, costs of public infrastructure, and pollution and water treatment costs. EPA (2013) research on case studies of economic benefits of low impact development and green infrastructure revealed that a number of benefits can be characterized along the triple bottom line (Table 2).

Table 2: Examples of Potential Benefits from Green Infrastructure

Environmental benefits	Financial benefits	Societal benefits
Improved water quality	Reduced construction costs relative to grey infrastructure	Improved aesthetics
Improved air quality from trees	Reduced scale of grey infrastructure design	More urban greenways
Improved ground water recharge	–	Increase in public awareness of storm water management
Energy savings from reduced air conditioning	–	Reduced flash flooding
Reduced greenhouse gas emissions	–	Green jobs
Reduced urban heat stress	–	Increase in economic development from improved aesthetics
Reduced sewer overflow		

Source: EPA (2013)

Estimating benefits however can be challenging because of a lack of data on the physical changes and value of such changes. Data gaps can arise for either or both existing site conditions (prior to project implementation) or predicted changes in conditions (after implementation). In all cases, data must be collected at a specific site and project to develop credible benefit estimates. Where data gaps exist, analytical decisions can be made with respect to evaluating some types of benefits in qualitative terms (such as multi-objective decision analyses) or by quantifying uncertainty (using Monte Carlo simulation).

Several categories of benefits have been identified and described in published literature on storm water management benefits. This section reports on results from a literature review that focused on defining benefit categories and describing the conditions when it can arise. More detail on values and calculation methods are discussed in the Appendix 1. To facilitate the understanding of benefits, several groups of benefit categories are defined including: runoff retention/ detention, energy cost savings, air quality improvements, ecosystem services, and community livability. The categories of benefits in each of these groups are described below.

2.2.1 Runoff Retention / Detention Benefits

Several types of green infrastructure (e.g. green roofs, bio-retention, permeable pavement, rain barrels, etc.) are designed to detain, retain and/or infiltrate rain where it falls. Corresponding reductions in storm water runoff lower the total and peak volumes in the storm water system. Benefits of runoff retention / detention include a reduction in downstream flood risk to properties, and reduced irrigation costs for property owners, that is, if the retention systems can supplement irrigation needs. Another potential benefit includes any reduction in erosion in streams and corresponding habitat impacts, but this are rarely evaluated due to data limitations. The effectiveness of green infrastructure in reducing runoff and generating benefits is determined by several factors including local precipitation characteristics, design capacity and maintenance practices over its functional lifespan.

Flood Risk Reduction: Reduced runoff can reduce the frequency and severity of flooding in neighborhoods that are particularly susceptible to it. The effectiveness of green infrastructure on flooding depends on the design capacity and rainfall conditions, scale of implementation across a watershed, soil characteristics (for systems that facilitate infiltration), and watershed characteristics.[7] In addition, if the storm sewers are connected to combined sewer systems, the reduced volume can generate operational cost savings at the wastewater treatment plant.[8] The value of flood control is estimated as a reduction in property damage if flooding occurs.

Irrigation Cost Savings: On-site water retention in rain barrels or other similar systems can supplement irrigation needs in yards and gardens. Available captured water can generate an added benefit of reducing potable demand for irrigation and associated costs for owners. Key drivers of the life cycle cost savings for these systems include local rainfall characteristics (e.g. frequency and depth), storage capacity and water rates. The extent to which these systems can generate irrigation cost savings above installation costs (maintenance costs are often low), depends on the demand for irrigation and ability to meet this demand with stored water. For property owners, supplemental irrigation directly reduces the volumes demanded from public sources and its costs. From a utility and public perspective, reductions in water volumes demanded translate into lower levels of energy consumed for water treatment, which in turn reduces air contamination and greenhouse gas emissions (these benefits are discussed in Section 2.2.3).

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[7] Kane County, IL and Lenexa, KS evaluated flood control benefits of future land development scenarios (EPA, 2013). However, because these benefits are site-specific, the results cannot be generalized to other sites.

[8] Wastewater treatment operational cost savings, in the context of combined sewer systems, include reductions in: (a) treatment costs; (b) air pollution emissions; and (c) greenhouse gas emissions (CNT, 2010).

2.2.2 Energy Cost Savings Benefits

Several aspects of green infrastructure can lower energy use and generate cost savings. For instance, green roofs and trees can change the gain or loss of energy in buildings, and in turn decrease costs for heating or cooling (NRDC, 2013).[9] These benefits are influenced by several site and design factors and accrue directly to property owners.

Energy Cost Savings: Site-specific research has shown that the shade that trees provide adjacent buildings and the additional insulation of green roofs on buildings can lower the heating and cooling energy costs in buildings. Of course, the effectiveness of these BMPs in lowering energy use depends on many factors including the BMP design, type of plant material, building characteristics, and climate conditions (CNT, 2010). In addition, for trees, the benefits would not be realized for several years until they have reached a height and width that provides noticeable shading. In another example, green roofs and other storage systems have been installed at water utilities and have provided a supplemental water source that has reduced energy and operational costs for pumping (EPA, 2013).[10] These costs savings would constitute a benefit directly for the utility, and by extension to its rate-payers.

2.2.3 Emissions Reduction Benefits

Generation of electricity is reduced when green infrastructure (e.g. green roofs or trees) reduces energy demand in buildings, or when water harvesting reduces energy demand at treatment plants. Reductions in electricity demand means that some amount of burning fossil fuels is avoided. As a result, there would be a reduction in the harmful emissions of criteria air contaminants (e.g. NOx, SOx, PM, etc.) and greenhouse gas emissions. The U.S. electrical grid enables energy to flow from a large interconnected network and makes it nearly impossible to link a specific source of generation with a particular use. Still, it is possible to generalize over the types of energy consumed in a State and to use this information to characterize how a reduction in energy consumption leads to a reduction in pollution. The benefit of emissions reduction is then estimated using established economic valuation standards.

[9] These cost savings are additive to air pollution emissions savings from avoided energy generation (EPA, 2013).

[10] The L.A. County Department of Public Works in its Sun Valley Watershed Management Plan accounted for decreased energy demand for pumping water because the harvested and infiltrated water provide supplemental supplies. (EPA, 2013)

Air Pollution Emission Reduction: The total amount of reduction in criteria air contaminant emissions from a power plant is directly tied to the reduction in energy use in a specific location. Energy savings are readily converted to its emission rate reductions by utilizing data from EPA and other public sources. The economic value of lower air pollutants is inferred from its impact on human health and lower medical costs. The reduction of each type of criteria air contaminant has a different economic benefit value per ton. Evidence of the conversion of a reduction in emissions to economic benefits relies on published economic research and from Federal regulatory rule-making, in which values are ultimately approved by the US Office of Management and Budget.[11]

Greenhouse Gas Emission Reduction: Similar to criteria air contaminants, greenhouse gas emissions from energy generation also cause economic damages. The tons of greenhouse gas emissions are computed from the same data sources as criteria air contaminants. The value of lower greenhouse gas emissions is linked to a reduction in in long-term damage to the global economy. While the Federal government provides guidelines on the value per ton of greenhouse gas emission reduction, other agencies have used different values. For example, the Portland Bureau of monetized this reduction in carbon emissions due to cooling and heat savings in buildings with Ecoroofs (EPA, 2013).

2.2.4 Ecosystem Service Benefits

Green infrastructure such as green roofs, bio-swales and trees can also provide a number of additional environmental and ecosystem services. These include entrainment of air particulates, carbon sequestration and habitat creation. Each of these benefit categories is directly related to the plant material that is installed as part of the green infrastructure system. Accrual of benefits depends on a variety of design and site conditions though research is available to quantify some of the physical performance measures of green infrastructure. Estimation of economic benefits at a new site would in most cases require new research at that site since limited information has been broadly developed.

Air Particle Entrainment: Some green infrastructure systems have the ability to uptake pollutants directly from the environment, which reduces adverse human health impacts. The criteria air contaminant pollutants that can be entrained include nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter classifies as PM10.[12] Key drivers of these benefits include the amount (in square

[11] Many economic values originally come from regulatory rule-making in which an economic analysis is reviewed and ultimately accepted by the Office of Management and Budget before the rule becomes a law.

[12] The Charlotte-Mecklenburg Storm Water Services, serving an area of 526 square miles, included these entrainment benefits when analyzing their reforestation in their LID/GI approach, as it is relatively inexpensive but offers large benefits in terms of air quality and storm water management, the county has simply committed to making reforestation a priority (EPA, 2103)

footage, or number of trees) of green infrastructure, as well as the current levels of criteria pollutants, and size of the local population, especially those whose health is more vulnerable to environmental conditions. The quantified amount of pollutants entrained can be monetized using the same economic values per ton that are applied in the air pollution emission reduction calculations.

Carbon Sequestration: Carbon sequestration is the process of storing carbon in biomass and soils as atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis. The amount that can be sequestered is dependent on the above ground biomass of the tree, green roof or bio-swale. Sequestration benefits only last as long as the plants or trees are alive and that they vary with the age of the vegetation. Carbon sequestration rates depend on the type of species and location where it is grown (Pepper, 2012). Carbon sequestration in green roofs can have high variability due to roof age and substrate depth.[13] Other factors that affect carbon sequestration in green roofs are geographic region, plant species and roof management or maintenance (Getter, K. L. et al., 2009; Wise, S. et al., 2010; City of Portland BES, 2010; CNT, 2010). In addition, healthy and large trees can store about 1000 times more carbon than smaller trees and if those trees have a long lifespan they also tend to be the biggest contributor to carbon removal (Nowak, D. J. & Crane, D. E., 2001; Escobedo, et. al. 2012; McPherson, E. G. et al., 2007; CNT, 2010). The value of carbon sequestration is estimated with the same benefit parameters as with greenhouse gas emissions.

Habitat Related Benefits: Green roofs, rain gardens and other vegetated infiltration systems can improve the habitat for flora and fauna, such as bird and insect species. These different types of habitats are usually small in size and have limited impacts. But, it is conceivable that greater benefits may arise from large-scale strategies that are connected to habitat corridors. Limited research is available to directly assess the economic value of habitat creation. As a first step, a biological survey would be required to assess current conditions and to evaluate potential changes in flora and fauna habitat and other ecosystem services. Valuation of these changes though would remain difficult because of a lack of economic research on the benefits of small scale habitats. Potential proxy values may be drawn from wetland valuation research for some types of green infrastructure, but developing accurate estimates would be highly uncertain. Still, in some studies such as the benefit cost analysis in Ann Arbor, the value of habitat creation is estimated (ECONorthwest, 2011).

[13] One study indicated that three roofs with similar substrate depth had increased carbon with age of the roof and vegetation. Data from another study showed green roofs stored, on average, between 60 to 240 grams of carbon per square meter in the aboveground plant and between 30 and 185 g C·m-2 in belowground biomass.

2.2.5 Community Livability Benefits

A series of quantifiable and qualitative benefits also enhance the quality of life across a community. Emerging research on these benefits stems in part from the ways in which *social capital* forms and grows in a community. For example, the Portland Bureau of Environmental Services writes "social capital is the benefits that individuals and communities derive from having social contacts and networks throughout their communities and is based on the notion that individuals who interact with each other will support each other to the benefit of the entire community" (Portland BES, 2010). Green infrastructure, and especially ones that encourage use of the outdoors, can help induce interactions and connections across the community. This includes the personal value of health and recreation, as well as an improvement in the level of investment in business district.

Reduced Health Effects - Heat Island Related Impacts: The term "heat island" describes a landscape characteristic in which cities tend to be hotter than nearby rural areas.[14] These hotter temperatures come from the radiant heat off of impervious surfaces and buildings, and a lack of plant material to produce evapotranspiration that cools the air (EPA, 2008; Grimmond, C. et al., 2010; Wise, S. et al., 2010; Burden, D., 2006; City of Portland Bureau of Environmental Services, 2010; Grimmond, C. et al., 2010; and Stratus Consulting Inc., 2009). Across a city, higher temperatures can lead to adverse health effects on people (e.g. respiratory difficulties, exhaustion, heat stroke and heat-related mortality), particularly older and more vulnerable populations.[15] Green infrastructure can reduce temperatures and lead to lower health effects if implemented widely across a city. Urban trees, for example, emit low volatile organic compounds (VOC), and reduce air temperatures through transpiration. Research has shown that trees can reduce local temperatures up to 8.7°F compared to impervious surfaces. In Chicago, a study showed substantial differences in roof surface temperatures between green and conventional coverings. The effect of green infrastructure on mitigating heat island effects depends on wide scale implementation (Stratus, 2009). Data on the demographics of an area also influence related benefits because certain age cohorts are more susceptible to heat related illnesses than others.

Aesthetic Improvements: Some strategies improve the overall visual appearance of a community simply by having planted material among impervious surfaces. In addition, some BMPs strategies aim to directly reduce litter or debris from public spaces to make it more visually appealing. These aesthetic improvements are difficult to estimate directly but can be observed in differences in the prices on properties which are in the vicinity of aesthetically attractive areas. To estimate benefits of these improvements, property value studies are conducted to isolate

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[14] http://www.epa.gov/heatisland/index.htm

[15] The heat island mitigation to lowering emission levels of air pollutants and greenhouse gases through the reduced energy demand (via greater air conditioning needs) and lower demand for outdoor irrigation needs. These effects, if they can be quantified, are discussed above.

only a small portion of price differences that relate to being near the green infrastructure installation. A number of researchers have evaluated such property value differences and used them in BCAs. For example, the Alachua County Environmental Protection Department and Public Works Department (in Florida) examined the changed in property values due to the county's green infrastructure programs and found that the increase in land values for properties adjacent to some measures (EPA, 2103). The application of findings from one site to another is not always straightforward and depends on site specific conditions.

Recreational Benefits: In addition to providing a pleasant visual experience, certain green infrastructure can provide recreational benefits as well. Philadelphia estimated the number of persons who would use (i.e. walk or bike on) a vegetated acre, as part of their triple bottom line analysis of the Combined Sewer Overflow Long Term Control Plan Update (PWD, 2009). The residents of Alachua County in Florida noted that recreational benefits that stem from green infrastructure were a top priority for the impacts of development. Their concerns for these issues have driven the county's pursuit of GI programs (EPA, 2013). For the Blackberry Creek Watershed Alternative Study, open spaces and natural greenways to preserve and connect significant natural features for valued for aesthetic, recreational, and/or alternative transportation uses (EPA, 2013). Valuation of recreational features stems from economic research on the time and money spent to reach a recreational area.

Noise Reduction: Some green infrastructure systems, such as wetlands or trees, are effective in reducing ambient noise because they can absorb it. CNT (2010) discusses the noise-reducing properties of GI for porous concrete and green roofs, but does not provide a methodology for quantifying these benefits. A case study in Lancaster County, PA notes that positive effects of green infrastructure can arise from noise pollution reduction (EPA, 2014).

Crime Reduction: Researchers from the University of Illinois asked the question "Does Vegetation Reduce Crime?" and came to the conclusion that the greener a buildings surroundings were, the fewer crimes reported (Kuo and Sullivan, 2001). This study examined crime activity levels around apartment buildings in Chicago, and measured differences in the amount of trees and grass cover between sites. Vegetation may deter crime both by increasing informal surveillance and by mitigating some of the psychological precursors to violence. While these are just theories and have not been comprehensively examined, what this research shows is that vegetation does not necessarily facilitate crime by providing cover – a long-held belief among some planners. Instead, a green environment encourages outdoor use, and as such, provides a deterrent because more people are in places where crimes can be committed. The benefits of crime reduction would be derived through data per crime on the avoided costs for the judicial system.

Public Education/Environmental Stewardship. Promoting strategies that seek to change people's behaviors and make them more aware of their environmental impacts helps to cultivate a stewardship perspective in the community about its local natural resources. CNT (2010) notes that community tree planting provides a valuable educational opportunity for residents since in this process they become more aware of the benefits of green infrastructure. Research on urban tree planting has shown that such environmental initiatives make environmentally sound behaviors more likely to occur in the future. Other strategies involving public education and advertising has appeared to be less effective in changing attitudes (Kuo and Sullivan, 2001; and Summitt and Sommer, 1997). The economic valuation of such changes though has not been sufficiently studied for it to be included in a BCA. In this case, only a qualitative assessment of changes in stewardship could be included in a decision framework.

Business Development: Green infrastructure, especially on the scale of a comprehensive green street design can lead to an enhanced sense of place, and increase in foot and bicycle traffic can support retail development. The NRDC found that consumers are willing to spend more on products, visit more frequently, or travel farther to shop in areas with attractive landscaping, good tree cover, or green streets (NRDC, 2013). Case studies by the New York City DOT examined before and after changes in Retail Sales Tax Filings, Commercial Leases & Rents, and City−Assessed Market Value. While the study's methodology does not ultimately prove causality between the street improvement projects and any resulting economic changes, some locations of green street development saw a significant increase in retail sales compared to the changes in retail sales for the borough as a whole.

Job Creation and Economic Impacts: Spending on capital investments and operations and maintenance (O&M) leads to job creation. Moreover, since installation and maintenance of most of these systems requires unskilled labor, the economic benefits of job creation often goes directly to those who may be in most need of work. The total economic impact of capital and O&M expenditures is measured in terms of the number of jobs created, change in income, gross regional product, and sales and property tax revenue. In addition, wider impacts across the region can also be estimated by applying appropriate economic *multipliers*. As an example, PWD (2009) focused on the fact that many of these jobs are for unskilled labor, which provides a valuable social benefit in an urban setting.

2.3 What Evidence Of Benefits Have Been Found Elsewhere?

Economic benefits of storm water management depend on site conditions and characteristics of the green infrastructure systems and program. While CNT (2010) establishes a number of methods for computing benefits, for each set of calculations it is necessary to collect (or establish assumptions) site specific data about BMPs performance and establish analytical standards for the suitability of economic valuation parameters. Despite these constraints and uncertainties, some agencies have pushed forward in collecting data and using these methods. The most recent review of economic evaluations of green infrastructure is found in EPA (2013). This document has developed a fairly comprehensive assessment of the efforts by some utilities to evaluate economic benefits of storm water management. Table 3 presents an excerpt from the EPA (2013) report and indicates that some of case studies performed BCAs, as opposed to other analytical approaches such as cost-effectiveness.

Table 3: Excerpt of EPA Case Studies on Economic Evaluation of Storm water Management BMPs

Entity	LID/GI program description	Type of analysis	Outcome of analysis
Lenexa Public Works Department, KS	Adoption of LID/GI-oriented development standards, BMPs, and systems development fees as part of the Rain to Recreation program.	Capital cost assessment	Savings of tens to hundreds of thousands of dollars in site work and infrastructure costs with GI BMPs.
Charlotte-Mecklenburg Storm Water Services, NC	Restoration of streams damaged by runoff from development, and BMPs to reduce impacts of rapid development, were assessed to determine impacts on drinking water quality.	Cost-effectiveness	Analysis showed that stream restoration is the most cost-effective way to immediately control sediment in this area.
Capitol Region Watershed District (CRWD), MN	Eighteen BMPs in a 298-acre watershed designed to reduce localized flooding and storm water runoff, improve water quality, enhance recreation in local park.	•Capital cost assessment •Cost-effectiveness	Initial capital cost assessment found substantial cost savings with GI compared with grey infrastructure.
New York City Mayor's Office of Long-term Planning and Sustainability, NY	Distributed GI controls to reduce storm water runoff and CSOs, improve water quality, and increase public access to tributaries, compared to conventional CSO controls such as tunnels and basin storage.	Cost-effectiveness	Cost savings with GI compared to grey infrastructure
Seattle Public Utilities (SPU), WA	Natural drainage system (NDS) projects on residential streets; LID/GI-based storm water regulations and Residential Rainwise Program to encourage customers to reduce the volume of storm water sent to the public system.	Cost-effectiveness	By integrating LID/GI into asset management process, SPU can minimize life-cycle costs to meet established levels of service and balance the risks to minimize life-cycle costs.
West Union, IA	Pilot community for Iowa Sustainable Green Streets Initiative to replace aging infrastructure and reduce localized flooding in downtown area.	•Life-cycle cost analysis •Benefit valuation (avoided costs)	Lower maintenance and repair costs for deicing permeable pavement result in projected savings over the life-span of the pavement.
Kirkland Public Works Department, WA	Integration of LID/GI into conceptual design phase of all capital improvement projects within public rights-of-way.	Quantitative ranking of costs, benefits	LID/GI options for CIP projects are investigated as early in the planning phase as possible.
Kane County, IL	Adoption of county storm water ordinance and corresponding LID/GI-based BMPs, including development approaches that preserve natural areas and use naturalized drainage/retention/detention (i.e., conservation-based development).	Fiscal impact analysis	Study found that conservation development alternative incurs a lower public cost than the conventional alternative.

Table 3: Excerpt of EPA Case Studies on Economic Evaluation of Storm water Management BMPs (Continued)

Entity	LID/GI program description	Type of analysis	Outcome of analysis
Milwaukee Metropolitan Sewerage District (MMSD), WI	Integration of distributed LID/GI strategies into overall planning efforts including facilities plans and CSO control plan; projects on both public and private lands.	•Cost effectiveness •Benefit valuation	Results will be used to help select which projects to implement in the future, and to show where the use of GI is a valid and effective approach
Alachua County Environmental Protection and Public Works Departments, FL	County acquires and preserves open-space lands through ACF program to reduce development impacts and improve water quality.	Benefit-cost analysis (BCA)	Proximity to open space adds to parcel value, for an increase in property tax revenue of several million dollars per year.
Portland Bureau of Environmental Services (BES), OR	Ecoroof Program includes incentives for green roofs on privately owned buildings and green roof requirements for new city-owned buildings.	BCA analysis	Ecoroofs generate significant public and environmental benefits, as well as benefits to developers and building owners (due to extended life of ecoroofs compared to traditional roofs).
Sun Valley Watershed, LACDPW, CA	Goal of watershed-based project was to alleviate localized flooding while providing multiple benefits. Fifteen project elements with LID/GI components.	BCA analysis	Demonstrated potential for multi-objective storm water strategies to provide greater community value than a single-objective flood control strategy would provide.
PWD, PA	Green City Clean Waters Program aims to reduce CSOs and improve water quality in part through distributed GI controls and comprehensive stream restoration program.	BCA analysis	LID/GI-based approaches provide important environmental and social benefits that are generally not provided by grey infrastructure.

A summary of several case studies is presented below. These studies integrated local data with some aspects of the CNT (2010) framework to estimate quantifiable benefits.

Economic Benefits of Green Infrastructure in Milwaukee, WI and Ann Arbor, MI: ECONorthwest (2011), evaluated benefit analyses of storm water management efforts in Milwaukee, WI and Ann Arbor, MI. In *Milwaukee,* the Department of Public Works - Infrastructure Division, manages infrastructure consisting of about 300 miles of sewer pipes, 3,000 miles of municipal pipes, and 3,000 miles of private laterals. A primary focus is to reduce the quantity of total suspended solids entering its waterways by 40 percent by 2013, as required by the Wisconsin Department of Natural Resources (City of Milwaukee, 2011). The Systems Planning Unit in Ann Arbor has a much smaller management responsibility and consists of just 359 miles of underground pipes and over 11,000 inlets and catch basins to manage storm water (City of Ann Arbor, 2011). In both communities, monetizable, quantifiable and qualitative benefits are evaluated (see Table 4) using the methodology established by CNT (2010). Where appropriate and possible, local data was integrated into calculations to estimate benefits. A number of additional assumptions are made to illustrate the scale of benefits that could arise from a much larger future program.

Table 4: Benefits Evaluated in Great Lakes Study

Quantified and Monetized	Quantified, but not Monetized	Qualitative
Avoided costs of reduced storm water runoff and water quality	Flood Reduction	Public Education
Avoided costs related to water quality benefits	Heat Island Effect	
Avoided costs of additional future gray infrastructure capacity	Aesthetics	
Avoided costs of treatment operations and maintenance for combined sewer flows	Improved health and well-being from recreation	
Energy Cost Savings Benefits	Improving well-being by reducing noise pollution	
Decreased air pollution emissions from reduced energy use		
Improved air quality from vegetation on green roofs and trees		
Reduced CO2 equivalent emissions from reduced energy use		
Increased carbon sequestration from trees and green roofs		
Wetland habitat protection		

Economic Benefits of Green Infrastructure in Lancaster, PA: With a population of 60,000, the city has a combined sewer system (CSS) and needed to address burden on the treatment facility when intense precipitation events occurred. The EPA notes that combined sewer overflows (CSOs) discharge approximately 750 million gallons of untreated wastewater and storm water into the Conestoga River (EPA, 2014). To address this issue, Lancaster County published a Green Infrastructure plan which estimated water quality benefits, but not the additional environmental, social, and economic benefits. The EPA published this case study to highlight and bring awareness to quantify and highlight these benefits. The specific benefits they monetized were energy, air quality, and climate-related benefits. They also estimated the avoided capital costs of gray infrastructure, and the avoided wastewater pumping and treatment costs. The methodology used in quantifying and monetizing the benefits followed CNT (2010). They also made several high-level assumptions with regard to long-term reduction, the future distribution of green infrastructure projects, and when the monetary benefits would begin accruing.

Philadelphia Combined Sewer Overflow Long Term Control Plan Update: The purpose of the City's report was to demonstrate the full range of societal benefits of the Green City Clean Waters Program. The program aims to reduce CSOs and improve water quality in part through distributed GI controls and comprehensive stream restoration program. The analysis helped PWD to determine that a GI-based approach, coupled with targeted grey infrastructure, is their preferred approach for city to follow. A table of the monetized benefits over 40 years is presented below. It is assumed that these benefits arise from a 50% level of LID coverage throughout the city.

Table 5: City-wide present value benefits of key CSO options: Cumulative through 2049 (2009 Dollars)

Benefit categories	Value
Increased recreational opportunities	$524.50
Improved aesthetics/property value (50%)	$574.70
Reduction in heat stress mortality	$1,057.60
Water quality/aquatic habitat enhancement	$336.40
Wetland services	$1.60
Social costs avoided by green collar jobs	$124.90
Air quality improvements from trees	$131.00
Energy savings/usage	$33.70
Reduced (increased) damage from SO2 and NOx emissions	$46.30
Reduced (increased) damage from CO2 emissions	$21.20
Disruption costs from construction and maintenance	($5.60)
Total	$2,846.40

Alachua County Environmental Protection and Public Works Departments, FL: The county developed a comprehensive low impact development (LID) / green infrastructure (GI) program based on three different components: (1) LID/GI-based land development policies and regulations developed through the county's Comprehensive Plan; (2) Alachua County Forever (ACF), a conservation and land acquisition program; and (3) a unique governance structure designed to increase interdepartmental collaboration to promote the adoption of LID/GI program elements. To demonstrate the benefits of ACF and alleviate public concerns that the program reduces property tax revenue, the county calculated the benefits for the increase in property values from increased open space. This measure was used to compare with any lost tax revenue to acquire, protect, and manage environmentally significant lands in order to protect water resources, wildlife habitat, and natural areas suitable for resource-based recreation. Twelve thousand seven hundred parcels in the county are close enough to open space to show an increase in value due to their proximity to water. The total impact on their value is just under $150 million, which would result in additional property tax revenues of approximately $3.5 million per year.

Portland Bureau of Environmental Services, OR. The Portland BES performed an analysis of ecoroofs versus conventional roofs to gain support and increase implementation of ecoroofs in the city. Portland receives an average of 37 inches of precipitation per year, which creates an annual volume of storm water runoff of about 10 billion gallons. As part of its storm water management programs, BES has implemented the Sustainable Storm water Management Program, which focuses on green infrastructure initiatives, including the Ecoroof Program.

Table 6: Value of Benefits from 40,000 SQFT Ecoroof (2008 Dollars)

Benefit categories	Total Over 40 Years
Cooling demand reduction	$19,983
Heating demand reduction	$23,509
Carbon reduction	$845
Improved air quality	$104,576
Habitat creation	$25,300
Total	$174,213

Sun Valley Watershed, Los Angeles, California: The Sun Valley watershed is in the San Fernando Valley, about 14 miles northwest of downtown Los Angeles. It encompasses the communities of Sun Valley and North Hollywood. The watershed is approximately 4.4 square miles and six miles in length from north to south.

The economic analysis was undertaken because the county and other stakeholders needed to show that although the costs of the LID/GI-oriented solutions would be much greater than the cost of traditional infrastructure, and they would yield significantly higher benefits. The results of the analysis were used to help to gain public support, bring in outside partners, and raise funds. The tables below show the descriptions of each alternative the value of alternatives compared to a grey infrastructure scenario.

Table 7: Description of Alternatives for Sun Valley Watershed

	1 - Infiltration	2 - Water Conservation	3 - Storm water Reuse	4 - Urban Storm Protection
Description	Widely Distributed Small Projects	Maximizes Wildlife Habitat	Maximizes Storm water Reuse for Industry	Full Conveyance with Regional BMPs
Retention Basin Size	50-Year	50-Year: Subareas 1-6 10-Year: Subareas 7-8	50-Year	10-Year

Table 8: Values by benefit over 50 years (2002 Dollars)

Benefit	Grey Infrastructure	1	2	3	4
County Flood Control					
Regional damage avoidance	$64.46	$64.46	$64.46	$64.46	$64.46
Change in downstream flooding	-$1.03	$5.37	$3.65	$5.37	$3.22
City Flood Control	$10.01	$10.01	$10.01	$10.01	$10.01
Avoided cost of imported water	$0.00	$22.35	$17.89	$24.07	$22.65
Energy Reduction	$0.00	$4.30	$1.70	$4.30	$1.70
Air Quality	$0.00	$20.50	$8.10	$20.50	$8.10
Greenwaste	$0.00	$20.00	$10.00	$20.00	$10.00
Ecosystem Restoration	$0.00	$1.86	$4.04	$4.58	$4.48
Recreation	$0.00	$23.34	$23.34	$23.34	$23.34
Property Values	$0.00	$10.20	$3.90	$10.20	$3.90
Total Benefits	**$73.44**	**$270.47**	**$295.39**	**$274.93**	**$239.95**

3 Summary of Water Quality Improvement Strategies

3.1 Program Background

The Division has been working for several years with other jurisdictions and community groups to establish Water Quality Improvement Plans (WQIPs) for each of its watersheds. WQIPs draw from the processes in developing Watershed Asset Management Plans (WAMPs) and Comprehensive Load Reduction Plans (CLRPs) which aim to protect, preserve, enhance, and restore water quality in receiving waters. WAMPs provide an understanding of critical assets owned by the Division and the management and investment strategies necessary to deliver required services. CLRPs are efforts to identify BMPs and funding levels needed to comply with TMDL and other storm water regulations established by the Regional Water Quality Control Board. These efforts, as described below, have identified a series of projects and initiatives that have been defined as either structural or nonstructural initiatives.

3.2 Structural WQIP Strategies

3.2.1 Types of Strategies

Structural BMPs are physical infrastructures that are designed for site-specific conditions and placed strategically across a watershed to improve water quality. The effectiveness and feasibility of implementing any of these BMPs varies depending on the design and site conditions. For example, the effectiveness of a BMP in enhanced infiltration capacity of a watershed depends on amenable soil types. Other site-specific considerations include the physical land area available for effective implementation and maintenance. Also, the capital and maintenance costs of a BMP influence its feasibility for the Division, especially in comparison to other BMPs which can be implemented more cost-effectively.

Various types of structural strategies have been identified as potentially suitable for San Diego watersheds and have been classified as one of three types: (1) green infrastructure, (2) multiuse treatment areas, and (3) water quality improvement BMPs.[16] Each of these types of structural BMPs is discussed below.

Green Infrastructure

Green infrastructure covers a range of BMPs that are designed to be integrated in a broader site plan to maintain healthy waters, provide multiple environmental benefits, and support sustainable communities. Green infrastructure is distinguished from other methods by making deliberate and effective use of vegetation and soil to manage storm water (USEPA, 2014). Table 9 presents a series of green infrastructure BMPs that can be integrated into site designs and implemented at the site scale (on-site treatment) or street right-of-way scale (green streets).

[16] San Dieguito Potential Strategies Final Draft 4/11/14

Table 9: List of Structural BMPs – Green Infrastructure

BMP*	BMP Description
Bioretention	Shallow vegetated features constructed in green spaces alongside roads, sidewalks, and other paved surfaces. Bioretention includes an engineered soil media designed to encourage pollutant treatment and water storage.
Infiltration Trenches	Narrow, linear BMPs that have similar functions as bioretention areas with variable surface materials, including rock or decorative stone, designed to allow storm water to infiltrate into subsurface soils.
Bioswales	Shallow, open channels designed to reduce runoff volume through infiltration and pollutant removal by filtering water through vegetation within the channel and infiltration into bioretention soil media. Bioswales can serve as storm water conveyance, but the primary objective is water quality enhancement (often referred to as linear bioretention).
Planter Box	Fully contained system containing soil media and vegetation that functions similarly to a small biofiltration BMP, but includes an impermeable liner and underdrain.
Constructed Wetland	Engineered, shallow marsh systems designed to control and treat storm water runoff. Particle-bound pollutants are removed through settling and other pollutants are removed through biogeochemical activity.
Permeable Pavement	Allows streets, parking lots, sidewalks, and other impervious covers to retain their natural infiltration capacity while maintaining the structural and functional features of the materials they replace. Roads such as highways can include PFC overlays which provide water quality benefits when traditional permeable pavement is not suitable.
Sand Filters	Treatment systems that removes particulates and solids from storm water runoff by facilitating physical filtration.
Vegetated Swales	Shallow, open channels that are designed primarily for storm water conveyance. Pollutants such as trash and debris are removed by physically straining/filtering water through vegetation in the channel.
Vegetated Filter Strips	Bands of dense, permanent vegetation with a uniform slope, designed to provide pretreatment of runoff generated from impervious areas before flowing into another BMP as part of a treatment train.
Green Roofs	Roofing systems that layer a soil/vegetative cover over a waterproofing membrane and can reduce runoff through interception and evapotranspiration.

*Source: San Dieguito River WMA Water Quality Improvement Plan (2014)

Table 10 outlines the expected levels of effectiveness in green infrastructure in handling different types of impacts of storm water, including water chemistry and physical and biological impacts. This chart is adapted from the San Dieguito River WMA Water Quality Improvement Plan (2014) provides an initial indication of the kinds of benefits (beyond water quality improvements) that can be achieved by green infrastructure BMPs. In particular, while trash removal is a water chemistry benefit, its removal from streets can lead to more aesthetically pleasing neighborhoods, which in turn can foster economic value. In addition, depending on the extent to which these BMPs improve physical and biological factors, there can be follow-on improvements in recreational value and ecosystem value of streams and riparian areas. It is noted here that only constructed wetlands have the potential to generate tangible improvements in habitat or wildlife.

Table 10: Green Infrastructure BMPs and Pollutant Reduction BMP

	Water Chemistry Benefit									Physical and Biological Benefits			
	Bacteria[1]	Metals	Organics	Sediment	Pesticides	Nutrients	Oil and grease	Dissolved minerals	Trash	Flow rate	Volume reduction	Habitat or Wildlife	Aquatic Life
Bioretention	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Infiltration Trenches	●	●	●	●	●	●	●	●	●	●	●	○	●
Bioswales	●	●	●	●	●	◗	●	◗	●	●	●	○	◗
Planter Boxes	●	●	●	●	●	◗	●	◗	●	◗	◗	○	◗
Permeable Pavement	◗	●	◗	●	●	◗	◗	◗	◗	●	●	○	◗
Constructed Wetlands	●	●	◗	●	●	●	◗	◗	●	●	◗	●	◗
Sand Filters	●	●	●	●	●	◗	●	○	●	◗	◗	○	◗
Vegetated Swales	◗	◗	◗	●	◗	◗	◗	○	●	◗	◗	○	◗
Vegetated Filter Strips	◗	◗	◗	●	◗	◗	◗	○	●	◗	◗	○	◗
Green Roofs	◗	◗	○	●	○	○	○	○	○	●	◗	○	◗

Key: ● - Primary pollutant reduction; ◗ - Secondary pollutant reduction; ○ - Minimal or no pollutant reduction.

Multiuse Treatment Areas

San Dieguito River WMA WQIP (2014) identifies large-scale treatment areas such as multiuse basins and stream, channel, and habitat rehabilitation projects. These systems are designed as regional facilities that can receive flows from neighborhoods or larger areas and become cost-effective solutions that provide multiple benefits. For example, such systems can be integrated in public spaces such as active (soccer fields) and passive (parks) recreation areas and provide benefits in flood control, ground water recharge, restoration, habitat enhancement, and recreation. In addition streambank projects that reduce erosion can improve water quality and simultaneously improve habitat. Table 11 defines the list of measures considered in San Dieguito River WMA WQIP (2014).

Table 11: List of Structural BMPs – Multiuse Treatment Areas

BMP*	BMP Description
Infiltration and Detention Basins	Large multiuse surface BMPs (on public parcels) that provide treatment through the runoff detention and infiltration (e.g. infiltration basins and dry extended detention basins). These BMPs are designed to hold runoff for an extended period of time to allow water to evaporate into the atmosphere, infiltrate into native soils, or be transpired by vegetation, while accommodating for overflow and bypass during large storm events.
Stream, Channel, and Habitat Rehabilitation Projects	Stream, channel, and habitat restoration or enhancement projects can help sustain habitat for wildlife and provide water quality benefits downstream of these activities.
Other Opportunities	Construction of multiuse treatment areas BMPs on private land to achieve the load reductions. These BMPs are the cost effective and considered a low priority.

Water Quality Improvement BMPs

Additional structural BMPs include systems that supplement the design performance of existing infrastructure. For example, systems that segregate trash includes inlet devices, such as trash guards or racks that capture debris before they enter surface waters. Another example are proprietary commercial products that often aim to use settling, filtration, absorptive/adsorptive materials, vortex separation, and sometimes vegetative components to remove pollutants from runoff. Finally, dry weather flow separation and treatment projects target non-storm water dry season flows and divert these flows for treatment either on-site or to sanitary sewer systems and ultimately waste water treatment plants.

3.2.2 Measuring Impacts of Structural Strategies

The benefits of structural systems - both the type of benefit and the magnitude – depend on the system's design and surrounding site characteristics. Some strategies such as constructed wetlands can generate a range of benefits (which are partially indicated by Table 10) and may also include recreational and aesthetic values. Most of these benefits accrue to the general public who may have access or benefit from proximity to the wetland. Green roofs, on the other hand, create both public benefits in water retention as well as potential private benefits for property owners in terms of energy savings, from additional roof insulation.

The effectiveness of each structural system in generating benefits is determined directly from key physical features associated with its design. That is, each system benefit, whether it includes flood risk reduction, air quality improvement, or aesthetics, depends on a characteristic of the system that is measured in physical units. For example, flood risk reduction benefits depend fundamentally on the quantity of water retained by the BMP – that benefit's *unit of measure*.

The unit of measure of green streets (Figure 1) would certainly include the designs of various BMPs on the street such as bio-swales, permeable pavement and tree plantings. In aggregate however, a standard green street design would be measured by its length in miles. In addition, the features and length of the green street may also influence the value of properties on either side of it. Site specific characteristics associated with the type of neighborhood (e.g. mixed use, residential, commercial, etc.), population / employment density, socio-economic characteristics (e.g. income, household size), safety conditions and other factors could influence different types of benefits.

Figure 1: Illustration of Sample Structural BMP: Green Streets

Bioswales: can reduce runoff and downstream flood potential and create aesthetically appealing environment

Permeable Pavement: can reduce runoff and downstream flood potential

Tree Plantings: can reduce runoff and downstream flood potential, entrain harmful particulates, create aesthetically appealing environments, lower ambient temperatures

3.3 Nonstructural Strategies

3.3.1 Types of Strategies

The Division and its stakeholders have also identified nonstructural strategies that may achieve water quality improvements. Nonstructural strategies include “those actions and activities intended to reduce storm water pollution, which do not involve construction of a physical component or structure to filter and treat storm water.” These strategies include administrative policies, creation and enforcement of municipal ordinances, education and outreach programs, rebate and other incentive programs, and cooperation and collaboration with other watershed or regional partners. In general, many of these initiatives have been implemented by the Division for many years and are considered to be integral to regulatory compliance on a watershed-specific basis.

WQIP documents have organized Nonstructural Strategies into a number of categories (see Table 12). These categories include: Development Planning, Construction Management, Existing Development, Illicit Discharge, Detection, and Elimination (IDDE) Program, Public Education and Participation, Enforcement Response Plan, and Non-JRMP Strategies. Across the watersheds and jurisdictions, a long list of potential nonstructural strategies in each category has been developed – reflecting the differing site characteristics in different locations. A comprehensive list of specific strategies across all of the watersheds is included in Appendix 2.

Table 12: Nonstructural Strategies

Strategy Category	Strategy Description
Development Planning	Program uses Responsible Agencies' land use and planning authority to require implementation of best management practices (BMPs) to address effects from new development and redevelopment.
Construction Management	Program addresses pollutant generation from construction activities associated with new development or redevelopment.
Existing Development	Program addresses pollutant generation from existing development including commercial, industrial, municipal, and residential land uses. It includes stream, channel, and habitat restoration and retrofitting in areas of existing development.
Illicit Discharge, Detection, and Elimination (IDDE) Program	Program actively detects and eliminates illicit discharges and improper disposal of wastes into the MS4.
Public Education and Participation	Promotes and encourages the development of programs, management practices, and behaviors that reduce the discharge of pollutants in storm water to the maximum extent practicable (MEP), prevent controllable non-storm water discharges from entering the MS4, and protect water quality standards in receiving waters.
Enforcement Response Plan	Enforcement of each JRMP is required.
Non-JRMP Strategies	Strategies that are outside of the JRMPs, but are designed to effectively prohibit non-storm water discharges to the MS4, protect the beneficial uses of receiving waters from MS4 discharges, or achieve the interim and final numeric goals identified in the Water Quality Improvement Plan.

3.3.2 Measuring Impacts of Nonstructural Strategies

The economics perspective on nonstructural strategies is manifested in the change that they create, which in turn causes a change in value for the community. In particular, the impact of some nonstructural strategies that are directly related to structural systems, such as new design standards for BMPs, generates value when the design standard is used to improve BMP performance. The value of this nonstructural strategy is captured through the value of the structural systems that are implemented. Other nonstructural strategies directly generate value that is separate from a structural BMP. For example, an educational campaign that aims to reduce litter would directly target people's behavior and its effectiveness would be determined by how many people's behavior is changed. The value of this change would be captured by benefit categories associated with improved community livability and business development.

To reflect these differences in nonstructural strategies, we have developed several categories to differentiate them in terms of how they generate value. These categories include strategies that: (a) Increase # of structural systems; (b) Improve structural systems performance; (c) Initiatives to change behavior; and (d) Initiatives to reduce pollutants directly. The revised grouping of specific nonstructural strategies is briefly described in Table 13.

Table 13: Nonstructural Categories by Type of Impact and Identified Strategies

Changing Behavior to reduce pollutants at the source
Implement pet waste program
Identify and reduce incidents of power washing discharges from nonresidential sites.
Require BMPs to address pesticides, herbicides, and fertilizers issues
Implement Illicit Discharge, Detection, and Elimination (IDDE) Program
Implement a public education and participation program
Enhance education and outreach
Technical education and outreach on the MS4 Permit and WQIP
Implement escalating enforcement responses to compel compliance
Continue participating in source reduction initiatives.
Improve / Maintain BMPs or LIDs
Update BMP Design Manual procedures
Administer an alternative compliance program
Oversee implementation of BMPs during the construction
Require implementation of minimum BMPs for existing development
Gather monitoring information about priority conditions or beneficial uses
Collaborate with entities potentially including, but not limited to:
Increasing # of BMPs or LIDs
For all development projects, ensure source control BMPs
Amend municipal code to encourage LID
Train staff on LID regulatory changes and LID Design Manual.
For PDPs, require implementation of on-site structural BMPs or LIDs
Promote and encourage implementing designated BMPs at residential areas.
Develop pilot project to identify and carry out site disconnections in targeted areas.
Promote and encourage implementation of designated BMPs in nonresidential areas.
Monitor for erosion, and slope stabilization on municipal property.
Identify sites for pilot study to test Permeable Friction Course (PFC)
Identify candidate areas for retrofitting projects
Identify areas for stream, channel, or habitat rehabilitation projects
Enforcement of actionable erosion and slope stabilization issues
Conduct a feasibility study on urban tree canopy (UTC) program
Removing pollutants or sources directly
Implement operation and maintenance activities
Implement controls to prevent infiltration of sewage into the MS4
Implement operation and maintenance activities for public streets
Require sweeping and maintenance of private roads and parking lots in targeted areas.
Develop a program to address and capture trash and debris.
Sanitation and trash management for persons experiencing homelessness.
Protect areas that are functioning naturally.

As mentioned above, the first two of these nonstructural categories relates directly to structural systems themselves. In this case, whether the change in BMP adoption is due to training in the community or general promotion of BMP adoption, the success of these strategies would be determined directly by how many additional BMPs are installed and then by the various benefits generated by their installation. Similarly, new design standards and performance monitoring would be measured by the improvement in the performance of installed structural systems.

On the other hand, nonstructural strategies can generate water quality and other benefits on their own. For example, some of these strategies entail education, enforcement and outreach activities which attempt to alter behavior that leads to water quality pollution. These strategies may at the same time lead to an overall aesthetically better environment with less litter on the street. In addition, programs to promote rain barrels and other water harvesting systems on private property can generate benefits to the property owner and the general public. Measured in terms of their water holding capacity, these systems have the potential to offset water demand for irrigation purposes which has the dual effect of reducing water costs for the owner and water treatment demand from the utility. Lower water demand would reduce energy demanded and associated pollutants.

Figure 2: Illustration of Nonstructural BMP: Water Harvesting

Irrigation costs savings:
Quantity of water retained for irrigation purposes
(retained water also reduces energy emissions from lower energy use at the water treatment plant)

Each of these types of strategies will be discussed in greater detail relative to the benefits that they can generate in the next chapter.

4 Accounting for Benefits of BMP Strategies in San Diego

Discussions above on the economic benefits of storm water management and the varied types of structural and nonstructural BMPs strategies under consideration by that the Division sets up the potential to evaluate strategies with an economic framework. The challenge in performing an economic analysis is that some benefits may not be quantifiable, let alone monetizable. In that case, the Division faces some options in how to account for benefits that are perceived to be relevant in decision making. This section begins with an outline of the types of benefits which could be applicable to different categories of strategies and then closes with a discussion on the options for analytically accounting for benefits with different levels of information.

4.1 Evaluation of Benefits for BMP Strategies

This assessment of the applicability of benefits to different BMP strategies represents an initial effort to characterize and differentiate BMPs by the value that they may create for the economy, environment and community. In a series of tables (Table 14) through Table 17), each category of benefit is evaluated relative to applicability for each type of structural and nonstructural strategy. This initial assessment determines for each strategy type whether a benefit can be: (a) monetized; (b) monetized but depending on site specific conditions; (c) quantified but not monetized; or (d) qualitatively evaluated.

To facilitate the review of these tables, a standard symbol key is created to establish how benefits may be evaluated for each strategy.

Key to Symbols for Table 14 through Table 17	
●	Monetizable
☉	Monetizable, but site-specific
⊗	Quantifiable
○	Qualitative

The following delineation of how benefits can be evaluated for a general strategy can only be viewed as our initial assessment. Recall that Table 13 briefly identifies individual strategies under each of these major groups. At this stage, only a general indication of applicability of benefits is discussed. Further evaluation of benefits per strategy would be developed in a subsequent report.

4.1.1 Structural Strategies – Economic and Environmental Benefits

Table 14 represents the additional economic and environmental benefits that could arise from various structural strategies. As shown, many benefits are readily monetizable for *Green Infrastructure* strategies. This finding reflects the fact that much of the existing research that can be applied in San Diego has focused on the various BMPs identified as green infrastructure. Such research and the various storm water management BCA case studies that have been produced provide standardized methods, data, and evidence that can be applied to new sites and projects. As noted in the table, with some additional data on site conditions (e.g. evidence of flood risk, and irrigation demand, for example), many of the green infrastructure systems have the potential to be monetized. Only benefits related to habitat creation would be unlikely to be monetized. The reason is that not only to these types of benefit calculations require detailed biological surveys, but predictions on the improvement in habitat services with green infrastructure are not well understood at present. Any assessment of monetary benefits would be highly uncertainty and thus, this type of benefit is better characterized in quantitative terms, such as in units of habitat area created.

Multiuse Treatment Area strategies differ from green infrastructure because of the scale and placement of these systems. Benefits can arise from these strategies, especially in flood control because of the volumes that can be potentially detained but the quantification of benefits depends on whether there is a downstream flooding risk. The planted material in these systems can provide benefits in air particulate entrainment, carbon sequestration, and habitat creation but the evidence is not established well enough to characterize these impacts in monetary terms. Other benefits would entail a qualitative assessment.

Water Quality Improvement strategies do not have as clear an impact on economic and environmental benefits as green infrastructure and multi-use treatment areas. For example, trash guards or racks that capture debris before they enter surface waters can improve fish habitat but do not have enough supporting documentation to clearly assess benefits from some of the improved livability characteristics. If less trash in surface waters can be attributed to less trash on neighborhood streets, associated benefits in business development and social capital could arise, but such a connection is not likely to be quantifiable.

Table 14: Structural Strategies – Economic and Environmental Benefits

Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement
Flood Risk Reduction	⊙	⊙	⊙
Irrigation Cost Savings	⊙	○	○
Energy Cost Savings	⊙	○	○
Air Particulate Entrainment	●	⊗	○
Climate Impacts	●	⊗	○
Habitat Related Benefits	⊗	⊗	⊗
Air Quality Emission Reduction	●	○	○
GHG Emission Reduction	●	○	○

4.1.2 Structural Strategies – Community Livability Benefits

Community livability benefits from structural systems (Table 15) represent benefits which directly or indirectly enhance local development and quality of life. These benefits are largely derived from the physical features of structural strategies in creating benefits to local residents and property owners. For example, green roofs are noted in their ability to provide noise insulation in a building and tree plantings along green streets can lead to local retail business development because the environment is a more pleasant place to shop.

Similar to economic and environmental benefits in the table above, the applicability of community livability benefits to *Green Infrastructure* also depends on site specific characteristics. For example, the influence of aesthetic improvements on property values usually depends on the type of neighborhood (e.g. residential, commercial, or mixed-use areas). In commercial districts, monetized benefits would be observed in property values, increased sales or employment levels.

The other types of strategies, *Multiuse Treatment Areas* and *Water Quality Improvements*, have fewer types of benefits which can be quantified, let alone monetized. *Multiuse Treatment Areas* certainly have the potential to be located in areas that by design can create recreational opportunities. However, the type of features at the site depends on how it can be used for recreational purposes. The choice of plant materials (e.g. tree species) at the site would affect aesthetics and heat island / health effects but it depends on the location and installation scale of these systems. For *Water Quality Improvements*, it is not clear if there are quantifiable benefits that extend beyond water quality improvements themselves and thus, these benefit categories may be evaluated only in qualitative terms.

Table 15: Structural Strategies – Community Livability Benefits

Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement
Heat Island Effect	⊙	⊙	○
Aesthetics	⊙	⊙	○
Recreational Benefits	⊙	⊙	○
Noise Reduction	⊗	○	○
Business Development & Jobs	⊙	○	○
Crime Reduction	⊗	○	○
Public Education/ Environmental Stewardship	⊗	⊗	⊗

4.1.3 Nonstructural Strategies – Economic and Environmental Benefits

The potential applicability of economic and environmental benefits for *Nonstructural Strategies* is presented in (Table 16). As discussed above, some types of nonstructural strategies relate directly to structural systems by *Increasing the Number of Structural Systems* and *Improving the Structural Systems Performance*. Accordingly, estimating monetary benefits in of these is directly linked to whether the influence of a nonstructural strategy on implementing a structural system can be quantified. If so, then benefits are assessed relative to the structural system itself. The assessment of benefit estimation in the first two columns is therefore similar to that of structural systems, assuming though that the effectiveness of these nonstructural strategies can be estimated.

The two other nonstructural approaches, *Initiatives to Change Behavior* and *Initiatives to Reduce Pollutants Directly,* generate benefits from their own effectiveness in changing behavior or pollution control initiatives. Initiatives to Change Behavior primarily target efforts to encourage improved environmental stewardship and storm water protection throughout the community. Various types of actions then that people may take who are more area of environmental impacts include adoption of rain barrels, reducing litter, and reducing unnecessary levels of pesticides, herbicides and fertilizers. These types of activities could generate a range of economic and environmental benefits, some of which can be monetized if there is sufficient site specific information. In addition, *Initiatives to Reduce Pollutants Directly*, including a number of public agency initiatives in street sweeping, storm water system maintenance and trash removal, can also generate quantifiable and monetizable benefits. On the other hand, street sweeping initiatives entail some amount of environmental costs (or “negative benefits”) associated with emissions from vehicle use. These costs could be compared with any benefits created from cleaner streets.

Table 16: Nonstructural Strategies – Economic and Environmental Benefits

Strategy	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives to Change Behavior	Initiatives to Reduce Pollutants Directly
Flood Risk Reduction	⊙	⊙	⊙	○
Irrigation Cost Savings	⊙	⊙	⊙	○
Energy Cost Savings	●	⊗	⊙	●
Air Particulate Entrainment	●	⊗	⊙	⊙
Climate Impacts	●	⊗	⊙	⊙
Habitat Related Benefits	⊗	⊗	⊗	⊗
Air Quality Emission Reduction	●	⊗	⊙	●
GHG Emission Reduction	●	⊗	⊙	●

4.1.4 Nonstructural Strategies – Community Livability Benefits

The effectiveness of nonstructural strategies in enhancing various aspects of community livability are similar to those for economic and environmental outcomes. That is, some of these strategies influence the adoption and performance of structural systems and some aim to change behavior and municipal operations. Also, similar to the structural strategies for the same types of benefits, fewer of these benefits can be evaluated without some site specific information. For the most part though, the evaluation of potential benefits for green infrastructure has been applied to nonstructural systems that aim to increase the numbers and performance of these systems.

Strategies which seek to change behavior such as proper storage of pesticides or the use of rain barrels/water harvesting can have a positive impact, but the scale of that impact will be dependent upon factors such as the number of persons or households who change their behavior. This same uncertainty applies to strategies to reduce pollutants directly. While there is likely to be a net positive impact on society, these impacts on the broader quality of life are less clear. With respect to improved education and awareness, it is possible to quantify the numbers of people who attended a class or have been exposed to an advertising campaign, it is less clear how this information changes behavior or leads to increased number or maintenance of BMPs.

Table 17: Non Structural Strategies – Community Livability Benefits

Strategy	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives to Change Behavior	Initiatives to Reduce Pollutants Directly
Heat Island Effect	⊙	⊙	⊙	○
Aesthetics	⊙	⊙	⊙	⊙
Recreational Benefits	⊙	⊙	⊙	⊙
Noise Reduction	⊗	⊗	⊗	⊗
Business Development & Jobs	⊙	⊙	⊙	⊙
Crime Reduction	⊗	⊗	⊗	○
Public Education/ Environmental Stewardship	⊗	⊗	⊗	⊗

4.2 Review of BMP Prioritization Frameworks

In consideration of the types of benefits that can and cannot be estimated with data for various types of BMP strategies, a number of options are available for summarizing the likely outcomes for decision making. As noted in the tables, some benefit categories are readily monetized under certain conditions and others require site specific information to perform computation. Many other benefits may arise from a specific BMP strategy but cannot be explicitly quantified. Evaluations of any of these benefits for consideration in decision making also entails some significant uncertainties.

Accordingly, several approaches for summarizing benefits and impacts for decision making are available including: cost-effectiveness, benefit-cost analysis, multi-criteria analysis, and SROI. Each of these approaches has strengths and weaknesses for meeting the Division’s objectives in developing a prioritization strategy. Overall though, each method can be implemented in a process that applies principles of economics, even in multi-objective decision analyses which do not require monetization, so that the categories of benefits are not overlapping or over-estimating value.

Cost-Effectiveness Analysis (CEA): This type of analysis focuses on identifying the best value for money in achieving a specific goal, such as storm water reduction. The process is not necessarily identifying the least costly strategy but the one that generates the greatest quantity of a goal per unit of cost (e.g. dollars per gallon of water detained). Costs in these analyses include the capital, maintenance and operations for implementing. This type of analysis is suitable for evaluating projects in which outcomes (benefits) can not be measured in dollar units but can be quantified. Cost-effectiveness analyses often apply a 'knee-of-the-curve' criterion to identify selecting the most cost-effective strategy because beyond this level of investment cost the effectiveness may increase but at a declining rate. These analyses have been used by communities across the country to identify opportunities for saving money while achieving storm water management goals.

Benefit-Cost Analysis (BCA): Since storm water BMPs can offer more benefits than conventional storm water management systems, cost-effectiveness analysis fails to offer decision makers adequate information for evaluating the alternatives (MacMullen, 2007). Benefit-cost analyses attempt to monetize as many benefits as possible to compare results with costs. This approach is a more direct way of accounting for multiple environmental, societal and economic benefits on a common basis and is not limited to a single goal as is often performed in a conventional cost-effectiveness framework. In some cases, direct environmental value cannot be computed directly, but observed from avoided damage costs or inferred from changes in property values. BCAs account for separate evaluation of benefit categories provided that they are not overlapping. In addition, BCA can be used to evaluate the benefits and costs to individual stakeholders, and comparison with strictly financial benefits with combined environmental and societal benefits – all in the same units of measure. The comparison of costs and benefits allows an explicit consideration of the trade-offs in project options. A BCA can determine whether the benefits of preservation (or restoration) are "worth" the costs and when the project is best implemented. In this sense, it ensures that the limited resources used to provide goods and services to society are used in the most efficient way—that is, to achieve the greatest net benefit (NRC, undated). The overall economic worth of an option can be summarized with a Net Present Value (NPV) or Benefit/Cost Ratio (BCR).[17] BCA results do not incorporate perspectives on who gains or loses but whether the overall net

[17] The NPV is the difference between the present value of benefits and the present value of costs. The present value of benefits is the discounted sum of all future benefits. The present value of costs is the discounted sum of all future costs. The BCR is a ratio of the present value of benefits to the present value of costs. It measures how much benefit would be obtained for each unit of cost invested in a project or policy.

benefits justify the investment. [18] Also, where impacts are perceived to be important but a lack of data is available to assign monetary values to it, additional consideration must be given beyond BCA metrics. For example, a trade-off analysis can be used to compare monetary net benefits with non-monetary impacts to determine a best overall value.

Economic Impact Analysis (EIA): The creation of jobs and business development is a direct and tangible measure of value to the community from expenditures to install storm water BMPs. As mentioned above, since these systems can be installed by low-skilled labor, implementation of these types of systems can provide opportunities for some of those who are most in need. Economic impact analyses trace the levels of expenditures on BMPs through the economy to reveal a total impact for the region. Also, green infrastructure tends to use more local labor and materials compared to grey infrastructure and as such would generate a larger local economic impact. The results can be determined in units of numbers of jobs created, increased income, value added, output, and tax revenue. To many stakeholders, these outcomes are more tangible because the results are shown in units that can be related to the unemployment rate and in gross regional product. For decision making purposes, economic impacts are directly proportional to the level of expenditure. As a result, larger projects would appear to provide greater value even if they are not the most cost-effective. These analyses also do not account for benefits that affect the local community and environment.

Multi-Objective Decision Analysis (MODA): For some project impacts, quantitative and monetary metrics are difficult to determine and the appropriateness of any related assumptions would be highly uncertain. MODA formalizes the process of including non-monetary characteristics of a project into decision making. Just like monetary measures, non-monetary measures try to account in a transparent way stakeholders' preferences for certain characteristics. These preferences are the basis for weights on criteria, which are used to compute an index for ranking projects. Non-monetized performance measures may be weighted with monetary values to produce a single performance metric, or reported alongside monetized values for assessing tradeoffs in decisions. These approaches can be as simple as establishing an equal weight and equal score to all benefit categories – whether they can be monetized or not – to sophisticated frameworks in which non-monetary and monetary benefits are scored and weighted in ways that can be consistent with economic principles. The drawback is that weights are subjective and not based on economic theory or evidence.

[18] In theory, an initiative or project would be rated positively if the benefits to some are large enough to compensate the losses of others, assuming some mechanism existed.

Sustainable Return on Investment (SROI): SROI is a proven, economics-based method for appropriately estimating the monetary value of infrastructure. In such cases, the SROI process first identifies measurable performance indicators that can determine the impact of the infrastructure in specific categories of monetizable benefits. In the context of storm water, benefit categories can include those readily monetized as well as those with some quantitative indicators. In this way, SROI uses stakeholder input to estimate values for inclusion in monetary valuation. The SROI process has several notable features that separate it from more conventional evaluation methods. For instance, true to its economics roots, SROI ensures that key performance indicators do not measure overlapping outcomes which would ‘double-count’ benefits. In addition, the SROI process is marked by its transparency in accounting for uncertainty through Monte Carlo simulation. Uncertainty in the performance, cost and unit values of green infrastructure benefits would be modeled with probability distributions that account for the entire range of reasonable outcomes. Through Monte Carlo simulation, the full range of value for each strategy would be revealed and decisions can be made relative to the upside and downside risk. To be transparent, the probability distributions are established through facilitated discussions in a workshop setting.[19] The discussions are guided towards reaching consensus on how to best use available evidence, including the formation of quantitative descriptions of the uncertainty in the data.

Each of these approaches has strengths and weaknesses for the Division’s purposes. For example, BCA is an established approach for evaluating the worthiness of an investment, such as green infrastructure. Benefits which cannot be monetized because they lack sufficient evidence would be treated in a qualitative assessment, but not included in a benefit-cost comparison. In such contexts a MODA approach can be taken to establish weights and scores for non-monetary outcomes and produce an index of value that can be compared with BCA results. Alternatively, an SROI approach can be undertaken that establishes monetary values for all key benefit categories through a collaborative review of evidence and then risk analysis methods are applied to quantify the uncertainty in quantitative and monetary parameters. MODA methods in establishing weights and scores can be used to support SROI results but ultimately with a SROI process, all key categories of benefits would be evaluated in monetary terms.

The next step for the Division is to develop a sound basis for using this information to prioritize BMPs across each watershed. Many challenges arise in prioritizing BMP strategies with the types of varying benefits presented in Chapter 4. Ideally, a prioritizing approach would be objective, based on site-specific and peer-reviewed evidence, account for life cycle outcomes and reflect various sources of uncertainty. Several prioritization options exist that address some of these goals for the framework.

[19] An initial workshop was held in May in San Diego to discuss benefit categories, strategies and decision making frameworks. Comments received from this workshop are included in Appendix 3.

5 Summary of Key Findings

Our findings in this report indicate that many types of benefits can accrue to local residents, businesses, and the general public. Computing benefits of BMPs has been standardized to some extent in the Center for Neighborhood Technology (CNT) report which outlines the data and calculations for a number of benefits (CNT, 2010). For the Division, a similar calculation process could be implemented and it would be consistent with efforts implemented in other cities. However, a significant level of uncertainty would arise in preparing such estimates without specific data on BMP designs and activities for each strategy as well as site specific information about where they would be implemented.

The next best evaluation strategy for the Division at present would entail a simplified assessment of the likely *existence* of quantifiable benefits for each strategy. In this report, we have evaluated the degree to which benefits can be quantified and potentially monetized for each type of strategy. Drawing from the previous tables in Chapter 4, the results of this assessment are shown in Table 18. A “Yes” in one of the table cells indicates that there would be sufficient evidence to quantifiably determine the value of a strategy, provided that information about the strategy and implementation location is better understood. In this high-level summary, it may be assumed that if a quantifiable benefit exists, they would be large enough to generate observable public value and influence decisions accordingly.

These initial findings however must be developed in more detail to provide practical use in prioritizing strategies for the Division. In particular, the feasibility of estimating benefits must assessed for each individually identified strategy (see Appendix 2), not its strategy group as shown in Table 18. With this information, the Division can establish an initial indication of specific strategies that provide the best value. This effort is planned for phase two of this project.

Table 18: Summary of Evidence for Estimating Benefits for Structural and Nonstructural Strategies

	Structural			Nonstructural			
Strategy	Green Infrastructure	Multiuse Treatment Areas	Water Quality Improvement	Increase # Of Structural Systems	Improve Structural Systems Performance	Initiatives To Change Behavior	Initiatives To Reduce Pollutants Directly
Flood Risk Reduction	YES	YES	YES	YES	YES	YES	
Irrigation Cost Savings	YES			YES	YES	YES	
Energy Cost Savings	YES			YES		YES	YES
Air Particulate Entrainment	YES			YES		YES	YES
Climate Impacts	YES			YES		YES	YES
Habitat Related Benefits							
Air Quality Emission Reduction	YES			YES		YES	YES
GHG Emission Reduction	YES			YES		YES	YES
Heat Island Effect	YES	YES		YES	YES	YES	
Aesthetics	YES	YES		YES	YES	YES	YES
Recreational Benefits	YES	YES		YES	YES	YES	YES
Noise Reduction							
Business Development & Jobs	YES			YES	YES	YES	YES
Crime Reduction							
Public Education/ Environmental Stewardship							

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Appendix 1: Benefit Calculations

This appendix discusses the quantitative calculations and data involved in estimating benefits for those categories which can be converted to monetary values, given site specific data. Benefit categories that can be readily quantified and monetized are discussed here. Benefit categories that are not included here are: Habitat Creation Benefits, Heat Island Effects, and Environmental Awareness / Stewardship.

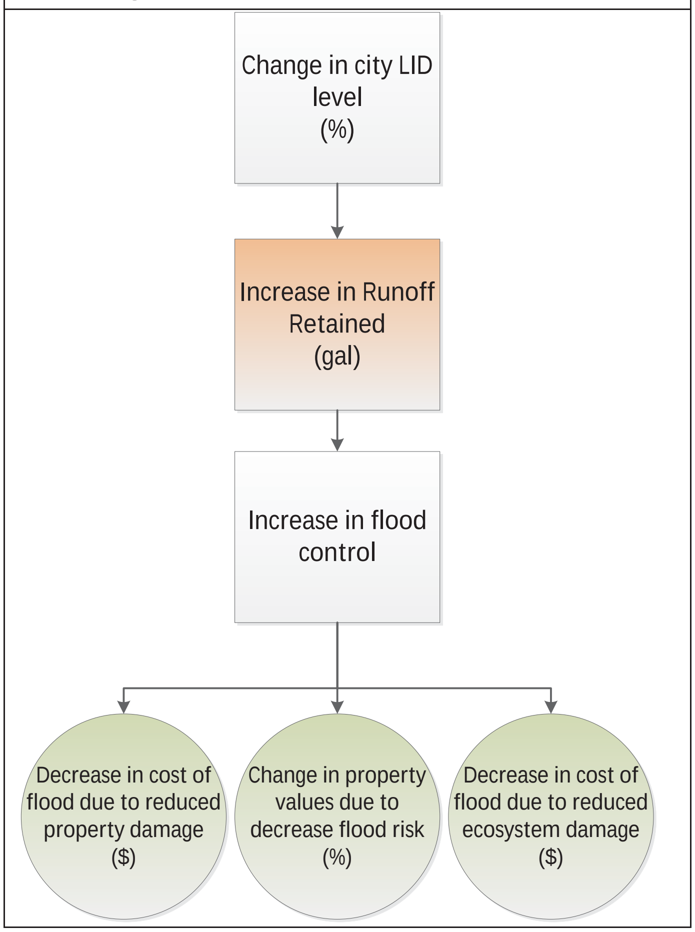
Flood Risk Reduction Benefits

By reducing the volume of storm water runoff, the proposed strategies can reduce the frequency and severity of flooding. The impact of green infrastructure on flooding is highly site and watershed specific, and thus this guide does not provide general instructions for quantifying the reduction in flood risk resulting from a green infrastructure program. There are several methods[20] for valuing the impact of flood control:

- Hedonic pricing to examine how flood risk is priced into real estate markets;
- Insurance premiums paid for flood damage insurance as a proxy for the value of reducing the risk of flood damage;
- Avoided damage cost approach; and
- Contingent valuation methods

The diagram presents a high level overview of how the benefits could be monetized. The 'Increase in Flood Control' could be monetized using any of the methods suggested above. Some methods have more robust information than others. CNT recommends using a range of 2–5 percent property value increase for removal from the floodplain (CNT, 2010).

Figure 3: Flood Control Benefits



[20] Downstream Economic Benefits From Storm-Water Management. Journal of Water Resources Planning and Management. Braden, J.B. and D.M. Johnston. November/December, 2004

Irrigation Cost Savings

The method for determining the irrigation cost savings begins with quantifying the reduction in water demand from utilities based on the amount that is harvested on site.

This amount can be calculated by using the various water retention factors for the various green infrastructure and multiplying by the annual precipitation.

A diagram is provided here that determines benefits of retention based on cost avoidance. This information would be used in calculating the Decrease in Potable Water. The cost of the water would be derived from local utilities.

Figure 4: Irrigation Cost Savings

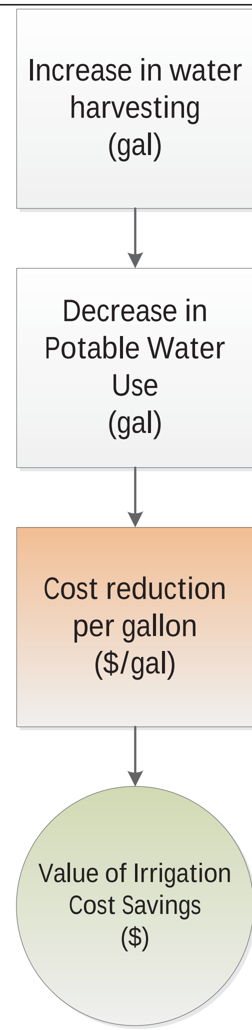


Table 19: Green Infrastructure Retention Parameters

	Amount Retained	Unit	Scale
Water Harvesting	0.62	Gallons of runoff	Per inch of Rain

Source: CNT, 2010, McPherson, E. et al. 2006

Energy Cost Savings

The most important step in this calculation will be the reduced energy needs which will depend on the number of buildings which will benefit from the temperature control provided by green infrastructure and LID and the scale of LID/GI implementation. The data on the physical characteristics of GI to insulate or reduce energy use are provided as well.

The first step to valuing the benefits of reduced energy use is determining the amount of energy saved by BMP. The benefit of energy savings can be terms of kilowatt hours (kWh) of electricity and British thermal units (Btu) of natural gas reduced.

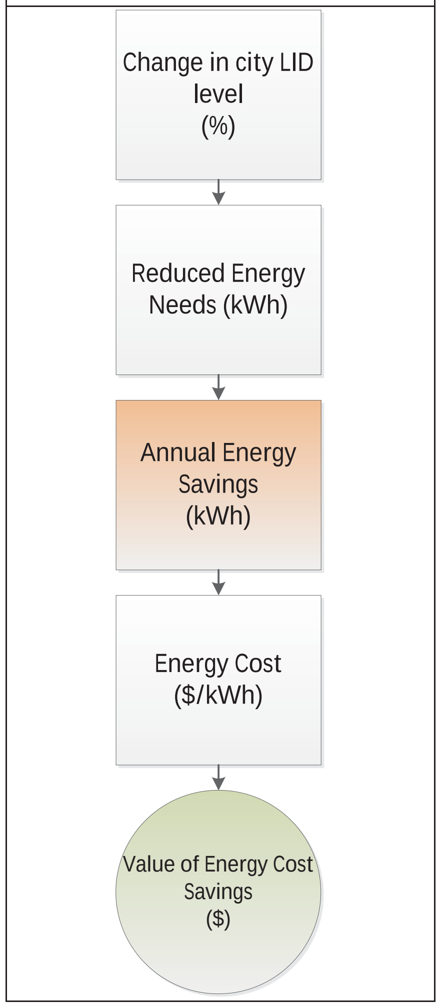
As noted, the total reduction is very specific to the type of improvement/change. The actual benefits realized in terms of energy savings due to the implementation of a green roof will be significantly impacted by the following variables:

- Growing media composition, depth and moisture content
- Plant coverage and type
- Building characteristics, energy loads and use schedules
- Local climate variables and rainfall distribution patterns

These characteristics will influence the R values for conventional and green roofs in region (which will be used to calculate the annual energy savings from reduced energy needs). Other data needs are:

- Annual number of cooling degree days (°F days) in your region
- Annual number of heating degree days (°F days) in your region

Figure 5: Energy Cost Savings



Having calculated the direct kWh and BTU saved in reduced building energy use, it is possible to assign a dollar value to these savings.

One may calculate the direct cost savings by multiplying the kilowatt hours or BTUs of electricity and natural gas, respectively, by local utility rates

Air Pollution Emission Reduction

Practices that indirectly lower emissions of air pollution include any practices that reduce energy consumption through decreased energy use in neighboring buildings or through reduced water treatment needs.

The kilowatt hours (or million BTUs) of reduced energy from the energy cost savings will be used in calculating the air pollution emission reduction benefit. The total amount of energy saved will be converted to the pounds of criteria pollutants reduced. The values, in dollars per pound, of the pollutants will come from existing guidance from the EPA and other sources that value these pollutants.

The EPA provides estimates for annual output emissions rates of national electricity production and natural gas:

Figure 6: Air Pollution Emission Reduction

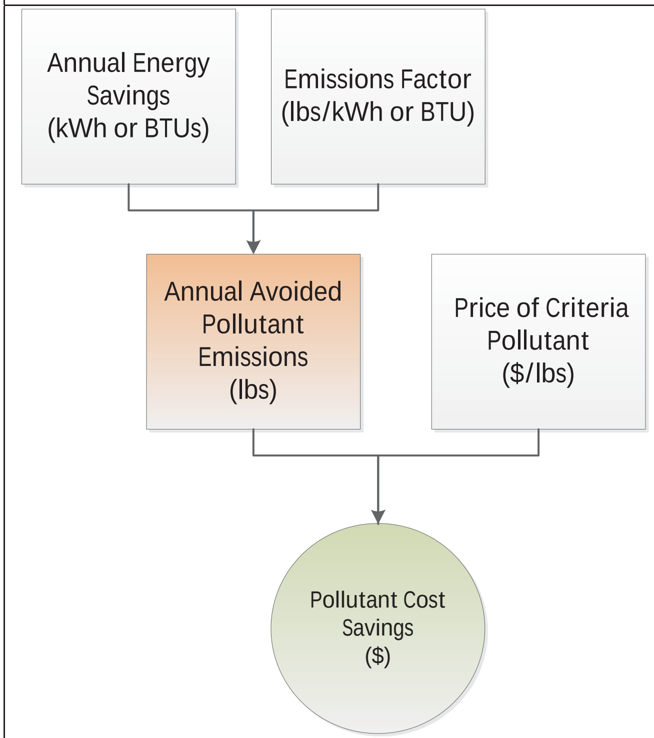


Table 20: Sample Criteria Pollutant Emission Factors

Pollutant	lbs/kWh	lbs/Million Btu
NO2	0.001937	0.721
SO2	0.005259	0.266

Table 21: Costs of Pollutants

Pollutant	Value per lb
NO2	$3.34
O3	$3.34
SO2	$2.06
PM-10	$2.84

Source: CNT (2010), McPherson et al. (2006), Wang and Santini (1995)

Greenhouse Gas Emission Reduction

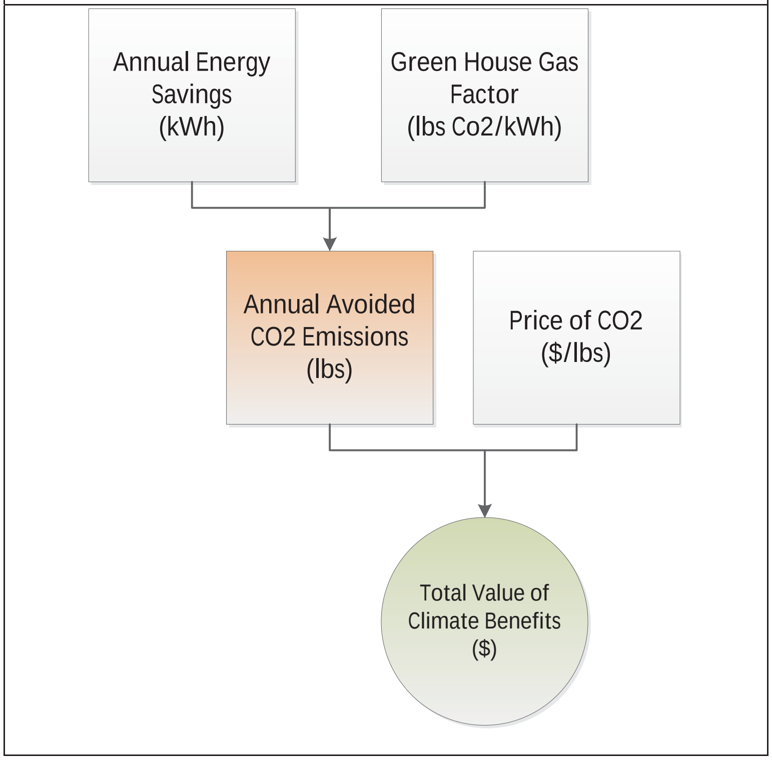
This benefit calculation follows the same methodology as the air pollution emission reduction benefit, only different conversion factors for CO2 will be used, and different monetary values.

The amount of CO2 emissions from power plants varies depending on the electricity source (e.g. coal, nuclear, wind, etc), so the EPA eGRID program should be consulted.

The CAMX subregion for 2010 has 932.82 lb per M Wh[21].

The current recommended price of CO2 is $40 per metric ton[22].

Figure 7: Greenhouse Gas Emission Reduction



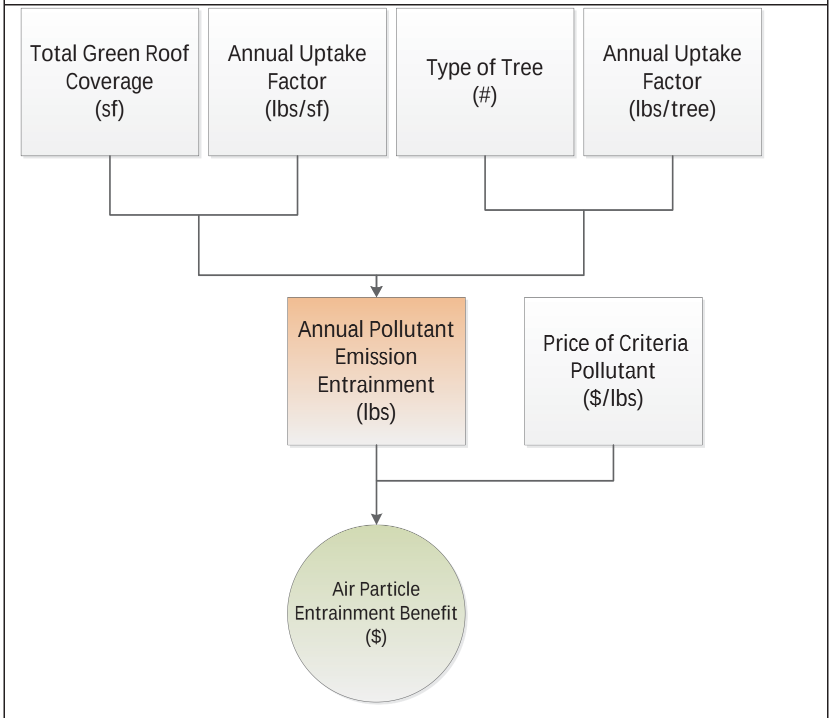
[21] http://www.epa.gov/cleanenergy/energy-resources/egrid/

[22] Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013; revised November 2013), page 18

Air Particle Entrainment

This section quantifies the direct uptake and deposition of air pollutants by green infrastructure and provides a framework for establishing value these impacts in monetary terms. The criteria pollutants addressed here are nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter of aerodynamic diameter of ten micrometers or fewer (PM-10).

Figure 8: Air Particle Entrainment



Practices that provide a direct benefit of uptake and deposition include green roofs, trees and bio-infiltration. Similar to the methodology for emission cost savings from reduced energy use, the air particle entrainment benefits will quantify the amount (in pounds) of criteria pollutants removed from the environment. The total amount will depend on the scale of LID/GI and the type of GI. Table 22 provides values compiled by CNT (2010) per square foot of green roof installed. It should be noted that local values should be used if available (CNT, 2010). Factors such as local climates will influence plants ability to grow, and climates with longer growing seasons will see greater air quality improvements than those with shorter ones. Additionally, trees provide benefits in a similar manner. The Forest Service *Tree Guides* provides information for trees for particular climate regions (Table 23).

Table 22: Pollutant Removal Factors for Green Roofs

	Low (lbs/SF)	High (lbs/SF)
NO2	3.00×10^{-4}	4.77×10^{-4}
O3	5.88×10^{-4}	9.20×10^{-4}
SO2	2.29×10^{-4}	4.06×10^{-4}
PM-10	1.14x10-4	1.33x10-4

Table 23: Annual Criteria Pollutant Reductions, 40 year Average

	Small tree: Crabapple (22 ft tall, 21 ft spread)	Medium tree: Red Oak (40 ft tall, 27 ft spread)	Large tree: Hackberry (47 ft tall, 37 ft spread)
NO2	0.39 lbs	0.63 lbs	1.11 lbs
SO2	0.23 lbs	0.42 lbs	0.69 lbs
O3	0.15 lbs	0.2 lbs	0.28 lbs
PM-10	0.17 lbs	0.26 lbs	0.35 lbs

Carbon Sequestration

Similar to the air particle entrainment methodology, LID/GI can provide carbon sequestration benefits. The pounds of carbon sequestered per unit area depend on several local factors, including the specific practice, the types of species planted and the local climate.

For green roofs, the recommended range of grams of carbon sequestered per square meter from aboveground biomass, as determined by research synthesized in a Michigan State University report offers average carbon sequestration values provided by extensive green roofs' aboveground biomass (Getter et al. 2009).

Figure 9: Carbon Sequestration

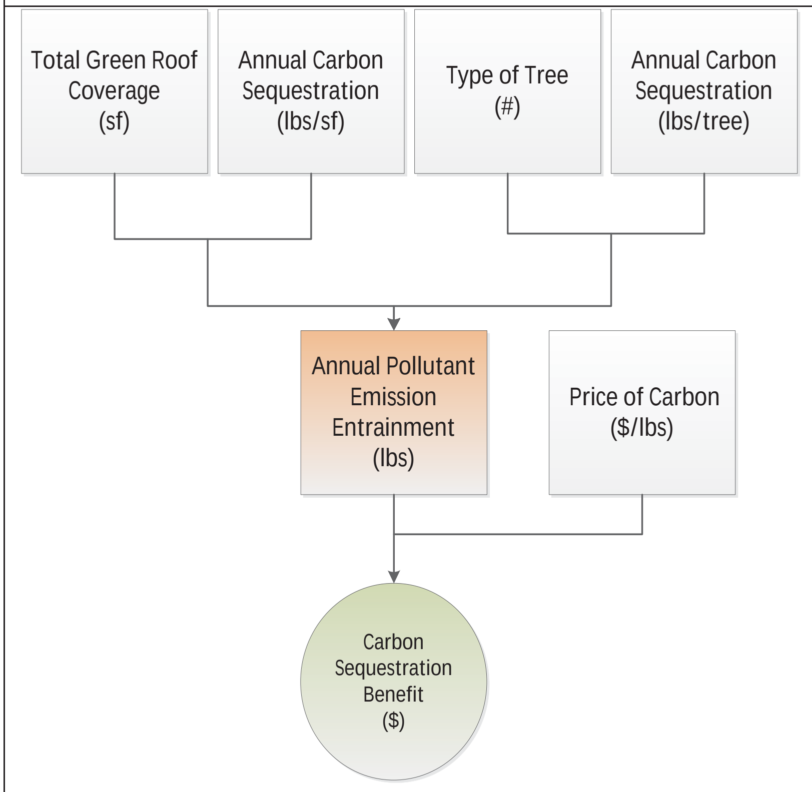


Table 24: Green Roof Carbon Sequestration Rates

	Low (lbs/SF)	High (lbs/SF)
CO2	0.0332	0.0344

Table 25: Sample Carbon Sequestration Rates for Different Trees

Net CO2 (lbs)	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	390	226	335	336
Medium tree: Red Oak (40 ft tall, 27 ft spread)	594	212	487	444
Large tree: Hackberry (47 ft tall, 37 ft spread)	911	665	806	735

Aesthetic Improvements

The current method to calculate the benefit of aesthetics is to look at the changes in property values due to LID/GI. While the research on this subject supports the belief that there is a positive (increase) in property value due to LID/GI, there is much uncertainty regarding the size and scale of that. The methodology for calculating this benefit is to apply a premium on property that will capitalize on the aesthetic benefits of LID/GI.

Street trees and urban vegetation have been estimated by realtors to add $15,000 to $25,000 in value to a property compared to similar areas with o trees. The NRDC notes that buildings with green roofs can rent at a 16% premium.[23] Additionally, the NRDC reports that Tyrväinen and Miettinen (2000) found that units in multifamily buildings with views of trees or forest cover can increase rents by as much as 4.9 percent (Wolf 2007)[24].

Figure 10: Aesthetic Improvements

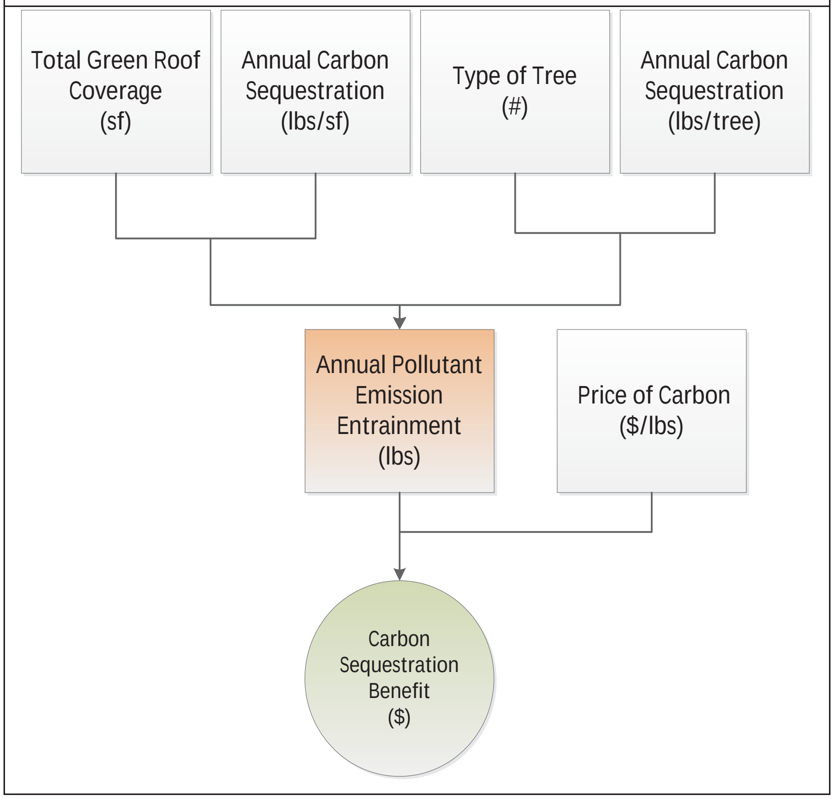


Table 26: Premiums on Property Value due to Aesthetics

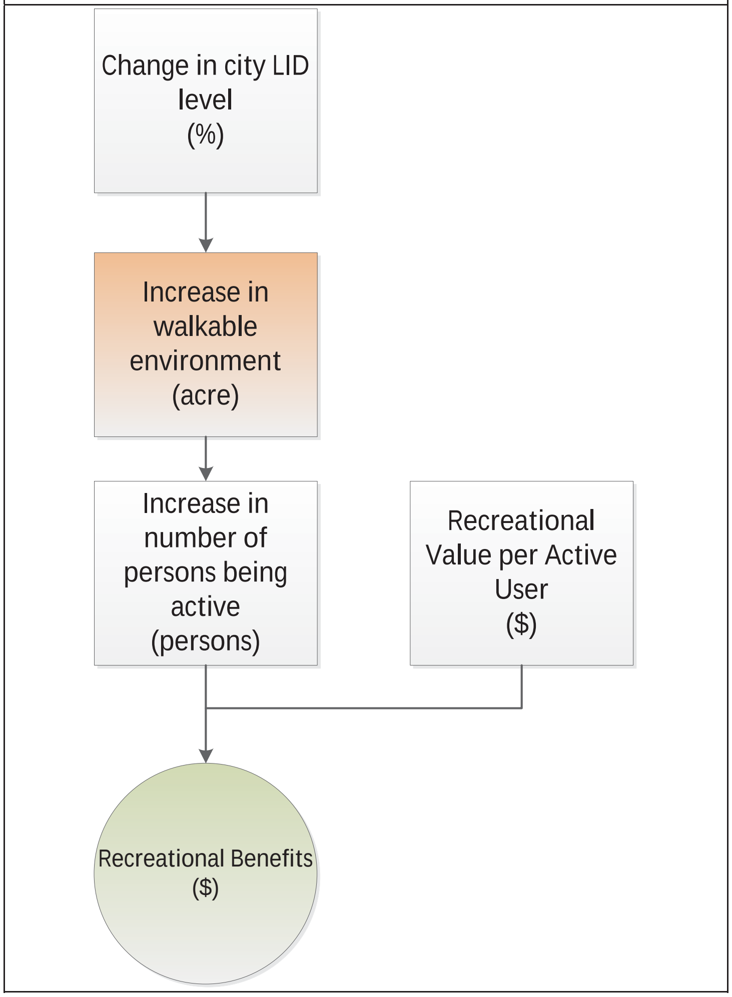
Action	Monetized Benefit	Location	Source
LID and proximity to trees and other vegetation	0 to 7% Increase in Property Value	Philadelphia, PA	Stratus 2009
LID of adjacent properties	3.5 to 5% Increase in Property Value	King County, WA	Ward et al. 2008

[23] Natural Resources Defense Council 2013

[24] Ibid

Recreation Benefits

Figure 11: Recreation Benefits



The methodology for calculating this benefit will involve determining the total number of recreational users of the new LID/GI facilities and applying a monetary value per user to get total benefits.

The total number of users will be based on local information. The monetized value of recreational benefits comes from different research fields. Some research from the transportation literature suggests benefits can be determined on an individual user basis. A wide variety of studies of outdoor recreational activities (non-bicycling) generated typical values of about $40 per day (in 2004 dollars).[25]

The value of time is estimated based on US DOT guidance for TIGER VI. The value of time for personal travel is $12.98 per hour. The benefit per trip for the appropriate facility is multiplied by the number of daily existing and induced commuters, and then doubled to include trips both to and from work. This results in a daily mobility benefit.

A premium on the value of a trip is developed from the January 2010 UK's Department of Transport *Guidance on the Appraisal of Walking and Cycling Schemes*. This Guidance reports a premium value of an off-road bicycle track versus an on-road facility. Hopkinson & Wardman (1996) developed estimates of on-road segregated cycle lane assuming benefits of £0.02 per minute. This benefit is assigned to existing recreational cyclists that would enjoy the new bike facility's quality, comfort and convenience.

[25] San Francisco County Transportation Authority Department of Parking and Traffic. *Maintain Bicycle Facilities (spreadsheet)*. 2004 2/28/2004, as cited in *Guidelines for Analyzing the Benefits and Costs of Bicycle Facilities*, Krizek et al., 2005.

Crime Reduction Benefits

Residents living in "greener" surroundings report lower levels of fear, fewer incivilities, and less aggressive and violent behavior. While there is not literature with respect to monetizing this benefit, there is research that looks at quantifying the benefit of crime reduction do to a greener environment. This study was performed in a public housing complex in an urban environment, so the actual percentage reduction may not be the same in other areas.

However, that does not mean there is no impact on crime. A possible methodology is to look at current crime levels in areas where proposed LID/GI will occur, and apply a reduction, but smaller in size than those listed below.

	Areas with Medium Level of Vegetation	Areas with High Levels of Vegetation
Total Crimes	42%	52%
Property Crimes	40%	48%
Violent Crimes	44%	56%

Source: Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Kuo & Sullivan. Environment and Behavior, Volume 33 No.3, May, 2001

Business Development Benefits

In areas where green streets lead to an enhanced the sense of place, and increase in foot and bicycle traffic can support retail development. Case studies by the New York City DOT examined before and after changes in Retail Sales Tax Filings, Commercial Leases & Rents, and City−Assessed Market Value. The study's methodology does not ultimately prove causality between the street improvement projects and any resulting economic changes; however, some locations of green street development saw a significant increase in retail sales compared to the changes in retail sales for the borough as a whole.

Researchers do believe that any benefits from the green streets will be fully realized 2 years after development, and so applying this growth to retail sales further in the future is not applicable.

We can apply these percentages to current retail sales of businesses located along areas that will be developed into green streets to see the potential impact on businesses.

Table 27: Increase in Retail Sales after Street Development

Area	Change in Sales Year 1	Change in Sales Year 2
Vanderbilt Ave	39%	59%
Borough	27%	19%
Area	**Change in Sales Year 1**	**Change in Sales Year 2**
St. Nicholas Avenue/Amsterdam	18%	48%
Borough	17%	39%

Job Creation Benefits

Determining the number of jobs created, and the economic impact of those jobs, is simply a function of the total amount spent on the program. In general, the larger the area (or economic base) the larger the impact. Direct, indirect and induced economic impacts from spending on the strategies can be calculated using Economic Impact Analysis models.

The creation of jobs, and such, salaries for the workers to spend, would also have tax impacts at the State, Local, and Federal government level.

Current guidance on a methodology from the Council of Economic Advisors' [26] methodology as assumes that for every **$76,923** of additional government spending, one job-year is created. A job-year means one job for one year. To estimate the employment impacts in terms of job-years one simply adds up the number of jobs created every year over the analysis period.

The number of jobs created is a division of the total spending by the CEA recommended value.

[26] Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009; and September 2011 Update.

Appendix 2: Comprehensive List of Nonstructural Strategies

This list of strategies has been compiled from a review of each WAMP, CLRP and WQIP document

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
Jurisdictional Runoff Management Program (JRMP) Strategies			
Development Planning			
All Development Projects			
1	For all development projects, administer a program to ensure implementation of source control BMPs to minimize pollutant generation at each project and implement low-impact development (LID) BMPs to maintain or restore hydrology of the area, where applicable and feasible.	For all development projects, ensure source control BMPs	Increasing # of BMPs or LIDs
2	Amend municipal code and ordinances, including zoning ordinances, to facilitate and encourage LID opportunities.	Amend municipal code to encourage LID	Increasing # of BMPs or LIDs
3	Train staff on LID regulatory changes and LID Design Manual.	Train staff on LID regulatory changes and LID Design Manual.	Increasing # of BMPs or LIDs
Priority Development Projects (PDPs)			
4	For PDPs, administer a program requiring implementation of on-site structural BMPs or LIDs to control pollutants and manage hydromodification. Includes confirmation of design, construction, and maintenance of PDP structural BMPs or LIDs.	For PDPs, require implementation of on-site structural BMPs or LIDs	Increasing # of BMPs or LIDs
5	Update BMP Design Manual procedures to determine nature and extent of storm water requirements applicable to development projects and to identify conditions of concern for selecting, designing, and maintaining appropriate structural BMPs or LIDs.	Update BMP Design Manual procedures	Improve / Maintain BMPs or LIDs
	1. Amend BMP Design Manual for trash areas. Require full four-sided enclosure, siting away from storm drains and cover. Consider the retrofit requirement.		Improve / Maintain BMPs or LIDs
	2. Amend BMP Design Manual for animal-related facilities.		Improve / Maintain BMPs or LIDs
	3. Amend BMP Design Manual for nurseries and garden centers.		Improve / Maintain BMPs or LIDs
	4. Amend BMP Design Manual for auto-related uses.		Improve / Maintain BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
6	Administer an alternative compliance program to on-site structural BMP implementation (includes identifying Watershed Management Area Analysis [WMAA] candidate projects).	Administer an alternative compliance program	Improve / Maintain BMPs or LIDs
	1. Develop a mitigation policy for public and private development projects that links development with mitigation within the same watershed.		Improve / Maintain BMPs or LIDs
	1a. Create an In-Lieu Fee		Improve / Maintain BMPs or LIDs
	Construction Management		
7	Administer a program to oversee implementation of BMPs during the construction phase of land development. Includes inspections at an appropriate frequency and enforcement of requirements.	Oversee implementation of BMPs during the construction	Improve / Maintain BMPs or LIDs
Existing Development			
	Commercial, Industrial, Municipal, and Residential Facilities and Areas		
8	Administer a program to require implementation of minimum BMPs for existing development (commercial, industrial, municipal, and residential) that are specific to the facility, area types, and PGAs, as appropriate. Includes inspecting existing development at appropriate frequencies and using appropriate methods. (Inspections for PGAs of concern: Vehicle Washing area inspections and inspections for food-related businesses, animal-related businesses, nurseries and garden centers, and auto-related businesses.)	Require implementation of minimum BMPs for existing development	Improve / Maintain BMPs or LIDs
	1. Update minimum BMPs for existing residential, commercial, and industrial development and enforce them.		Improve / Maintain BMPs or LIDs
	2. Design, implement, and enforce property- and PGA-based inspections.		Improve / Maintain BMPs or LIDs
	1. Review policies and procedures to ensure discharges from swimming pools meet permit requirements.		Improve / Maintain BMPs or LIDs
	3. Develop a self-reporting inspection option for select industrial and commercial facilities.		Improve / Maintain BMPs or LIDs
9	Implement pet waste program. May include installation and maintenance of pet waste bag dispensers and trash bins, signage and education, physical removal of pet waste, or enforcement.	Implement pet waste program	Changing Behavior to reduce pollutants at the source
10	Promote and encourage implementing designated BMPs at residential areas.	Promote and encourage implementing designated BMPs at residential areas.	Increasing # of BMPs or LIDs
	1. Expand residential BMP (irrigation, rainwater harvesting, and turf conversion) rebate programs to multi-family housing in target areas.		Increasing # of BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	2. Residential BMP: Rain Barrel		Increasing # of BMPs or LIDs
	3. Residential BMP: Irrigation Control (Turf Conversion)		Increasing # of BMPs or LIDs
	4. Residential BMP: Downspout Disconnect		Increasing # of BMPs or LIDs
	5. Provide financial incentives to property owners to convert landscaping to site-specific native plants.		Increasing # of BMPs or LIDs
11	Develop pilot project to identify and carry out site disconnections in targeted areas.	Develop pilot project to identify and carry out site disconnections in targeted areas.	Increasing # of BMPs or LIDs
12	Identify and reduce incidents of power washing discharges from nonresidential sites.	Identify and reduce incidents of power washing discharges from nonresidential sites.	Changing Behavior to reduce pollutants at the source
13	Promote and encourage implementation of designated BMPs in nonresidential areas.	Promote and encourage implementation of designated BMPs in nonresidential areas.	Increasing # of BMPs or LIDs
14	Proactively monitor for erosion, and complete minor repair and slope stabilization on municipal property.	Monitor for erosion, and slope stabilization on municipal property.	Increasing # of BMPs or LIDs
	MS4 Infrastructure		
15	Implement operation and maintenance activities (inspection and cleaning) for MS4 and related structures (catch basins, storm drain inlets, detention basins, etc.).	Implement operation and maintenance activities	Removing pollutants or sources directly
	1. Optimize catch basin cleaning to maximize pollutant removal.		Removing pollutants or sources directly
	2. Proactively repair and replace MS4 components to provide source control from MS4 infrastructure.		Removing pollutants or sources directly
	3. Increase frequency of open-channel cleaning and scour pond repair to reduce pollutant loads.		Removing pollutants or sources directly
16	Implement controls to prevent infiltration of sewage into the MS4 from leaking sanitary sewers.	Implement controls to prevent infiltration of sewage into the MS4	Removing pollutants or sources directly

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	1. Identify sewer leaks and areas for sewer pipe replacement prioritization.		Removing pollutants or sources directly
	Roads, Streets, and Parking Lots		
17	Implement operation and maintenance activities for public streets, unpaved roads, paved roads, and paved highways.	Implement operation and maintenance activities for public streets	Removing pollutants or sources directly
	1. Enhance street sweeping through equipment replacement and route optimization.		Removing pollutants or sources directly
	2. Initiate sweeping of medians on high-volume arterial roadways.		Removing pollutants or sources directly
	3. Increase maintenance on access roads and trails.		Removing pollutants or sources directly
18	Require sweeping and maintenance of private roads and parking lots in targeted areas.	Require sweeping and maintenance of private roads and parking lots in targeted areas.	Removing pollutants or sources directly
19	Identify sites for pilot study to test Permeable Friction Course (PFC), which is a porous asphalt that overlays impermeable asphalt.	Identify sites for pilot study to test Permeable Friction Course (PFC)	Increasing # of BMPs or LIDs
	Pesticide, Herbicides, and Fertilizer Program		
20	Require implementation of BMPs to address application, storage, and disposal of pesticides, herbicides, and fertilizers on commercial, industrial, and municipal properties. Includes education, permits, and certifications.	Require BMPs to address pesticides, herbicides, and fertilizers issues	Changing Behavior to reduce pollutants at the source
	Retrofit and Rehabilitation in Areas of Existing Development		
21	Develop and implement a strategy to identify candidate areas of existing development appropriate for retrofitting projects and facilitate the implementation of such projects.	Identify candidate areas for retrofitting projects	Increasing # of BMPs or LIDs
22	Develop and implement a strategy to identify candidate areas of existing development for stream, channel, or habitat rehabilitation projects and facilitate implementation of such projects.	Identify areas for stream, channel, or habitat rehabilitation projects	Increasing # of BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	IDDE Program		
23	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program per the JRMPs. Requirements include maintaining an MS4 map, using municipal personnel and contractors to identify and report illicit discharges, maintaining a hotline for publicly reporting illicit discharges, monitoring MS4 outfalls, and investigating and addressing any illicit discharges.	Implement Illicit Discharge, Detection, and Elimination (IDDE) Program	Changing Behavior to reduce pollutants at the source
	Public Education and Participation		
24	Implement a public education and participation program to promote and encourage development of programs, management practices, and behaviors that reduce pollutant discharge in storm water prioritized by high-risk behaviors, pollutants of concern, and target audiences.	Implement a public education and participation program	Changing Behavior to reduce pollutants at the source
	1. Expand outreach to homeowners' association (HOA) common lands and HOA rebates.		Changing Behavior to reduce pollutants at the source
	2. Develop an outreach and training program for property managers responsible for HOAs and maintenance districts.		Changing Behavior to reduce pollutants at the source
	3. Conduct trash cleanups through community-based organizations involving target audiences.		Changing Behavior to reduce pollutants at the source
	4. Target human behavior in parks and other public areas including trash reduction or other high-impact behavior to habitat, wildlife, and water quality.		Changing Behavior to reduce pollutants at the source
	5. Improve consistency and content of websites to highlight enforceable conditions and reporting methods.		Changing Behavior to reduce pollutants at the source
	6. Contribute to San Diego County-led effort through regional education group for outreach, education, and policy measures for the equestrian community and property owners.		Changing Behavior to reduce pollutants at the source
	1. Develop a targeted education and outreach program for homeowners adjacent to or with tributaries or streams within their property.		Changing Behavior to reduce pollutants at the source
	1. Develop a targeted education and outreach program for homeowners with orchards or other agricultural land uses on their property.		Changing Behavior to reduce pollutants at the source

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
	2. Enhance school and recreation-based education and outreach		Changing Behavior to reduce pollutants at the source
	3. Develop education and outreach to reduce over-irrigation		Changing Behavior to reduce pollutants at the source
	7. Develop regional training for water-using mobile businesses.		Changing Behavior to reduce pollutants at the source
25	Enhance education and outreach based on results of effectiveness survey and changing regulatory requirements.	Enhance education and outreach	Changing Behavior to reduce pollutants at the source
26	Provide technical education and outreach to the development community on the design and implementation requirements of the MS4 Permit and Water Quality Improvement Plan requirements.	Technical education and outreach on the MS4 Permit and WQIP	Changing Behavior to reduce pollutants at the source
	Enforcement Response Plan		
27	Implement escalating enforcement responses to compel compliance with statutes, ordinances, permits, contracts, orders, and other requirements for IDDE, development planning, construction management, and existing development in the Enforcement Response Plan.	Implement escalating enforcement responses to compel compliance	Changing Behavior to reduce pollutants at the source
	1. Increase enforcement of over-irrigation.		Changing Behavior to reduce pollutants at the source
	2. Focus locally on enforcement of water-using mobile businesses.		Changing Behavior to reduce pollutants at the source
28	Increase identification and enforcement of actionable erosion and slope stabilization issues on private property and require stabilization and repair.	Enforcement of actionable erosion and slope stabilization issues	Increasing # of BMPs or LIDs
	Optional Strategies		
29	Continue participating in source reduction initiatives. (Varies. For example, the Brake Pad Partnership is existing. Considered may be a plastic bag ban, banning leaf blowers, banning pesticides or herbicide.)	Continue participating in source reduction initiatives.	Changing Behavior to reduce pollutants at the source
30	Develop a program to address and capture trash and debris.	Develop a program to address and capture trash and debris.	Removing pollutants or sources directly

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
31	Support partnership efforts by social service providers to provide sanitation and trash management for persons experiencing homelessness.	Sanitation and trash management for persons experiencing homelessness.	Removing pollutants or sources directly
32	Protect areas that are functioning naturally.	Protect areas that are functioning naturally.	Removing pollutants or sources directly
	1. Develop a policy to avoid additional hardscape development and degradation in unpaved open space areas.		Removing pollutants or sources directly
	2. Add permanent open space protections to undeveloped city-owned land.		Removing pollutants or sources directly
	3. Acquire privately owned undeveloped parcels of land.		Removing pollutants or sources directly
	Mapping and risk assessment of agricultural operations.		Removing pollutants or sources directly
	Implement a program to target on-site wastewater treatment (septic) systems. May include mapping and risk assessment, inspection, or maintenance practices.		Removing pollutants or sources directly
	Removal of invasive plants and animals.		Removing pollutants or sources directly
33	Conduct a feasibility study to determine if implementing an urban tree canopy (UTC) program would benefit water quality and other goals.	Conduct a feasibility study on urban tree canopy (UTC) program	Increasing # of BMPs or LIDs
	Investigate alternative pollutant removal or treatment strategies such as fungus used to remove soil contaminants.		Removing pollutants or sources directly
34	Conduct special studies to gather additional monitoring information about priority conditions or beneficial uses. (Monitoring may include investigative measures such as genetic tracking for bacteria sources or geomorphic studies for sediment sources or processes. - LOS PEN)	Gather monitoring information about priority conditions or beneficial uses	Improve / Maintain BMPs or LIDs

ID	NONSTRUCTURAL STRATEGY (Official Description)	Short Description	Category
35	Collaborate with entities potentially including, but not limited to:	Collaborate with entities potentially including, but not limited to:	Improve / Maintain BMPs or LIDs
	• Departments within the same Responsible Agency.		Improve / Maintain BMPs or LIDs
	• Other governmental agencies such as water, transportation, or public health agencies.		Improve / Maintain BMPs or LIDs
	• Nongovernmental agencies such as environmental and community groups and private corporations.		Improve / Maintain BMPs or LIDs
	• Dischargers regulated under other permits including the Phase II National Pollutant Discharge Elimination System (NPDES) Permit, Industrial General Permit, and Construction General Permit.		Improve / Maintain BMPs or LIDs
	Collaboration may take the form of joint participation in stakeholder meetings, studies or development studies or BMPs, hiring of a Watershed Coordinator to facilitate communication between community groups and the City, formation of a City Watershed team to protect and restore the watershed, or participating in existing groups, such as Integrated Regional Water Management (IRWM) groups.		Improve / Maintain BMPs or LIDs
	1. Funding for collaborative strategies may include providing in-kind services, shared costs through agreements, and preparation and competition for grant funding.		Improve / Maintain BMPs or LIDs
	Added		
	Vehicle Washing areas supplemental standards		Improve / Maintain BMPs or LIDs
	Keeping of large animals		Improve / Maintain BMPs or LIDs
	Xeriscaping, turf conversion and other irrigation, pesticide and fertilizer reduction (Caltrans specific. CLRP P. E-19)		Changing Behavior to reduce pollutants at the source
	Garden and landscape practices (primarily for Contractors. Otherwise covered in W.)		Changing Behavior to reduce pollutants at the source
	Increase street sweeping frequency (otherwise covered in P.)		Improve / Maintain BMPs or LIDs
	Rebates/Incentives to residential and non-residential. (Otherwise covered in J.)		Improve / Maintain BMPs or LIDs

Notes: Purple highlighting where there was a modification between the "Potential Strategies" documents.

Appendix 3: Workshop Summary

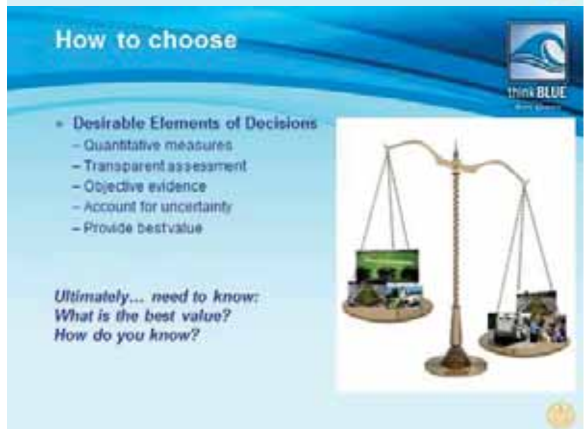
This section includes the presentation provided to the stakeholders, which guided discussion on benefits. Stakeholder comments were written down post workshop and sent back to the Division for consideration. These comments are included below.

Workshop Presentation


Schedule
think BLUE
May 20, 2014
Co-benefit Workshop
May 27, 2014
Comments on Co-benefits Due
June - August 2014
Preliminary SROI Analysis
Late August, 2014 (tentative)
SROI Workshop Review
September, 2014
Finalize Analysis
Late September 2014
Potential Changes to WQIP Strategies (non-structural)


Choices
think BLUE

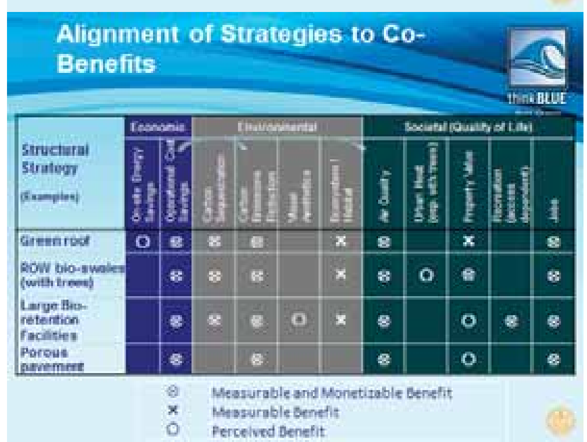

Co-benefits
think BLUE
Improve Water Quality
Generate Co-Benefits
Ecosystem habitat
Visual aesthetics
Energy, Operations Savings
Air pollution reduction
Education / Stewardship


How to choose
think BLUE
Desirable Elements of Decisions
– Quantitative measures
– Transparent assessment
– Objective evidence
– Account for uncertainty
– Provide best value
Ultimately… need to know:
What is the best value?
How do you know?


Introduction to Sustainable Return on Investment (SROI) Process
think BLUE
Best practices:
– Objective, theory-based
– Peer-reviewed evidence
– Life cycle monetary outcomes
– Accounts for uncertainty
– Avoids double-counting
Key Features:
– Comprehensive
– Transparent analysis
– Impact distribution
– Adaptable to local conditions
– Decision metrics that matter


SROI: A Four Step Process
think BLUE
Step 1: Determine Co-Benefits
–Determine key performance metrics
Step 2: Preliminary Analysis
–Research and analyze potential project performance
Step 3: Stakeholder Workshop
–Review methods, metrics and risks
Step 4: Quantitative Analysis
–Generate results for decision making


Application of SROI to Prioritizing Potential Strategies
think BLUE
Identify types of co-benefits (examples)
Ecosystem habitat
Visual aesthetics
Energy, Operations Savings
Air pollution reduction
Education / Stewardship
Identify methods of valuation
Select Practice
Established Equation
Quantified Impacts
Established Equation
Monetized Value of Co-Benefits
$$$


Alignment of Strategies to Co-Benefits
think BLUE
Economic
Environmental
Societal (Quality of Life)
Structural Strategy
(Examples)
Green roof
ROW bio-swales (with trees)
Large Bio-retention Facilities
Porous pavement
Measurable and Monetizable Benefit
Measurable Benefit
Perceived Benefit

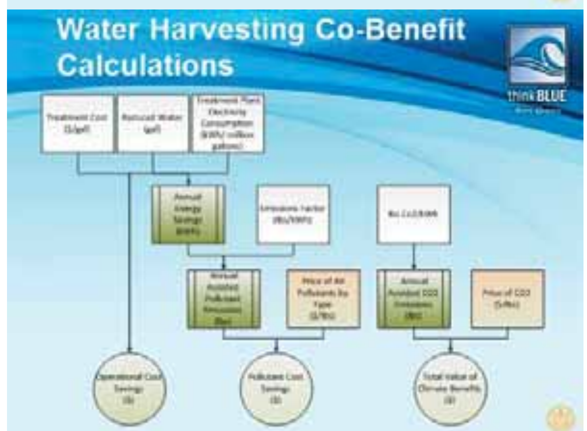

Potential Structural Strategies
think BLUE
• Green Infrastructure
– Green streets, permeable pavement etc
• Multiuse Treatment Areas
– Infiltration and detention basins, stream rehabilitation, etc
• Water Quality Improvement
– Trash segregation, Proprietary BMPs, etc


Co-Benefits of Green Streets
think BLUE
» Unit of Measure
» Street miles of improvements
» Drivers of Impact
» Water retained
» Type of improvement (trees, etc.)
» Key Co-Benefits
» Habitat creation
» Business investment
» Human health improvement
» Energy Reduction

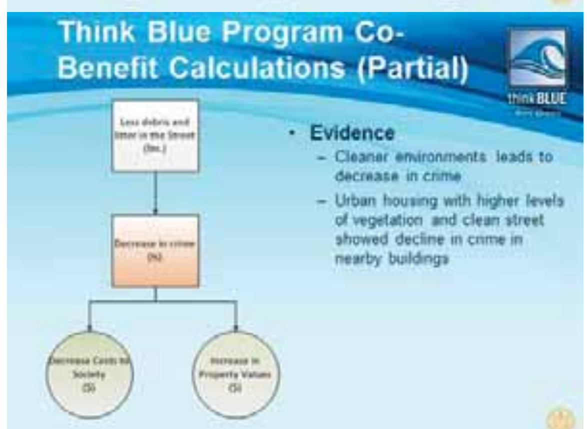

Green Streets Co-Benefit Calculations
think BLUE


Potential Non-Structural Strategies
think BLUE
» Increase # of structural systems
– Training, promotion, etc
» Improve structural systems performance
– Design codes, monitor, etc.
» Initiatives to change behavior
– Education, enforcement, outreach, reduced pesticides, etc
» Initiatives to reduce pollutants directly
– Street sweeping, protect natural areas, etc

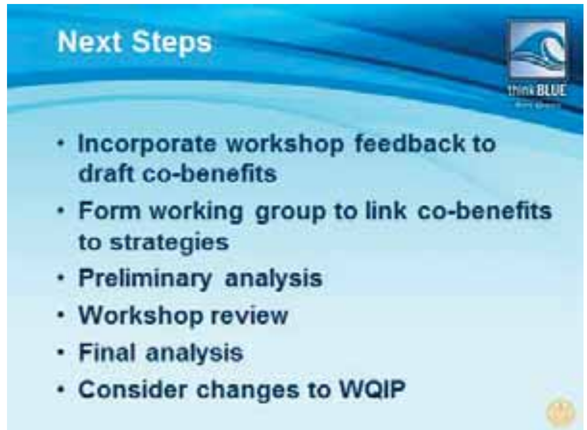

Co-Benefits of Water Harvesting Strategy
think BLUE
» Unit of Measure
» Reduction in stormwater runoff
» Drivers of Impact
» Less water processed
» Key Co-Benefits
» Reduced water consumption, less municipal water diversion
» Reduced energy use and air pollution, GHG impacts


Water Harvesting Co-Benefit Calculations
think BLUE


Co-Benefits of Education / Promotion of Think Blue Campaign
think BLUE
» Unit of Measure
» # of people reached
» Drivers of Impact
» # of people who reduce litter
» Key Co-Benefits
» Improved residential neighborhoods aesthetics
» Increase in business investment reduction in crime


Think Blue Program Co-Benefit Calculations (Partial)
think BLUE
• Evidence
– Cleaner environments leads to decrease in crime
– Urban housing with higher levels of vegetation and clean street showed decline in crime in nearby buildings


Breakout Session
Property Owners
Aesthetics
Flood Control
Business Investment
Environmental
Green House Gas Reductions
Habitat Creation
Soil Stabilization
General Public
Recreational
Human Health
Stewardship
Heat Island
Air Quality
Crime Reduction
Operational Cost Savings
Jobs
Other
?


Next Steps
• Incorporate workshop feedback to draft co-benefits
• Form working group to link co-benefits to strategies
• Preliminary analysis
• Workshop review
• Final analysis
• Consider changes to WQIP


Closing Remarks
Questions?
Thanks for your participation!

Workshop Handout:

Water Quality Improvement Plans Co-Benefits Description Workbook

Co-Benefit: Aesthetics

Description: Visually appealing environments in communities, especially neighboring properties

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties, Proximity to BMP, % increase in Property Value

Unit of Value: $ increase per property

Comments:

Co-Benefit: Air Quality

Description: Reduction of pollutants which cause health impacts

Unit of Measure: Tons of Pollutant

Drivers of Value: Reduction in Energy Use, Increase in Absorbtion of Air Pollutants

Unit of Value: $ per ton of pollutant reduced

Comments:

Co-Benefit: Business Development

Description: Increase in investment and revenue in clean, walkable environments

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties,

Proximity to BMP, % pedestrian activity

Unit of Value: $ increase in retail sales

Comments:

Co-Benefit: Crime Reduction

Description: Clean/green neighborhods reduce incidents

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, # of Affected Properties,

Proximity to BMP, % decrease in crime incidents

Unit of Value: $ per incident reduced

Comments:

Co-Benefit: Environmental Stewardship

Description: Increased awareness and environmental responsibility

Unit of Measure: # of persons educated

Drivers of Value: Population

Unit of Value: # of persons educated

Comments:

Co-Benefit: Flood control

Description: Reduced flood risk

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: $ Cost per flood

Unit of Value: $ per flood damage reduced

Comments:

Co-Benefit: Green House Gas Reduction

Description: Reduction of CO2

Unit of Measure: Tons of CO2

Drivers of Value: Reduction in Energy Use, Increase in Carbon Sequestration

Unit of Value: $ per ton of CO2 reduced

Comments:

Co-Benefit: Habitat Creation

Description: Protection or Creation of habitats

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: Acres of urban habitat protected/create

Unit of Value: $ per reduced heat related illness

Comments:

Co-Benefit: Heat Island Reduction

Description: Reduced ambient temperatures

Unit of Measure: Area of BMPs

Drivers of Value: # of Reduced Heating Degrees Days

Unit of Value: $ benefits from reduction in health

Comments:

Co-Benefit: Jobs

Description: Increase in # of local jobs in installation and maintenance

Unit of Measure: Capital & Maintenance Expenditures

Drivers of Value: $ spent

Unit of Value: Number of jobs created

Comments:

Co-Benefit: Operational Savings

Description: Reduction in energy use to process water

Unit of Measure: Gallons of water reduced

Drivers of Value: Cost per gallon processed

Unit of Value: $ per gallon of Water Reduced

Comments:

Co-Benefit: Public Health

Description: Reduced exposure to pesticides and other chemicals

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: # and Type of BMP, Ton of chemicals reduced

Unit of Value: $ per ton of chemicals reduced

Comments:

Co-Benefit: Recreation

Description: Increase in walkable environment

Unit of Measure: Size of recreational facility

Drivers of Value: Number of Recreational Users

Unit of Value: $ per recreational user

Comments:

Co-Benefit: Soil Stabilization

Description: Reduction in soil erosion

Unit of Measure: Area of BMPs or Reduction in Street Debris

Drivers of Value: Acres of Stabilized Soil, Cost of Land Damage

Unit of Value: $ per acre of soil protect

Comments:

Workshop Comments Received

	Structural		
	Green Infrastructure (co-benefits)	Multi-Treatment Areas	Water Quality Improvements
1	Given that on the mesas, we have mostly clay soils that do not absorb storm water runoff, some of these potentials are limited. However, implementation of cisterns, vegetated filter strips, etc. have the potential to * Decrease flood risks as water is released into existing creeks over a longer period of time * Improve habitat as habitat is changing due to excessive water from urban run off (especially dry weather run off) * Dry water flow diversions will also reduce the excessive flows in many of our streams (compared to historical conditions)		
2	Topographic Blending of BMP/IMP approaches: upper watershed, mid, lower, coast Need to think beyond MS4 Parkways/sidewalks as filters, volume reduction, peakflow	Athletic Fields Parks - temp flooding,sedmiment capture	Micro - capture/treat; avoid regional systems Let habitat/green space do treatment
3	Comprehensive approach to improve water quality, reduce storm runoff and dry weather flows while providing education/outreach, as well as improving quality of life (improved feeling of "wellness", reduction in health costs associated with polluted and/or stressful environments). Weight native landscapes (endemic to location) to give higher value than standard palette approach that uses species that excel in erosion control and/or coverage to meet landscaping sign off criteria as quickly as possible	Construct facilities (e.g. detention basins) that are specifically designed for the location versus "cookie-cutter" approach to design and implementation. Favor designs that can be passively converted back to native landscapes (e.g. basin becomes a wetland). Weight native landscapes (endemic to location) to give higher value than standard palette approach that uses species that excel in erosion control and/or coverage to meet landscaping sign off criteria as quickly as possible. Factor in maintenance needs (costs, access, mitigation, permits) and responsibilities into design and implementation. Consult with other divisions and departments within the City, as well as consultation with key stakeholder groups (neighboring communities, jurisdictions, NGOs that include	KEY CO-BENEFITS - Eliminating dry weather flows and reducing peak flows of storm runoff will provide a suite of co-benefits. Freshwater itself causes problems when inputs become perennial (e.g. habitat conversion, non-native species introduction and establishment, vector breeding habitat). More effective management and (hopeful) elimination of dry weather inputs could provide co-benefits by reducing the aforementioned impacts and assist in efforts to mitigate and, eventually, remediate them. Eliminating dry weather inputs will be needed for compliance for the Los Penasquitos Lagoon's Sediment TMDL, since restoring salt marsh habitat within the lagoon in areas recently converted to brackish/freshwater habitat is one of the key compliance targets. Eliminating dry weather flows will also assist in compliance with the County-wide bacteria TMDL, since many "hot spots" are created or exacerbated by dry weather flows. Peak flows of storm runoff augmented by MS4 design or placement can create

	Structural		
	Green Infrastructure (co-benefits)	Multi-Treatment Areas	Water Quality Improvements
		non-profit management entities) to avoid conflicts in BMP implementation that include violation of NPDES permits, TMDLs, downstream impacts to receiving water bodies and valued habitats, creation of breeding habitat for harmful vectors, etc. Follow a comprehensive approach that considers benefits and impacts of both individual BMPs and a network of BMPs implemented throughout the watershed, including 9 receiving water body and valued habitats. Avoid knee-jerk reaction of putting out fires at specific locations. Rather, develop a comprehensive and adaptive approach that can be phased in over time to address water-quality priorities throughout their stages (shortterm, mid-term, long-term), take advantage of windows of opportunities (e.g. grant funding ops) and efficiently use available funding while setting up justification for future (and, when needed continuous) funding needs.	another suite of nasty things with regard to water quality that include loaded and delivery of contaminants to receiving water bodies, as well as contribute greatly to erosion and downstream sedimentation that create additional maintenance costs (e.g. digging out a box culvert or clearing sediment from a street) and can impact sensitive habitats that include receiving water bodies. Managing peak flows will also be needed to comply with the Lagoon's sediment TMDL, the county-wide bacteria TMDL, and load reductions for constitutes of concern and other harmful pollutants (e.g. pyrethroids) that cause impacts but have yet to be labeled "constituent of concern." Co-benefits of water quality improvements will need to consider improving the conditions of receiving water bodies (reduced bacteria loads, loss of functional habitats native to the region) rather than box checking to meet compliance targets (reduction of % of load by certain date, sending X amount of educational fliers out to communities). This will most likely involve consideration of qualitative data at some point, which should be captured some how (e.g. using it to weight criteria or alternatives under consideration. 10 Need to internalize costs associated with unintended and/or offsite consequences. For example - habitat conversion or creation of vector breeding habitat as a result of lowflow diversion that simply moves dry weather runoff somewhere else instead of addressing source(s) of the dry weather flows.
4	Possible portable water purification systems that operates on solar/wind energy	Treat the water before it enters the main body of water (canal, creek, river, lagoon, bay, ocean) by means of detention ponds, catch basins, vaults, diversion systems, sump wells, or any underground storage unit.	Removing bacteria and metals that are associated with trash and run-off.
5			

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
1	Stream and/or habitat rehabiliation projects will increase biological diversity and provide more nature in our neighborhoods. Multi-treatment areas when focused on habitat restoration will enhance recreational opportunities, improve air quality, enhance aesthetics, contribute to heat island reduction, create jobs for upkeep and maintenance and providing living laboratories for our children to take their classroom learning into the field.		Initiatives to educate public and professional users of pesticides, herbicides and fertilizers will increase human health. Requiring interagency teams to deal with issues of homelessness will increase public safety while at the same time reducing feces and other toxic substances in our water. Initiatives to encourage proper disposal of pet waste will increase human health Initiatives to more quickly remove trash from recreational areas to keep them out of surface water will also improve recreational experiences and increase human health by limiting the amount of food available to rodents and hence reduce the rat population. Insuring that trash containers are available in all areas will keep trash out of surface water and will also improve recreational experiences and increase human health by limiting the amount of food available to rodents and hence reduce the rat population.	

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
2	School Cirriculum, Incentives			
3	Improve or replace existing MS4 structures before building new ones when feasible (the City cannot maintain what it has now, let alone new structures) Hire additional staff to manage permits and contracts to third-parties hired to assist Storm Water Division. improve enforcement actions (e.g. controlling dry weather runoff that meets water quality criteria or circumvents MS4 (e.g. freshwater mounding) but still creates impacts to receiving waters, such as habitat conversion, invasive plant establishment, breeding habitat for disease transmitting vectors).	Design and implement monitoring programs that make sense (e.g. answers questions or generates useful data) rather than just following programmatic lines. Review and enforce third-party agreements (e.g. HOAs maintaining private BMPs). Provide incentives to landowners and businesses to comply with hydromod requirements in areas already developed (and exempt from hydromod regs)	Coordinate with other stakeholder groups (e.g. NGOs) to help promote efforts that provide co-benefits to local communities and clarify/modify resource regulation that does not apply or should not in certain cases where lines of evidence support the effort over the regulation. Promote and incentivize native landscapes and water re-use	Improve controls over dry weather flows to address freshwater mounding and seepage into the MS4 or open space areas. Remove City infrastructure (e.g. MS4, sewer lines, water lines) from sensitive lands (e.g. Los Peñasquitos Lagoon).
	Include lessons learned from case studies regarding design, implementation and maintenance. Use site specific design and implementation rather than cookie-cutter approach to BMP and private properties (e.g. Hansen Agregate). Re-locate businesses built and operating in the flood zone (e.g. Sorrento Valley) as a longterm solution that is more cost-effective than annual maintenance and lawsuits.			

	Non-Structural			
	Increase Number of Structural Systems (co-benefits)	Improve Structural System Performance	Initiatives to Change Behavior (co-benefits)	Reduce Pollutants directly
4	Private properties, as mentioned by the participants of the meeting on May 20th. (My company has had the privilege or working with Barona Casino I Barona Creek Golf where we found that they recycle all or their water run-off including rain, pavement, parking structure, landscaping and irrigation, which they all filter into one pond system for treatment. In addition, they are in the process of building reservoirs.}	Retrofit new proprietary technologies into existing structures by enhancing performance, focusing on set goals of contaminants of concern as overseen by SDRWQCB, EPA, etc. (Quantum Ozone has retrofitted into an existing vault/Catch Detention System prior to entering into a State Park, into a County Flood Tunnel, and also into existing ponds/lakes/reservoirs. We are open to any county/city or private property that would be willing to co-venture on a pilot project.)	Research outside the box of standard set BMP guidelines, to more natural /innovative technologies that are not part of existing BMPs. For example, ozone is 3,125 times more powerful than chlorine, and the misconception of it being "harmful" is due to lack of education. When properly applied, ozone will not cause negative bi-products, as Quantum Ozone has proved by not producing one negative bi-product in 7 years. We are an ozone planet, constantly having 0.02 parts per million of ozone constantly around us naturally.	Ground level education and awareness to future generations (3rd grade on up) to have Environmental Stewardship as part of the school curriculum along with' history and math, so that the governments that they create in the future will have these ideas naturally implemented into city maintenance and daily living.
5				Strategy: Elimination, to the maximum extent possible, of toxic chemicals in the environment, including herbicides, pesticides, detergents, poisons, paints, and petrochemicals. Co-benefit: an urban ecosystem that supports, to the maximum extent possible, a functioning food web from micro organisms to invertebrates and vertebrates. Co-benefit: recreation and educational opportunities in the form of diverse and inter-dependent organisms to observe and study. Co--benefit: swimmable and fishable waters.

APPENDIX N

WMA Alternative Compliance Program Overview

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APPENDIX N. WMA ALTERNATIVE COMPLIANCE PROGRAM OVERVIEW

The 2013 San Diego National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater (MS4) Permit (R9-2013-0001) allows for implementation of offsite alternative compliance methods in lieu of meeting structural best management practice (BMP) design standards and/or hydromodification management criteria on the project site.

To implement an offsite alternative compliance program, a jurisdiction must first complete an optional Watershed Management Area Analysis (WMAA), as detailed in Permit Section B.3.b.(4). The San Diego County Responsible Agencies have collectively funded and provided guidance for development of a regional WMAA. Findings of the regional WMAA, specific to the Los Peñasquitos Watershed Management Area (WMA), are summarized in this appendix. The full WMAA will be attached as an appendix to the forthcoming *BMP Design Manual*, currently in development under direction from the Responsible Agencies.

In development of the Offsite Alternative Compliance Program framework, Responsible Agencies began with research of potential benefits and barriers to program implementation, as summarized in Sections N.1 and N.2. The sections following that discussion outline the selection of candidate sites and the program implementation schedule.

N.1 Alternative Compliance Program Benefits

The 2013 MS4 Permit (Permit) requirements will result in more priority development projects (PDPs), stricter criteria for onsite storm water retention, and larger hydromodification management facilities as compared to the 2007 Permit. The Responsible Agencies identified these factors as driving the need for offsite alternative compliance program implementation in the Los Peñasquitos WMA.

Alternative compliance methods can be implemented at the subwatershed scale (such as regional detention BMPs) or as green infrastructure BMPs (such as green streets). Regardless of scale, the Responsible Agencies acknowledged that offsite alternative compliance BMPs provide the opportunity to mitigate for pollutants not reliably retained on the project site or hydromodification impacts not reliably mitigated onsite per requirements detailed in Permit Sections E.3.c.(1) and E.3.c.(2). Note that onsite treatment control BMPs will still be required, though such BMPs would not be required to meet the onsite retention requirements.

Offsite alternative compliance methods can provide enhanced benefits for the watershed. For instance, facilities can be designed and customized to maximize targeted pollutant load reductions. If the facilities are located offsite and capable of filtering pollutants from larger contributing watershed areas, the pollutant removal effectiveness can be enhanced. Thus, such facilities could be used as part of total maximum daily load (TMDL) reduction strategies implemented at the watershed level.

N.2 Alternative Compliance Program Implementation Barriers

Implementation of an offsite alternative compliance program will require updates to jurisdictional ordinances and development of funding mechanisms, water quality credit systems, and payment structures. Funding options, which are outlined in Table N-1, should be developed to minimize jurisdictional financial risk and to guarantee funding of long-term maintenance activities at the offsite alternative compliance facility. The options should include provisions of jurisdictional responsibility in the event that planned projects do not move forward or projects do not meet funding responsibility after occupancy.

Table N-1
Funding Methods for Offsite Alternative Compliance Candidate Projects

Funding Option	Comment
In-lieu funding of candidate projects	Project applicant must follow the BMP construction and long-term maintenance payment structure to be developed by the jurisdiction.
Funding and construction of BMP water quality credits	Project applicant must follow the water quality credit structure and BMP construction and long-term maintenance payment structure to be developed by the jurisdiction. This could include a process for water quality credit banking and trading.
Funding to offset temporal mitigation of pollutant loads prior to construction of alternative compliance project	Project applicant must follow the temporal loading payment structure to be developed by the jurisdiction.

For Responsible Agencies to move forward with offering offsite alternative compliance options to land development applicants, it will be necessary to reduce sources of financial risk, public liability risk, and compliance risk through legal agreements and other mechanisms.

The Permit specifies a timing element regarding the amount of time that may lapse between the completion of development project construction and completion of construction for the offsite mitigation. Programs will need to establish some assurance that the development applicant will meet that timeline and that the Responsible Agency will not be subject to enforcement actions caused by the development applicant's failure to meet the timeline. A program must be established with sufficient staffing to prevent delays in approvals, funding releases, or contract procurement required by the Responsible Agency to facilitate implementation of the offsite compliance.

For private development, the Responsible Agency review process provides some assurance that the permanent BMPs are properly designed and constructed to comply with the performance requirements of the Permit. However, the developer and subsequent owner can be held responsible for corrective work if the BMPs are subsequently determined to be out of compliance with performance requirements of the

Permit. It will be necessary to give Responsible Agencies the same level of protection for any offsite BMPs used as compliance credit for the development project.

Bonding mechanisms can protect the Responsible Agencies from abandoned projects or other issues that could affect the private development. Similar mechanisms would need to be established for offsite BMPs if the Responsible Agency is relying on the development applicant to supply funds or provide construction.

There are public liability risks associated with any public improvements including the offsite BMPs as well as any associated improvements, such as sidewalks and traffic lanes for the alternative compliance site. Responsible Agencies will need to establish measures that prevent additional risk associated with the introduction of Green Infrastructure into public spaces and having a private entity design and construct non-standard designs within public lands and right-of-ways. One measure could the development of new design standards and standard drawings specific to Green Infrastructure in public spaces.

The obligation to maintain any offsite BMPs is essentially “into perpetuity.” Therefore, it will be necessary for Responsible Agencies to have durable mechanisms in place that can assure private development financing of maintenance well into the future. Historically, some mechanisms such as homeowner associations and maintenance assessment districts, have not always proven to be durable over long periods of time including the possibility of severe downturns in the economy. Proper maintenance of BMP facilities is essential to provide for the intended BMP function and to prevent health concerns resulting from potential vector issues.

Possible alternative compliance arrangements could include public-to-public (where a public agency is both the project owner and the owner of the land with the offsite BMP), private-to-private, and private-to-public. The mechanisms needed for a public-to-public arrangement, particularly if both sites are within the same agency, are much less than what might be required for private-to-public. Therefore, some Responsible Agencies might be able to exercise alternative compliance in a public-to-public arrangement before all of the assurance mechanisms necessary for private-to-public arrangements are in place.

Per Permit requirements, offsite alternative compliance facilities must be constructed within the Los Peñasquitos WMA and provide for a greater water quality benefit, as compared to implementation of structural BMPs at the project site. To assess the water quality benefit metric, the jurisdiction must either develop or adopt water quality equivalency standards. Development of these equivalency standards, which represents another barrier to program implementation, has begun at the regional level between representatives of the City of San Diego, the County of San Diego, Orange County, and Riverside County. Equivalency calculations will provide the metric by which watershed improvement is demonstrated.

N.3 Selection of Candidate Projects

Per Permit Section B.3.b.(4)(a), the WMAA must include geographic information system (GIS) mapping layers to characterize the watershed functions detailed in Table N-2. The Responsible Agencies have compiled these layers for potential use in selecting candidate project sites. Such detailed information provides for initial project planning guidance, but should be field verified since much of the information was generated using desktop methods.

Table N-2
WMAA GIS Mapping Layers

GIS Mapping Layer	Potential Use
Dominant hydrologic processes	Identify areas prone to overland flow or infiltration.
Existing stream condition	Identify stream bed material, geomorphic processes, flow regime.
Coarse sediment yield areas	Identify buffer areas to minimize reduction in sediment supply and subsequent hydromodification impacts.
Current and future land uses	Determine the developable footprint.
Existing channel structures	Identify flood control channels, grade control structures, and detention facilities that can significantly affect watershed response.

Within the Los Peñasquitos watershed, detailed stream assessments were prepared for Los Peñasquitos Creek, Poway Creek, Rattlesnake Creek, and Carroll Canyon Creek.

In addition to allowing for offsite alternative compliance program development, the WMAA findings can also help determine the feasibility of candidate projects for offsite alternative compliance implementation (Permit Section B.3.b.(4)(b)). Responsible Agencies compiled a list of candidate projects that include projects previously identified in Comprehensive Load Reduction Plans (CLRPs), Jurisdictional Runoff Management Plans (JRMPs), and other regulatory documents. The numeric goals of the Los Peñasquitos WMA are also being considered in candidate project selection. Consistent with the Permit, project types being considered are detailed in Table N-3.

Table N-3
Candidate Project Types

Project Type	Potential Mitigation Provided
Infrastructure retrofits	Best management practice (BMP) pollutant mitigation Hydromodification management
Green streets	BMP pollutant mitigation Hydromodification management
Regional BMPs	BMP pollutant mitigation Hydromodification management Floodplain management
Stream rehabilitation or restoration	Hydromodification management Floodplain management Natural water quality filtering
Riparian habitat rehabilitation or restoration	Biological resources
Groundwater recharge and water supply augmentation	Water resources BMP Pollutant mitigation Hydromodification management
Floodplain buffer land acquisition	Floodplain management Open space preservation Natural water quality filtering

This appendix and the Water Quality Improvement Plan will be updated to include the final candidate project list for future drafts, as that list is made available.

Responsible Agencies will use the results of the WMAA to develop the formal Offsite Alternative Compliance Program. As part of program development, Responsible Agencies will need to identify funding mechanisms, develop payment and credits structures, formulate water quality equivalency standards, and implement required ordinance updates. Consideration will also focus on the potential roles of regulatory agencies, such as the U.S. Army Corps of Engineers and the State Department of Fish and Wildlife, in helping to implement offsite alternative compliance facilities.

N.4 Alternative Compliance Implementation Schedule

Table N-4 summarizes milestones regarding the WMAA and potential Offsite Alternative Compliance Program initiation.

Table N-4
WMAA and Alternative Compliance Program Implementation

Milestone	Date
WMAA public outreach effort	July 2014 to September 2014
Watershed-specific WMAA GIS layers provided to Water Quality Improvement Plan groups	September 2014
Watershed specific WMAAs provided to Water Quality Improvement Plan groups	October 2014
Draft Water Quality Improvement Plan candidate project list	October 2014
BMP Design Manual submittal (with WMAA as attachment)	June 2015
Final Water Quality Improvement Plan submittal with watershed-specific WMAA attached	June 2015
Water quality equivalency standards—final document	December 2015
First potential approval of Offsite Alternative Compliance Program	To be determined

N.5 Los Peñasquitos WMAA Report and Attachments

The Los Peñasquitos WMAA report and attachments are included as Attachments N-1 and N-2. These documents were developed as part of a regional Copermittee effort and included a call for data for information to be included in the analysis. The WMAA documents were developed following criteria set forth in the MS4 Permit. Data included in the documents are intended for guidance purposes. Where more site specific data is available, then the more detailed information should be used.

The WMAA also provides an assessment of applicable exemptions to hydromodification management requirements, in addition to the Permit's allowed exemptions regarding direct discharges to exempt receiving waters including the Pacific Ocean, lakes, or reservoirs (or direct discharges to underground storm drains or concrete-lined channels directly discharging to the Pacific Ocean). For the Los Peñasquitos watershed, no additional potential exemptions are recommended with regard to exempt river reaches, stabilized conveyances, highly impervious watersheds, or tidally-influenced lagoons.

Candidate project lists currently available are provided in Attachment N-3.

Attachment N-1

Los Peñasquitos WMAA Report

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Los Peñasquitos
Watershed Management Area Analysis

Lake Henshaw

October 3, 2014

Prepared for:
San Diego County Copermittees

Prepared by:

Geosyntec consultants

RICK ENGINEERING COMPANY

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ACRONYMS AND ABBREVIATIONS

%	percent
>	greater than
<	less than
BMP	Best Management Practice
CB	Coarse Bedrock
CEG	Certified Engineering Geologist
CIP	Capital Improvement Project
CLRP	Comprehensive Load Reduction Plan
CSI	Coarse Sedimentary Impermeable
CSP	Coarse Sedimentary Permeable
E_P	Erosion Potential
ET	Evapotranspiration
FB	Fine Bedrock
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
FSI	Fine Sedimentary Impermeable
FSP	Fine Sedimentary Permeable
GIS	Geographic Information System
GLU	Geomorphic Landscape Unit
HA	Hydrologic Area
HCP	Hydromodification Control Plan
HMP	Hydromodification Management Plan
HRU	Hydrologic Response Unit
HSA	Hydrologic Sub Area
HSG	Hydrologic Soil Group
IRWM	Integrated Regional Water Management
JURMP	Jurisdictional Urban Runoff Management Plan
LDW	Land Development Workgroup
LID	Low Impact Development
MAP	Mean Annual Precipitation

ACRONYMS AND ABBREVIATIONS continued

MHPA	Multiple Habitat Planning Area
MS4	Municipal Separate Storm Sewer System
MSCP	Multiple Species Conservation Program
NED	National Elevation Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
PDP	Priority Development Project
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
SCAMP	Southern California Aerial Mapping Project
SCCWRP	Southern California Coastal Water Research Project
SD	San Diego
SDRWQCB	San Diego Regional Water Quality Control Board
S_P	Sediment Supply Potential
SSURGO	Soil Survey Geographic Database
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WMA	Watershed Management Area
WMAA	Watershed Management Area Analysis
WQIP	Water Quality Improvement Plan
WURMP	Watershed Urban Runoff Management Plan

1. Introduction

1.1. Background

On May 8, 2013 the California Regional Water Quality Control Board, San Diego Region adopted Order No. R9-2013-0001; NPDES No. CAS 0109266, National Pollutant Discharge Elimination System (NPDES) Permit and Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds within the San Diego Region (Regional MS4 Permit). The Regional MS4 Permit, which became effective on June 27, 2013, replaces the previous MS4 Permits that covered portions of the Counties of San Diego, Orange, and Riverside within the San Diego Region. There were two main goals for the Regional MS4 Permit:

1. To have more consistent implementation, as well as improve inter-agency communication (particularly in the case of watersheds that cross jurisdictional boundaries), and minimize resources spent on the permit renewal process.
2. To establish requirements that focused on the achievement of water quality improvement goals and outcomes rather than completing specific actions, thereby giving the Copermittees more control over how their water quality programs are implemented.

To achieve the second goal, the Regional MS4 Permit requires that Water Quality Improvement Plans (WQIPs) be developed for each Watershed Management Area (WMA) within the San Diego Region. As part of the development of WQIPs, the Regional MS4 Permit provides Copermittees an option to perform a Watershed Management Area Analysis (WMAA) through which watershed-specific requirements for structural BMP implementation for Priority Development Projects can be developed for each WMA. This report presents the Copermittees' approach and results for the regional elements of the WMAA developed for the San Diego County area.

1.2. Watershed Management Area Analysis (WMAA)

The Regional MS4 Permit, through inclusion of the WMAA, provides an optional pathway for Copermittees to develop an integrated approach for their land development programs by promoting evaluation of multiple strategies for water quality improvement and development of watershed-scale solutions for improving overall water quality in the watershed. The WMAA comprises the following three components as indicated in the Regional MS4 Permit:

1. Perform analysis and develop Geographic Information System (GIS) layers (maps) by gathering information pertaining to the physical characteristics of the WMA (referred to herein as WMA Characterization). This includes, for example, identifying potential areas of coarse sediment supply, present and anticipated future land uses, and locations of physical structures within receiving streams and upland areas that affect the watershed hydrology (such as bridges, culverts, and flood management basins).
2. Using the WMA Characterization results, compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects. Such projects may include, for example, opportunities for stream or riparian area

rehabilitation, opportunities for retrofitting existing infrastructure to incorporate storm water retention or treatment, or opportunities for regional BMPs, among others. Prior to implementing these candidate projects the Copermittees must demonstrate that implementing such a candidate project would provide greater overall benefit to the watershed than requiring implementation of the onsite structural BMPs. Note, compilation or evaluation of potential projects was not performed as part of this regional effort. Identification and listing of candidate projects will be performed for each WMA through the WQIP process for WMAs that elect to submit the optional WMAA as part of the WQIP.

3. Additionally, using the WMA Characterization maps, identify areas within the watershed management area where it is appropriate to allow for exemptions from hydromodification management requirements that are in addition to those already allowed by the Regional MS4 Permit for Priority Development Projects. The Copermittees shall identify such cases on a watershed basis and include them in the WMAA with supporting rationale to support claims for exemptions.

1.3. Scope of Work for Regional WMAA

In July 2013, the Copermittees elected to fund a regional effort to develop elements of the regional WMAA for the 9 San Diego-area WMAs within the County of San Diego that are currently subject to the Regional MS4 Permit, which include:

- Santa Margarita River (for portion in San Diego County)
- San Luis Rey River
- Carlsbad
- San Dieguito River
- Los Peñasquitos
- Mission Bay & La Jolla Watershed
- San Diego River
- San Diego Bay
- Tijuana River (for portion in San Diego County)

The regional-level information developed through this effort is intended to provide consistency across WMAs and serve as the foundation for developing watershed-specific information for each WMA to be developed through the WQIP process. The regional effort scope of work included:

1. Development of GIS map layers that characterize the WMAs using data previously collected, readily available, and provided by the Copermittees, including:
    a. Description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
    b. Description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;

   c. Current and anticipated future land uses;
   d. Potential coarse sediment yield areas; and
   e. Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.
2. Development of a Microsoft® Excel (Excel) template for use by Copermittees to compile lists of candidate projects for an optional alternative compliance program.
3. Development of additional criteria and analyses to support reinstating the following proposed exemptions that were originally developed in the approved 2011 Final Hydromodification Management Plan but not included in the Regional MS4 Permit unless provided by the Copermittees in the WMAA. In addition, development of the associated Hydromodification Applicability/Exemption Mapping.
   a. Exempt River Reaches including:
      i. San Diego River;
      ii. Otay River;
      iii. San Dieguito River;
      iv. San Luis Rey River; and
      v. Sweetwater River
   b. Stabilized Conveyance Systems Draining to Exempt Water Bodies
   c. Highly Impervious/Highly Urbanized Watersheds and Urban Infill, and
   d. Tidally Influenced Lagoons (where data/study provided)

The scope of work for the regional effort excluded performing analysis within the following areas unless data was readily available, as Copermittees do not have jurisdiction over these areas:

1. State Lands;
2. U.S. Departments of Defense land;
3. U.S. National Forest land;
4. U.S. Department of Interior land and
5. Tribal land

Additional description of excluded areas, for the purposes of the Regional WMAA, is indicated in Section 2.3 Land Uses.

1.4. Project Process

The process for developing the Regional WMAA included close coordination with the Land Development Workgroup (LDW) at key points during the project. The LDW is composed of the 21 San Diego-area Copermittees and serves to develop and implement regional land development plans and programs necessary to support the requirements of the Regional MS4 Permit. The consultant team (Geosyntec Consultants and Rick Engineering Company) presented preliminary project assumptions and methodologies proposed to be used to develop the Regional WMAA to meet the requirements of the Regional MS4 Permit in December 2013. The consultant team incorporated workgroup feedback from this meeting and subsequently presented the preliminary Regional WMAA project results to the LDW in March 2014, again to receive direction and incorporate input on the preliminary results. Subsequently, the draft report was released to the public in July 2014, by a public workshop that included Consultation Panel members from each of the WMAs on July 29, 2014. This version of the report including all of the input described above is being issued for optional inclusion into the respective WQIP Provision B.3 submittals to the SDRWQCB in December 2014.

1.5. Report Organization

This report is organized as follows:

- Chapter 1 provides the project background and purpose;
- Chapter 2 describes the technical basis for characterizing the WMA;
- Chapter 3 describes the template that can be used by Copermittees to compile the list of candidate projects;
- Chapter 4 summarizes the analyses performed to support reinstating select exemptions from hydromodification control requirements for PDPs;
- Chapter 5 presents the WMAA conclusions;
- Chapter 6 presents the references used for the WMAA;
- Attachment A presents the exhibits and additional supporting information for watershed management area characterization;
- Attachment B presents the exhibits and additional supporting information for hydromodification management applicability/exemptions;
- Attachment C expands on the structure of the geodatabase that hosts the GIS data developed by the WMAA; and
- Attachment D provides a crosswalk between the Regional MS4 Permit requirements for WMAA and this report.

1.6. Terms of Reference

The work described in this report was conducted by Geosyntec Consultants (Geosyntec) and Rick Engineering Company (RICK) on behalf of the County of San Diego and the regional Copermittees.

2. Watershed Management Area Characterization

Watershed health and function are strongly influenced by hydrological and geomorphological processes occurring in the watershed. Both hydrological response and geomorphological response of the watershed are dependent on a variety of physical characteristics of the watershed. To this end, the Regional MS4 Permit specifies a set of data that is required to adequately characterize overall watershed processes as a foundation to enhancing integration and effectiveness of watershed management and water quality programs. The following GIS map layers were developed to characterize the hydrological and geomorphological processes within the Los Peñasquitos WMA:

- Dominant Hydrologic Processes: A description of dominant hydrologic processes, such as areas where infiltration or overland flow likely dominates;
- Stream Characterization: A description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral;
- Land Uses: Current and anticipated future land uses;
- Potential Coarse Sediment Yield Areas; and
- Physical Structures: Locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins.

These GIS layers can be used to:

- Identify the nature and distribution of key macro-scale watershed processes;
- Identify potential opportunities and constraints for regional and sub-regional storm water management facilities that can play a critical role in meeting water quality, hydromodification, water supply, and/or habitat goals within the watershed;
- Assist with determining the most appropriate management actions for specific portions of the watershed; and
- Suggest where further study is appropriate.

2.1. Dominant Hydrologic Processes

The Regional MS4 Permit identifies in the provisions related to the WMAA that a description of dominant hydrologic processes within the watershed must be developed, with GIS layers (maps) as output. The Permit specifically calls for processes "*such as areas where infiltration or overland flow likely dominates*." These particular aspects of the hydrological mechanics of watersheds are particularly important when attempting to understand the macro-scale opportunities for locating projects that take advantage of either capturing overland flow for treatment or for infiltration.

Investigation of the dominant hydrologic processes in the San Diego-area watersheds indicates that evapotranspiration (ET) is the most dominant hydrologic process for the region based on review of a published study (Sanford and Selnick, 2013). ET is the sum of evaporation and plant transpiration in the hydrologic cycle that transports water from land surfaces to the atmosphere. This is conclusion is supported by comparing the 30-year average annual rainfall for the study area (San Diego County east of the peninsular divide) of between 15 and 18 inches per year (San Diego County, 2005) to the average annual ET rates. According to the California Irrigation Management Information System (CIMIS) Reference Evapotranspiration Map (CIMIS, 1999), the study area (within Zones 4, 6, and 9) experiences annual reference ET of 46.6, 49.7 and 59.9 inches, respectively. Therefore, theoretically, if all of the annual precipitation for the San Diego-area watersheds remained stationary where it fell and did not either infiltrate or runoff to local waterbodies where it would be conveyed downstream ultimately to the ocean, it all would be consumed by ET. As such, the effect of ET on the overall hydrologic processes within the San Diego watersheds is a function of the temporal scale over which it acts. Precipitation events often produce runoff in these watersheds, particularly in the urbanized portions, based on the topography and land cover that tend to accelerate the conveyance of runoff downstream rather than collecting, storing, or spreading out that then would maximize the effect of ET.

Because this study is focused on developing information and mapping for the portion of the hydrologic process that informs watershed management decisions, i.e., locating beneficial projects in areas of greatest opportunity, the next tier of dominant hydrologic processes are studied and mapped by this project. As such, the study area was characterized, based on the methodology described in the following section, according to the predicted fate of runoff within the watersheds being either overland flow or infiltration after considering the effects of ET (as well as an intermediate category of interflow). Areas that were mapped as overland flow do not necessarily preclude infiltration but rather indicate the dominant expected process that runoff would experience if not intercepted for the express purpose of infiltrating storm water runoff. The Model BMP Design Manual will provide more detailed guidance and procedures for determining the potential for infiltrating captured storm water at the project level irrespective of the mapping produced in the WMAA. To reiterate, the WMAA mapping is to provide macro-scale processes for high-level analysis and to inform decisions affecting regional scales. Furthermore, the Model BMP Design Manual will indicate the degree to which site-scale BMPs can expect to benefit from ET or how ET is considered in the sizing of BMPs. In brief, typical storm water BMPs only store water for a few days and therefore are not really capable of significant volume disposal through ET. However, pervious area dispersion (i.e., directing storm water runoff to flat areas for spreading and infiltration) has appreciable benefits with regard to ET and is a practice promoted in the BMP Design Manual.

The processes of interest are further defined as follows:

Overland flow: This process can be thought of as the inverse of infiltration; precipitation reaching the ground surface that does not immediately soak in must run over the land surface (thus, "overland" flow). It reflects the relative rates of rainfall intensity and the soil's infiltration capacity: wherever and whenever the rainfall intensity exceeds the soil's infiltration capacity, some overland flow will occur. Most uncompacted, vegetated soils have infiltration capacities of one to several inches per hour at the ground surface, which exceeds the rainfall intensity of even unusually intense storms. In contrast, pavement and hard surfaces reduce the effective infiltration capacity of the ground surface to zero, ensuring overland flow regardless of the meteorological attributes of a storm, together with a much faster rate of runoff relative to vegetated surfaces.

Infiltration and groundwater recharge: These closely linked hydrologic processes are most apparent near ephemeral and perennial conveyances in the San Diego region. Their widespread occurrence is expressed by the common absence of surface-water channels on even steep (undisturbed) hillslopes. Thus, on virtually any geologic material on all but the steepest slopes (or bare rock), infiltration of rainfall into the soil is inferred to be widespread, if not ubiquitous. With urbanization, changes to the process of infiltration are also quite simple to characterize: some (typically large) fraction of that once infiltrating water is now converted to overland flow.

Interflow: Interflow takes place following storm events as shallow subsurface flow (usually within 3 to 6 feet of the surface) occurring in a more permeable soil layer above a less permeable substrate. In the storm response of a stream, interflow provides a transition between the rapid response from surface runoff and much slower stream discharge from deeper groundwater. In some geologic settings, the distinction between "interflow" and "deep groundwater" is artificial and largely meaningless; in others, however, there is a strong physical discrimination between "shallow" and "deep" groundwater movement. Development reduces infiltration and thus interflow as discussed previously, as well as reducing the footprint of the area supporting interflow volume.

The datasets used, methodology for creating the dominant hydrologic processes maps, and the results are described in the sections below.

2.1.1. Datasets Used for identifying dominant hydrologic processes

The following datasets were used in the analysis:

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Soils Data	SanGIS	2013	NRCS (SSURGO) Database for San Diego County downloaded from SanGIS
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS

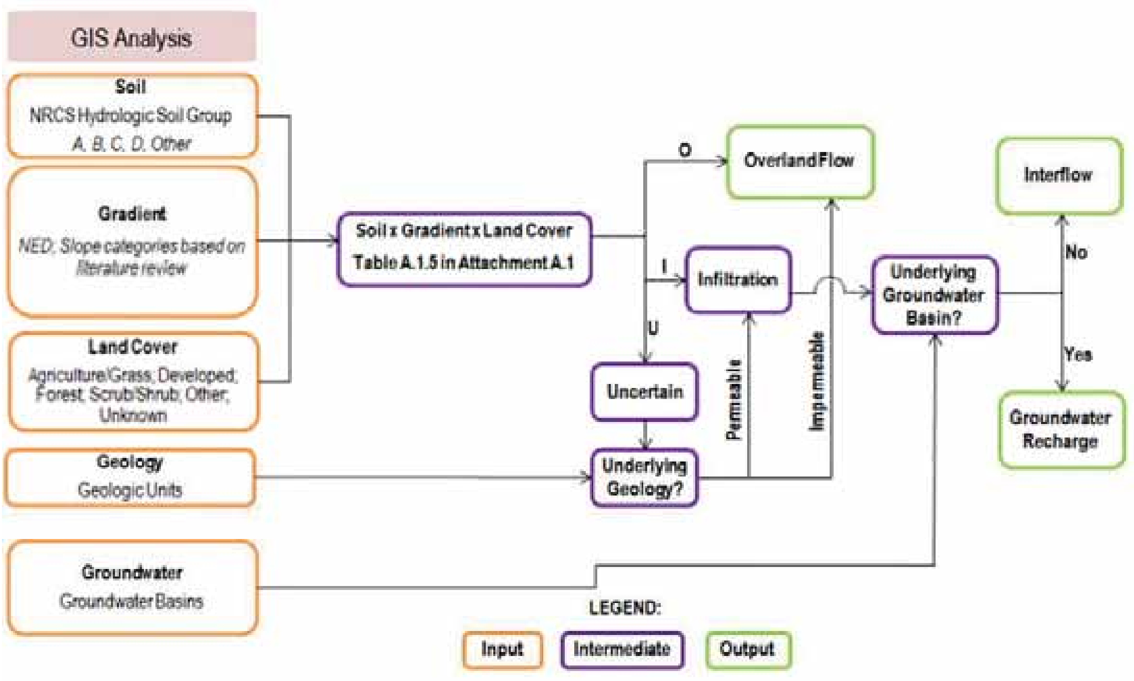
Dataset	Source	Year	Description
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30’x60’ Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30’x60’ Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30’x60’ Quadrangle, Southern California, United States Geological Survey, Southern California Aerial Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	“Geologic Map of California,” California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale
Groundwater Basins	SanGIS	2013	Groundwater Basins in San Diego County downloaded from SanGIS

2.1.2. Methodology/Assumptions/Criteria for identifying dominant hydrologic processes

The methodology used to describe dominant hydrologic processes is based on recommendations included in the Southern California Coastal Water Research Project’s (SCCWRP) Technical Report 605 titled “Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge” (SCCWRP, 2010). The foundation for this analysis was to incorporate the Report’s concept of grouping common hydrologic attributes into Hydrologic Response Units (HRUs). The report states the following:

> *“Grouping common hydrologic attributes across a watershed into a tractable number of Hydrologic Response Units (HRUs: a term first used by England and Holtan 1969) has become a well-established approach for condensing the near-infinite variability of a natural watershed into a tractable number of different elements. The normal procedure for developing HRUs is to identify presumptively similar rainfall–runoff characteristics across a watershed by combining spatially distributed climate, geology, soils, land use, and topographic data into areas that are approximately homogeneous in their hydrologic properties (Green and Cruise 1995, Becker and Braun 1999, Beven 2001, Haverkamp et al. 2005). As noted by Beighley et al (2005), this process of merging the landscape into discrete HRUs is a common and effective method for reducing model complexity and data requirements. Using watershed characteristics to predict runoff is the explicit task of hydrologic models, and there is a host of such models available for application to hydromodification evaluation. For purposes of “screening,” however, the goal is simplicity and ease of application even if the precision of the resulting analysis is crude.”*

The following process describes the methodology used to define Hydrologic Response Units (HRUs) and then relate the HRUs to the dominant hydrologic processes (i.e., overland flow, interflow, and groundwater recharge) in the Los Peñasquitos WMA.



The first step is to define the HRUs. Once these are defined, the remaining steps determine the dominant hydrologic process.

1. **Integrate data sets used to determine HRU**: Categories for soil type, gradient, and land cover were defined based on readily available GIS datasets for the region and classifications found in relevant literature, as indicated below. The different combinations of these three categories comprise the distinct HRUs.

   - **Soil Categories**: based on National Resource Conservation Service (NRCS) Hydrologic Soil Group (HSG) classifications, which are commonly used to describe runoff/infiltration potential of soils on a regional scale. These categories include: A, B, C, and D. HSG A soils have the lowest runoff potential, while HSG D soils have the highest runoff potential.

   - **Gradient Categories**: based on slope ranges found in a review of relevant literature identified in Chapter 6. The spatial processing of the slope categories utilized the United States Geologic Survey (USGS) National Elevation Dataset (NED). Slopes were grouped (bins) into the following ranges: 0% to 2%; 2% to 6%; 6% to 10%; and greater than 10%. The 2% and 6% slope thresholds were based on slope ranges included in Table A.1.1 (McCuen, 2005) presented in Attachment A.1. This table provides runoff coefficients as a function of slope, soil group, land cover, and return period and was used for subsequent steps in the mapping effort. The 10% slope threshold was used in SCCWRP's Technical

Report 605 (SCCWRP, 2010) and is a logical cutoff since slopes steeper than 10% are assumed to be dominated by overland flow.

- **Land Cover Categories**: were defined using the Ecology Vegetation GIS map layer developed by the City of San Diego, the County of San Diego and SANDAG and downloaded from SanGIS (2013). The vegetation categories in the GIS layer were grouped (Table A.1.2 in Attachment A.1) to match the following categories used in SCCWRP's Technical Report 605 (SCCWRP, 2010): Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water), and Unknown.

2. **Evaluate Land Cover**: Land cover categories for Agriculture/Grass, Forest, Scrub/Shrub and Other were related to land use categories defined in Table A.1.1 as shown in Table A.1.3 in Attachment A.1. Relating a land use category for the Developed land cover category was not necessary because all Developed cover was assumed to have overland flow as its dominant hydrologic process.

3. **Determine Hydrology Characteristics for Land Covers**: For each of the land cover/land use categories listed in Table A.1.3, the ratio of precipitation lost to evapotranspiration (i.e. an evapotranspiration coefficient) was estimated using Table A.1.1 using the process described below. Since precipitation is considered to be the sum of the resulting runoff, infiltration, and evapotranspiration, the coefficients for these three hydrologic pathways sum to one, as indicated below.

   Runoff Coefficient + Infiltration Coefficient + Evapotranspiration Coefficient = 1

   i) **Estimate Evapotranspiration**: To estimate the evapotranspiration (ET) coefficient for each land cover, first the runoff coefficient was identified in Table A.1.1 for the highest runoff potential (i.e., Group D soil and 6%+ slope) and most common storm conditions (i.e., storm recurrence intervals less than 25 years). The infiltration for these high runoff conditions was assumed to be negligible, resulting in an infiltration coefficient of zero. Since the sum of the three coefficients should sum to one, the ET coefficient was assumed to be the remaining difference (i.e., ET Coefficient = 1 – Runoff Coefficient). The ET coefficient calculated for the highest runoff potential was then applied to all soil types and slopes within that land use category. The calculated ET coefficient for each applicable HRU is provided in Table A.1.4 in Attachment A.1. The ET coefficient for HRUs that have a Developed land cover or a gradient greater than 10% were not calculated since these HRUs were assumed to have overland flow as the dominant hydrologic process.

   ii) **Estimate Infiltration**: The infiltration coefficient for each applicable HRU (i.e., combination of soil, gradient, and land cover) was estimated by subtracting both the runoff coefficient, provided in Table A.1.1, and the ET coefficient, calculated in step 3(i), from one (i.e., Infiltration Coefficient = 1 – Runoff Coefficient – ET Coefficient). The calculated infiltration coefficient for each applicable HRU is provided in Table A.1.4 in Attachment A.1.

   iii) **Estimate Runoff**: For each applicable HRU, the runoff coefficient was divided by the infiltration coefficient to obtain a ratio representing the potential for runoff or infiltration. The higher the ratio, the greater the potential for runoff to be a more dominant hydrologic process than infiltration. Similarly, the lower the ratio, the greater the potential for infiltration to be a more dominant hydrologic process than runoff. The calculated runoff to infiltration ratios are provided in Table A.1.4 in Attachment A.1.

4. **Associate Runoff and Infiltration to HRUs**: The following designations were assigned to each applicable HRU based on the runoff to infiltration ratio (i.e., runoff coefficient/infiltration coefficient). These designations were based on best engineering judgment with the underlying assumption that if a runoff or infiltration coefficient is more than 50% greater than its counterpart, then the prevailing process is considered dominant.

    - HRUs with runoff to infiltration ratios greater than 1.5 (3:2 ratio) were assumed to have relatively high runoff and overland flow was considered its dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process) in Tables A.1.4 and A.1.5 in Attachment A.1.
    - HRUs with runoff to infiltration ratios less than 0.67 (2:3 ratio) were assumed to have relatively high infiltration and its dominant hydrologic process was either interflow or groundwater recharge, based on analysis described in subsequent steps. These HRUs are designated by the letter "I" (Interflow is dominant process) in Tables A.1.4 and A.1.5.
    - For HRUs with runoff to infiltration ratios between, and including, 1.5 and 0.67 it was uncertain whether it was dominated by overland flow or infiltration. These HRUs are designated by the letter "U" (Dominant process is uncertain) in Tables A.1.4 and A.1.5.
    - For HRUs that have a Developed land cover or a gradient greater than 10%, the runoff to infiltration ratios were not calculated because these HRUs were assumed to have overland flow as the dominant hydrologic process. These HRUs are designated by the letter "O" (Overland flow is dominant process) in Table A.1.5.

5. **Uncertain HRUs Assignment**: For HRUs with an uncertain designation ("U") in Table A.1.5 in Attachment A.1, the underlying regional geology (Kennedy and Tan, 2002 & 2008; Todd, 2004 and Jennings et al., 2010) was used to evaluate whether overland flow or infiltration were dominant. If the underlying geology was considered impermeable, then these uncertain areas were considered to have overland flow as its dominant hydrologic process. If the underlying geology was considered permeable, then these uncertain areas were considered to be dominated by infiltration. The determination of whether a geologic unit is impermeable or permeable was based on desktop evaluation and the best professional judgment of a Certified Engineering Geologist (CEG). This analysis was performed in GIS and is illustrated in the flowchart above.

6. **Associate Infiltration HRUs with Known Groundwater Basins**: For HRUs with relatively high infiltration and have a designation of "I" in Table A.1.5 in Attachment A.1, the presence or absence of a regional groundwater basin (SanGIS, 2013) underlying these areas determined whether the dominant hydrologic process was designated as interflow or groundwater recharge. The groundwater recharge hydrologic process was assigned as dominant for those applicable areas which had an underlying groundwater basin. The interflow hydrologic process was assigned as dominant for those applicable areas which did not have an underlying groundwater basin directly below it. This analysis was performed in GIS and is illustrated in the flowchart above.
7. **Resulting HRU Data:** The resulting GIS map of dominant hydrologic processes was reviewed by engineering professionals familiar with the hydrology in the County of San Diego to confirm that the mapping is consistent with their experience working in the region.

2.1.3. Results for identifying dominant hydrologic processes

The resulting GIS map showing the spatial distribution of dominant hydrologic processes (i.e., overland flow, interflow, and groundwater recharge) within the Los Peñasquitos WMAs is provided in Attachment A.1. An ArcMap document file which presents the results from each step of the methodology is included in Attachment C, as well as a Google Earth KMZ file. Based on this analysis, overland flow is the predominant hydrologic process in all this WMA, which is consistent with the experience of engineering professionals familiar with the hydrology of the County of San Diego.

Summary of Deliverables for Dominant Hydrologic Processes

Format	Item	Description	Location
Report	Figure	"Dominant Hydrologic Processes"	Attachment A.1
GIS	Map Group Title	Hydrologic Processes	Attachment C.1
	Map Layer Title	Soil Land Cover Slope Hydrologic Response Unit Initial Rating Permeability Groundwater Basin Dominant Hydrologic Processes	
	Geodatabase Feature Dataset	HydrologicProcesses	
	Geodatabase Feature Class	HRUAnalysis	
	Geodatabase Geometry Type	Polygon	
KMZ [1]	KMZ File Name	Dominant Hydrologic Processes	Attachment C.2

[1] To enhance the utilization of this data, the Dominant Hydrological Processes map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

2.1.4. Limitations for identifying dominant hydrologic processes

The resulting GIS map layer only lists the dominant hydrological process (i.e., an HRU assigned a dominant process of overland flow can also experience small amounts of infiltration) and provides a useful, rapid framework to perform screening-level analysis that is appropriate for watershed-scale planning studies. When more precise estimates are required for a particular site and subarea it is recommended that this analysis be augmented with site-specific analysis.

2.2.Stream Characterization

For the purpose of WMAA, the Regional MS4 Permit requires a description of existing streams in the watershed, including bed material and composition, and if they are perennial or ephemeral. Under the Regional WMAA, this analysis was prepared for 27 streams throughout the San Diego Region agreed upon by the consultant team and Copermittees. Within the Los Peñasquitos WMA, stream characterization and detailed mapping is provided for Los Peñasquitos / Poway Creek, Rattlesnake Creek, and Carroll Canyon Creek as shown on the exhibit titled "Watershed Management Area Streams" located in Attachment A.2.

2.2.1. Datasets Used for stream characterization

The following data were referenced for the purpose of stream characterization:

- USGS National Hydrography Dataset, downloaded from USGS November 2013
- USGS 7.5-minute quadrangles, compiled image of quadrangles covering San Diego County, various dates
- Floodplains: "National Flood Hazard Layer," provided by Federal Emergency Management Agency October 2012
- Various datasets provided by Copermittees depicting existing storm water conveyance infrastructure within their jurisdictions.
- Aerial photography by Digital Globe dated 2012

2.2.2. Methodology/Assumptions/Criteria for stream characterization

The analysis was prepared by digitizing each of the 27 streams based on review of data listed above. Within the pre-existing datasets depicting streams, floodplains, or infrastructure, no single dataset included a complete, accurate alignment of each stream. Digitizing the streams based on review of all of the data listed above allowed creation of GIS linework with a continuous corrected alignment for each stream. The following data were recorded as GIS attributes for each stream as the stream was digitized:

- River name
- Reach type (engineered or natural, constrained or un-constrained)
- Bed material
- Bank material
- Hydrographic category (perennial or intermittent)

The attributes listed above were collected manually based on interpretation of the reference data. Assumptions used in making the interpretations are listed below. The ***Hydrographic Category*** section below will provide the rationale as to why perennial and intermittent were the hydrographic categories chosen for this WMAA and not perennial and ephemeral.

Note that stream classification was not prepared within areas of Federal/State/Indian lands unless data was readily available. Stream lines were prepared within these areas for continuity, but some data fields were not populated within these areas.

Reach Type

Streams were classified as either engineered or natural, and either constrained or un-constrained. See the exhibit titled, "Watershed Management Area Streams by Reach Type" in Attachment A.2. The purpose of this exercise was to identify whether the stream has been modified by human activity within the stream itself, which may include addition of crossing structures, stabilization of banks, dredging, or any other human activity. This aids the identification of physical structures including stream armoring, constrictions, grade control, and other modifications as required by the Regional MS4 Permit.

Classification of the streams as either "**engineered"** or **"natural"** was based on the following criteria:

Engineered

- A classification of "engineered" was assigned where the stream itself has been modified by human activity.
- All culvert/bridge/pipe crossings either provided in the Copermittes' storm water conveyance system data or clearly visible on the aerial photo have been assigned as engineered within the limits of the crossing.
- If the Copermittees did not provide storm water conveyance system data for the dirt road crossings/dip sections the streams have been assigned as engineered within the limits of the crossing. These crossings may or may not have culverts.
- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, they were assigned as engineered.
- Golf courses have been assigned as engineered.
- If aerial photography showed large water bodies (lake, pond, irrigation pond, etc.) they were assigned as engineered.
- If the storm water conveyance system data provided by the Copermittees has identified the stream as "rockbs", the assumption has been made that these streams have rocks on their bottom and the sides ("bs"), and have been assigned as engineered.
- Sand mining operations have been assigned as engineered. Sand mining is an operation that is in continuous flux and does not typically result in a discrete, engineered geometry in any given channel cross section until restoration is implemented at the conclusion of the sand mining operation. It is assigned as engineered to acknowledge human alteration of the stream.

Natural

- Streams that have no apparent alteration within the stream itself by human activity have been assigned as natural.

Classification of the streams as either **"constrained"** or **"un-constrained"** was based on the following criteria:

Constrained

- All culvers/bridge/pipe crossings either provided in the Copermittes' storm water conveyance system data or clearly visible on the aerial photo have been assigned as constrained.
- If the Copermittees did not provide storm water conveyance system data for the dirt road crossings/dip sections the streams have been assigned as constrained. These crossings may or may not have culverts.
- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, they were assigned as constrained.
- Golf courses have been assigned as constrained if located within the Federal Emergency Management Agency (FEMA) floodway based on the "National Flood Hazard Layer" data.
- The USGS National Hydrographic Dataset in their hydrographic category had assigned some reaches as artificial paths. In these situations and if the aerial photography shows large water bodies (lake, pond, irrigation pond, etc.) these streams have been assigned as constrained.
- Sand mining operations located within the FEMA floodway based on the "National Flood Hazard Layer" have been assigned as constrained.

Un-constrained

- Golf courses have been assigned as un-constrained if not located within the FEMA floodway based on the "National Flood Hazard Layer" data.
- Sand mining operations not located within the FEMA floodway based on the "National Flood Hazard Layer" data have been assigned un-constrained.
- If the stream is located within the FEMA floodway based on the "National Flood Hazard Layer" and there is available land in the floodway fringe (the area between the floodway and the 100-yeaer floodplain) the area has been assigned un-constrained. Note that there may be only one side or both sides of the stream with available land in the floodway fringe therefore a note was added as to which side of the stream is constrained and un-constrained.
- If the stream is located within a FEMA 100-year floodplain based on the "National Flood Hazard Layer" data with no floodway and the FEMA floodplain width is not within an existing development or bordered by roads have been assigned as un-constrained.

Bed Material and Bank Material

The following bed and bank materials were identified:

- Concrete
- Riprap
- Pipe / culvert
- Earth

The assumptions made to identify the streams bed and bank materials were based on the following criteria:

- If the data provided by the Copermittees provided information about the stream bed and bank material, the provided data was used for the bed and bank material.
- Generally the data provided by the Copermittees did not identify the crossing type (pipe, box culvert, bridge with or without piers, etc.) or the material (RCP, RCB, earth, riprap, concrete, etc.). In that case, all culvert/bridge/pipe crossings were assigned as pipe/culvert for the bed and bank material.
- If the Copermittees did not provide data for the dirt road crossings/dip sections the bed and bank material have been assigned as pipe/culvert. These crossings may or may not have culverts.
- If the Copermittees' storm water conveyance system data stated the facility is a detention or desilting basin, the bed and bank material have been assigned as earth.
- If aerial photography showed large water bodies (lake, pond, irrigation pond, etc.) they were assigned as earth bed and bank material. The USGS National Hydrographic Dataset in their hydrographic category had assigned some of these types of reaches as artificial paths.
- Sand mining operations within the stream have been assigned as earth for bed and bank material.
- If the Copermittees did not provide data for the stream material the bed and bank material have been assigned based on the aerial photography.

See exhibits titled, "Watershed Management Area Streams by Bed Material" in Attachment A.2.

After stream bed and bank material was classified, earthen reaches were further classified by geologic group. This was accomplished by intersecting the streams with the geologic group layer that had been prepared for use in the dominant hydrologic process and potential coarse sediment yield analyses. The result is displayed in exhibits titled, "Watershed Management Area Streams by Geologic Group" in Attachment A.2.

Hydrographic Category

Streams were classified as "perennial" or "intermittent." See exhibits titled, "Watershed Management Area Streams by Hydrographic Category" in Attachment A.2. Classification was obtained from the USGS National Hydrography Dataset (NHD). The definitions of these categories in the USGS National Hydrography Dataset are:

- **Perennial**: Contains water throughout the year, except for infrequent periods of severe drought.
- **Intermittent**: Contains water for only part of the year, but more than just after rainstorms and at snowmelt.

While the specific Regional MS4 Permit language requested classification of perennial or ephemeral, rather than perennial or intermittent, the data that was referenced in order to classify streams did not include "ephemeral" streams. For reference, the USGS National Hydrography Dataset definition of "ephemeral" is: "contains water only during or after a local rainstorm or heavy snowmelt." None of the stream reaches in the study were classified as ephemeral in the NHD dataset, therefore none are classified as ephemeral in the WMAA product. The City of San Diego provided a map titled “City of San Diego Stream Survey” dated April 3, 2013 prepared by AMEC that shows streams that are “dry” and streams that are “flowing”. This information in conjunction with the other parameters listed in this section was used to determine if a stream was perennial or intermittent.

USGS NHD includes hydrographic category classification for many of the streams. However data was not available for all reaches of all streams. In order to classify reaches of streams that did not already contain this data in NHD, these assumptions were made:

- The USGS NHD information for the stream hydrographic category has been used when available.
- When USGS NHD has “artificial paths” for portions of the stream, the hydrographic category of the upstream portion of the stream have been assigned to the stream unless other assumptions took precedence.
- If aerial photography shows large waterbody (lake, pond, irrigation pond, etc.) perennial has been assumed for the hydrographic category.
- For ponded areas shown on the aerial photography and if the USGS 7.5-minute quadrangles shows cross hatching for the area, intermittent has been assigned unless the upstream portion of the stream was assigned as perennial pursuant to the USGS National Hydrography Dataset then assigned perennial for the ponded area.
- USGS has a dashed line for intermittent streams. USGS has a solid line for perennial streams. In some situations this information was used to assist in the determination of assigning perennial or intermittent to a stream.

2.2.3. Results for stream characterization

The 27 streams and data are contained in a GIS file titled "SD_Regional_WMAA_Streams" located in Attachment C. The streams are shown in watershed maps included in Attachment A.2.

Summary of Deliverables for Stream Characterization

Format	Item	Description	Location
Report	Title of Figures	• "Watershed Management Area Streams" • "Watershed Management Area Streams by Hydrographic Category" • "Watershed Management Area Streams by Bed Material" • "Watershed Management Area Streams by Geologic Group" • "Watershed Management Area Streams by Reach	Attachment A.2

Format	Item	Description	Location
		Type"	
GIS	Map Group Title	Not Grouped	Attachment C.1
	Map Layer Title	SD_Regional_WMAA_Streams	
	Geodatabase Feature Dataset	Streams	
	Geodatabase Feature Class	SD_Regional_WMAA_Streams	
	Geodatabase Geometry Type	Line	
KMZ [1]	KMZ File Name	SD_Regional_WMAA_Streams	Attachment C.2

[1] To enhance the utilization of this data, the Stream Characterization map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

In addition to the 27 streams that were subject of detailed analysis, NHD streams have been included on maps and within the geodatabase for reference. The NHD stream alignments have not been corrected and in some cases may be inconsistent with the existing infrastructure. The NHD streams are contained in a GIS file titled, "SD_NHD_Streams."

2.2.4. Limitations for stream characterization

- Only a desktop analysis was performed and no field verification was conducted.
- Infrastructure is only based on storm water conveyance system data provided by Copermittees or clearly visible on aerial photography. If the Copermittee used a numbering or lettering system for describing bed and bank material for example, since the metadata was not provided the bed and bank material could not be verified.
- In some instances concrete channels cannot be identified on aerial photography if it is filled with sediment and/ or vegetation.

2.3.Land Uses

For the purpose of the WMAA, the Regional MS4 Permit requires a description of current and anticipated future land uses. This is presented in the final GIS deliverable as "Land Use Planning" and includes the following representations of land uses in the watersheds: existing land uses, planned land uses, developable lands, redevelopment and infill areas, floodplains, Multiple Species Conservation Program (MSCP) designated areas, and areas not within the Copermittees' jurisdictions (tribal lands, state lands, and federal lands).

2.3.1. Datasets Used for land uses

The following existing regional datasets were referenced to meet this requirement:

- Municipal boundaries: "Municipal_Boundaries" dated August 2012, available from SanGIS/SANDAG
- Ownership: "Parcels" dated December 2013, available from SanGIS/SANDAG
- Existing land use: "SANGIS.LANDUSE_CURRENT" dated December 2012, available from SanGIS/SANDAG (existing land use)
- Planned land use: "PLANLU" (Planned Land Use for the Series 12 Regional Growth Forecast (2050)), dated December 2010, available from SanGIS/SANDAG
- Developable land: "DEVABLE" (Land available for potential development for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Redevelopment and infill areas: "REDEVINF" (Redevelopment and infill areas for the Series 12 Regional Growth Forecast), dated December 2010, available from SanGIS/SANDAG
- Floodplains: "National Flood Hazard Layer" provided by Federal Emergency Management Agency October 2012
- Multiple Species Conservation Program (MSCP), total of four datasets available from SanGIS/SANDAG: "MHPA_SD," dated 2012, (Multiple Habitat Planning Areas for City of San Diego); "MSCP_CN," dated 2009 (designations of the County of San Diego's Multiple Species Conservation Program South County Subregional Plan); "MSCP_EAST_DRAFT_CN," dated 2009 (draft East County MSCP Plan); and "Draft_North_County_MSCP_Version_8.0_Categories," dated 2008 (draft North County MSCP Plan)

2.3.2. Methodology/Assumptions/Criteria for land uses

The existing regional datasets for existing land use, planned land use, developable land, redevelopment and infill areas, floodplains, and MSCP designated areas were referenced with no modifications. Areas not within the Copermittees' jurisdictions (tribal lands, state lands, and federal lands) were compiled from SanGIS parcel data (December 2013) based on the "ownership" value. The owners listed below were excluded from the Copermittees jurisdictions and represent the "Federal/State/Indian" layer, which is displayed on various maps included in Attachment A.2.

- Bureau of Land Management
- California Department of Fish and Game
- Indian Reservations
- Military Reservations

- Other Federal
- State
- State of California Land Commission
- State Parks
- U.S. Fish and Wildlife Service
- U.S. Forest Service

When available, relevant data from these areas was included in analyses (e.g., developable land areas within Federal/State/Indian areas). Stream lines were prepared within these areas for continuity. However, stream classification (e.g., bed and bank material) was not prepared within these areas unless data was readily available (e.g., hydrographic category data available from NHD)

2.3.3. Results for land uses

The existing regional datasets are compiled into the Geodatabase in a group titled, "Land Use Planning." Current and anticipated future land uses are depicted in watershed maps included in Attachment C. Federal/State/Indian Lands are also referenced on all other map exhibits included in Attachment A.2.

Summary of Deliverables for Land Uses

Format	Item	Description	Location
Report	Title of Figures	• "Existing Land Use" • "Planned Land Use" • "Developable Land" • "Redevelopment and Infill Areas"	Attachment A.3
GIS	Map Group Title	Land Use Planning	Attachment C.1
	Map Layer Title	Municipal Boundaries Federal/State/Indian Lands SanGIS_ExistingLandUse SanGIS_PlannedLandUse SanGIS_DevelopableLand SanGIS_RedevelopmentandInfill FEMA Floodplain MHPA_SD MSCP_CN MSCP_EAST_DRAFT_CN Draft_North_County_MSCP_Version_8_Categories	
	Geodatabase Feature Dataset	LandUsePlanning	
	Geodatabase Feature Class	SanGIS_MunicipalBoundaries Federal_State_Indian_Lands SanGIS_ExistingLandUse SanGIS_PlannedLandUse	

Format	Item	Description	Location
		SanGIS_DevelopableLand SanGIS_RedevelopmentandInfill FEMA_NFHL SanGIS_MHPA_SD SanGIS_MSCP_CN SanGIS_MSCP_EAST_DRAFT_CN SanGIS_Draft_North_County_MSCP_Version_8_Categories	
	Geodatabase Geometry Type	Polygon	
KMZ [1]	KMZ File Name	Municipal Boundaries Federal/State/Indian Lands Floodplains Due to file size limitations, SanGIS land use datasets were not converted to KMZ.	Attachment C.2

[1] To enhance the utilization of this data, the Land Uses map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

2.3.4. Limitations

Some jurisdictions may have compiled GIS land use layers that include more detailed or more current information than the regional datasets available from SanGIS. SanGIS layers were selected for the Regional WMAA to provide consistent land use characterization region-wide, and to provide for repeatability of GIS analyses when a land use layer is required for input data. The definition of non-Copermittee areas identified in this document as "Federal/State/Indian Lands" is for the Regional WMAA. Some WQIPs may define non-Copermittee areas differently.

2.4. Potential Critical Coarse Sediment Yield Areas

The Regional MS4 Permit identifies in the provisions related to the WMAA that potential coarse sediment yield areas within the watershed be identified, with GIS layers (maps) as output. With regard to the function and importance of coarse sediment, SCCWRP Technical Report 667 titled "Hydromodification Assessment and Management in California" states the following:

"Coarse sediment functions to naturally armor the stream bed and reduce the erosive forces associated with high flows. Absence of coarse sediment often results in erosion of in-channel substrate during high flows. In addition, coarse sediment contributes to formation of in-channel habitats necessary to support native flora and fauna."

This report identifies the potential critical coarse sediment yield areas for the Los Peñasquitos WMAs in compliance with this permit provision. The applied datasets and methodologies for identifying the coarse sediment yield areas, along with their respective results, are described in the sections below.

2.4.1. Datasets Used for identifying potential critical coarse sediment yield areas

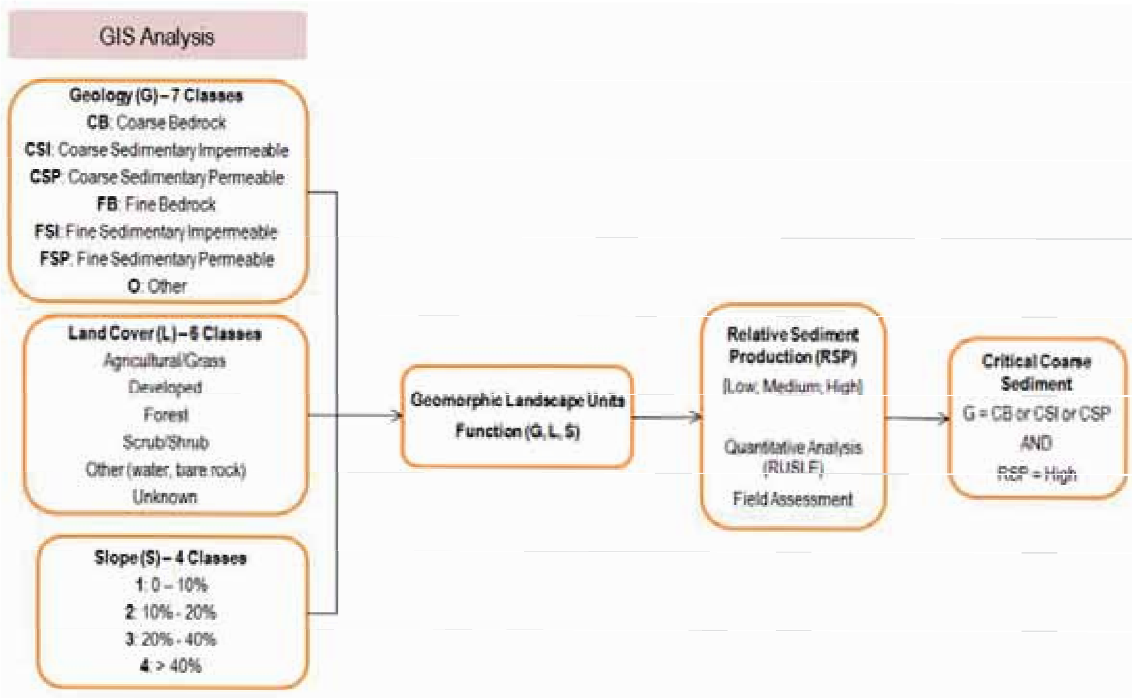
The following datasets were used in the analysis

Dataset	Source	Year	Description
Elevation	USGS	2013	1/3rd Arc Second (~10 meter cells) digital elevation model for San Diego County
Land Cover	SanGIS	2013	Ecology-Vegetation layer for San Diego County downloaded from SanGIS
Geology	Kennedy, M.P., and Tan, S.S.	2002	Geologic Map of the Oceanside 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 2, 1:100,000 scale.
	Kennedy, M.P., and Tan, S.S.	2008	Geologic Map of the San Diego 30'x60' Quadrangle, California, California Geological Survey, Regional Geologic Map No. 3, 1:100,000 scale.
	Todd, V.R.	2004	Preliminary Geologic Map of the El Cajon 30'x60' Quadrangle, Southern California, United States Geological Survey, Southern California Areal Mapping Project (SCAMP), Open File Report 2004-1361, 1:100,000 scale.
	Jennings et al.	2010	"Geologic Map of California," California Geological Survey, Map No. 2 – Geologic Map of California, 1:750,000 scale

2.4.2. Methodology/Assumptions/Criteria for identifying potential critical coarse sediment yield areas

The methodology used to identify coarse sediment yield areas is based on Geomorphic

Landscape Unit (GLU) methodology presented in the SCCWRP Technical Report 605 titled "Hydromodification Screening Tools: GIS-Based Catchment Analyses of Potential Changes in Runoff and Sediment Discharge" (SCCWRP, 2010). Geomorphic Landscape Units characterize the magnitude of sediment production from areas through three factors judged to exert the greatest influence on the variability on sediment-production rates: geology types, hillslope gradient, and land cover. The GLU approach provides a useful, rapid framework to identify sediment-delivery attributes of the watershed. The process to integrate these factors into GLUs is indicated in the flow chart below.



The following steps were used to define Geomorphic Landscape Units (GLUs), which were then related to the coarse sediment and critical coarse sediment yield areas in the Los Peñasquitos WMA.

1. **Integrate data sets used to determine GLU:** Categories for geology, gradient, and land cover were defined based on readily available GIS datasets for the region and classifications found in relevant literature listed in Chapter 6. The different combinations of these categories make up distinct GLUs.

   - **Geologic Categories**: based on methodology listed in Attachment A.4.1 of Attachment A.4. Resulting geologic categories from this analysis are: Coarse Bedrock (CB), Coarse Sedimentary Impermeable (CSI), Coarse Sedimentary Permeable (CSP), Fine Bedrock (FB), Fine Sedimentary Impermeable (FSI), Fine Sedimentary Permeable (FSP), and Other (O). An exhibit showing the regional geology groupings is presented in Attachment A.4.

- **Land cover categories**: defined using the Ecology Vegetation GIS map layer developed by the City of San Diego, the County of San Diego and SANDAG which were downloaded from SanGIS (2013). The vegetation categories in the GIS layer were grouped (Table A.1.2 in Attachment A.1) to match the following categories used in SCCWRP's Technical Report 605 (SCCWRP, 2010): Agriculture/Grass; Developed; Forest; Scrub/Shrub, Other (Water) and Unknown.

- **Gradient Categories**: based on slope ranges found in a review of relevant literature (GLU methodology applied in California) listed in Chapter 6. The spatial processing of the slope categories utilized the USGS National Elevation Dataset (NED). Slope ranges used include: 0% to 10%, 10% to 20%, 20% to 40%, and greater than 40%.

2. **GLU Union Results**: GIS mapping exercise for the study area resulted in 166 GLUs within the 9 WMAs in San Diego County. Table A.4.2 in Attachment A.4 provides the list of the 166 GLUs.

For implementing hydromodification management performance standards in the Regional MS4 Permit, the Copermittees need to identify Critical Coarse Sediment Yield areas in the study region. To provide information on the identification of Critical Coarse Sediment yield, the study assumed that critical coarse sediment would be generated from GLUs that are composed of geologic units likely to generate coarse sediment (based on the methodology listed in Step 3) and have the potential for high relative sediment production (as estimated using the methodology listed in Step 4).

3. **Define Pertinent Geologic groups**: the geologic groups (Attachment A.4.1) considered in this study to have the potential to generate coarse sediment are Coarse Bedrock (CB), Coarse Sedimentary Impermeable (CSI), and Coarse Sedimentary Permeable (CSP). An exhibit showing the regional geologic grouping is presented in Attachment A.4.

4. **Relate GLU to Sediment Production**: For assigning GLUs with a relative sediment production, the following methodology was utilized:

   - Conducted quantitative analysis to assign relative sediment production. Analysis was performed based on the assumption that sediment production from an area is proportional to the soil loss from the area, as evaluated using standard soil loss equation. Detailed analysis steps are documented in Attachment A.4.2;

   - To validate the quantitative assignment above, a qualitative field assessment was conducted for 40 sites. Site selection and findings from the field assessment is documented in Attachment A.4.3.

   - The result of the field assessment indicated a 65% match between field conditions and the quantitative assignments. The mismatches are attributed to differences in percent land cover as assumed for the quantitative analysis and those observed in the field. As such, the quantitative assignments were considered to be valid for the purposes of assigning relative sediment production.

2.4.3. Results for identifying potential critical coarse sediment yield areas

The resulting GIS maps showing the spatial distribution of geologic grouping and critical coarse sediment yield areas within the Los Peñasquitos WMA are provided in Attachment A.4. An ArcMap document which presents the results from each step of the methodology is included in Attachment C. Based on this analysis it was estimated that 5.1% of the study area is a potential critical coarse sediment yield area.

As a result of the regional-scale datasets, and commensurate data resolution, used to map the potential critical coarse sediment yield areas, some areas may were mapped that in reality do not produce critical coarse sediment as they are existing developed areas. As such, an opportunity for jurisdictions to incorporate more refined data into the preliminary WMAA GIS dataset based on local knowledge and review of current aerial images was provided. The City of Poway and the County of San Diego provided augmented data in the Los Peñasquitos WMA in their respective jurisdictional areas.

Summary of Deliverables for Potential Critical Coarse Sediment Yield Areas

Format	Item	Description	Location
Report	Figures	"Geologic Grouping" "Potential Critical Coarse Sediment Yield Areas"	Attachment A.4
GIS	Map Group Layer Name	Potential Coarse Sediment Yield	Attachment C.1
	Map Layer Title	Geologic Grouping Land Cover Slope Category Geomorphic Landscape Unit Potential Coarse Sediment Yield Area Relative Sediment Production Potential Critical Coarse Sediment Yield Area	
	Geodatabase Feature Dataset	PotentialCoarseSedimentYield	
	Geodatabase Feature Class	GLUAnalysis PotentialCoarseSedimentYieldAreas PotentialCriticalCoarseSedimentYieldAreas	
	Geodatabase Geometry Type	Polygon	
KMZ [1]	KMZ File Name	Potential Critical Coarse Sediment Yield Areas	Attachment C.2

[1] To enhance the utilization of this data, the Geomorphic Landscape Unit Analysis is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

2.4.4. Limitations for identifying potential critical coarse sediment yield areas

The resulting GIS layers were developed using regional datasets and provide a useful, rapid framework to perform screening-level analysis that is appropriate for watershed-scale planning studies. The methodology used to identify potential coarse sediment yield areas does not account for instream sediment supply and sediment production from mass failures like landslides which are difficult to estimate on a regional scale without performing extensive field investigation. This data set also does not account for potential existing impediments that may hinder delivery of coarse sediment to receiving waters or downstream locations within the watershed as this was beyond the scope of a regional study. Where more precise estimates are required for a particular site or subarea it is recommended that this analysis be augmented with site-specific analysis. It is also recognized that this regional data set is a function of the inherent data resolution and therefore may not conform to all site conditions, or does not reflect changes to particular areas that have occurred since the underlying data was developed. As such, the WMAA data for the potential critical coarse sediment yield areas should be verified in the field according to the procedures outlined in the Model BMP Design Manual and/or jurisdiction specific BMP Design Manual.

2.5.Physical Structures

The Regional MS4 Permit requires the Copermittees to identify information regarding locations of existing flood control structures and channel structures, such as stream armoring, constrictions, grade control structures, and hydromodification or flood management basins with GIS layers (maps) as output, for each WMA being analyzed for the purpose of developing watershed-specific requirements for structural BMP implementation. This study identified the physical structures using a desktop-level analysis for the stream(s) identified in Section 2.2 in compliance with this permit provision.

2.5.1. Approach for identifying physical structures

The intent of this portion of the WMAA project was to provide an initial assessment of the structures of interest for the stream(s) identified in Section 2.2. This desktop-level analysis was conducted primarily as a visual survey of aerial imagery and FEMA flood insurance study (FIS) profiles where available. The collected information was entered into a GIS layer for inclusion into the overall WMAA geodatabase containing the characterization layers required by the Regional MS4 Permit. To support overall WMA characterization, the information derived in this task provides insight into water and sediment movement through the watershed (SCCWRP, 2012), the opportunities and limitations for infrastructure retrofits and also informs efforts to identify appropriate locations for habitat or riparian area rehabilitation in relation to proximate infrastructure. Specific information regarding how the survey was performed and the attributes of the generated data is presented in Attachment A.5. Note that concrete channels, pipes/culverts, riprap or other artificial stream armoring, and basins have also been identified in the linework generated for the streams (see Section 2.2).

2.5.2. Results for identifying physical structures

The resulting GIS mapping provided in Attachment A.5 shows the spatial locations of the physical structures within the mapped stream(s).

Summary of Deliverables for Physical Structures

Format	Item	Description	Location
Report	Figure	Watershed Management Area Streams by Reach Type with Channel Structures	Attachment A.5
GIS	Map Group Layer Name	Channel Structures	Attachment C.1
	Map Layer Title	Channel Structures	
	Geodatabase Feature Dataset	ChannelStructures	
	Geodatabase Feature Class	ChannelStructures	
	Geodatabase Geometry Type	Point	
KMZ [1]	Kmz File Name	ChannelStructures	Attachment C.2

[1] To enhance the utilization of this data, the Physical Structures map is provided in both traditional GIS file format (ESRI software license purchase required) and as a Google Earth KMZ (Keyhole Markup Language/Zipped) file that can be viewed with the free download version of Google Earth (http://www.google.com/earth/).

3. Template for Candidate Project List

The Regional MS4 Permit requires each WMA to use the results from the WMA characterization to compile a list of candidate projects that could potentially be used as alternative compliance options for Priority Development Projects should an agency or jurisdiction opt to develop an alternative compliance program. Copermittees must first conclude that implementing such a candidate project would provide greater overall benefit to the watershed than requiring implementation of structural BMPs onsite prior to implementing these candidate projects as alternative compliance projects.

The Copermittees elected to identify potential candidate projects as a separate effort from this regional project, and therefore the process for identifying candidate projects is not documented in this report. Instead, this project only developed a template, in a spreadsheet format, for use by the Copermittees to compile lists of potential candidate projects. The template is intended to enhance regional consistency of the information that is gathered for candidate projects. The template spreadsheet file was distributed to the Copermittees on January 28, 2014. A table of the template components is indicated below:

Column	Primary Heading	Secondary Heading	Guidance for Completing the Project List
A	Project Identifier	-	Unique identifier for the project.
B	Watershed Management Area	-	Dropdown menu to select the watershed management area the project is located in
C	Hydrologic Area (HA)	-	Dropdown menu to select the hydrologic area the project is located in Select a WMA in column B for HA (Column C) dropdown menu to activate.
D	Hydrologic Subarea (HSA)	-	Dropdown menu to select the hydrologic subarea the project is located in. Select a HA in column C for HSA (Column D) dropdown menu to activate.
E	Jurisdiction	-	Dropdown menu to select the jurisdiction the project is located in. Select a HSA in column D for Jurisdiction (Column E) dropdown menu to activate.
F	Project Name	-	Indicate the name of the project.
G	Ownership	Type	Dropdown menu to select if the project is a public project, private project, or public-private partnership.
H	Ownership	Ownership Information	List the details for the owner.
I	Project Location	Address	List the address of the project site.
J	Project Location	APN	List the APN of the parcel.
K	Project Location	Latitude	List the latitude of the project site.
L	Project Location	Longitude	List the longitude of the project site.

Column	Primary Heading	Secondary Heading	Guidance for Completing the Project List
M	Project Origination/ Originator	Name	List the name of the report/organization/individual that provided the idea for the project. Potential origination sources: WQIP, WMAA, JURMPs, WURMPs, CLRPs, IRWM, MSCP, MHPA, Other.
N	Project Origination/ Originator	Contact Information	Link or report title if the proposed project is from a report [or] contact information if from an organization/individual.
O	Project Category	-	Drop Down menu to select the project category; In addition to the 6 project categories explicitly listed in the Regional MS4 Permit, the drop down menu also has a category "Other project types allowed by the MS4 Permit". Example for "Other" project types are agency CIP programs such as Green Streets, LID conversions (medians, parks), agency filter installation, etc.
P	Specific Project Type	-	List the subcategory of the project; for example, list Regional BMP type (i.e. infiltration basin, wetland, etc.).
Q	Potential Pollutant	-	Identify the potential pollutant(s) that can be treated by the proposed project.
R	Project Size & Parameters	Contributing Drainage Area (acres)	List the contributing drainage area to the project.
S	Project Size & Parameters	Parcel Size (acres)	List the size of the parcel the project is located on.
T	Project Size & Parameters	Project Footprint (acres)	List the size of the project footprint.
U	Project Size & Parameters	Parameters (with units as necessary)	Parameters needed to quantify benefits from the project; i.e. for an infiltration basin, list the water quality volume, long-term infiltration rate, depth of the basin, etc.
V	Regulatory Requirement	-	Indicate if the project is proposed to meet particular regulatory requirement such as TMDL, etc.
W	Project Timeline	-	Indicate if a project must be implemented by certain date to meet a grant deadline or other time commitment.
X	Other Notes	-	List any other relevant notes; for example, when retrofitting existing infrastructure project category is selected, input parameters needed to quantify benefits from existing infrastructure into this column as these will be needed to estimate additional benefits that can be used for alternative compliance. If N/A is selected in any dropdown menus, add additional explanation in here

4. Hydromodification Management Applicability/Exemptions

Hydromodification, which is caused by both altered storm water flow and altered sediment flow regimes, is largely responsible for degradation of creeks, streams, and associated habitats in the San Diego Region. The purpose of the hydromodification management requirements in the Regional MS4 Permit is to maintain or restore more natural hydrologic flow regimes to prevent accelerated, unnatural erosion in downstream receiving waters.

In some cases, priority development projects may be exempt from hydromodification management requirements if the project site discharges runoff to receiving waters that are not susceptible to erosion (e.g., a lake, bay, or the Pacific Ocean) either directly or via hardened systems including concrete-lined channels or existing underground storm drain systems.

The March 2011 Final Hydromodification Management Plan (HMP)P identified certain exemptions from hydromodification management requirements by presenting "HMP applicability criteria." The Regional MS4 Permit maintains some of these HMP applicability criteria. However, some of the applicability criteria are not included under the Regional MS4 Permit unless the area or receiving water is mapped in the WMAA. The intent of this Section is to provide mapping of areas exempt from hydromodification management requirements, and provide supporting technical analyses for exemptions that are recommended by the WMAA.

4.1. Additional Analysis for Hydromodification Management Exemptions

This section documents additional analysis performed to further evaluate the following exemptions that were already approved by the San Diego Regional Board with the 2011 Final HMP. This study only provides additional analysis, data, and rationale for supporting or eliminating the following existing exemptions and does not propose or study any new exemptions:

- Exempt River Reaches
- Stabilized Conveyance Systems Draining to Exempt Water Bodies
- Highly Impervious Watersheds and Urban Infill and
- Tidally Influenced Lagoons

4.1.1. Exempt River Reaches

There are no river reaches currently recommended for exemption from hydromodification management requirements in the Los Peñasquitos WMA. Potential river reach exemptions may be studied using the recommended approach documented in the Regional WMAA. Refer to the Regional WMAA for the criteria and an example exemption studies that were prepared for the five river reaches included in the San Diego County Final HMP dated March 2011. However, any future proposed HMP exemptions would need to be approved through the WQIP Annual Update process (Regional MS4 Permit Section F.1.2.c.).

4.1.2. Stabilized Conveyance Systems Draining to Exempt Water Bodies

There are no stabilized conveyance systems currently recommended for exemption from hydromodification management requirements in the Los Peñasquitos WMA. If engineered conveyance systems that are stabilized with materials other than concrete, such as riprap, turf reinforcement mat, or vegetation, including rehabilitated stream systems, are identified as potential candidates for exemption, they may be studied and may be recommended exempt if they meet specific criteria presented in the Regional WMAA for this exemption. Refer to the Regional WMAA for the criteria and an example study that was prepared for Forester Creek in the San Diego River WMA. However, any future proposed HMP exemptions would need to be approved through the WQIP Annual Update process (Regional MS4 Permit Section F.1.2.c.).

4.1.3. Highly Impervious/Highly Urbanized Watersheds and Urban Infill

Based on evaluation of the highly impervious/highly urbanized watershed and urban infill exemptions presented in the March 2011 Final HMP, and comparison with more recent research prepared for the Ventura County Hydromodification Control Plan (Ventura County HCP) (Final Draft dated September 2013), resurrection of these exemptions from the March 2011 Final HMP was not recommended by the Regional WMAA. The research prepared in support of the Ventura County HCP determined lower thresholds of additional impervious area (ranging from 0.44% to 1.65%) than the limit presented in the San Diego County Final HMP dated March 2011 (3%). No areas within the Los Peñasquitos WMA are currently recommended for highly impervious/highly urbanized watershed or urban infill exemption.

4.1.4. Tidally Influenced Lagoons

There are no areas recommended for exemption from hydromodification management requirements under the tidally influenced lagoons category in the Los Peñasquitos WMA. Refer to the Regional WMAA for further information regarding this exemption.

5. Conclusions

5.1. Watershed Management Area Characterization

The WMA Characterization data was developed using available regional data to further understand the macro-scale watershed characteristics and processes in the Los Peñasquitos WMA. The Regional MS4 Permit allows for flexibility in complying with land development requirements when using the information developed in the WMAA to improve water quality planning and implementation associated with land development. This dataset will assist with identifying the opportunities and constraints for projects and management decisions based on a watershed scale (rather than piecemeal project identification without context within the watershed) and provides Copermittees the ability to exercise the option to create an alternative compliance program that offers the opportunity to develop watershed-specific alternatives to universal onsite structural BMP implementation. The characterization data includes:

Characterization Data	Utilization Potential
Dominant Hydrologic Process: • Overland flow • Infiltration • Interflow	• Identify areas for enhanced infiltration or collection of storm water for treatment • Implement management measures that correspond to pre-development conditions – promotes long-term channel stability and health • Increases understanding of the natural functioning of the watershed and what has been (or is at risk of being) altered by urbanization.
Stream Characterization: • Reach type • Bed material • Bank material • Hydrographic category • Channel Structures	• Preliminary dataset that can be used to conduct stream power evaluations • Identify channel systems for preservation or restoration • Identification of appropriate space for channel processes to occur (e.g., flood plain connectivity) • Insight to sensitivity of receiving stream reach • Indicates the features within channels that affect water and sediment movement through the watershed

Characterization Data	Utilization Potential
Land Use: • Existing • Future	• Foresight (identifies relative risks, opportunities, or constraints) in comparing future to existing land uses, i.e., areas that may be more/less vulnerable to adverse impacts to changes in storm water runoff associated with development • Encourage infill development
Potential Critical Coarse Sediment Yield Areas	• Preservation of areas or function that contributes critical sediment within the watershed to stream armoring/stability • Assist with identifying potentially susceptible stream reaches that require uninterrupted coarse sediment supplies to remain stable • Dual goal of open space conservation

Regarding the identification of the potential critical coarse sediment yield areas in the WMAA using readily available regional datasets, it is anticipated that when more precise estimates for potential critical coarse sediment yield areas are required for a particular site or subarea that this regional study will be augmented with site-specific analysis. Development projects must avoid critical sediment yield areas or implement measures that allow critical coarse sediment to be discharged to receiving waters, such that there is no net impact to the receiving water to meet the requirements of the Regional MS4 permit. As such, projects should consult the Model BMP Design Manual and/or jurisdiction specific BMP Design manual for options to meet the Regional MS4 Permit requirements. It is anticipated that the data will not be static but will be enhanced over time through future studies or field assessments that will refine what is currently a macro-level data set.

5.2. Template for Candidate Project List

It is anticipated the Copermittees that elect to develop alternative compliance programs will conduct a separate exercise to nominate potential candidate projects for inclusion into the WQIPs using the template developed for this project.

5.3. Hydromodification Management Exemptions

Attachment B.2 presents hydromodification management applicability/exemption mapping for the Los Peñasquitos WMA. The mapping includes receiving waters that are exempt based on the Regional MS4 Permit or recommended exempt based on studies.

Receiving waters that are **exempt** based on the Regional MS4 Permit include:

- The Pacific Ocean
- Lakes and Reservoirs
- Existing underground storm drains or concrete-lined channels draining directly to the ocean

There are no additional exemptions recommended based on studies in the Los Peñasquitos WMA.

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Attachment N-2

Los Peñasquitos WMAA Report Attachments

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Los Peñasquitos
Watershed Management Area Analysis
ATTACHMENTS

Lake Henshaw

September 8, 2014

Prepared for:
San Diego County Copermittees

Prepared by:

Geosyntec consultants

engineers | scientists | innovators

RICK ENGINEERING COMPANY

ATTACHMENT A

WATERSHED MANAGEMENT AREA CHARACTERIZATION

ATTACHMENT A.1

DOMINANT HYDROLOGICAL PROCESS

A.1 Dominant Hydrological Process

Table A.1.1: Runoff Coefficients versus Land Use, Hydrologic Soil Group (A, B, C, D), and Slope Range

	A			B			C			D		
Land Use	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+	0–2%	2–6%	6%+
Cultivated land	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14[b]	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.15	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

[a] Runoff coefficients for storm recurrence intervals less than 25 years.

[b] Runoff coefficients for storm recurrence intervals of 25 years or longer.

Source: Table 7-9 in *Hydrologic Analysis and Design* (McCuen, 2005)

Table A.1.2: Land Cover Grouping

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
1	42000 Valley and Foothill Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
2	42100 Native Grassland		Agricultural/Grass
3	42110 Valley Needlegrass Grassland		Agricultural/Grass
4	42120 Valley Sacaton Grassland		Agricultural/Grass

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
5	42200 Non-Native Grassland	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Agricultural/Grass
6	42300 Wildflower Field		Agriculture/Grass
7	42400 Foothill/Mountain Perennial Grassland		Agriculture/Grass
8	42470 Transmontane Dropseed Grassland		Agriculture/Grass
9	45000 Meadow and Seep		Agriculture/Grass
10	45100 Montane Meadow		Agriculture/Grass
11	45110 Wet Montane Meadow		Agriculture/Grass
12	45120 Dry Montane Meadows		Agriculture/Grass
13	45300 Alkali Meadows and Seeps		Agriculture/Grass
14	45320 Alkali Seep		Agriculture/Grass
15	45400 Freshwater Seep		Agriculture/Grass
16	46000 Alkali Playa Community		Agriculture/Grass
17	46100 Badlands/Mudhill Forbs		Agriculture/Grass
18	Non-Native Grassland		Agriculture/Grass
19	18000 General Agriculture	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Agriculture/Grass
20	18100 Orchards and Vineyards		Agriculture/Grass
21	18200 Intensive Agriculture		Agriculture/Grass
22	18200 Intensive Agriculture - Dairies, Nurseries, Chicken Ranches		Agriculture/Grass
23	18300 Extensive Agriculture - Field/Pasture, Row Crops		Agriculture/Grass
24	18310 Field/Pasture		Agriculture/Grass
25	18310 Pasture		Agriculture/Grass
26	18320 Row Crops		Agriculture/Grass
27	12000 Urban/Developed		Developed
28	12000 Urban/Developed		Developed
29	81100 Mixed Evergreen Forest	Forest	Forest
30	81300 Oak Forest		Forest
31	81310 Coast Live Oak Forest		Forest
32	81320 Canyon Live Oak Forest		Forest
33	81340 Black Oak Forest		Forest
34	83140 Torrey Pine Forest		Forest
35	83230 Southern Interior Cypress Forest		Forest
36	84000 Lower Montane Coniferous Forest		Forest
37	84100 Coast Range, Klamath and Peninsular Coniferous Forest		Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
38	84140 Coulter Pine Forest	Forest	Forest
39	84150 Bigcone Spruce (Bigcone Douglas Fir)-Canyon Oak Forest		Forest
40	84230 Sierran Mixed Coniferous Forest		Forest
41	84500 Mixed Oak/Coniferous/Bigcone/Coulter		Forest
42	85100 Jeffrey Pine Forest		Forest
43	11100 Eucalyptus Woodland	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Forest
44	60000 RIPARIAN AND BOTTOMLAND HABITAT	Riparian and Bottomland Habitat	Forest
45	61000 Riparian Forests		Forest
46	61300 Southern Riparian Forest		Forest
47	61310 Southern Coast Live Oak Riparian Forest		Forest
48	61320 Southern Arroyo Willow Riparian Forest		Forest
49	61330 Southern Cottonwood-willow Riparian Forest		Forest
50	61510 White Alder Riparian Forest		Forest
51	61810 Sonoran Cottonwood-willow Riparian Forest		Forest
52	61820 Mesquite Bosque		Forest
53	62000 Riparian Woodlands		Forest
54	62200 Desert Dry Wash Woodland		Forest
55	62300 Desert Fan Palm Oasis Woodland		Forest
56	62400 Southern Sycamore-alder Riparian Woodland		Forest
57	70000 WOODLAND	Woodland	Forest
58	71000 Cismontane Woodland		Forest
59	71100 Oak Woodland		Forest
60	71120 Black Oak Woodland		Forest
61	71160 Coast Live Oak Woodland		Forest
62	71161 Open Coast Live Oak Woodland		Forest
63	71162 Dense Coast Live Oak Woodland		Forest
64	71162 Dense Coast Love Oak Woodland		Forest

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
65	71180 Engelmann Oak Woodland	Woodland	Forest
66	71181 Open Engelmann Oak Woodland		Forest
67	71182 Dense Engelmann Oak Woodland		Forest
68	72300 Peninsular Pinon and Juniper Woodlands		Forest
69	72310 Peninsular Pinon Woodland		Forest
70	72320 Peninsular Juniper Woodland and Scrub		Forest
71	75100 Elephant Tree Woodland		Forest
72	77000 Mixed Oak Woodland		Forest
73	78000 Undifferentiated Open Woodland		Forest
74	79000 Undifferentiated Dense Woodland		Forest
75	Engelmann Oak Woodland		Forest
76	52120 Southern Coastal Salt Marsh	Bog and Marsh	Other
77	52300 Alkali Marsh		Other
78	52310 Cismontane Alkali Marsh		Other
79	52400 Freshwater Marsh		Other
80	52410 Coastal and Valley Freshwater Marsh		Other
81	52420 Transmontane Freshwater Marsh		Other
82	52440 Emergent Wetland		Other
83	44000 Vernal Pool	Grasslands, Vernal Pools, Meadows, and Other Herb Communities	Other
84	44320 San Diego Mesa Vernal Pool		Other
85	44322 San Diego Mesa Claypan Vernal Pool (southern mesas)		Other
86	13100 Open Water	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
87	13110 Marine		Other
88	13111 Subtidal		Other
89	13112 Intertidal		Other
90	13121 Deep Bay		Other
91	13122 Intermediate Bay		Other
92	13123 Shallow Bay		Other
93	13130 Estuarine		Other
94	13131 Subtidal		Other
95	13133 Brackishwater		Other

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
96	13140 Freshwater	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Other
97	13200 Non-Vegetated Channel, Floodway, Lakeshore Fringe		Other
98	13300 Saltpan/Mudflats		Other
99	13400 Beach		Other
100	21230 Southern Foredunes	Dune Community	Scrub/Shrub
101	22100 Active Desert Dunes		Scrub/Shrub
102	22300 Stabilized and Partially-Stabilized Desert Sand Field		Scrub/Shrub
103	24000 Stabilized Alkaline Dunes		Scrub/Shrub
104	29000 ACACIA SCRUB		Scrub/Shrub
105	63000 Riparian Scrubs	Riparian and Bottomland Habitat	Scrub/Shrub
106	63300 Southern Riparian Scrub		Scrub/Shrub
107	63310 Mule Fat Scrub		Scrub/Shrub
108	63310 Mulefat Scrub		Scrub/Shrub
109	63320 Southern Willow Scrub		Scrub/Shrub
110	63321 Arundo donnax Dominant/Southern Willow Scrub		Scrub/Shrub
111	63330 Southern Riparian Scrub		Scrub/Shrub
112	63400 Great Valley Scrub		Scrub/Shrub
113	63410 Great Valley Willow Scrub		Scrub/Shrub
114	63800 Colorado Riparian Scrub		Scrub/Shrub
115	63810 Tamarisk Scrub		Scrub/Shrub
116	63820 Arrowweed Scrub		Scrub/Shrub
117	31200 Southern Coastal Bluff Scrub	Scrub and Chaparral	Scrub/Shrub
118	32000 Coastal Scrub		Scrub/Shrub
119	32400 Maritime Succulent Scrub		Scrub/Shrub
120	32500 Diegan Coastal Sage Scrub		Scrub/Shrub
121	32510 Coastal form		Scrub/Shrub
122	32520 Inland form (> 1,000 ft. elevation)		Scrub/Shrub
123	32700 Riversidian Sage Scrub		Scrub/Shrub
124	32710 Riversidian Upland Sage Scrub		Scrub/Shrub
125	32720 Alluvial Fan Scrub		Scrub/Shrub
126	33000 Sonoran Desert Scrub		Scrub/Shrub
127	33100 Sonoran Creosote Bush Scrub		Scrub/Shrub
128	33200 Sonoran Desert Mixed Scrub		Scrub/Shrub
129	33210 Sonoran Mixed Woody Scrub		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
130	33220 Sonoran Mixed Woody and Succulent Scrub	Scrub and Chaparral	Scrub/Shrub
131	33230 Sonoran Wash Scrub		Scrub/Shrub
132	33300 Colorado Desert Wash Scrub		Scrub/Shrub
133	33600 Encelia Scrub		Scrub/Shrub
134	34000 Mojavean Desert Scrub		Scrub/Shrub
135	34300 Blackbush Scrub		Scrub/Shrub
136	35000 Great Basin Scrub		Scrub/Shrub
137	35200 Sagebrush Scrub		Scrub/Shrub
138	35210 Big Sagebrush Scrub		Scrub/Shrub
139	35210 Sagebrush Scrub		Scrub/Shrub
140	36110 Desert Saltbush Scrub		Scrub/Shrub
141	36120 Desert Sink Scrub		Scrub/Shrub
142	37000 Chaparral		Scrub/Shrub
143	37120 Southern Mixed Chaparral		Scrub/Shrub
144	37120 Southern Mixed Chapparal		Scrub/Shrub
145	37121 Granitic Southern Mixed Chaparral		Scrub/Shrub
146	37121 Southern Mixed Chaparral		Scrub/Shrub
147	37122 Mafic Southern Mixed Chaparral		Scrub/Shrub
148	37130 Northern Mixed Chaparral		Scrub/Shrub
149	37131 Granitic Northern Mixed Chaparral		Scrub/Shrub
150	37132 Mafic Northern Mixed Chaparral		Scrub/Shrub
151	37200 Chamise Chaparral		Scrub/Shrub
152	37210 Granitic Chamise Chaparral		Scrub/Shrub
153	37220 Mafic Chamise Chaparral		Scrub/Shrub
154	37300 Red Shank Chaparral		Scrub/Shrub
155	37400 Semi-Desert Chaparral		Scrub/Shrub
156	37500 Montane Chaparral		Scrub/Shrub
157	37510 Mixed Montane Chaparral		Scrub/Shrub
158	37520 Montane Manzanita Chaparral		Scrub/Shrub
159	37530 Montane Ceanothus Chaparral		Scrub/Shrub
160	37540 Montane Scrub Oak Chaparral		Scrub/Shrub
161	37800 Upper Sonoran Ceanothus Chaparral		Scrub/Shrub
162	37830 Ceanothus crassifolius Chaparral		Scrub/Shrub
163	37900 Scrub Oak Chaparral		Scrub/Shrub
164	37A00 Interior Live Oak Chaparral		Scrub/Shrub

Id	SanGIS Legend	SanGIS Grouping	Land Cover Grouping
165	37C30 Southern Maritime Chaparral	Scrub and Chaparral	Scrub/Shrub
166	37G00 Coastal Sage-Chaparral Scrub		Scrub/Shrub
167	37K00 Flat-topped Buckwheat		Scrub/Shrub
168	39000 Upper Sonoran Subshrub Scrub		Scrub/Shrub
169	Diegan Coastal Sage Scrub		Scrub/Shrub
170	Granitic Northern Mixed Chaparral		Scrub/Shrub
171	Southern Mixed Chaparral		Scrub/Shrub
172	11000 Non-Native Vegetation	Non-Native Vegetation, Developed Areas, or Unvegetated Habitat	Unknown
173	11000 Non-Native VegetionVegetation		Unknown
174	11200 Disturbed Wetland		Unknown
175	11300 Disturbed Habitat		Unknown
176	13000 Unvegetated Habitat		Unknown
177	Disturbed Habitat		Unknown

Table A.1.3: Related Land Cover and Land Use Categories

Land Cover per San Diego County	Land Use per Table A.1.1
Agriculture/Grass	Meadow
Forest	Forest
Scrub/Shrub	Average (Meadow, Forest)
Unknown/Other	Meadow

Table A.1.4: Applicable Hydrologic Response Unit Calculations

Land Cover	Soil	Gradient	Runoff Coeff.	ET Coeff.	Infiltration Coeff.	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Agriculture/Grass	A	0-2%	0.10	0.60	0.30	0.33	I
Agriculture/Grass	A	2-6%	0.16	0.60	0.24	0.67	U
Agriculture/Grass	A	6-10%	0.25	0.60	0.15	1.67	O
Agriculture/Grass	B	0-2%	0.14	0.60	0.26	0.54	I
Agriculture/Grass	B	2-6%	0.22	0.60	0.18	1.22	U
Agriculture/Grass	B	6-10%	0.30	0.60	0.10	3.00	O
Agriculture/Grass	C	0-2%	0.20	0.60	0.20	1.00	U
Agriculture/Grass	C	2-6%	0.28	0.60	0.12	2.33	O
Agriculture/Grass	C	6-10%	0.36	0.60	0.04	9.00	O
Agriculture/Grass	D	0-2%	0.24	0.60	0.16	1.50	U
Agriculture/Grass	D	2-6%	0.30	0.60	0.10	3.00	O
Agriculture/Grass	D	6-10%	0.40	0.60	0.00	infinite	O

Land Cover	Soil	Gradient	Runoff Coeff.	ET Coeff.	Infiltration Coeff.	Runoff/ Infiltration Ratio	Hydrologic Process Designation
Forest	A	0-2%	0.05	0.80	0.15	0.33	I
Forest	A	2-6%	0.08	0.80	0.12	0.67	U
Forest	A	6-10%	0.11	0.80	0.09	1.22	U
Forest	B	0-2%	0.08	0.80	0.12	0.67	U
Forest	B	2-6%	0.11	0.80	0.09	1.22	U
Forest	B	6-10%	0.14	0.80	0.06	2.33	O
Forest	C	0-2%	0.10	0.80	0.10	1.00	U
Forest	C	2-6%	0.13	0.80	0.07	1.86	O
Forest	C	6-10%	0.16	0.80	0.04	4.00	O
Forest	D	0-2%	0.12	0.80	0.08	1.50	U
Forest	D	2-6%	0.16	0.80	0.04	4.00	O
Forest	D	6-10%	0.20	0.80	0.00	infinite	O
Scrub/Shrub	A	0-2%	0.08	0.70	0.23	0.33	I
Scrub/Shrub	A	2-6%	0.12	0.70	0.18	0.67	U
Scrub/Shrub	A	6-10%	0.18	0.70	0.12	1.50	U
Scrub/Shrub	B	0-2%	0.11	0.70	0.19	0.58	I
Scrub/Shrub	B	2-6%	0.17	0.70	0.14	1.22	U
Scrub/Shrub	B	6-10%	0.22	0.70	0.08	2.75	O
Scrub/Shrub	C	0-2%	0.15	0.70	0.15	1.00	U
Scrub/Shrub	C	2-6%	0.21	0.70	0.10	2.16	O
Scrub/Shrub	C	6-10%	0.26	0.70	0.04	6.50	O
Scrub/Shrub	D	0-2%	0.19	0.70	0.12	1.50	U
Scrub/Shrub	D	2-6%	0.23	0.70	0.07	3.29	O
Scrub/Shrub	D	6-10%	0.30	0.70	0.00	infinite	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain

Table A.1.5: Hydrologic Response Unit Designations

Land Cover	Slope	Soil Type				
		A	B	C	D	Other (fill/water)
Agriculture/ Grass/Unknown/ Other	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Developed	0-2%	O	O	O	O	O
	2-6%	O	O	O	O	O
	6-10%	O	O	O	O	O
	>10%	O	O	O	O	O
Forest	0-2%	I	U	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O
Scrub/Shrub	0-2%	I	I	U	U	U
	2-6%	U	U	O	O	U
	6-10%	U	O	O	O	U
	>10%	O	O	O	O	O

Hydrologic Process Designation: I = Interflow; O = Overland Flow; U = Uncertain

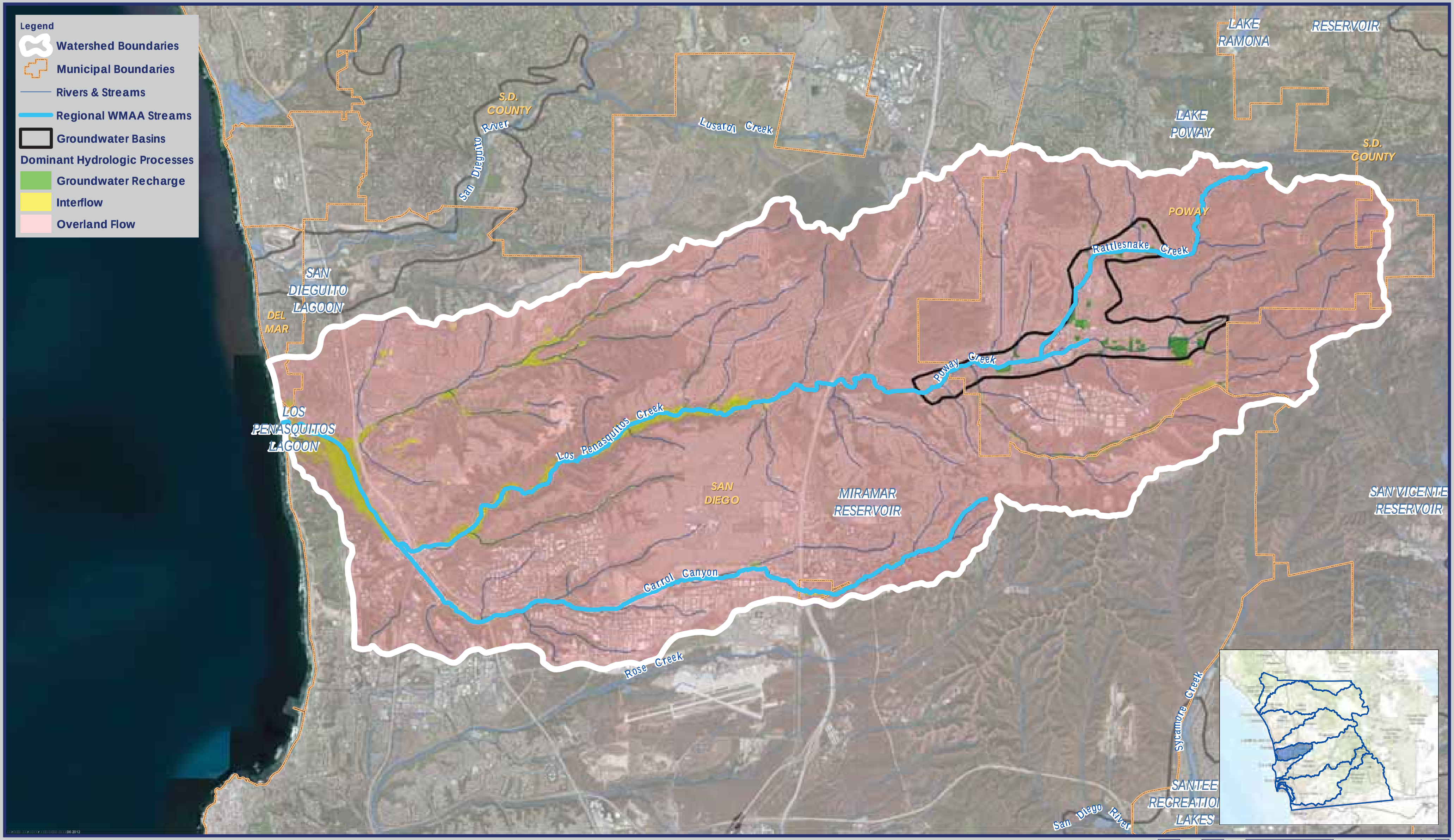


Exhibit Showing Dominant Hydrologic Processes

Los Penasquitos Watershed - HU 906.00, 94 mi2

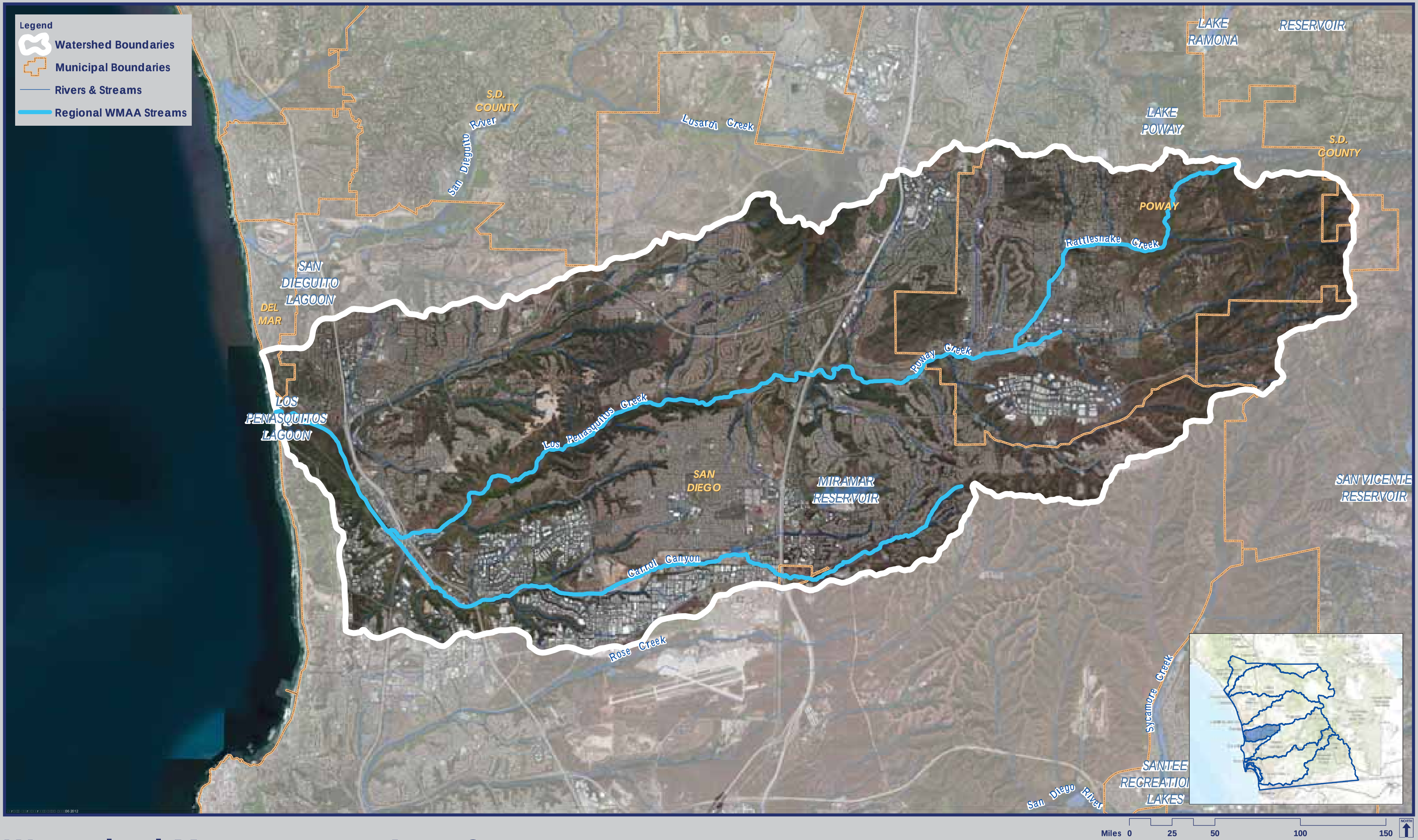
Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK

ATTACHMENT A.2

STREAM CHARACTERIZATION



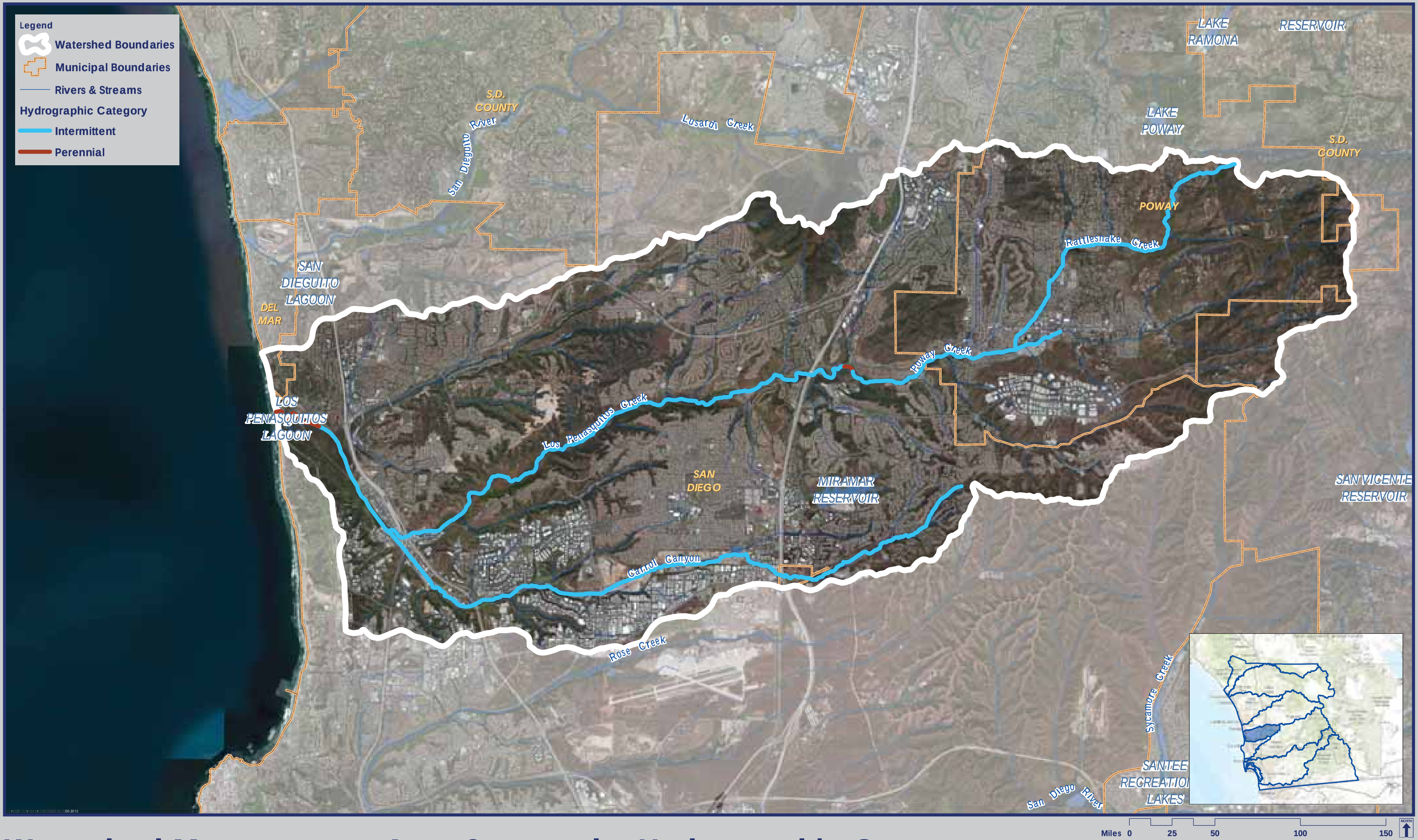
Watershed Management Area Streams

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK



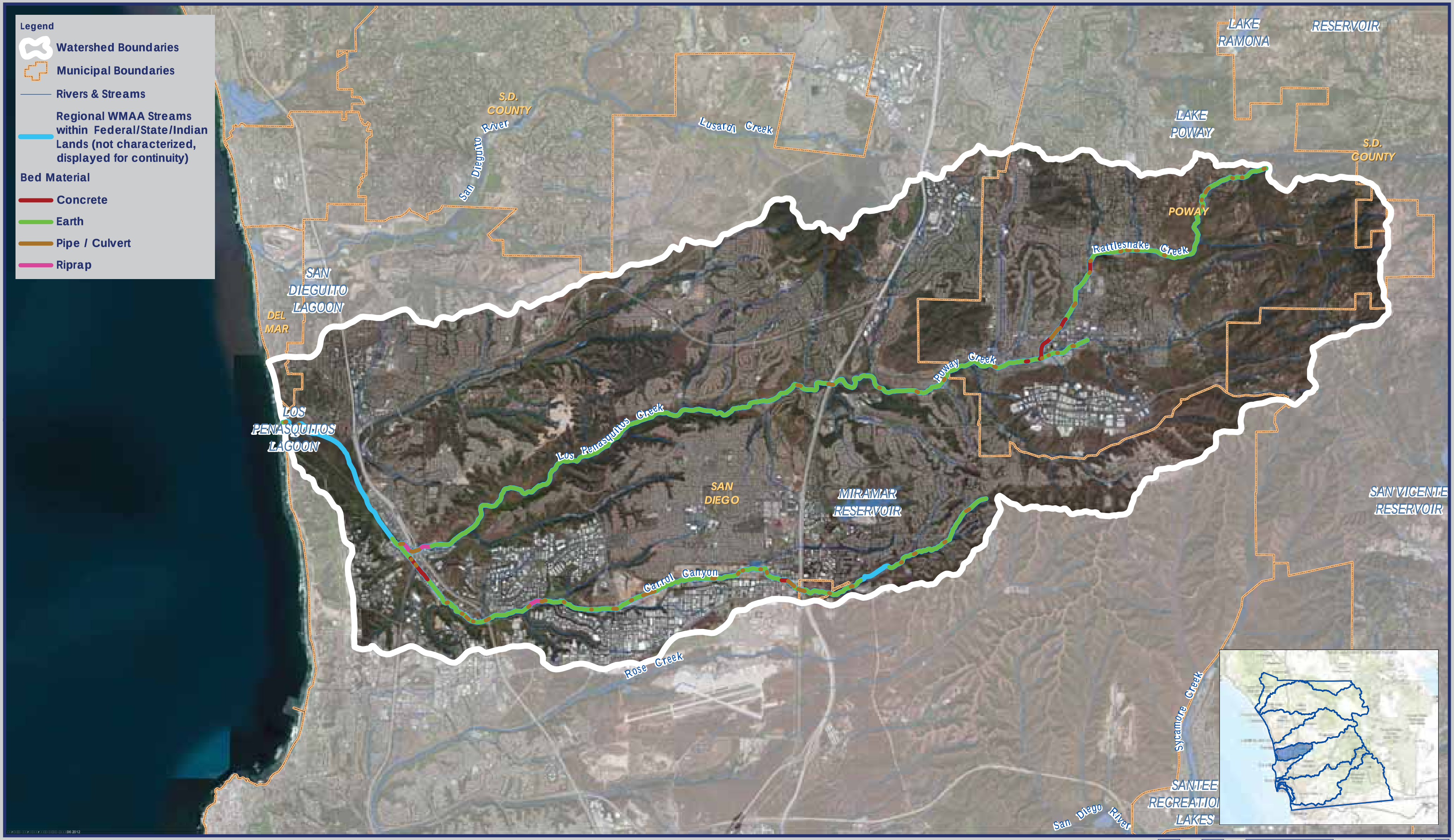
Watershed Management Area Streams by Hydrographic Category

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK



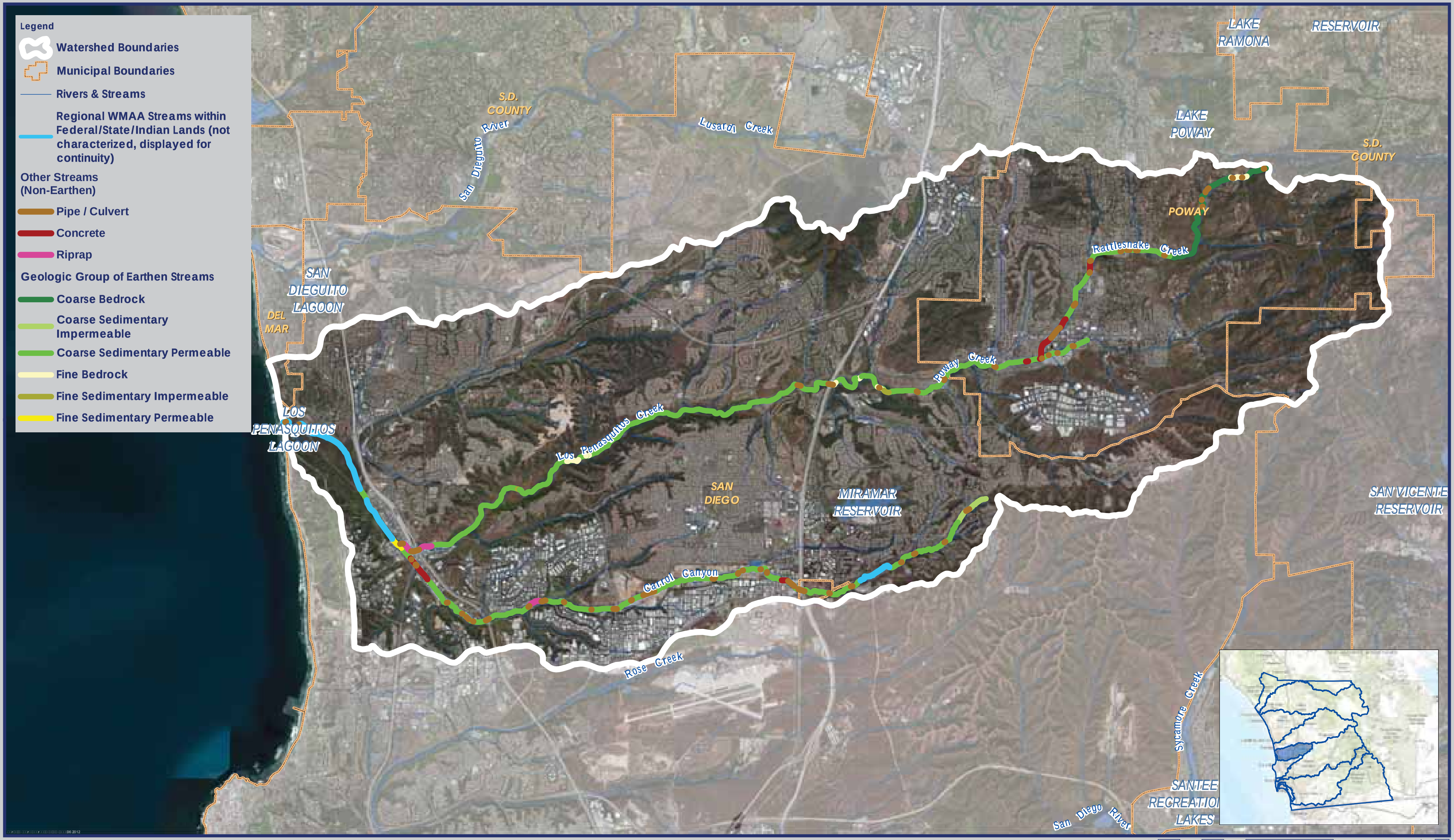
Watershed Management Area Streams by Bed Material

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK



Watershed Management Area Streams by Geologic Group

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

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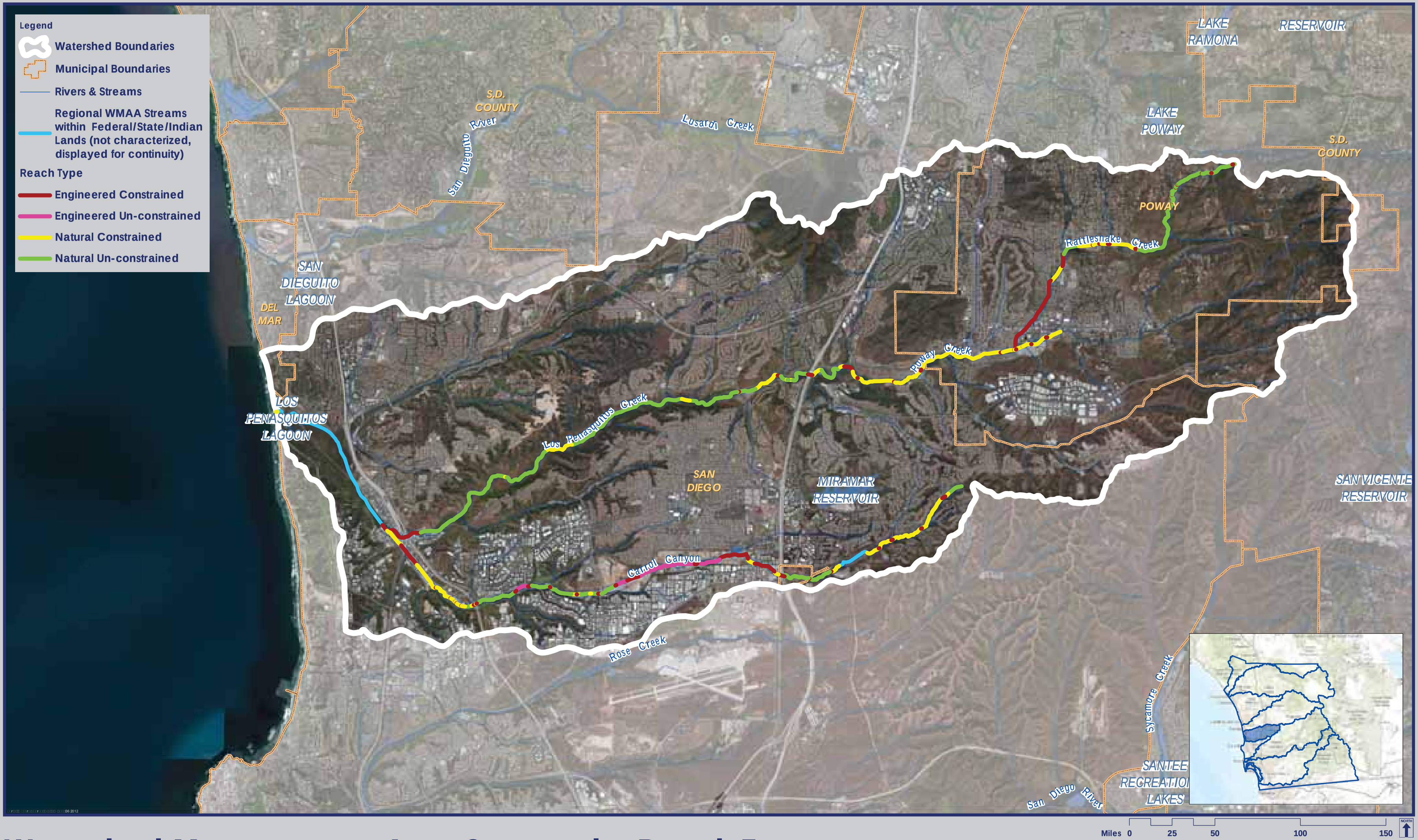


Watershed Management Area Streams by Reach Type

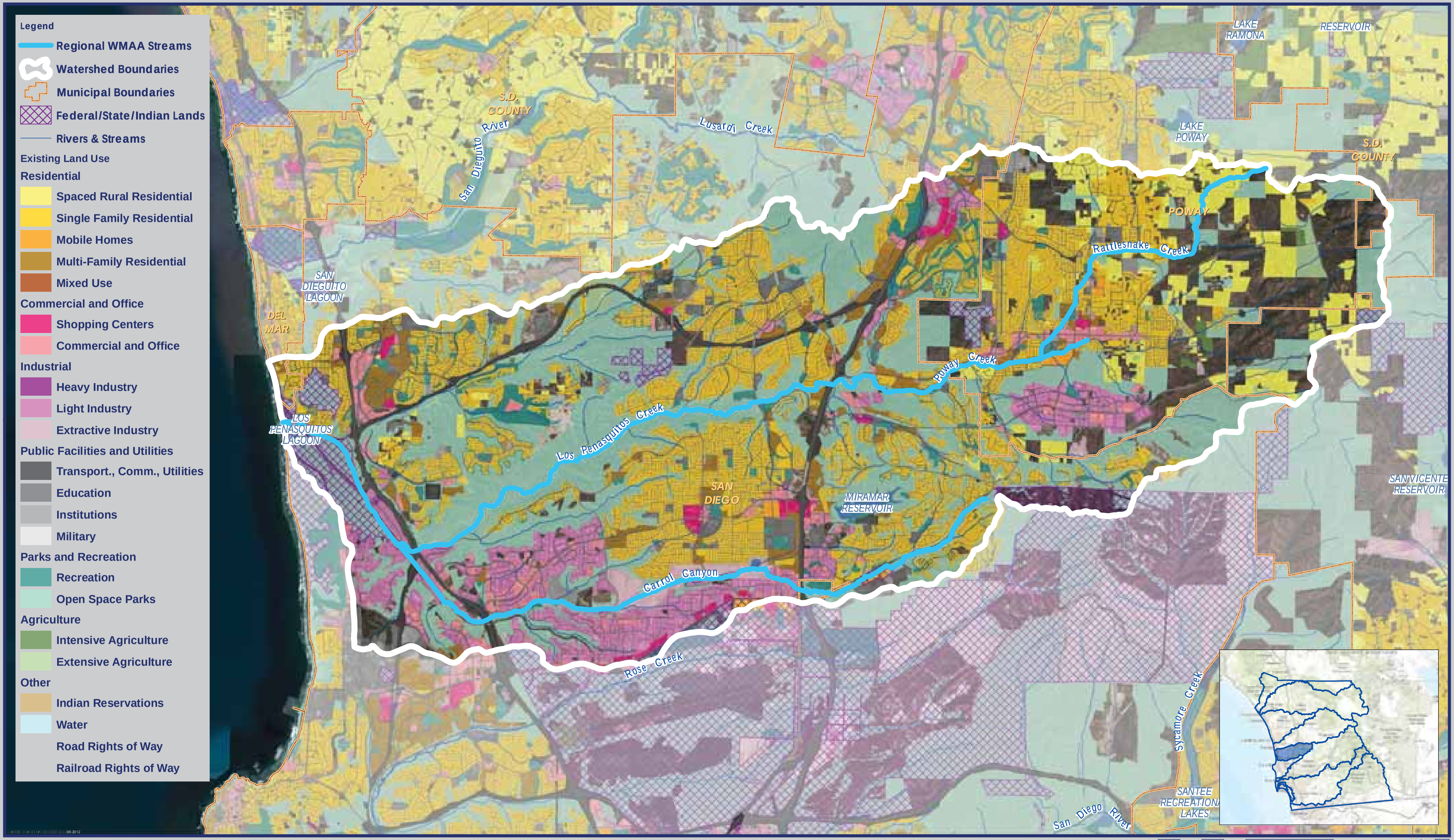
Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants RICK

ATTACHMENT A.3

LAND USES



Existing Land Use

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

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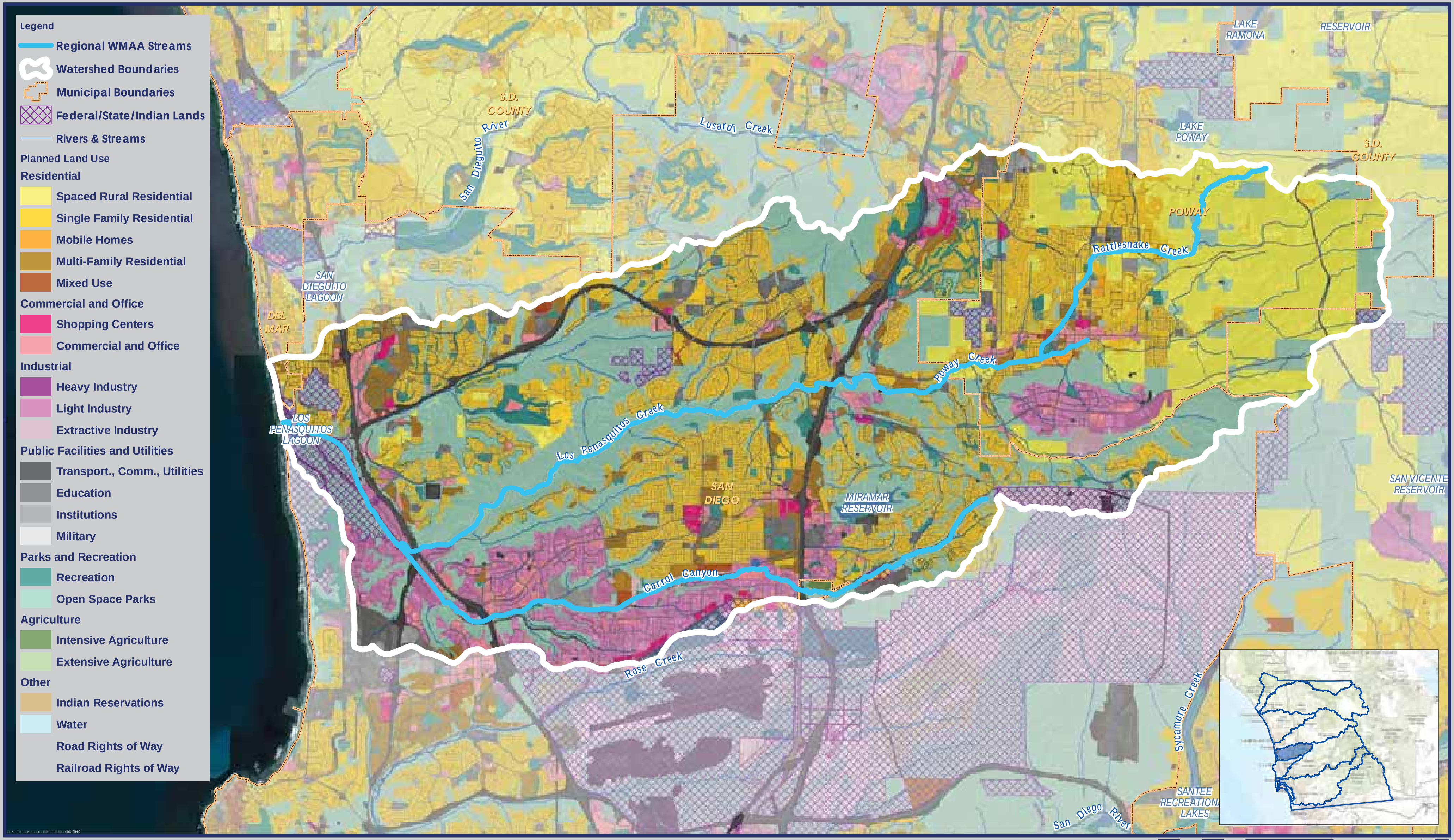
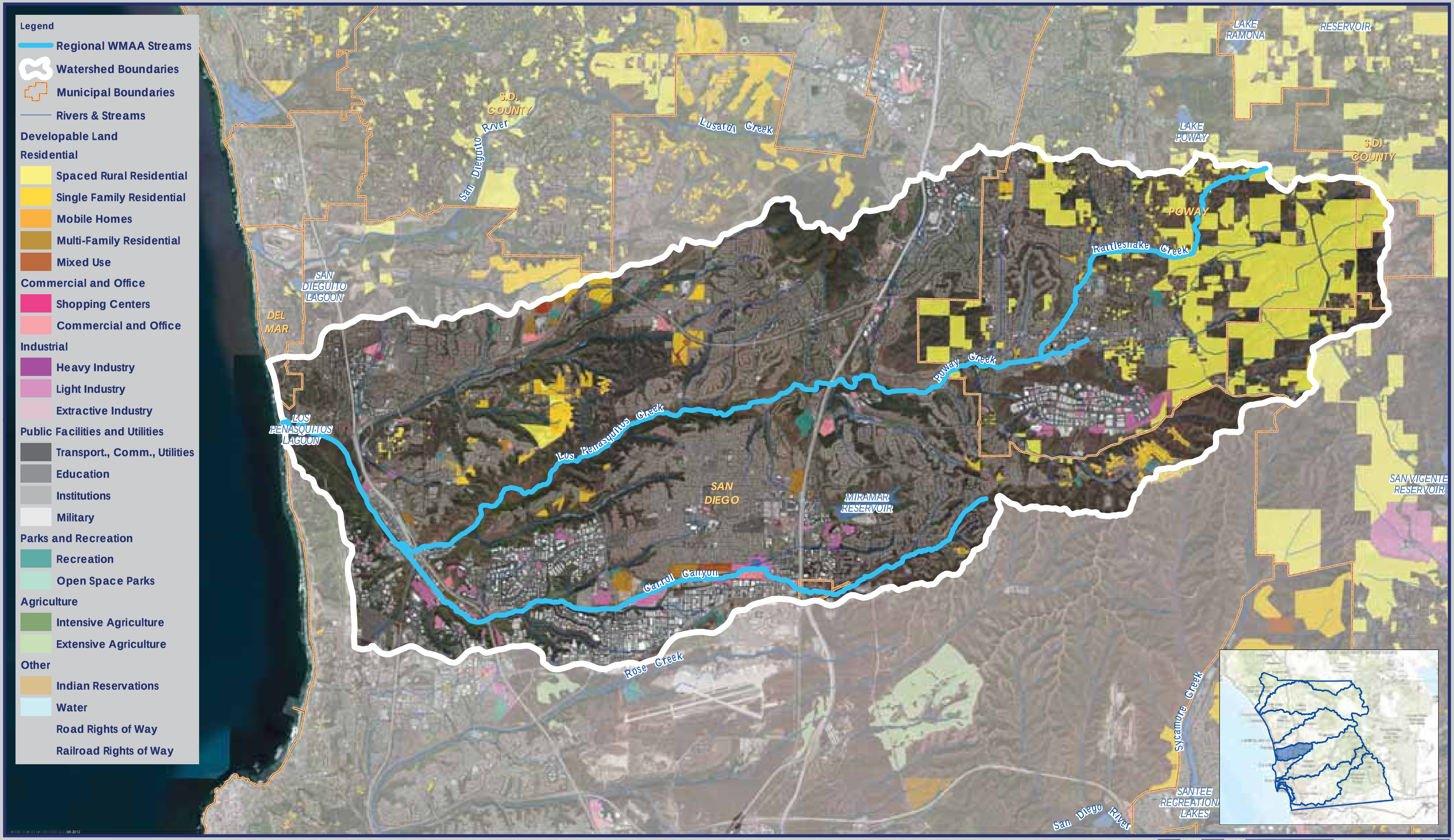
RICK



Planned Land Use

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014



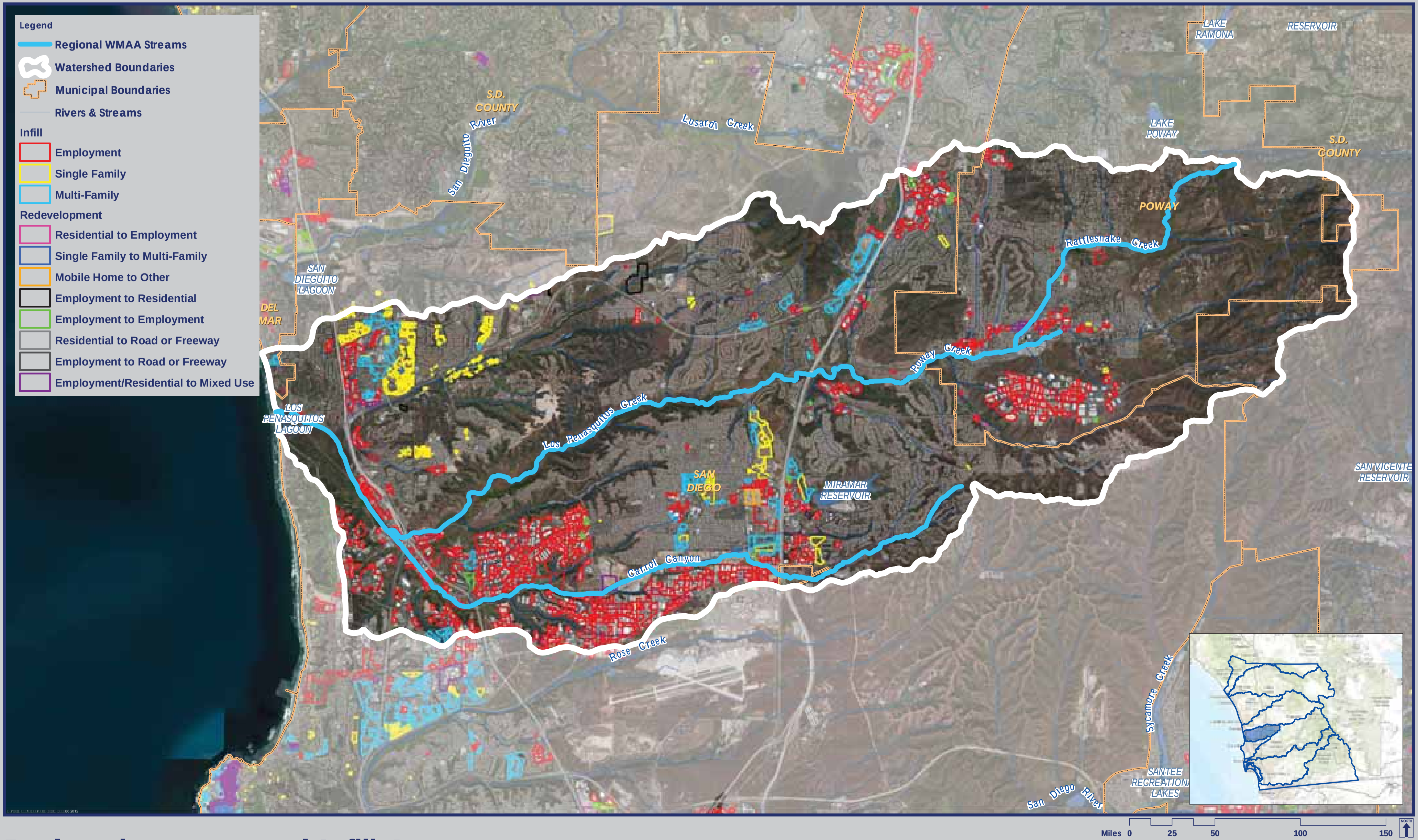
Developable Land

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK



Redevelopment and Infill Areas

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

ATTACHMENT A.4

POTENTIAL COARSE SEDIMENT YIELD AREAS

A.4.1 Geology Grouping

Geologic grouping was based on the mapped geologic unit as determined by published geologic mapping information. The following describes the methodology utilized to determine bedrock or sedimentary characteristics, anticipated grain size, and suitability for infiltration. A complete list of the various geologic maps used in this evaluation is listed in Chapter 6.

Due to the various mapped scales of the published data and differing mapped unit names, the geologic units were initially compiled into similar categories where possible. For example, the Lindavista Formation is mapped as unit Ql on geologic maps at a scale of 1:24,000 but correlates to the same unit Qvop8 on geologic maps at a scale of 1:100,000. Following the compilation of geologic unit names, the units were differentiated between crystalline bedrock and sedimentary formations based on geologic characterization and material behavior. The Point Loma Formation for example, is a Cretaceous-age sandstone, but it was classified as a “coarse bedrock” unit due to its indurated and resistant nature.

For each site location, the predominant geologic units were then described as “coarse” or “fine” based on typical weathering characteristics of the bedrock units, or primary grain size of the sedimentary units. For example, granodiorite or tonalite crystalline rock typically weathers to a coarse material such as a silty sand and therefore was classified as “coarse,” compared to a gabbro which generally weathers to a sandy clay and was characterized as “fine.” Sedimentary formations can be more variable, such as the Mission Valley Formation. In this case, the Mission Valley Formation was characterized as “coarse” since the unit is predominantly comprised of sandstone even if it does contain localities of siltstone and claystone within the unit.

To further characterize the sedimentary formations, these units were evaluated for suitability of infiltration. Since no field investigations were performed for this evaluation to determine permeability, the differentiation between impermeable and permeable were based on the age of the geologic unit with the assumption that relatively younger sedimentary units of Pleistocene-age or younger (<1.6 mya) would be more susceptible to surface water infiltration. Geology grouping of different map units is presented in Table A.4.1

Table A.4.1 Geologic grouping for different map units

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
gr-m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
grMz	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Jcr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jhc	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Jsp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ka	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kbp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kcp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kdl	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgbf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgd	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgdf	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgh	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm1	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm2	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm3	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgm4	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgr	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kgu	San Diego 30' x 60'	Coarse	Bedrock	Impermeable	CB
Khg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ki	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kis	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJem	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
KJld	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kjv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Klb	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klh	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Klp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Km	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmgp	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kmm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpa	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kpv	El Cajon 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kqbd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Krr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kt	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ktr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kvc	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwm	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwp	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Kwsr	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
m	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Mzd	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzg	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzq	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Mzs	Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
sch	Jennings; CA	Coarse	Bedrock	Impermeable	CB
Kp	San Diego & Oceanside 30' x 60'	Coarse	Bedrock	Impermeable	CB
Ql	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
QTf	El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ec	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
K	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI
Kccg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kcs	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Kl	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Ku	Jennings; CA	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qvof	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tp	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tpm	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsc	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tscu	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsd	San Diego & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdcg	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsdss	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsm	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tso	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tst	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tt	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tta	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tmv	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsi	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa11	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa12	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoa13	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvoc	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop1	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop10a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop11	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qvop11a	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop12	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop13	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop2	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop3	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop4	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop5	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop6	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop8	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qvop9	San Diego 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Tsa	Oceanside 30' x 60'	Coarse	Sedimentary	Impermeable	CSI
Qof	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qof2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Q	Jennings; CA	Coarse	Sedimentary	Permeable	CSP
Qa	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qd	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qmb	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qw	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyf	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qt	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa1-2	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa2-6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa5	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa6	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa7	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
Qoc	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop1	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qc	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qu	El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qoa	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop2-4	San Diego 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop3	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop4	Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop6	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qop7	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qya	San Diego, Oceanside & El Cajon 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Qyc	San Diego & Oceanside 30' x 60'	Coarse	Sedimentary	Permeable	CSP
Mzu	San Diego & Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
gb	Jennings; CA	Fine	Bedrock	Impermeable	FB
JTRm	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kat	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kc	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgb	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
KJvs	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kmv	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Ksp	El Cajon 30' x 60'	Fine	Bedrock	Impermeable	FB
Kvsp	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kwmt	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Qv	Jennings; CA	Fine	Bedrock	Impermeable	FB
Tba	San Diego 30' x 60'	Fine	Bedrock	Impermeable	FB
Tda	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tv	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Tvsr	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Kgdfg	Oceanside 30' x 60'	Fine	Bedrock	Impermeable	FB
Ta	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tcs	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Td	San Diego & Oceanside	Fine	Sedimentary	Impermeable	FSI

Map Unit	Map Name	Anticipated Grain size of Weathered Material	Bedrock or Sedimentary	Impermeable/ Permeable	Geology Grouping
	30' x 60'				
Td+Tf	San Diego 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qls	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tm	Oceanside 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tf	San Diego, Oceanside & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Tfr	El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
To	San Diego & El Cajon 30' x 60'	Fine	Sedimentary	Impermeable	FSI
Qpe	San Diego & Oceanside 30' x 60'	Fine	Sedimentary	Permeable	FSP
Mexico	San Diego 30' x 60'	NA	NA	Permeable	Other
Kuo	San Diego 30' x 60'	NA (Offshore)	NA	Permeable	Other
Teo	San Diego & Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Tmo	Oceanside 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
Qmo	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
QTso	San Diego 30' x 60'	NA (Offshore)	Sedimentary	Permeable	Other
af	San Diego & Oceanside 30' x 60'	Variable, dependent on source material	Sedimentary		Other

A.4.2 Quantitative Analysis

Soil loss estimates for each Geomorphic Landscape Unit were estimated using the Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) listed below:

$$A = R \times K \times LS \times C \times P$$

Where

A = estimated average soil loss in tons/acre/year

R = rainfall-runoff erosivity factor

K = soil erodibility factor

LS = slope length and steepness factor

C = cover-management factor

P = support practice factor; assumed 1 for this analysis

Regional datasets used to estimate the inputs required to estimate the soil loss from each GLU are listed in table below:

Dataset	Source	Download year	Description
RUSLE – R Factor	SWRCB	2014	Regional R factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_R_Factor/
RUSLE – K Factor	SWRCB	2014	Regional K factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_K_Factor/
RUSLE – LS Factor	SWRCB	2014	Regional LS factor map was downloaded from ftp://swrcb2a.waterboards.ca.gov/pub/swrcb/dwq/cgp/Risk/RUSLE/RUSLE_LS_Factor/
RUSLE – C Factor	USEPA	2014	Regional C factor map was downloaded from http://www.epa.gov/esd/land-sci/emap_west_browser/pages/wemap_mm_sl_rusle_c_qt.htm#mapnav

GIS analysis was used to calculate the area weighted estimate of R, K, LS and C factors using the regional datasets listed in the table above. For the developed land cover the C factor was then adjusted to 0 from the regional estimate to account for management actions implemented on developed sites (e.g. impervious surfaces). Soil loss estimates ranged from 0 to 15.2 tons/acre/year.

For evaluating the degree of relative risk to a stream solely arising from changes in sediment and/or water delivery SCCWRP Technical Report 605, 2010 states:

> *"The challenge in implementing this step is that presently we have insufficient basis to defensibly identify either low-risk or high-risk conditions using these metrics. For example, channels that are close to a threshold for geomorphic change may display significant morphological changes under nothing more than natural year-to-year variability in flow or sediment load.*

- *Acknowledging this caveat, we nonetheless anticipate that changes of less than 10% in either driver are unlikely to instigate, on their own, significant channel changes. This value is a conservative estimate of the year-to-year variability in either discharge or sediment flux that can be accommodated by a channel system in a state of dynamic equilibrium. It does not "guarantee," however, that channel change may not occur—either in response to yet modest alterations in water or sediment delivery, or because of other urbanization impacts (e.g., point discharge of runoff or the trapping of the upstream sediment flux; see Booth 1990) that are not represented with this analysis.*
- *In contrast, recognizing a condition of undisputed "high risk" must await broader collection of regionally relevant data. We note that >60% reductions in predicted sediment production have resulted in both minimal (McGonigle) and dramatic (Agua Hedionda) channel changes, indicating that "more data" may never provide absolute guidance. At present, we suggest using predicted watershed changes of 50% or more in either runoff (as indexed by change in impervious area) or sediment production as provisional criteria for requiring a more detailed evaluation of both the drivers and the resisting factors for channel change, regardless of other screening-level assessments. Clearly, however, only more experience with the application of such "thresholds," and the actual channel conditions that accompany them, will provide a defensible basis for setting numeric standards."*

The following criterion was developed using the suggestions listed above and then used to assign relative sediment production rating to each GLU:

- Low: Soil Loss < 5.6 tons/acre/year [GLUs that have a soil loss of 0 to 5.6 tons/acre/year produces around 10% of the total coarse sediment soil loss from the study area]
- Medium: 5.6 tons/acre/year < Soil Loss < 8.4 tons/acre/year
- High: > 8.4 tons/acre/year [GLUs that have a soil loss greater than 8.4 tons/acre/year produces around 42% of the total coarse sediment soil loss from the study area]

Results from the quantitative analysis are summarized in Table A.4.2.

Table A.4.2 Relative Sediment Production for different Geomorphic Landscape Units

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Agricultural/Grass-1	52883	0.20	4.67	0.14	50	6.5	Medium	No
CB-Agricultural/Grass-2	40633	0.21	5.19	0.14	56	8.3	Medium	No
CB-Agricultural/Grass-3	32617	0.22	6.04	0.14	57	10.6	High	Yes
CB-Agricultural/Grass-4	11066	0.23	7.38	0.14	57	13.5	High	Yes
CB-Developed-1	39746	0.22	3.77	0	49	0	Low	No
CB-Developed-2	32614	0.22	4.28	0	50	0	Low	No
CB-Developed-3	15841	0.22	4.86	0	49	0	Low	No
CB-Developed-4	1805	0.22	5.63	0	48	0	Low	No
CB-Forest-1	32231	0.20	6.38	0.14	39	6.8	Medium	No
CB-Forest-2	38507	0.20	7.20	0.13	45	8.8	High	Yes
CB-Forest-3	55303	0.20	8.14	0.13	48	10.6	High	Yes
CB-Forest-4	38217	0.20	9.95	0.14	50	13.6	High	Yes
CB-Other-1	1036	0.20	5.52	0.13	45	6.5	Medium	No
CB-Other-2	317	0.20	6.46	0.13	45	7.9	Medium	No
CB-Other-3	296	0.20	6.96	0.14	43	8.3	Medium	No
CB-Other-4	111	0.21	6.84	0.14	41	8.2	Medium	No
CB-Scrub/Shrub-1	88135	0.20	5.66	0.14	33	5.3	Low	No
CB-Scrub/Shrub-2	143694	0.20	6.51	0.14	37	6.8	Medium	No
CB-Scrub/Shrub-3	246703	0.21	7.33	0.14	41	8.4	Medium	No
CB-Scrub/Shrub-4	191150	0.21	8.28	0.14	42	9.8	High	No
CB-Unknown-1	1727	0.21	5.32	0.13	44	6.3	Medium	No
CB-Unknown-2	1935	0.21	5.95	0.13	44	7.1	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CB-Unknown-3	1539	0.22	6.21	0.13	44	7.7	Medium	No
CB-Unknown-4	278	0.22	6.61	0.13	44	8.4	High	Yes
CSI-Agricultural/Grass-1	14609	0.34	2.72	0.14	39	4.8	Low	No
CSI-Agricultural/Grass-2	9059	0.37	3.61	0.14	47	8.7	High	Yes
CSI-Agricultural/Grass-3	10096	0.38	3.99	0.14	47	9.8	High	Yes
CSI-Agricultural/Grass-4	2498	0.37	4.33	0.14	47	10.5	High	Yes
CSI-Developed-1	82371	0.28	2.51	0	39	0	Low	No
CSI-Developed-2	22570	0.30	2.66	0	41	0	Low	No
CSI-Developed-3	13675	0.30	2.89	0	40	0	Low	No
CSI-Developed-4	3064	0.27	3.20	0	39	0	Low	No
CSI-Forest-1	449	0.27	4.26	0.13	43	6.6	Medium	No
CSI-Forest-2	611	0.25	5.11	0.13	44	7.5	Medium	No
CSI-Forest-3	716	0.29	4.43	0.13	44	7.4	Medium	No
CSI-Forest-4	348	0.30	4.49	0.13	43	7.6	Medium	No
CSI-Other-1	319	0.31	2.50	0.13	32	3.2	Low	No
CSI-Other-2	83	0.27	3.01	0.13	39	4.3	Low	No
CSI-Other-3	45	0.28	3.03	0.13	39	4.5	Low	No
CSI-Other-4	13	0.24	4.01	0.14	39	5.2	Low	No
CSI-Scrub/Shrub-1	9051	0.26	3.53	0.13	39	4.7	Low	No
CSI-Scrub/Shrub-2	10802	0.27	4.36	0.13	41	6.3	Medium	No
CSI-Scrub/Shrub-3	28220	0.26	4.82	0.13	41	6.7	Medium	No
CSI-Scrub/Shrub-4	20510	0.26	5.52	0.13	41	7.8	Medium	No
CSI-Unknown-1	5292	0.28	2.38	0.13	36	3.1	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSI-Unknown-2	2074	0.29	2.98	0.13	40	4.5	Low	No
CSI-Unknown-3	2171	0.27	3.04	0.13	39	4.2	Low	No
CSI-Unknown-4	676	0.26	3.04	0.13	38	3.8	Low	No
CSP-Agricultural/Grass-1	59327	0.22	3.01	0.14	44	4.0	Low	No
CSP-Agricultural/Grass-2	8426	0.23	3.81	0.14	42	5.2	Low	No
CSP-Agricultural/Grass-3	2377	0.24	4.05	0.14	41	5.6	Low	No
CSP-Agricultural/Grass-4	291	0.22	6.28	0.14	52	10.1	High	Yes
CSP-Developed-1	85283	0.27	2.10	0	42	0	Low	No
CSP-Developed-2	7513	0.26	2.77	0	42	0	Low	No
CSP-Developed-3	2317	0.27	2.70	0	40	0	Low	No
CSP-Developed-4	272	0.27	2.76	0	38	0	Low	No
CSP-Forest-1	14738	0.22	4.52	0.14	44	6.0	Medium	No
CSP-Forest-2	3737	0.22	5.99	0.14	45	8.2	Medium	No
CSP-Forest-3	1858	0.21	6.42	0.14	45	8.5	High	Yes
CSP-Forest-4	484	0.21	7.62	0.14	48	10.2	High	Yes
CSP-Other-1	7404	0.23	2.61	0.14	39	3.2	Low	No
CSP-Other-2	343	0.24	3.68	0.13	40	4.8	Low	No
CSP-Other-3	126	0.24	3.76	0.13	40	4.9	Low	No
CSP-Other-4	17	0.24	4.19	0.13	39	5.3	Low	No
CSP-Scrub/Shrub-1	22583	0.23	3.75	0.14	41	4.8	Low	No
CSP-Scrub/Shrub-2	8938	0.24	5.63	0.14	40	7.1	Medium	No
CSP-Scrub/Shrub-3	7186	0.23	6.15	0.13	39	7.5	Medium	No
CSP-Scrub/Shrub-4	2609	0.22	7.16	0.14	43	9.3	High	Yes

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
CSP-Unknown-1	6186	0.25	2.63	0.13	40	3.4	Low	No
CSP-Unknown-2	744	0.27	3.49	0.13	39	4.8	Low	No
CSP-Unknown-3	350	0.28	3.32	0.13	38	4.5	Low	No
CSP-Unknown-4	78	0.28	3.26	0.13	40	4.5	Low	No
FB-Agricultural/Grass-1	6103	0.25	5.49	0.14	49	9.2	High	No
FB-Agricultural/Grass-2	7205	0.25	5.87	0.14	51	10.1	High	No
FB-Agricultural/Grass-3	6730	0.24	6.43	0.14	53	11.3	High	No
FB-Agricultural/Grass-4	2586	0.22	8.62	0.14	57	15.2	High	No
FB-Developed-1	10116	0.28	3.94	0	46	0	Low	No
FB-Developed-2	9075	0.28	4.41	0	45	0	Low	No
FB-Developed-3	5499	0.27	4.72	0	44	0	Low	No
FB-Developed-4	785	0.27	5.08	0	43	0	Low	No
FB-Forest-1	3780	0.21	7.24	0.13	39	8.0	Medium	No
FB-Forest-2	7059	0.21	7.53	0.13	43	8.8	High	No
FB-Forest-3	13753	0.22	8.02	0.13	43	9.7	High	No
FB-Forest-4	8899	0.26	9.63	0.13	35	11.5	High	No
FB-Other-1	172	0.26	5.72	0.13	44	8.6	High	No
FB-Other-2	75	0.26	5.97	0.13	38	7.7	Medium	No
FB-Other-3	76	0.28	6.27	0.13	34	7.6	Medium	No
FB-Other-4	36	0.31	6.70	0.13	33	8.6	High	No
FB-Scrub/Shrub-1	10297	0.24	6.94	0.14	36	8.3	Medium	No
FB-Scrub/Shrub-2	25150	0.25	7.24	0.14	38	9.0	High	No
FB-Scrub/Shrub-3	70895	0.25	7.89	0.13	38	10.0	High	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FB-Scrub/Shrub-4	70679	0.26	9.05	0.14	39	12.1	High	No
FB-Unknown-1	654	0.30	5.33	0.13	37	7.6	Medium	No
FB-Unknown-2	829	0.29	5.26	0.13	40	7.9	Medium	No
FB-Unknown-3	1062	0.29	5.54	0.13	39	8.2	Medium	No
FB-Unknown-4	299	0.28	6.02	0.13	38	8.4	High	No
FSI-Agricultural/Grass-1	8462	0.32	3.91	0.13	24	3.9	Low	No
FSI-Agricultural/Grass-2	4979	0.33	4.29	0.13	31	5.7	Medium	No
FSI-Agricultural/Grass-3	4808	0.34	4.26	0.13	34	6.3	Medium	No
FSI-Agricultural/Grass-4	1055	0.35	4.11	0.13	36	6.7	Medium	No
FSI-Developed-1	9953	0.29	3.09	0	34	0	Low	No
FSI-Developed-2	4972	0.31	3.22	0	37	0	Low	No
FSI-Developed-3	3350	0.29	3.30	0	36	0	Low	No
FSI-Developed-4	763	0.28	3.31	0	37	0	Low	No
FSI-Forest-1	186	0.33	4.62	0.13	37	7.2	Medium	No
FSI-Forest-2	217	0.35	4.47	0.13	39	7.9	Medium	No
FSI-Forest-3	262	0.37	4.71	0.13	40	9.2	High	No
FSI-Forest-4	111	0.36	4.73	0.13	40	9.2	High	No
FSI-Other-1	266	0.31	3.11	0.13	24	2.9	Low	No
FSI-Other-2	81	0.30	3.29	0.13	25	3.1	Low	No
FSI-Other-3	56	0.31	3.04	0.13	27	3.2	Low	No
FSI-Other-4	15	0.29	3.57	0.13	33	4.4	Low	No
FSI-Scrub/Shrub-1	2241	0.27	4.46	0.13	29	4.5	Low	No
FSI-Scrub/Shrub-2	3911	0.28	4.96	0.13	31	5.7	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSI-Scrub/Shrub-3	7590	0.29	5.05	0.13	34	6.3	Medium	No
FSI-Scrub/Shrub-4	3502	0.30	5.14	0.13	37	7.5	Medium	No
FSI-Unknown-1	1117	0.29	2.83	0.13	27	3.0	Low	No
FSI-Unknown-2	780	0.30	3.44	0.13	32	4.3	Low	No
FSI-Unknown-3	855	0.29	3.41	0.13	31	4.0	Low	No
FSI-Unknown-4	285	0.28	3.21	0.13	32	3.7	Low	No
FSP-Agricultural/Grass-1	13	0.22	2.22	0.13	40	2.5	Low	No
FSP-Agricultural/Grass-2	3	0.22	2.59	0.13	40	3.0	Low	No
FSP-Agricultural/Grass-3	2	0.22	2.69	0.13	40	3.2	Low	No
FSP-Agricultural/Grass-4	0	0.20	2.94	0.12	40	2.9	Low	No
FSP-Developed-1	180	0.26	2.85	0	40	0	Low	No
FSP-Developed-2	13	0.25	2.69	0	40	0	Low	No
FSP-Developed-3	8	0.21	2.25	0	40	0	Low	No
FSP-Developed-4	0	0.21	2.29	0	40	0	Low	No
FSP-Forest-1	8	0.22	2.29	0.14	40	2.9	Low	No
FSP-Forest-2	5	0.20	2.22	0.14	40	2.5	Low	No
FSP-Forest-3	0	0.20	2.22	0.14	40	2.5	Low	No
FSP-Other-1	1307	0.20	2.38	0.14	40	2.7	Low	No
FSP-Other-2	34	0.21	2.36	0.14	40	2.7	Low	No
FSP-Other-3	8	0.22	2.56	0.13	40	3.0	Low	No
FSP-Other-4	0	0.43	4.35	0.12	40	9.3	High	No
FSP-Scrub/Shrub-1	147	0.23	2.68	0.14	40	3.3	Low	No
FSP-Scrub/Shrub-2	18	0.23	2.55	0.14	40	3.3	Low	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
FSP-Scrub/Shrub-3	4	0.20	2.23	0.14	40	2.6	Low	No
FSP-Scrub/Shrub-4	0	0.20	1.70	0.12	40	1.7	Low	No
FSP-Unknown-1	40	0.20	1.87	0.13	40	1.9	Low	No
FSP-Unknown-2	5	0.20	1.99	0.12	40	2.0	Low	No
FSP-Unknown-3	1	0.20	2.39	0.12	40	2.4	Low	No
O-Agricultural/Grass-1	2433	0.20	2.93	0.14	34	2.8	Low	No
O-Agricultural/Grass-2	112	0.21	3.44	0.14	32	3.2	Low	No
O-Agricultural/Grass-3	30	0.23	3.89	0.13	32	3.8	Low	No
O-Agricultural/Grass-4	1	0.26	6.47	0.13	37	7.9	Medium	No
O-Developed-1	8327	0.27	1.37	0	39	0	Low	No
O-Developed-2	474	0.25	2.12	0	40	0	Low	No
O-Developed-3	157	0.26	3.07	0	41	0	Low	No
O-Developed-4	26	0.24	3.89	0	41	0	Low	No
O-Forest-1	235	0.22	6.15	0.13	43	7.6	Medium	No
O-Forest-2	67	0.21	5.07	0.13	45	6.6	Medium	No
O-Forest-3	45	0.21	5.43	0.13	47	7.3	Medium	No
O-Forest-4	20	0.20	5.95	0.13	59	9.0	High	No
O-Other-1	9362	0.25	3.86	0.13	36	4.3	Low	No
O-Other-2	344	0.24	3.32	0.13	35	3.5	Low	No
O-Other-3	120	0.23	4.86	0.13	35	5.0	Low	No
O-Other-4	37	0.22	5.64	0.13	39	6.6	Medium	No
O-Scrub/Shrub-1	688	0.22	4.83	0.13	40	5.7	Medium	No
O-Scrub/Shrub-2	224	0.22	5.80	0.13	36	6.3	Medium	No

Geomorphic Landscape Unit (GLU)	Area (acres)	K	LS	C	R	A	Relative Sediment Production	Critical Coarse Sediment
O-Scrub/Shrub-3	209	0.22	6.47	0.13	41	7.5	Medium	No
O-Scrub/Shrub-4	96	0.22	6.62	0.13	44	8.2	Medium	No
O-Unknown-1	1236	0.28	1.60	0.12	26	1.5	Low	No
O-Unknown-2	62	0.27	1.48	0.13	36	1.8	Low	No
O-Unknown-3	15	0.29	3.52	0.13	38	4.9	Low	No
O-Unknown-4	7	0.34	3.87	0.12	40	6.6	Medium	No

GLU Nomenclature: Geology – Land Cover – Slope Category

Geology Categories:

CB Coarse Bedrock

CSI Coarse Sedimentary Impermeable

CSP Coarse Sedimentary Permeable

FB Fine Bedrock

FSI Fine Sedimentary Impermeable

FSP Fine Sedimentary Permeable

O Other

Slope Categories:

1 0%-10%

2 10% - 20%

3 20% - 40%

4 > 40%

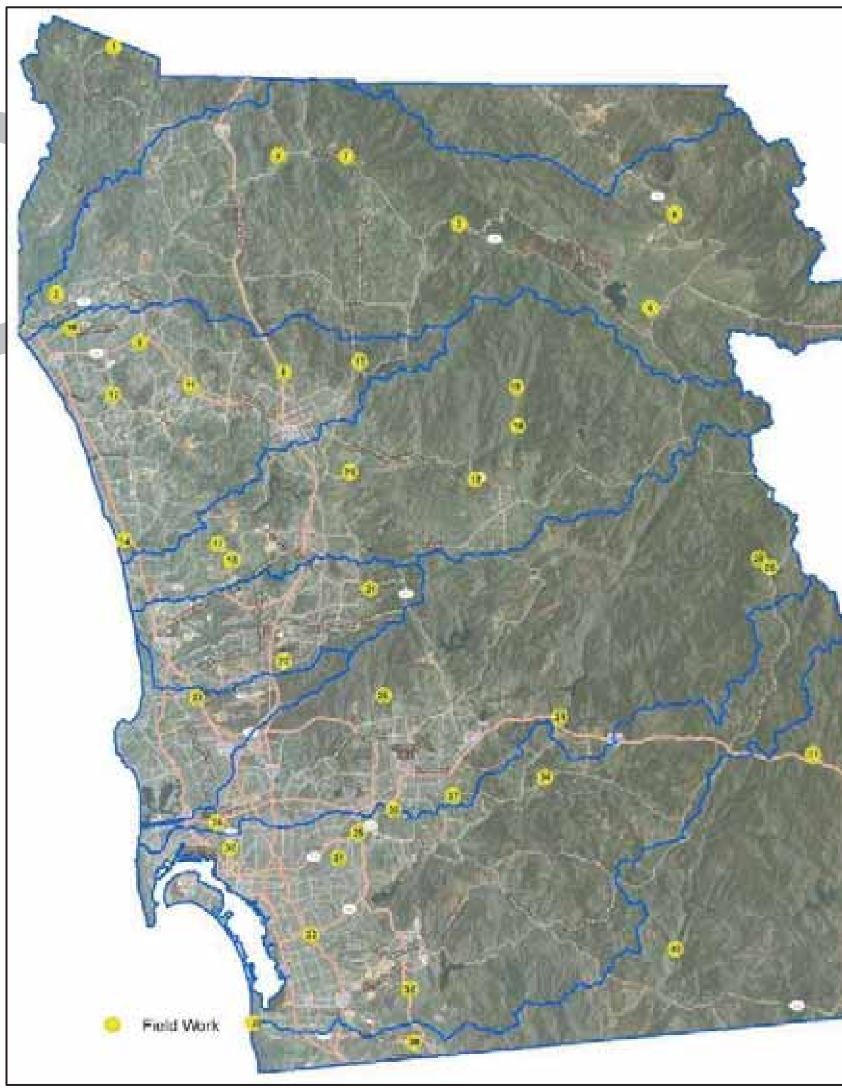
A4.3 Field Assessment

Site Selection:

Forty locations were selected from the study region for field assessment. Sites were selected such that they are accessible by existing road network based on review of satellite imagery and are uniformly distributed considering the following criteria:

- Geologic grouping
- Land cover
- Slope category
- WMA
- Jurisdiction

Yellow circles in the figure below shows the 40 locations for which field assessment was performed.



Pre-Field Activities

Prior to conducting field activities, the consultant team reviewed available published geologic information at each site location and prepared satellite imagery of each site using Google Earth™. Pre-field activities consisted of evaluating site access at each location using aerial imagery and logistics were coordinated based on regional site location to maximize field efficiency.

Site Reconnaissance

Site reconnaissance was performed at forty locations between 22 January and 7 February 2014 by a team of geologists. The reconnaissance consisted of:

- Visual soil classification,
- Assessing existing vegetative cover (0-100%),
- Qualitative assignment of existing sediment production (low, medium, and high) [based on existing vegetative cover],
- Qualitative assignment of potential sediment production (low, medium, and high)[assuming there is 0% vegetative cover], and
- Identifying existing erosional features.

Descriptions and visual classifications of the surficial materials were based on the Unified Soil Classification System (USCS). Underlying geologic units were confirmed where exposed formations were observed within the individual site limits.

SITE AND GEOLOGIC CONDTIONS

Our knowledge of the site conditions has been developed from a review of available geologic literature, previous geologic and geotechnical investigations by the consultant team in the study region, professional experience, site reconnaissance, and field investigations performed for this study.

Surface Conditions

Site locations were sited in open space with the exception of sites ID-27, -30, and -31 which were situated within developed areas with paved streets and sidewalks. The surface conditions at the site locations were characterized by sloping terrain varying from relatively flat (< 5%) to very steep slopes (> 40%). At the time of our reconnaissance the natural hillsides along the areas of interest were covered by varying degrees of moderate to dense growth scrub brush, low grasses, and scattered trees.

Existing erosional and geomorphic features at each site location were identified where possible. The observed erosional features included notable drainages, rilling, scour, and sediment accumulation. Observed geomorphic features included areas of minor slope instability and surficial slumping. Several sources of ground disturbance were identified during the site reconnaissance included active grading operations and bioturbation.

An evaluation of the existing and potential sediment production for each site was determined based on surface conditions. Sediment production was assigned as “high, medium, or low” based on the existing conditions and consultant team’s professional experience.

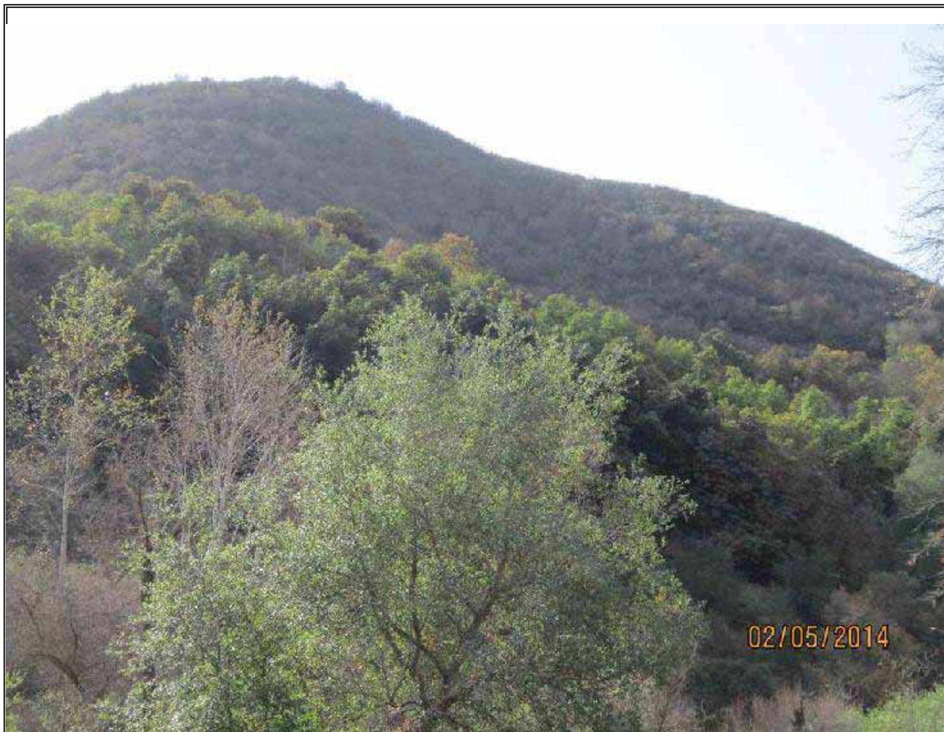
Surficial Deposits

Surficial deposits, including topsoil, alluvium, colluvium, slopewash, and residual soils are present in portions of the study area within the natural drainages and mantling the slope areas. The composition and grain size of these materials are variable depending on the age, parent sources, and mode of deposition.

Geologic Conditions

Our knowledge of the subsurface conditions at the site locations is based on a review of available published geologic information, professional experience, site reconnaissance, previous explorations and geotechnical investigations performed by the consultant team in the study region.

Field Assessment Photo Log



Field Visit ID-1

GLU: CB-Scrub/Shrub-4

View: Looking southwest

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 90%

Field Visit ID-2

GLU: CB-Forest-4

View: Looking north

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 95%

Field Visit ID-3

GLU: CSI-Agricultural/ Grass-3

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover:

95-100%

Field Visit ID-4

GLU: CSI-Scrub/Shrub-2

View: Looking north

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 70%

Field Visit ID-5

GLU: CSP-Agricultural/ Grass-1

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 90%

Field Visit ID-6

GLU: CSP-Agricultural/ Grass-3

View: Looking east

Existing sediment production: Low to Med

Potential sediment production:

Low to Med

Existing veg. cover: Southeast slope ~50%

Northeast slope ~70%

Field Visit ID-7

GLU: CSP-Forest-3

View: Looking east

Existing sediment production: Med to High

Potential sediment production: High

Existing veg. cover: 75-80%

Field Visit ID-8

GLU: CB-Scrub/Shrub-3

View: Looking southeast

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 90-95%

Field Visit ID-9

GLU: CB-Agricultural/ Grass-2

View: Looking northwest

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 70%

Field Visit ID-10

GLU: CSI-Unknown-2

View: Looking north

Existing sediment production: Med to High

Potential sediment production: High

Existing veg. cover: 75%

Field Visit ID-11

GLU: CSI-Agricultural/ Grass-2

View: Looking east

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 85%

Field Visit ID-12

GLU: CSP-Unknown-2

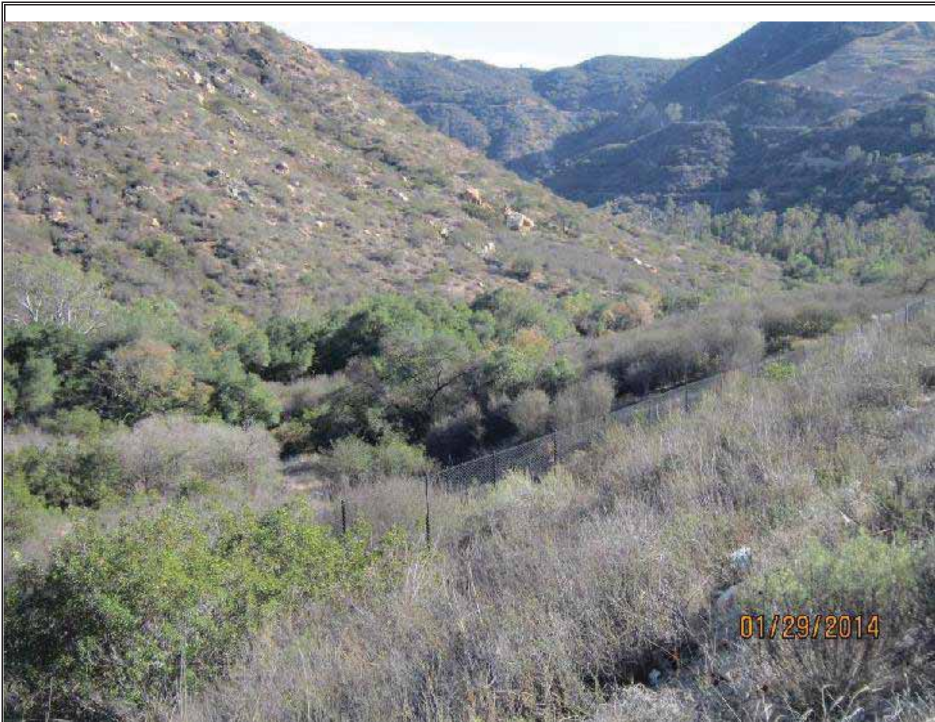
View: Looking southwest

Existing sediment production: Low

Potential sediment production:

Low to Med

Existing veg. cover: 50%



Field Visit ID-13

GLU: CSP-Scrub/Shrub-2

View: Looking southeast

Existing sediment production: Med

Potential sediment production:

Med to High

Existing veg. cover: 80-85%

Field Visit ID-14

GLU: FSP-Scrub/Shrub-1

View: Looking northeast

Existing sediment production: Low

Potential sediment production:

Low to Med

Existing veg. cover:

95-100%

Field Visit ID-15

GLU: CB-Agricultural/ Grass-4

View: Looking west

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 95%

.

Field Visit ID-16

GLU: CB-Agricultural/ Grass-3

View: Looking south

Existing sediment production: High*

Potential sediment production: High

Existing veg. cover: 90-95%

* Area was burned in 2014 fires after the field assessment so existing sediment production was adjusted to High (based on potential sediment production) from Medium

Field Visit ID-17

GLU: CSI-Scrub/Shrub-4

View: Looking west

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 95%

Field Visit ID-18

GLU: CSP-Forest-1

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 80%

Field Visit ID-19

GLU: CSP-Scrub/Shrub-3

View: Looking southwest

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 60%

Field Visit ID-20

GLU: CSP-Unknown-1

View: Looking southeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 95%

Field Visit ID-21

GLU: CB-Unknown-3

View: Looking northwest

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 50-60%

Field Visit ID-22

GLU: CSI-Forest-3

View: Looking east

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 60%

Field Visit ID-23

GLU: CSI-Scrub/Shrub-1

View: Looking north

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 80%

Field Visit ID-24

GLU: CB-Unknown-4

View: Looking northeast

Existing sediment production: Low to Med

Potential sediment production: High

Existing veg. cover: 80%

Field Visit ID-25

GLU: CSI-Agricultural/ Grass-4

View: Looking east

Existing sediment production: Low

Potential sediment production: Med-High

Existing veg. cover: 95%

Field Visit ID-26

GLU: CSI-Scrub/Shrub-3

View: Looking east

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 100%

.

Field Visit ID-27

GLU: CSP-Developed-2

View: Looking north

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 30-35%

.

Field Visit ID-28

GLU: CSP-Agricultural/ Grass-2

View: Looking north

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 90-95%

.

Field Visit ID-29

GLU: FB-Forest-3

View: Looking northwest

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 80-85%

Field Visit ID-30

GLU: CB-Developed-4

View: Looking northeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 70%

.

Field Visit ID-31

GLU: CSI-Developed-3

View: Looking north

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 30-35%

Field Visit ID-32

GLU: CSI-Unknown-3

View: Looking west

Existing sediment production: Low to Med

Potential sediment production: Med

Existing veg. cover: 70-75%

Field Visit ID-33
GLU: CSP-Scrub/Shrub-1

View: Looking northeast

Existing sediment production: Low to Med

Potential sediment production:

Med to High

Existing veg. cover: 70%

Field Visit ID-34
GLU: CSP-Developed-2

View: Looking south

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 95%

Field Visit ID-35

GLU: FB-Scrub/Shrub-3

View: Looking northeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 90-95%

Field Visit ID-36

GLU: FSI-Agricultural/ Grass-2

View: Looking northeast

Existing sediment production: Low

Potential sediment production: Med

Existing veg. cover: 95%

	**Field Visit ID-37** **GLU: CB-Forest-3** View: Looking southeast Existing sediment production: Med-High Potential sediment production: High Existing veg. cover: 75-80%

	**Field Visit ID-38** **GLU: CSI-Agricultural/ Grass-1** View: Looking northeast Existing sediment production: Low Potential sediment production: Med Existing veg. cover: 85%

Field Visit ID-39

GLU: CSP-Developed-1

View: Looking west

Existing sediment production: Low

Potential sediment production: Low

Existing veg. cover: 30-35%

Field Visit ID-40

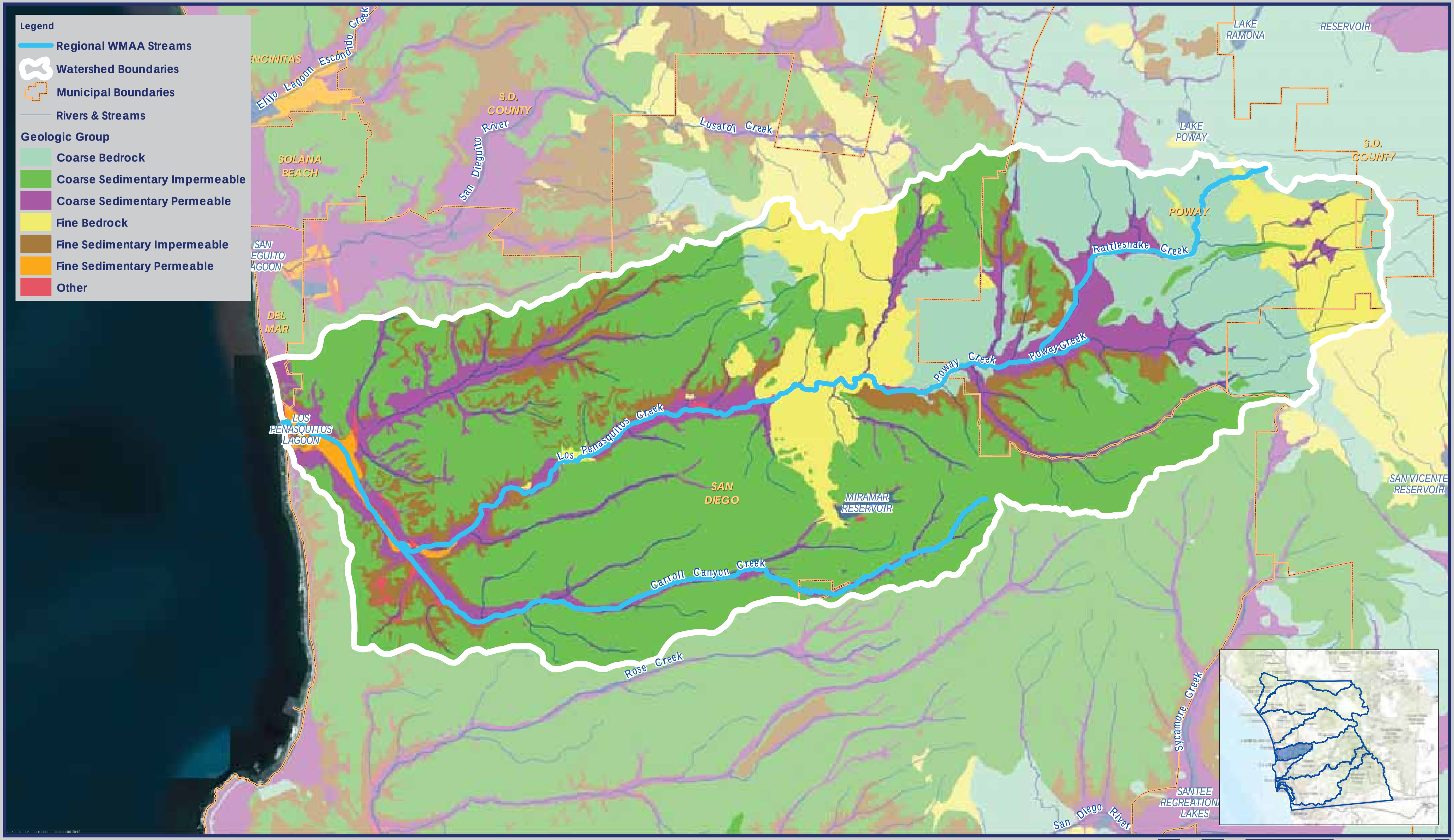
GLU: CSP-Scrub/Shrub-4

View: Looking south

Existing sediment production: Med

Potential sediment production: High

Existing veg. cover: 90-95%



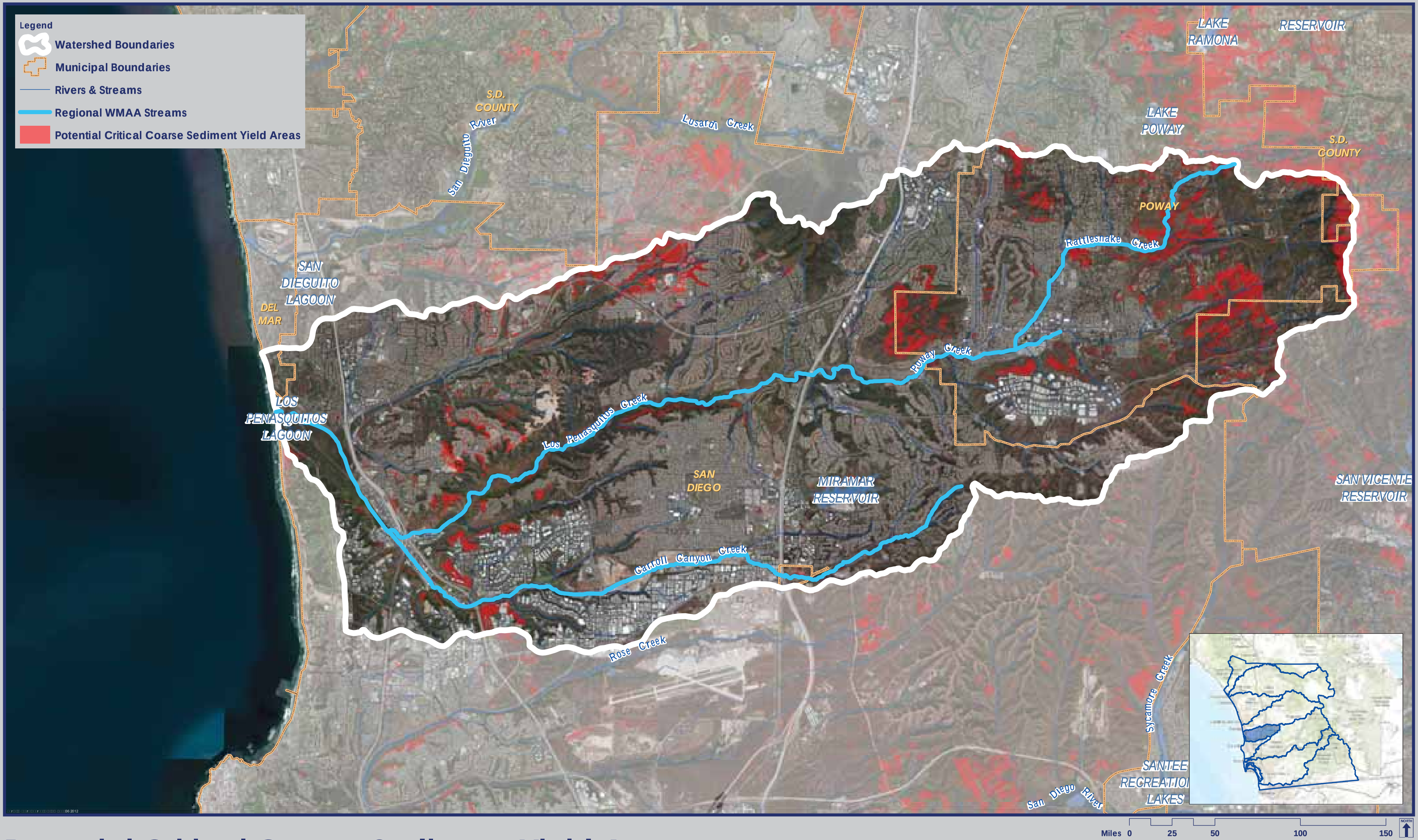
Geologic Group

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK



Potential Critical Coarse Sediment Yield Areas

Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK

ATTACHMENT A.5

PHYSICAL STRUCTURES

A.5 Physical Structures

The desktop-level analysis to identify existing physical structures within the nine watershed management areas within the San Diego region utilized the following GIS data sources:

- ESRI ArcMap, Google Earth, and Google Maps products
- Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) Flood Profiles and FEMA Flood Insurance Rate Map (FIRM)
- National Flood Hazard Layer (NFHL)
- Municipal master drainage plans (as provided)
- San Diego Geographic Information Source (SanGIS) Municipal Boundaries and Hydrologic Basins
- United States Geological Survey (USGS) National Hydrography Dataset (NHD) California data
- Stream data generated as indicated in Section 2.2

The following documents the process used to identify the physical structures along the reaches and the resulting GIS data:

- The process began by importing the data sources indicated above into a single ArcMap document that served as a master map file from which all further analysis proceeded.
- The data were screened and selected for inclusion as appropriate to the project scope.
- Point features were placed along river reach line segments to coincide with visually identified structures, utilizing different feature symbols according to the type of infrastructure.
- In the case of levees, the point was placed at the downstream-most end of the FEMA NFHL Shapefile. All point features generated in this task appear in the GIS shapefile.
- Municipal boundaries intersecting river reaches were identified to identify the applicable municipal drainage plan data.
- Point feature attributes and associated information for Physical Structures GIS shapefile is indicated in Table A.5.1 below.

Table A.5.1: Structure Identification Point Feature Attribute Development and Information

Attribute	Description
Struct_ID	The Structure ID field provides a six-digit identification number based upon the structure's specific location within a watershed. The first three digits in the code reflect the structure's Hydrologic Unit (HU) Basin number (ranging between 902-911 for Region 9, as defined in the Water Quality Control Plan for the San Diego Basin). The subsequent three digits reflect the structure's location along the reach, ascending along the channel from the headwaters to tailwaters (ranging between 001-999, beginning at the confluence and increasing in the upstream direction).

Attribute	Description
WMA	The Watershed Management Area field provides the name of the watershed in which the structure exists. The WMA corresponds with the HU identified in the first three digits in the Struct_ID (e.g., 911, Tijuana Watershed).
Channel_ID	The Channel ID field provides the name of the channel in which the structure exists.
Struct_Typ	The Structure Type field classifies known structures as one of the following types:, Bridge, Culvert, Dam, Energy Dissipater, Flood Management Basin, Flood Wall, Grade Control, Levee, Pipeline, Weir.
Struct_Dtl	The Structure Detail field provides known quantitative information for multi-section culverts.
Struct_Mtl	The Structure Material field provides known qualitative information for structure material composition.
Struct_Shp	The Structure Shape field provides known geometric information for culvert shapes, and is classified as one of the following types: Arch, Box, Pipe.
Jurisd_ID	The Jurisdiction ID field, when applicable, provides the known separate structure identification number developed and utilized by the jurisdiction or entity responsible for creating and distributing the coinciding structure Shapefile data used for this analysis. This number was copied from the coinciding external Shapefile data attribute field best representing a unique jurisdiction or entity-based identification number (external Shapefile data received from regional WMAA data call; for jurisdictional information, see "Other" attribute field). Coinciding external Shapefile data was used to determine various structure attributes.
Plan_ID	The Plan ID field, when applicable, provides the known structure plan number corresponding with the Jurisdiction ID. This number was copied from the coinciding external Shapefile data attribute field best representing a unique plan number received from the regional WMAA data call (external Shapefile data received from regional WMAA data call; for jurisdictional information, see "Other" field). Coinciding external Shapefile data was used to determine various structure attributes.
Diameter	The Diameter field, when applicable, provides the known diameter (in US feet) for culverts.
Length	The Length field, when applicable, provides the known length (in US feet) for select structure types. When lengths were determined using FEMA FIS Flood Profiles, the scaled horizontal distances along the indicated roadway or channel slope were used.
Width	The Width field, when applicable, provides the known width (in US feet) for select structure types.
Height	The Height field, when applicable, provides the known height (in US feet) for select structure types. When heights were determined using FEMA FIS Flood Profiles, the scaled vertical distances from channel bed to indicated roadway bottom were used.
US_Invert	The Upstream Invert field, when applicable, provides the known upstream invert elevation (in US feet) for select structure types.
DS_Invert	The Downstream Invert field, when applicable, provides the known downstream invert elevation (in US feet) for select structure types.

Attribute	Description
RD_EL_NAVD	The Roadway Elevation (NAVD) field, when applicable, provides the known roadway elevation (in US feet, NAVD) for select structure types. When roadway elevations were determined using FEMA FIS Flood Profiles, the horizontal projection onto the vertical grid scales were used.
Loc_Descr	The Location Description field, when applicable, provides information for structures crossing a known roadway. In nearly all cases, Google Earth imagery was used to determine the roadway name.
Other	The Other field is used to convey any information not present within the preceding fields. Typically, "other" information includes jurisdictional, plan, and supplemental dimensions for a given structure.

Example Structure Identification

The following example demonstrates the structure identification process for a discrete structure (ID 907029) along the San Diego River. The San Diego River is located in the San Diego River watershed (WMA 907). Scanning the river from lower to higher reached, a new point feature was placed at the road crossing over the San Diego River as indicated in Figure A.5.1. Select attributes of this particular structure were available from the FEMA NFHL as displayed in the highlighted boxes in Figure A.5.1. Additional attributes such as the culvert height, length, roadway elevation, and name were also determined from the FIS Flood Profile as indicated in Figure A.5.2. Satellite imagery (e.g., Google) was used to verify the existence of structure. In this case, the most current Google Map data indicated that the culvert still exists and that the roadway name has been changed to Qualcomm Way. When structures could not be verified with satellite imagery, the structure identification was based solely upon the information provided or readily available and was not physically verified in the field. Figure A.5.3 displays an example of imagery used to identify structures.

Figure A.5.1: Typical ArcMap Window

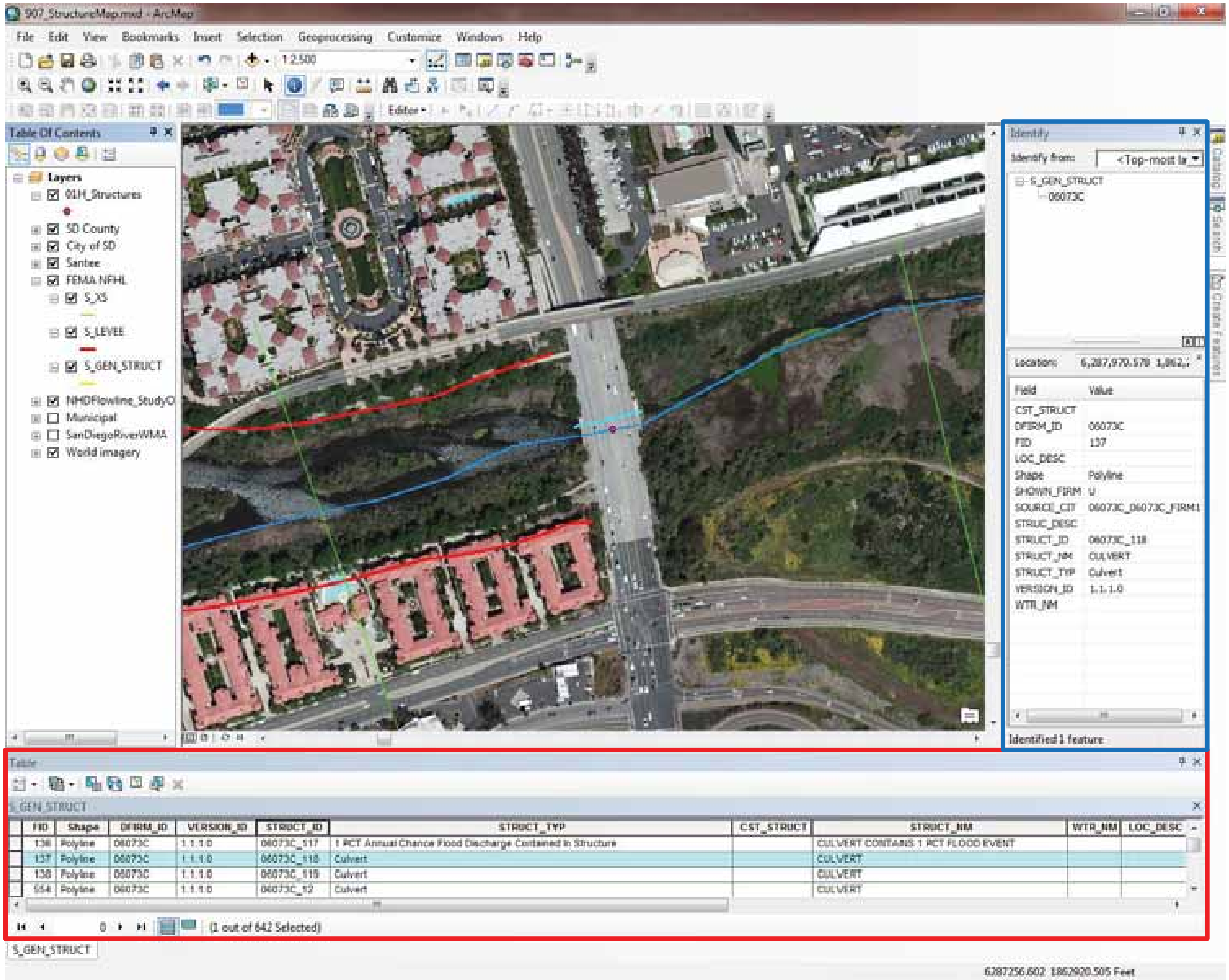
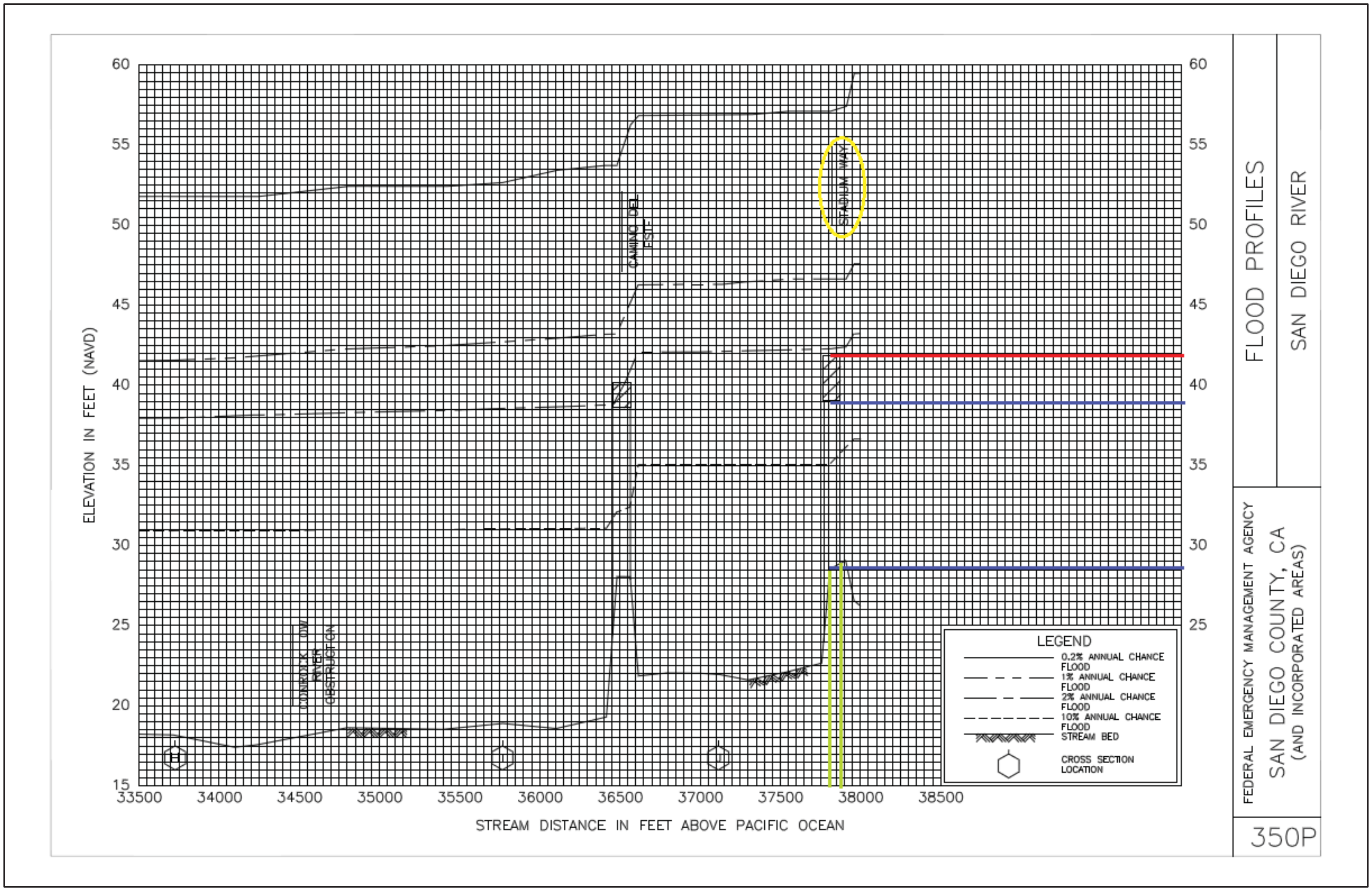


Figure A.5.2: Typical FEMA FIS Flood Profile



Legend: roadway elevation (red), roadway name (yellow), culvert height (blue), culvert width (green)

Figure A.5.3: Google Map Imagery for Structure Identification

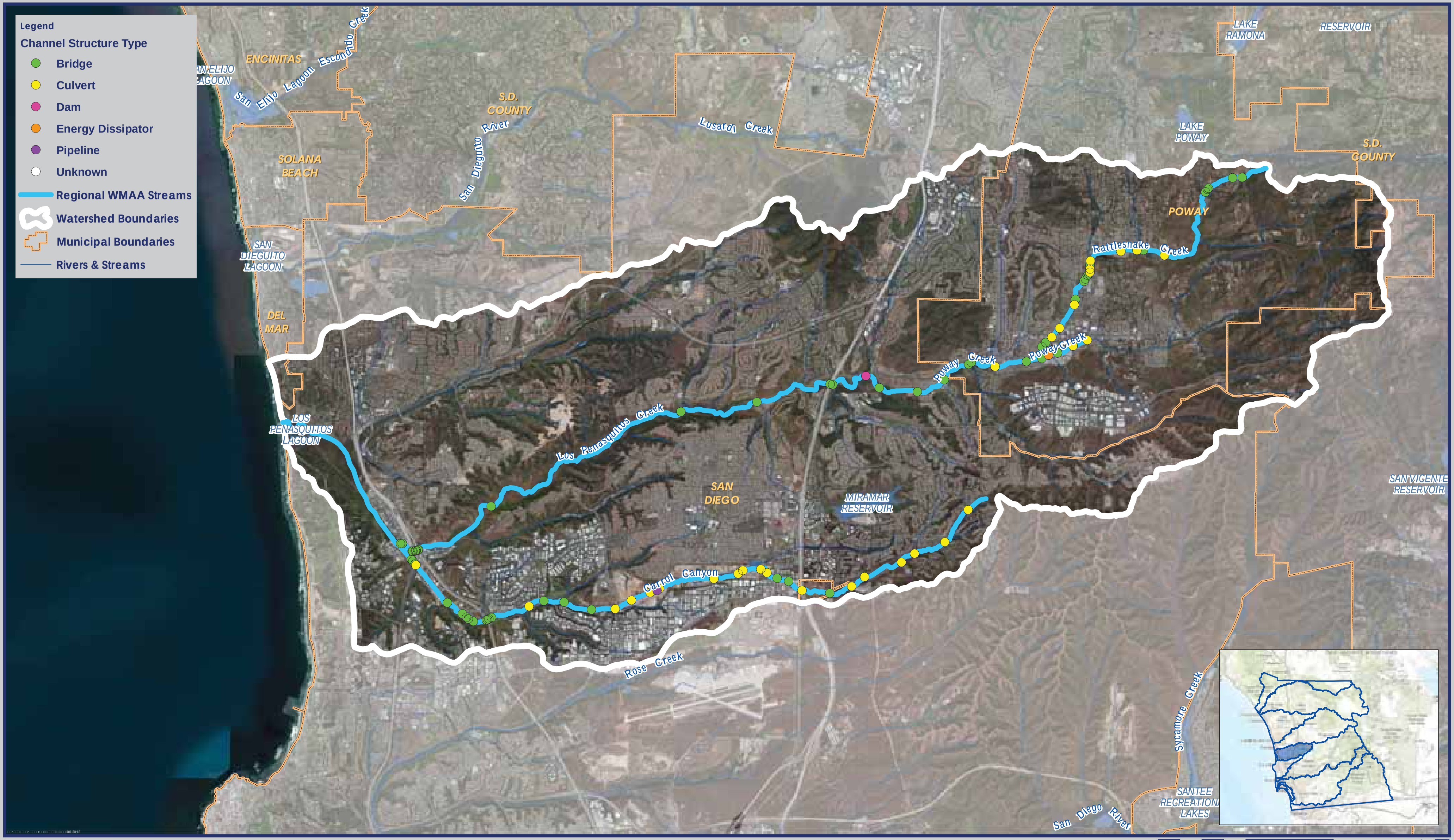
The following bridge structure dimensional attributes were included in the point feature attributes:

- length 110 feet
- height 10 feet
- roadway elevation 41.9 feet

The attribute table associated with the identified structure included in the GIS shapefile is indicated in Table A.5.2.

Table A.5.2: Structure 907029 Attribute Table

Attribute	Description
Struct_ID	907029
WMA	San Diego
Channel_ID	San Diego River
Struct_Typ	Culvert
Struct_Dtl	
Struct_Mtl	
Struct_Shp	
Jurisd_ID	06073C_118
Plan_ID	06073C_06073C_FIRM1
Diameter	0
Length	110
Width	0
Height	10
US_Invert	0
DS_Invert	0
RD_EL_NAVD	41.9
Loc_Descr	Qualcomm Way
Other	Info from FEMA NFHL shapefile data/FIS FP V.9-350P



Watershed Management Area Streams with Channel Structures

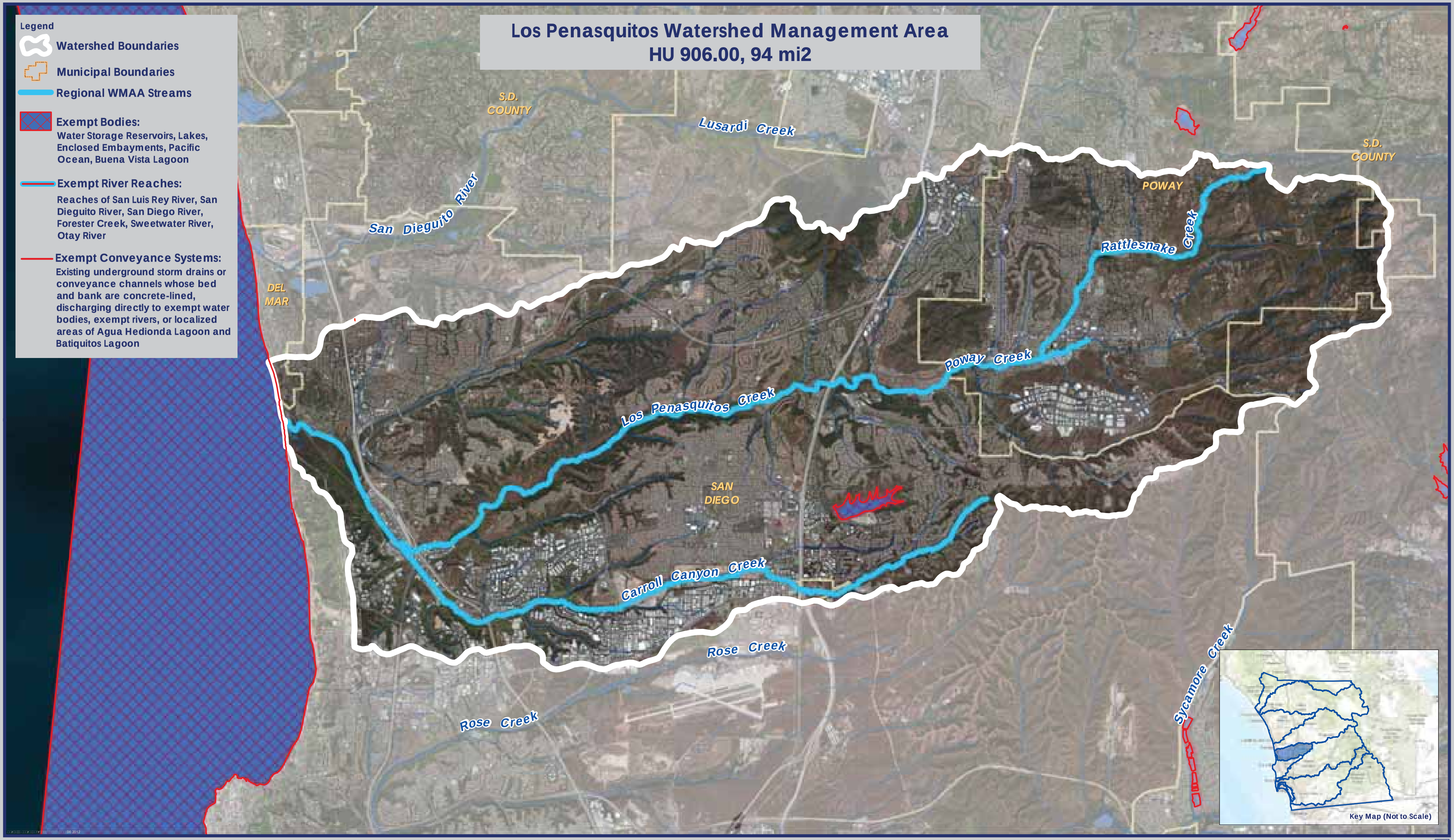
Los Penasquitos Watershed - HU 906.00, 94 mi2

Exhibit Date: Sept. 8, 2014

Geosyntec consultants
RICK

ATTACHMENT B

HYDROMODIFICATION MANAGEMENT EXEMPTION MAPPING



Receiving Waters and Conveyance Systems Exempt from Hydromodification Management Requirements

Exhibit Date: Sept. 8, 2014

Geosyntec consultants

RICK

ATTACHMENT C

ELECTRONIC FILES

Electronic Folder titled "Los Penasquitos_WMAA_Attachment C Electronic_Data.zip" Contents:

1. ArcMap 10.0 and 10.1 map files created for purpose of viewing Regional WMAA data
    - WMAA_05_Los Penasquitos_Data_2014_0908_v10.mxd
    - WMAA_05_Los Penasquitos_Data_2014_0908_v101.mxd
2. ESRI Geodatabase titled " WMAA_05_Los Penasquitos_Data_2014_0908_v10.gdb" containing the following data:
    - WatershedBoundaries
        - Watershed_Boundaries
    - HydrologicProcesses
        - HRUAnalysis
    - Streams – description of existing streams in the watershed
        - SD_Regional_WMAA_Streams (streams selected for detailed analysis)
        - SD_NHD_Streams (portion of NHD dataset included for reference)
    - LandUsePlanning
        - SanGIS_ExistingLandUse
        - SanGIS_PlannedLandUse
        - SanGIS_DevelopableLands
        - SanGIS_RedevelopmentandInfill
        - SanGIS_MunicipalBoundaries
        - Federal_State_Indian_Lands
        - SanGIS_MHPA_SD
        - SanGIS_MSCP_CN
        - SanGIS_MSCP_EAST_DRAFT_CN
        - SanGIS_Draft_North_County_MSCP_Version_8_Categories
    - PotentialCoarseSedimentYield
        - GLUAnalysis
        - PotentialCoarseSedimentYieldAreas
        - MacroLevelPotentialCriticalAreas
        - PotentialCriticalCoarseSedimentYieldAreas
    - ChannelStructures
        - ChannelStructures
    - HydromodExemptions
        - Exempt_Systems
        - Exempt_Bodies
    - Floodplains: included for reference
        - FEMA_NFHL
    - Baselayers: included for reference
        - SanGIS_Lakes
        - link to ESRI World Imagery (internet connection is required to access ESRI World Imagery basemap)

Electronic Folder titled "Los Penasquitos_WMAA_Attachment C Electronic_Data.zip" Contents, continued:

3. Google Earth – KMZ file titled: "WMAA_05_LosPenasquitos_Data_2014_0908_GoogleEarth.kmz", containing the following data:
   - WatershedBoundaries
   - Streams
     - SD Regional WMAA Streams (streams selected for detailed analysis)
     - SD NHD Streams (portion of NHD dataset included for reference)
   - LandUsePlanning
     - Municipal Boundaries
     - Federal/State/Indian Lands
   - ChannelStructures
   - HydromodExemptions
     - Exempt_Systems
     - Exempt_Bodies
   - Floodplains: included for reference
     - FEMA Floodplain
   - Dominant Hydrologic Processes
   - Potential Critical Coarse Sediment Yield Areas

Notes:
- Open a map file (with extension .mxd) using ArcMap to view the data.
- All data contained in the geodatabase is loaded into the map.

Attachment D

Regional MS4 Permit Crosswalk

Table below provides a linkage between the Regional MS4 Permit requirements for WMAA and this report.

Regional MS4 Permit Provision	Regional WMAA Report
B.3.b.(4)(a)	Chapter 2; Section 5.1; Attachment A and Attachment C
B.3.b.(4)(a)(i)	Section 2.1; Attachment A.1 and Attachment C
B.3.b.(4)(a)(ii)	Section 2.2; Attachment A.2 and Attachment C
B.3.b.(4)(a)(iii)	Section 2.3; Attachment A.3 and Attachment C
B.3.b.(4)(a)(iv)	Section 2.4; Attachment A.4 and Attachment C
B.3.b.(4)(a)(v)	Section 2.5; Attachment A.5 and Attachment C
B.3.b.(4)(b)	Chapter 3 and Section 5.2
B.3.b.(4)(c)	Chapter 4; Section 5.3; Attachment B and Attachment C

Attachment N-3

Alternative Compliance Candidate Projects Lists

Intentionally Left Blank

Project Identifier	Watershed Management Area	Jurisdiction	Ownership	Project Location				Project Size & Parameters				Other Notes
			Owner Information	Address	APN	Latitude (X-Coordinate)	Longitude (Y-Coordinate)	Contributing Drainage Area (acres)	Parcel Size (acres)	Project Footprint (acres)	Parameters (with units as necessary)	
Public Parcels Identified as Suitable for Further Assessment to Determine Feasibility of Retrofitting with Green Infrastructure												
Parcels on this list that are 0.25 acres or greater have been assessed using broad assumptions necessary for computer modeling and were found to be potentially effective as an opportunity for contributing to load reduction goals. Considerable further assessment would be required before determining any of these sites to be viable retrofit sites for implementation of Green Infrastructure. That assessment includes verifying public ownership, determining if land use agreements and financing can be established, assessing feasibility based upon further investigation of physical site constraints at a project design level, and determining that construction and necessary approvals, including approvals from regulatory agencies other than the City of San Diego, can be completed within the time constraints in the Municipal Storm Water Permit that pertain to Alternative Compliance.												
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Los Penasquitos WMAA Candidate Projects in the City of San Diego

			Ownership	Project Location				Project Size & Parameters				
Project Identifier	Watershed Management Area	Jurisdiction	Owner Information	Address	APN	Latitude (X-Coordinate)	Longitude (Y-Coordinate)	Contributing Drainage Area (acres)	Parcel Size (acres)	Project Footprint (acres)	Parameters (with units as necessary)	Other Notes
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Public Parcels Identified as Suitable for Further Assessment to Determine Feasibility of Retrofitting												
Parcels on this list have been assessed using broad assumptions necessary for computer modeling and were found to be potentially effective as an opportunity for contributing to load reduction goals. Considerable further assessment would be required before determining any of these sites to be viable retrofit. That assessment includes verifying public ownership, determining if land use agreements and financing can be established, assessing feasibility based upon further investigation of physical site constraints at a project design level, and determining that construction and necessary approvals, including approvals from regulatory agencies other than the City of San Diego, can be completed within the time constraints in the Municipal Storm Water Permit that pertain to Alternative Compliance.												
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Project Concept for Green Streets Retrofits – Quantity and Location of Suitable City Streets To-Be-Determined												
The City of San Diego is in the process of identifying potential public street locations that could feasibly be retrofitted with Green Infrastructure and provide a meaningful contribution to pollutant load reduction goals. As locations become verified for feasibility and effectiveness, funding mechanisms under an Alternate Compliance program could potentially be used to fill gaps in construction and maintenance funding necessary for the project to go forward. This is pending the ability to establish suitable legal mechanisms and verify that approvals and construction can be completed within the time constraints in the Municipal Storm Water Permit that pertain to Alternative Compliance.												
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Project Identifier	Hydrologic Area (HA)	Hydrologic Subarea (HSA)	Jurisdiction	Project Name	Ownership		Project Location				Project Origination/ Originator		Project Category	Specific Project Type	Potential Pollutant	Project Size & Parameters			Project Timeline	Other Notes	Originating Report	E-Mail	Phone	Contact Address
					Type	Owner Information	Address	APN	Latitude	Longitude	Name	Contact Information				Contributing Drainage Area (acres)	Parcel Size (acres)	Project Footprint (acres)						
TBD	906.1	906.1	City of Del Mar	Varies	Public or Public/ Private Partnership	Varies	TBD	TBD	TBD	TBD	TBD	TBD	Retrofitting existing infrastructure	LID/ Green Streets/ Source Control	Multiple	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	906.1	906.1	City of Del Mar	Varies	Public or Public/ Private Partnership	Varies	TBD	TBD	TBD	TBD	TBD	TBD	Retrofitting existing infrastructure	Stormwater Retention/ Treatment	Multiple	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	906.1	906.1	City of Del Mar	Varies	Public or Public/ Private Partnership	Varies	TBD	TBD	TBD	TBD	TBD	TBD	Regional BMPs	Wetland Rehabilitation/ Enhancement/ Restoration	Multiple	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	906.1	906.1	City of Del Mar	Varies	Public or Public/ Private Partnership	Varies	TBD	TBD	TBD	TBD	TBD	TBD	Floodplain Preservation	-	Multiple	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

NOTE: Candidate projects listing does not commit Responsible Agencies to developing or implementing an Offsite Alternative Compliance Program; or commit to the planning, design or construction of the projects on the list

APPENDIX O

Alternative BMP Implementation Scenario Methodology

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APPENDIX O. ALTERNATIVE BMP IMPLEMENTATION SCENARIO METHODOLOGY

An alternative modeling analysis was performed for the Los Peñasquitos watershed as part of the Water Quality Improvement Plan. The pollutant loads from Non-Phase I MS4s (Non-MS4s) can be differentiated from Phase I MS4s (MS4s) loads to more accurately and fairly assess load reduction responsibilities. The purpose of this analysis is to foster future discussions about accurate and fair apportionment of pollutant reduction responsibilities in the subwatershed to ensure that Non-MS4 discharges are regulated before they enter a MS4 to improve water quality throughout the watershed. The current analysis does not differentiate between MS4 loads and Non-MS4 loads. This baseline analysis represents the primary scenario included in this Water Quality Improvement Plan, which provided the foundation for the alternative modeling analysis that was used to estimate MS4 and Non-MS4 loads.

This appendix describes the methodology that was used to perform the alternative analysis, which focused on removing Non-MS4 areas to allow for BMP optimization within MS4 areas to achieve the required MS4 load reductions to meet the Water Quality Improvement Plan numeric goals while maintaining cost efficiencies. There are four classifications that constitute Non-MS4 areas, as summarized below:

- Areas covered by NPDES General Permit No. CA CAS000004—Waste Discharge Requirements for Storm Water Discharges from Small MS4s (General Phase II Permit)
- Industrial Areas, some of which may be covered by NPDES General Permit No. CAS000001 – Waste Discharge Requirements for Dischargers of Storm Water Associated with Industrial Activities Excluding Construction Activities (Industrial General Permit)
- Agricultural areas, some of which may addressed by the Conditional Waiver of Discharges from Agricultural and Nursery Operations (Ag Waiver)
- Areas identified as Federal and State lands (and Indian lands, if present)

Alternative scenario results are presented in Section 4.4. The MS4s will continue to refine and update the alternative scenario analysis, and engage stakeholders in a dialogue about how all the responsible parties within the watershed can work together to achieve the numeric goals in the Water Quality Improvement Plan. For example, the current list of Industrial General Permit (IGP) non-filers could be added to the analysis to more accurately estimate load reduction responsibilities for industrial dischargers within the watershed.

O.1 Alternative Scenario: Remove Non-MS4 Areas

The baseline watershed model was used to estimate the load reduction requirement for MS4 areas. The contributing load from MS4 areas was derived from the model output.

The required load reduction was then calculated based on multiplying the MS4 load by the percent reduction numeric goals. It is important to note that the overall watershed load reduction goal would be met through reductions by both the MS4s and Non-MS4s within each subwatershed, thereby maintaining equity among all dischargers within each subwatershed. Estimated load reductions were based on the relative loading from each responsible discharger in the watershed.

After defining the load reduction requirement for MS4 areas, BMP optimization using the EPA-released SUSTAIN (version 1.2) model was performed. BMP optimization refers to the modeling analysis that was conducted to identify the “optimal” structural BMP opportunities (considering BMP size, type, and location in the watershed) that would achieve the load reduction with the lowest cost. Figure O-1 provides a conceptual diagram that summarizes the alternative modeling approach. Non-MS4 areas were removed from the modeling analysis.

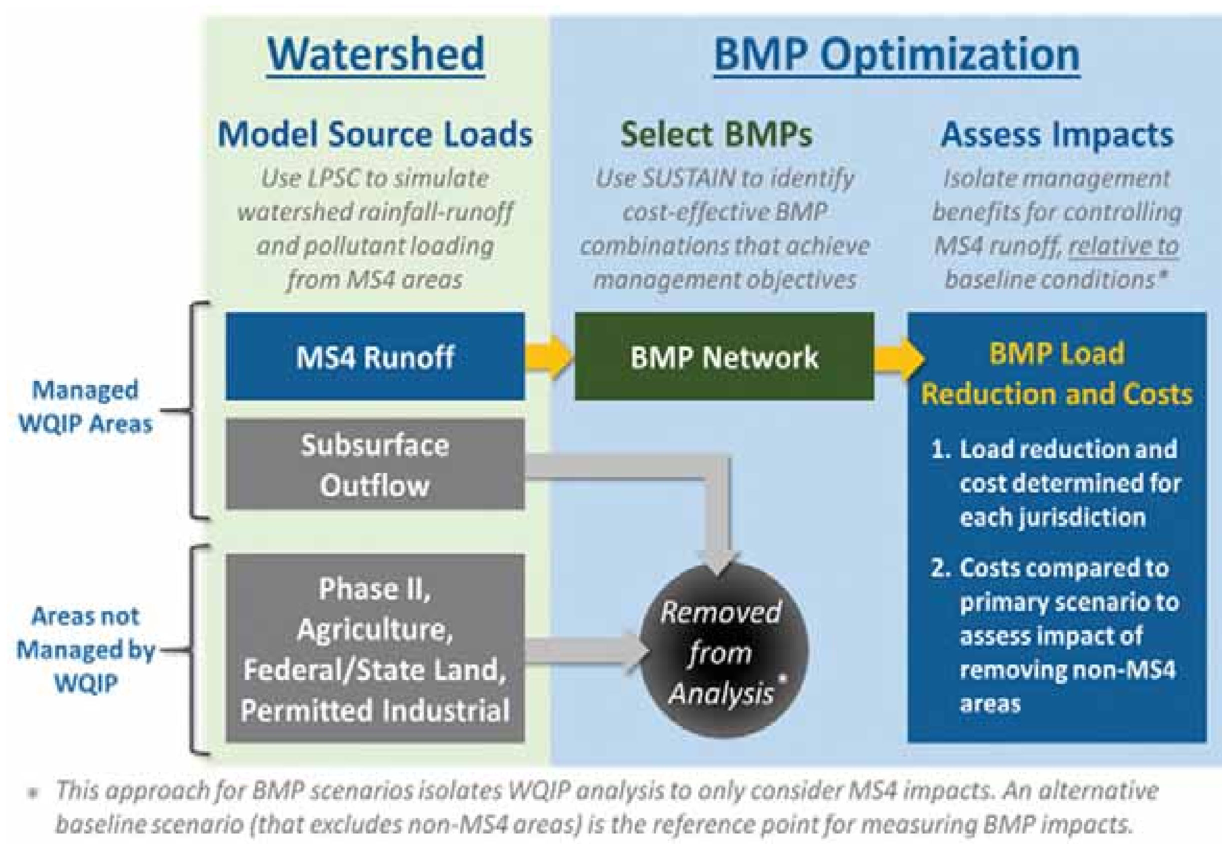

Figure O-1 Conceptual Modeling Approach

The modeling analysis was performed following the same methodology as in the primary scenario (for the entire watershed), except BMPs were optimized to treat runoff from MS4 areas only and a two-tiered optimization approach was used. This approach provides BMP optimization first at the subwatershed level (Tier 1), then watershed-wide to meet the load reduction target (Tier 2).

O.2 Technical Notes and Assumptions

- Areas associated with each Non-MS4 category were delineated based on GIS analysis. Industrial areas are represented by facilities that are currently registered in the Industrial General Permit (IGP) program (from California's SMARTS database). GIS was used to identify the area associated with each facility (based on review of the SANDAG parcel layer and aerial photography). Current Phase II permit areas were also delineated based on review of the SANDAG parcel layer and aerial photography, as well as review of available maps showing the spatial extent of Phase II permitted areas. SANDAG land use data were used to identify agricultural areas and Federal/State/Indian lands.
- Non-Modeled Nonstructural strategies. Although these programs primarily reduce loads from MS4 areas, they implicitly provide benefits to MS4s and Non-MS4s through various programs. For example, MS4 industrial inspection activities help reduce pollutant loads from industrial areas. The ratio of MS4 and Non-MS4 pollutant loading within the watershed was used to estimate the load reduction associated with each MS4/Non-MS4 category. This adjustment was also needed to maintain the estimated 10 percent load reduction associated with this BMP category.
- Modeled Nonstructural BMPs (catch basin cleaning, street sweeping, irrigation reduction, downspout disconnects, and rain barrels incentives) and Green Infrastructure (GI) were assumed to reduce loads from MS4 areas only.
- Multiuse Treatment Areas (MUTAs) and Green Streets. These BMPs generally treat large drainage areas that may include MS4 and Non-MS4 areas. Within each BMP drainage area, MS4 and Non-MS4 loads were estimated based on the modeled pollutant load generated within each drainage area. Pollutant load estimates were based on land use characteristics and other factors that influence pollutant loading. The ratio of MS4 and Non-MS4 areas within each BMP drainage area was used to estimate the load for each MS4/Non-MS4 category.
- Green Streets optimization. A 2-tiered optimization was used in the alternative analysis (first at the subwatershed level, then watershed-wide to meet the load reduction target).
- Lagoon Restoration/Additional Opportunities were included for the City of San Diego, City of Poway, and San Diego County. This suite of restoration activities and BMPs was estimated to provide a 15 percent load reduction (specifically, 15 percent of the total load reduction required).

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APPENDIX P
Monitoring and Assessment Program Fact Sheets

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P.1 Receiving Water Monitoring

P.1.1 Long-Term Dry Weather Receiving Water Monitoring (Permit Prov. D.1.c)

Overview

Objectives

- Determine whether the conditions in the receiving water during dry weather are protective or likely protective of beneficial uses
- Determine the extent and magnitude of the current or potential dry weather receiving water problems
- Evaluate whether conditions in the receiving water during dry weather are improving or declining.

Sampling Locations

Table P-1
Dry Weather Receiving Water Monitoring Station

Station Name	Waterbody	Subwatershed	Latitude	Longitude
LPC-MLS	Los Peñasquitos Creek	Los Peñasquitos Creek	32.90444	-117.22283

Frequency of Events

- Water Quality Sampling Events—Three During Permit Term
  - Event 1—During dry season (May 1—Sep. 30)
  - Event 2—During wet season (Oct. 1—Apr. 30)[1]
  - Event 3—At-large dry weather event
- Bioassessment Event – One During Permit Term
- Hydromodification Event – One During Permit Term

Monitoring Methods Reference

- Transitional Receiving Water Monitoring Plan (2013-2015) (www.projectcleanwater.org)
- Receiving Water Monitoring Plan (2015-2018) (www.projectcleanwater.org)

[1] Dry weather sample must be preceded by ≥72 hrs antecedent dry period following rainfall event of >0.1" and occur after the first wet event of the season

Sample Collection (Shown in Figures P-1 through P-5)

- Field Observations
- Flow-Weighted Composites
- Water Grab Samples
- Bioassessment Monitoring
- Hydromodification Monitoring

Sample Analysis

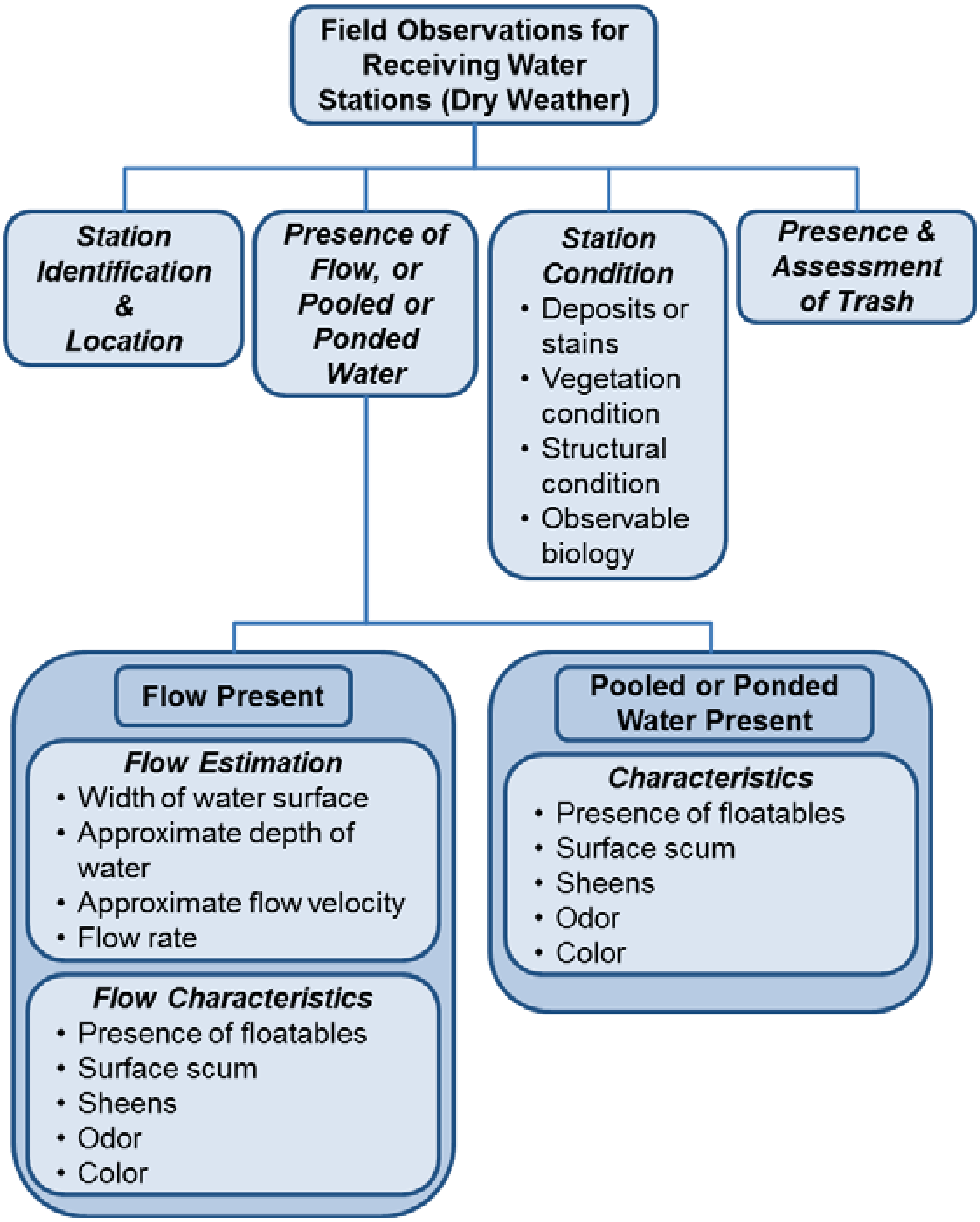


Figure P-1
Dry Weather Receiving Water Field Observations

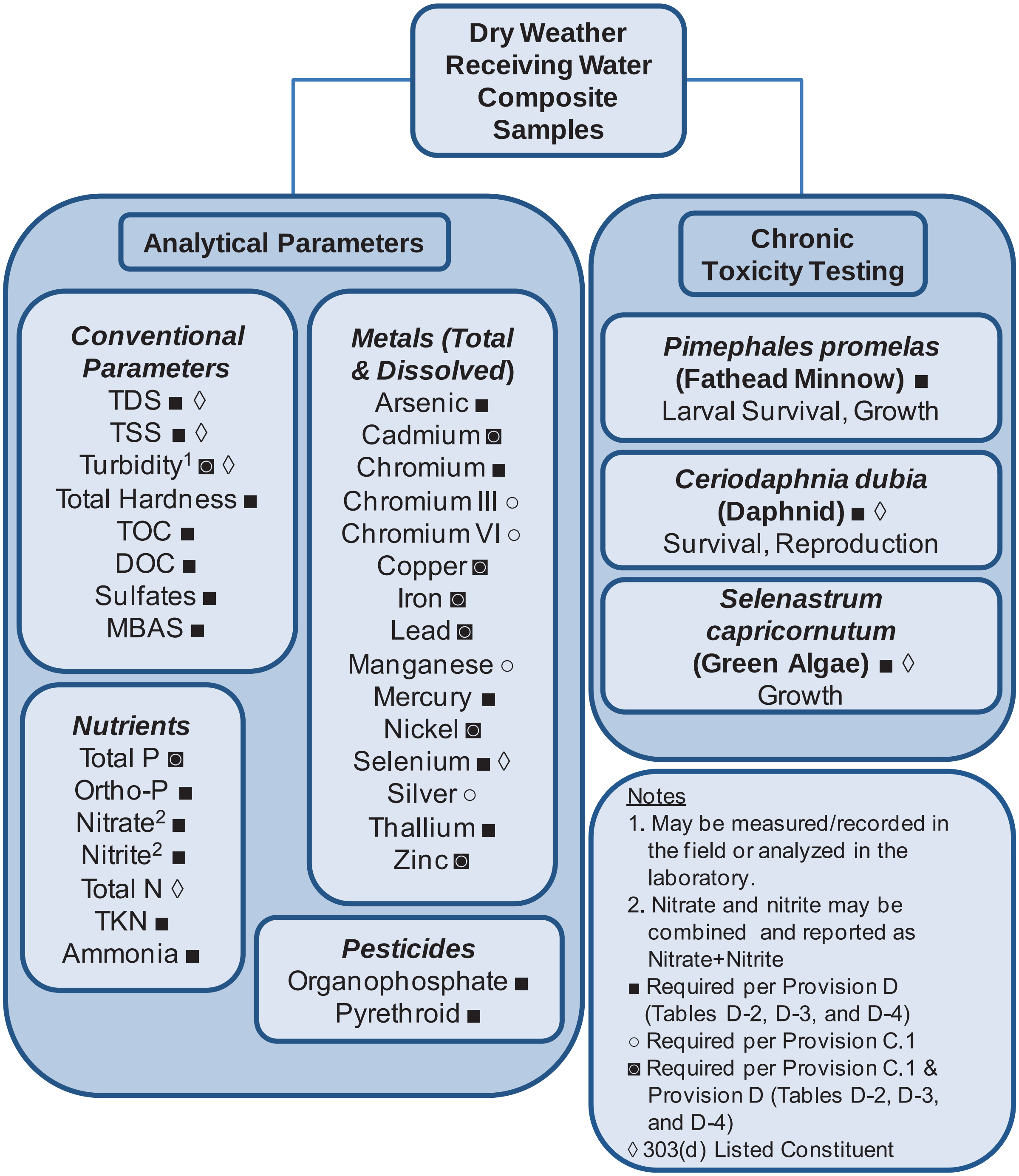


Figure P-2
Dry Weather Receiving Water Monitoring Composite Samples

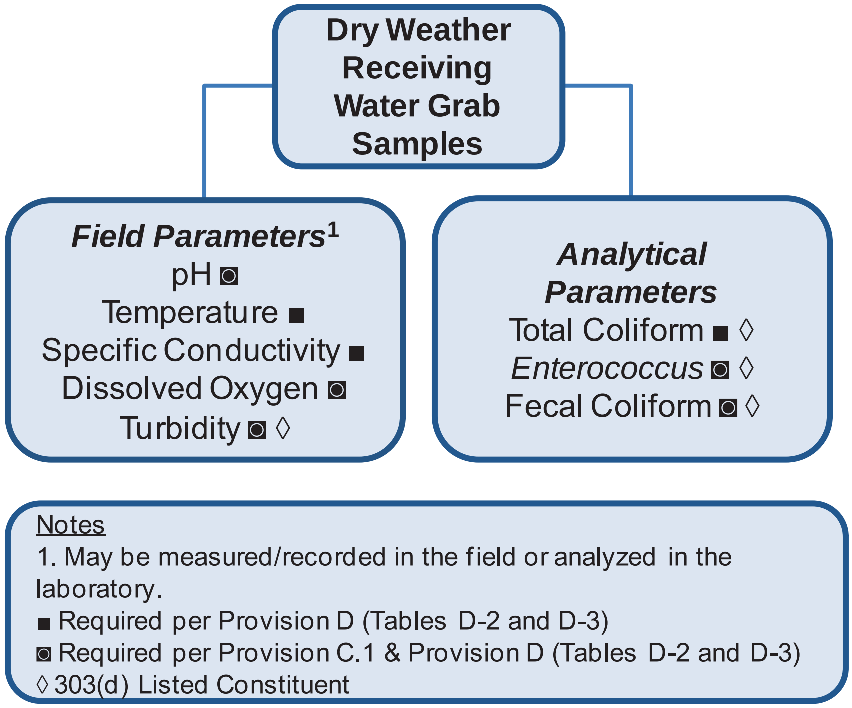


Figure P-3
Dry Weather Receiving Water Monitoring Grab Samples

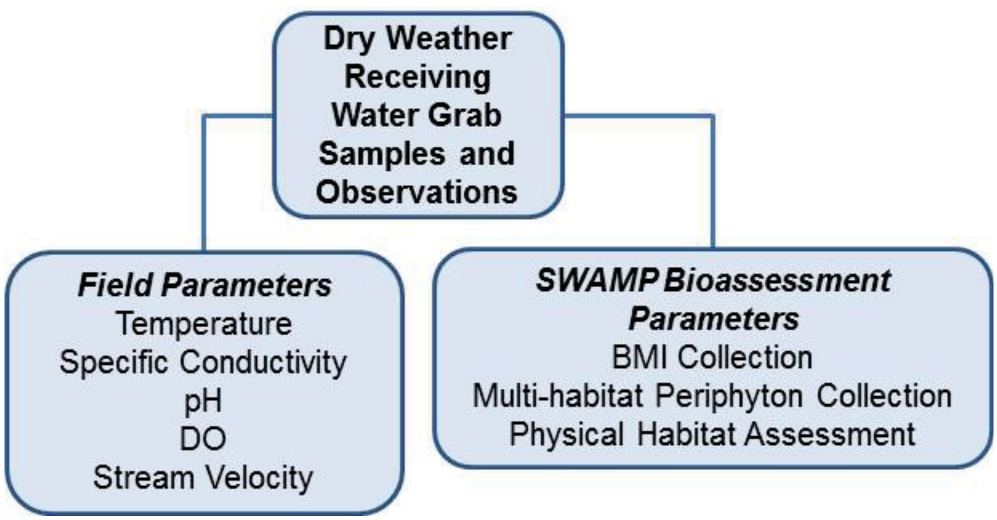


Figure P-4
Dry Weather Receiving Water Bioassessment Monitoring

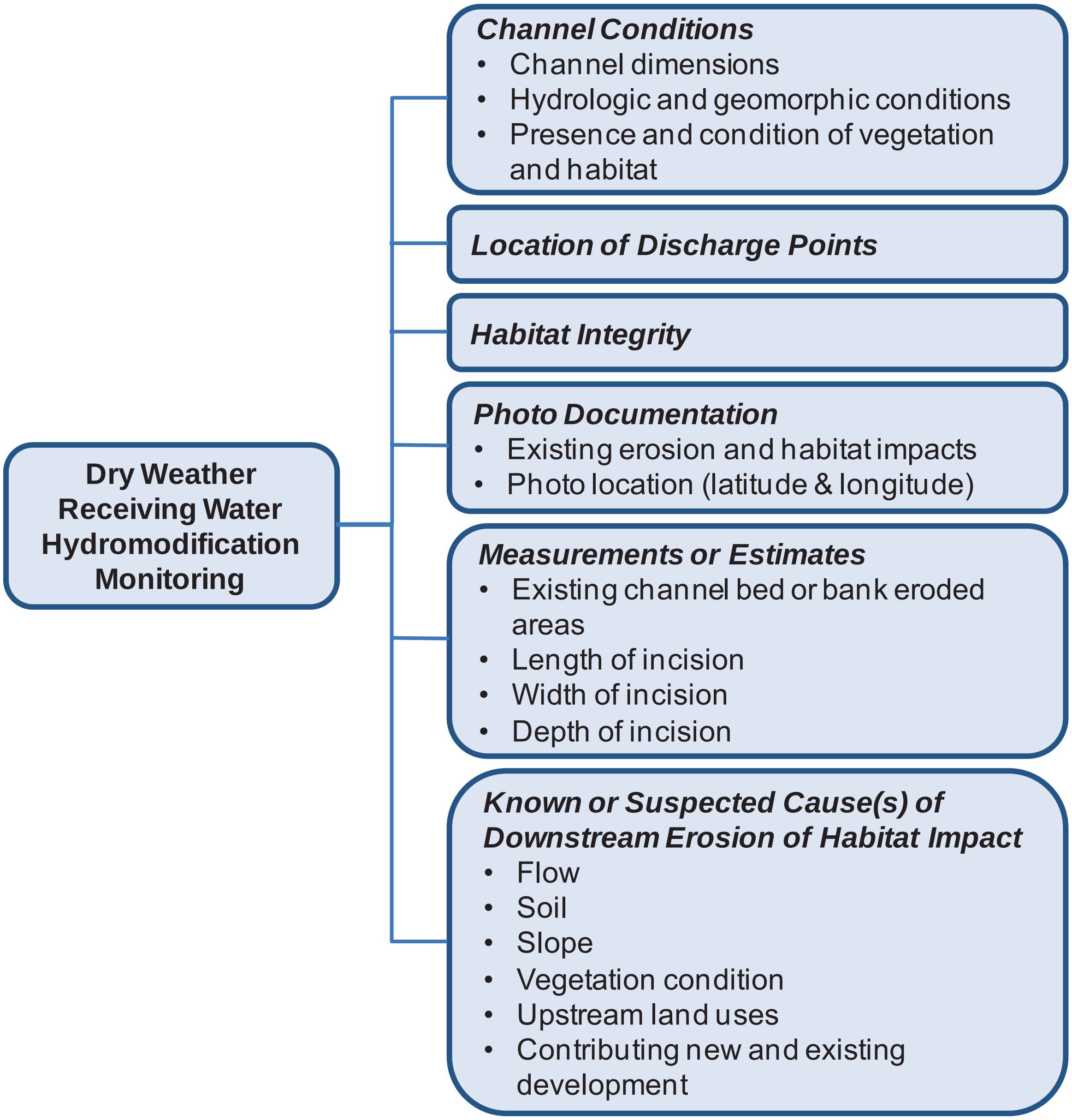


Figure P-5
Dry Weather Receiving Water Hydromodification Monitoring

P.1.2 Long-Term Wet Weather Receiving Water Monitoring (Permit Prov. D.1.d)

Overview

Objectives

- Determine whether the conditions in the receiving water during wet weather are protective or likely protective of beneficial uses
- Determine the extent and magnitude of the current or potential wet weather receiving water problems
- Evaluate whether conditions in the receiving water during wet weather are improving or declining.

Sampling Locations

Table P-2
Wet Weather Receiving Water Monitoring Stations

Station Name	Waterbody	Subwatershed	Latitude	Longitude
LPC-MLS	Los Peñasquitos Creek	Los Peñasquitos Creek	32.90444	-117.22283

Water Quality Sampling Events—Three During Permit Term

- Event 1—First wet weather event of wet season (Oct. 1—Apr. 30)
- Event 2—Event occurring after February 1
- Event 3—At-large wet weather event

Monitoring Methods Reference

- Transitional Receiving Water Monitoring Plan (2013-2015) (www.projectcleanwater.org)
- Receiving Water Monitoring Plan (2015-2018) (www.projectcleanwater.org)

Sample Collection (Shown in Figures P-6 through P-8)

- Field Observations
- Flow-Weighted Composites
- Grab Samples

Sample Analysis

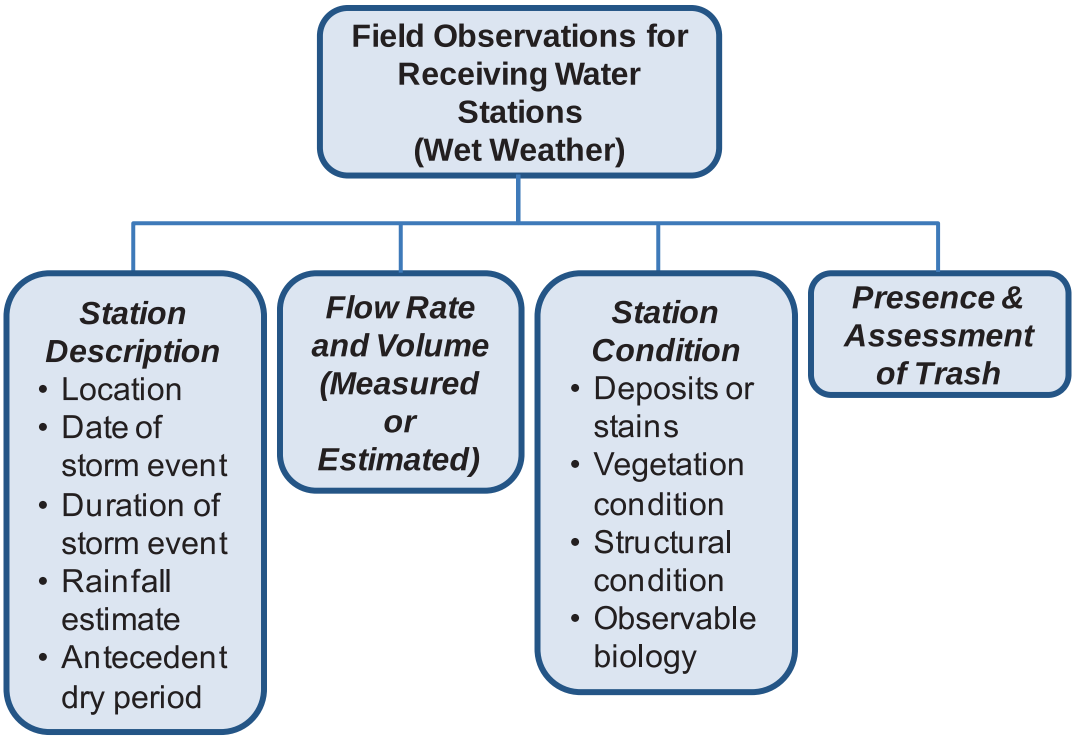
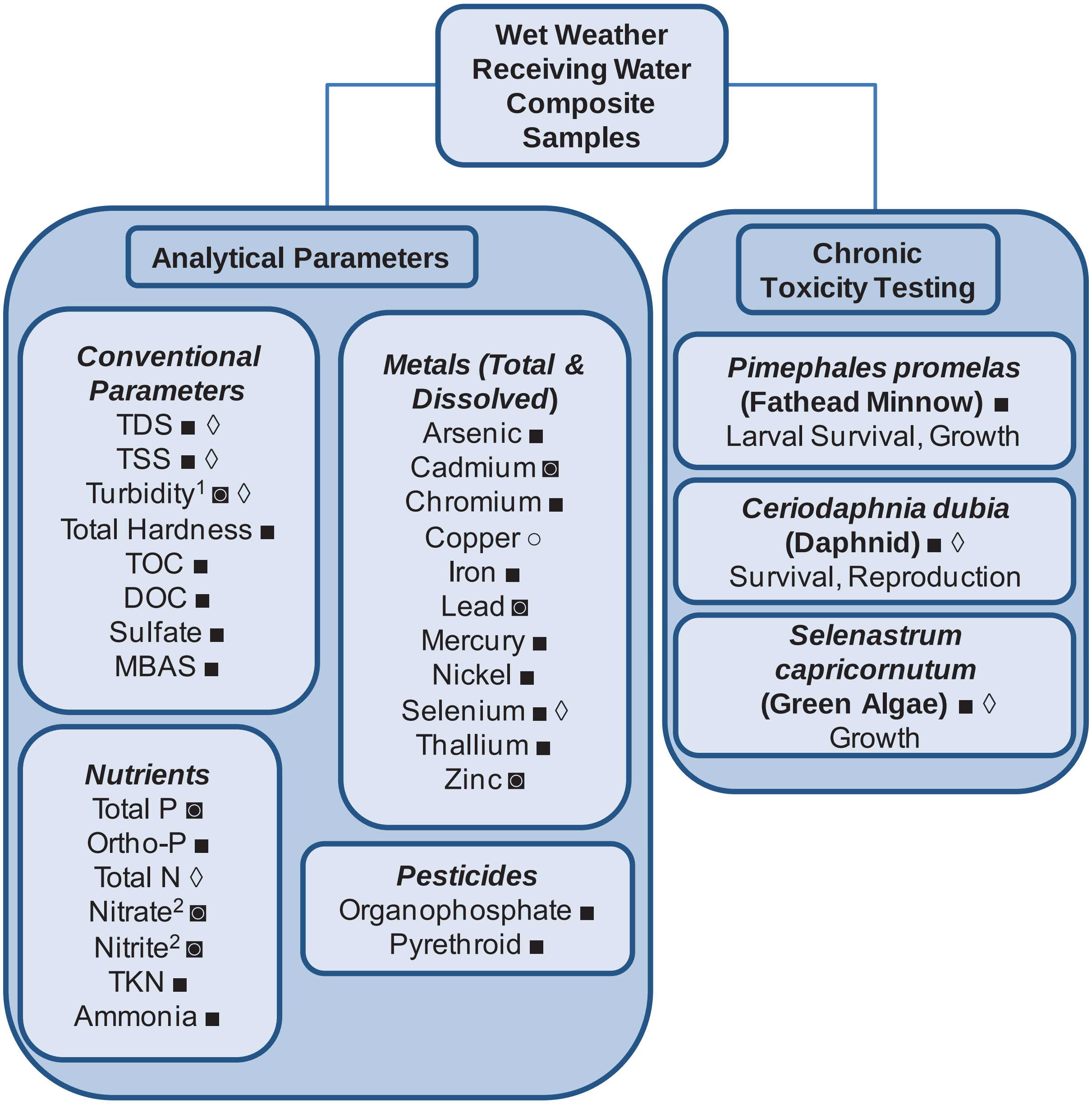


Figure P-6
Wet Weather Receiving Water Field Observations



Notes
1. May be measured/recorded in the field or analyzed in the laboratory.
2. For Provision C.2, nitrate and nitrite are to be combined and reported as nitrate+nitrite (total)
■ Required per Provision D (Tables D-2, D-3, and D-4)
○ Required per Provision C.2
◙ Required per Provision C.2 & Provision D (Tables D-2, D-3, and D-4)
◊ 303(d) Listed Constituent

Figure P-7
Wet Weather Receiving Water Monitoring Composite Samples

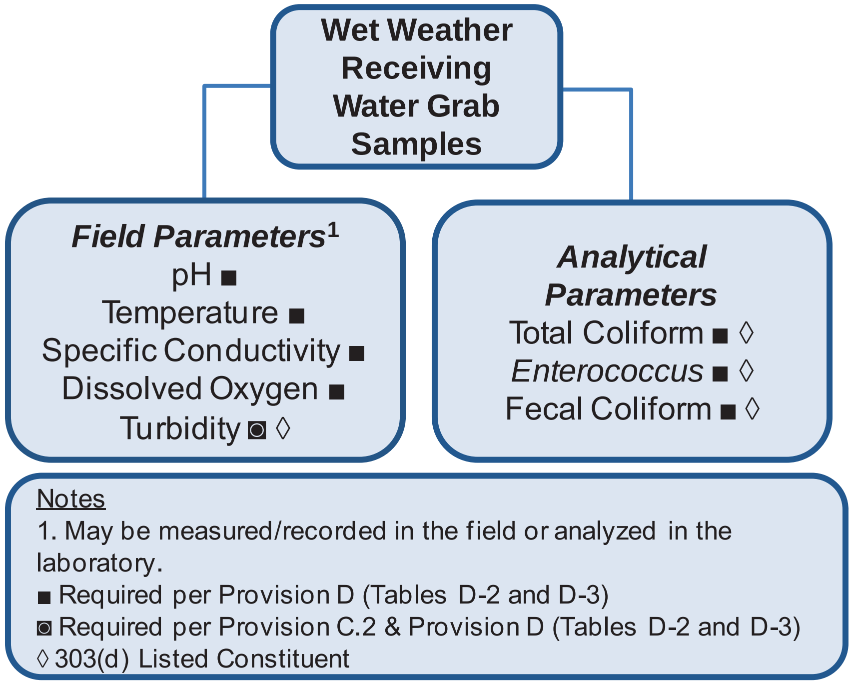


Figure P-8
Wet Weather Receiving Water Monitoring Grab Samples

P.1.3 Southern California Bight Regional Monitoring (Permit Prov. D.1.e.(1))

Overview

Objectives

- ❖ Evaluate the extent and magnitude of direct impact from sediment contaminants
- ❖ Determine how the extent and magnitude of environmental impact varies by habitat
- ❖ Evaluate the trend, in terms of extent and magnitude, of direct impacts from sediment contaminants

Sampling Location

Table P-3
Los Peñasquitos River WMA Bight '13 Monitoring Stations

Waterbody	Site ID	Latitude	Longitude	Sample Depth
Los Peñasquitos Lagoon	8169	32.9317	-117.2521	1.7
	8176	32.9336	-117.2567	0.9

<u>Sampling Program</u>

- Sampling of 397 sites in the Southern California Bight
- Stratified random site selection from 11 sediment subpopulations as shown in Figure P-9
- Each site sampled once between July 1 and September 30, 2013

<u>Monitoring Methods Reference</u>

- Bight ’13 Contaminant Impact Assessment Work Plan (www.projectcleanwater.org)
- Bight ’13 Sediment Quality 2014 Sampling and Analysis Plan for Follow-up Investigations (www.projectcleanwater.org)

Sample Collection (Shown in Figures P-10 through P-13)

- Sediment sampling indicator types
- Contaminant exposure in sediments and from marine debris
- Biological response
- Sediment habitat condition
- Bioaccumulation monitoring

Planned Bight ’13 Special Studies

- Analysis of Contaminants of Emerging Concern in Sediment
- Bioanalytical Screening of Sediment Extracts
- Sediment Toxicity Identification Evaluation in Embayments
- Gene Microarray Analysis of Sediment Toxicity Samples
- Alternative Toxicity Test Species Comparison
- In situ Toxicity Testing Using the SEA Ring
- Effects of Macrobenthic Preservation Techniques on Efficacy of Molecular and Morphological Taxonomy
- Adaptation to Hypoxic, High CO, Environments—Phenotypic Plasticity in Echinoderms

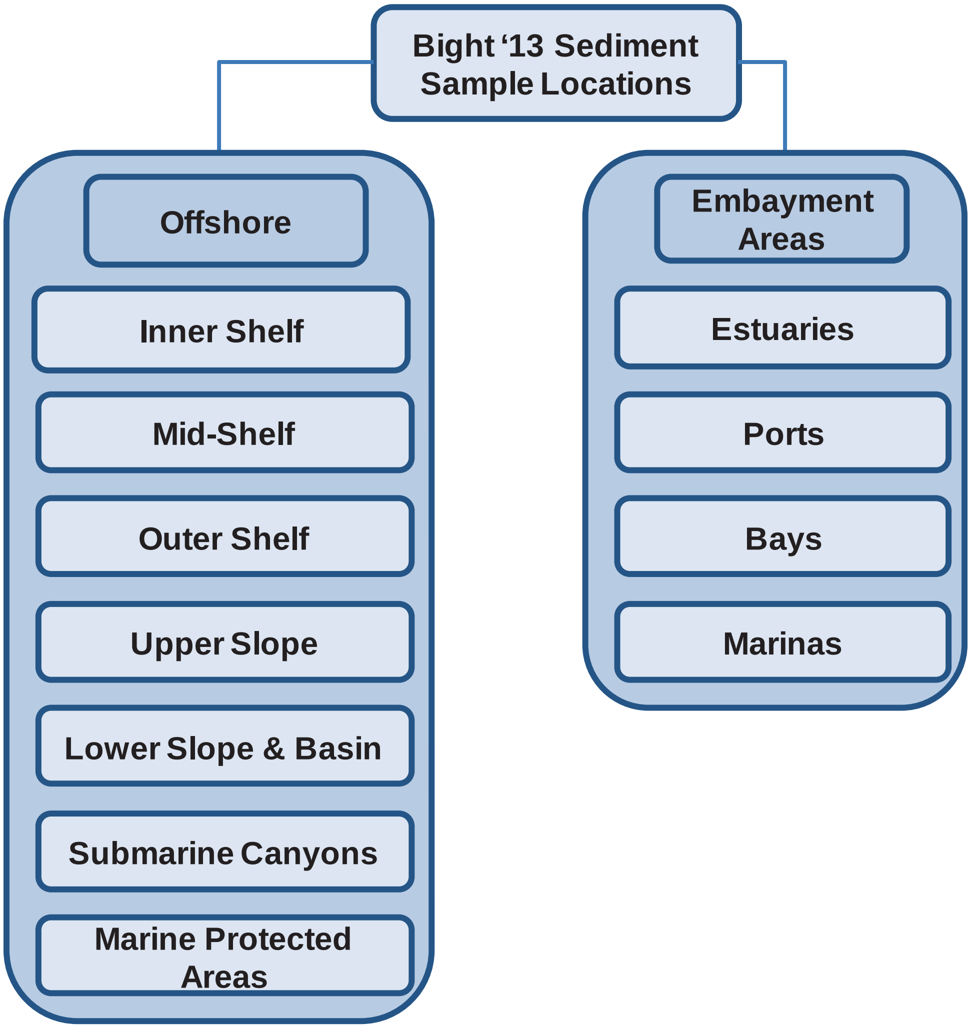


Figure P-9
Bight '13 Sediment Subpopulation Sampling Locations
Sample Analysis

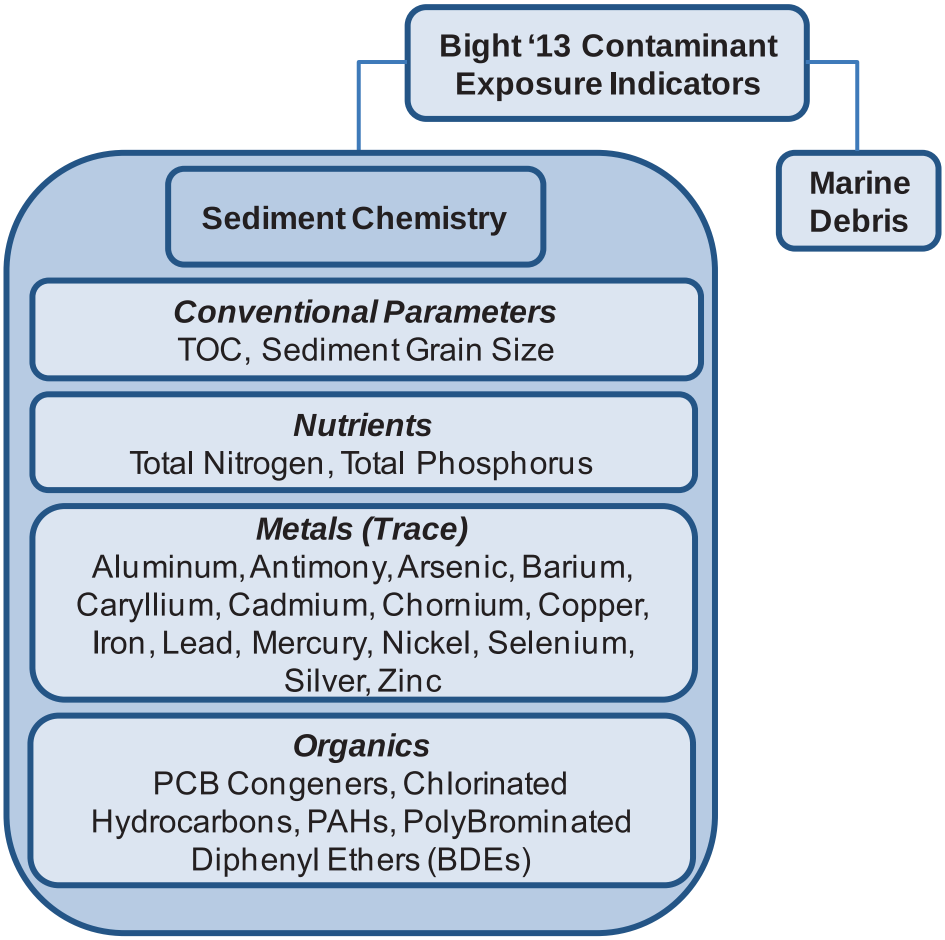


Figure P-10
Bight '13 Sediment Indicators of Contaminant Exposure

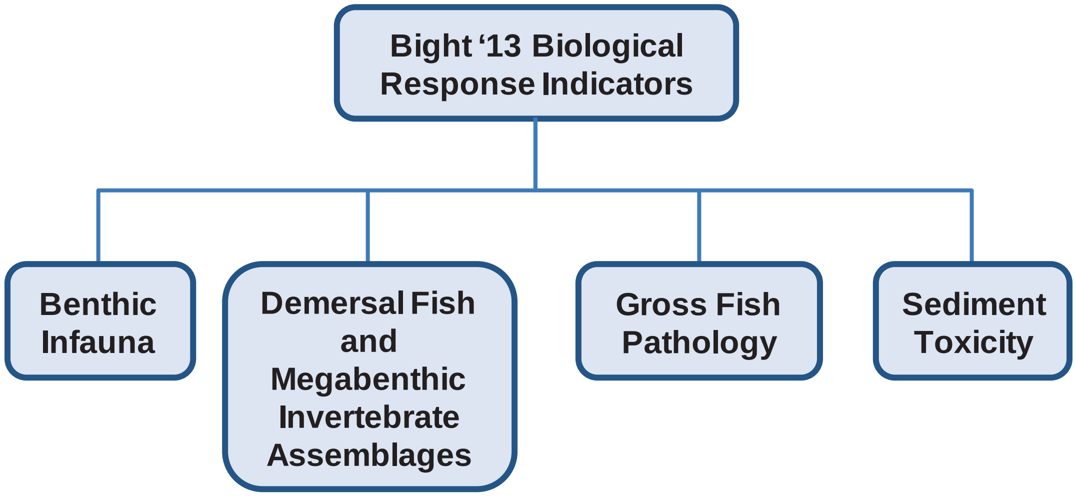


Figure P-11
Bight '13 Sediment Indicators of Biological Response

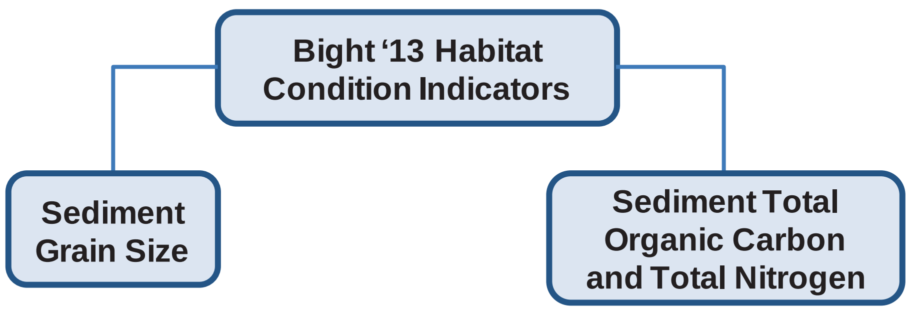


Figure P-12
Bight '13 Sediment Indicators of Habitat Condition

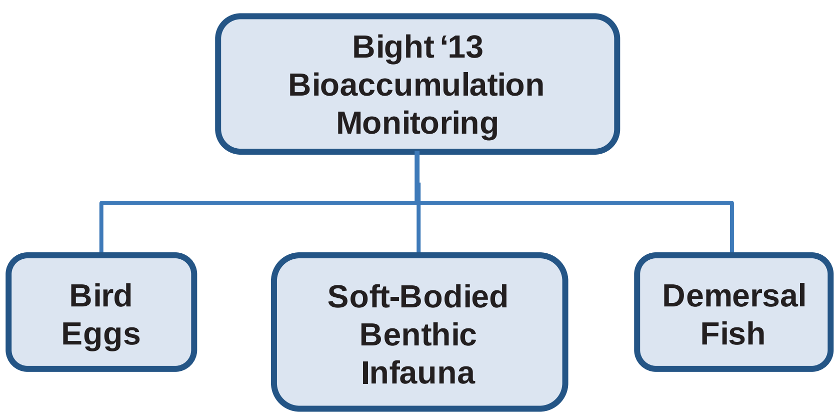


Figure P-13
Bight '13 Bioaccumulation Monitoring Target Organisms

P.1.4 Storm Water Monitoring Coalition Regional Monitoring (Permit Prov. D.1.e.(1))

Overview

Objectives

- Determine whether the conditions in the receiving water are protective or likely protective of beneficial uses on a regional scale
- Determine the extent and magnitude of the current or potential receiving water problems

Sampling Location

Table P-4
2013-2014 Storm Water Monitoring Coalition Bioassessment Monitoring Locations

SMC Region	Stream	Station Identifier	Latitude	Longitude
Central San Diego	Los Peñasquitos Creek	SMC00198	32.93710	-117.13851

- Sites presented are from 2013-2014 monitoring year. Additional locations may be selected in future monitoring years.

2013-2014 Sampling Program

- Bioassessment monitoring of non-perennial streams and trend sites in Southern California

2015-2019 Sampling Program

- Responsible Agencies will continue to participate is bioassessments. Sites we will be determined

Other Proposed Projects:

- Twenty-one (21) proposed projects over five years (2014-2019) within four study categories
- Responsible Agencies have not committed to participate in any of these projects at this time

<u>Monitoring Methods Reference</u>

- SCCWRP Regional Watershed Monitoring Program – Proposal for 2014 Sampling (available upon request)
- Southern California Stormwater Monitoring Coalition, Bioassessment Quality Assurance Project Plan (www.projectcleanwater.org)
- Southern California Stormwater Monitoring Coalition 2014 Research Agenda (http://www.socalsmc.org/Docs/828_SMC2014ResearchAgenda.pdf)
- *Other methods to be determined* as projects are implemented. Project implementation based on collective need and availability of funding

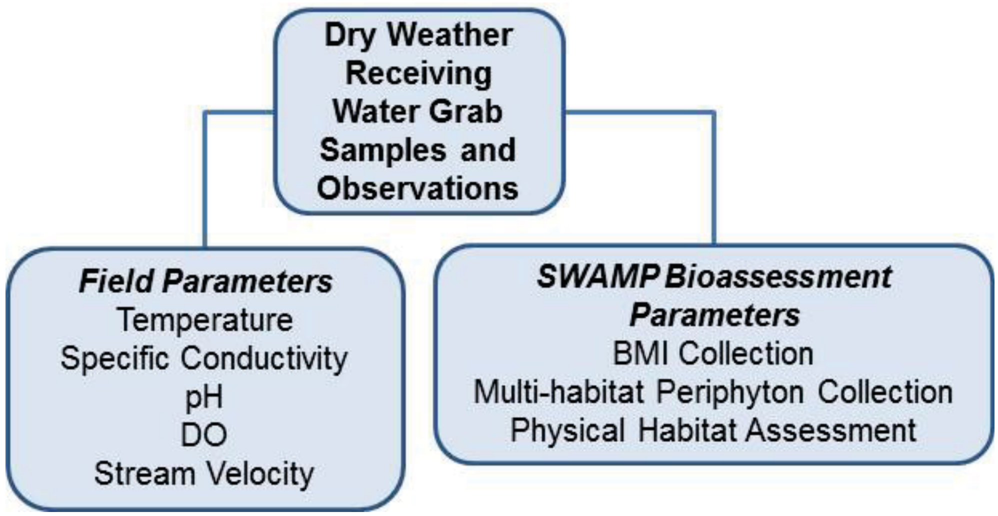


Figure P-14
2013-2014 Storm Water Monitoring Coalition Bioassessment Monitoring

Proposed Storm Water Monitoring Coalition Regional Monitoring Projects

Study Category 1: Ecosystem Characterization and Assessment

1) Standardizing Monitoring Approaches for Wet and Dry Weather Monitoring
2) Improving Stormwater Agency Reporting and Communication
3) Characterization of Stormwater Effects
4) Contaminants of Emerging Concern
5) Characterization of Stormwater Impacts on Marine Protected Areas

Study Category 2: Method Development and Tool Evaluation

6) Adapt Biological Assessment Tools for Non-Perennial Streams
7) Develop New Tools for Causal Assessment
8) Standardize Hydrologic Methods
9) Hydromodification Guidance of Urban Streams
10) Evaluating Potential of Remote Sensing Technology

Study Category 3: Optimizing Management Effectiveness

11) Optimizing Best Management Practices for Southern California
12) Flood Control Detention Retrofit to Improve water Quality Performance
13) Evaluating the Potential Benefits and Negative Impacts of Onsite Stormwater Retention
14) Improving Trash Controls and Tools to Assess Progress
15) Development of a Model Framework for a Stormwater Control Offset/Trading Program
16) Use Attainability Analysis Case Study for an Engineered Channel
17) Optimizing retrofit of Existing Urban Areas with Green Infrastructure

Study Category 4: Foundational Scientific Understanding

18) Improved quantification of Linkages between Nutrient Concentrations and Indicators of Beneficial Uses
19) Stormwater Effects on Ocean Acidification and Hypoxia
20) Effect of Climate Change on Stormwater Quality
21) Interaction Between Stormwater Runoff and Cyanotoxins

Figure P-15
Storm Water Monitoring Coalition Regional Monitoring Projects
(Proposed Implementation 2014-2019)

P.1.5 Hydromodification Management Plan Monitoring

Overview

Objectives

- Assess the effectiveness of the Hydromodification Management Plan (HMP) in managing increases in runoff discharge rates and duration from all Priority Development Projects, where such increased rates and durations are likely to cause increased erosion of channel beds and banks, sediment pollutant generation, or other impacts to beneficial uses and stream habitat due to increased erosive forces.

Monitoring Location

- Nine (9) monitoring locations in San Diego County, including
  - Three (3) HIGH susceptibility Development sites
  - Two (2) HIGH susceptibility Reference sites
  - Two (2) MEDIUM susceptibility Reference sites
  - One (1) HIGH susceptibility Urban site
  - One (1) MEDIUM susceptibility Urban site

Monitoring Methods Reference

- San Diego HMP Revised Monitoring Plan (www.projectcleanwater.org)

Monitoring Activities

- Rain gauge analysis
- Stream gauge analysis
- Channel assessments
- Sediment transport analysis
- Flow duration analysis

P.1.6 Sediment Quality Monitoring (Permit Prov. D.1.e.(2))

Overview

Objectives

- Evaluate the condition of sediments in enclosed bays or estuaries with respect to the statewide sediment quality objectives

Sampling Locations

- Conducted as part of Bight '13. See Section P.1.3 for sampling location details.

Sampling Program

- Sediment monitoring in enclosed bays and estuaries per State Sediment Control Plan (www.projectcleanwater.org)
- Each site sampled at least twice between June and September during the Permit cycle[2].

Monitoring Methods Reference

- State Sediment Control Plan Section VII.D (Receiving Water Limits Monitoring Frequency (www.projectcleanwater.org)
- State Sediment Control Plan Section VII.E (Sediment Monitoring) (www.projectcleanwater.org)
- Sediment Quality Monitoring Plan (www.projectcleanwater.org)
- Sediment Quality Monitoring Quality Assurance Project Plan (www.projectcleanwater.org)

Sample Collection

Sediment Quality Objectives Multiple Lines of Evidence Approach (shown in Figure P-16)

- Sediment and Water Chemistry
- Toxicity
- Benthic Community Condition

[2] Monitoring may be reduced to a frequency of once per Permit cycle if station has been classified as unimpacted or likely unimpacted using a Multiple Line of Evidence approach

Sample Analysis

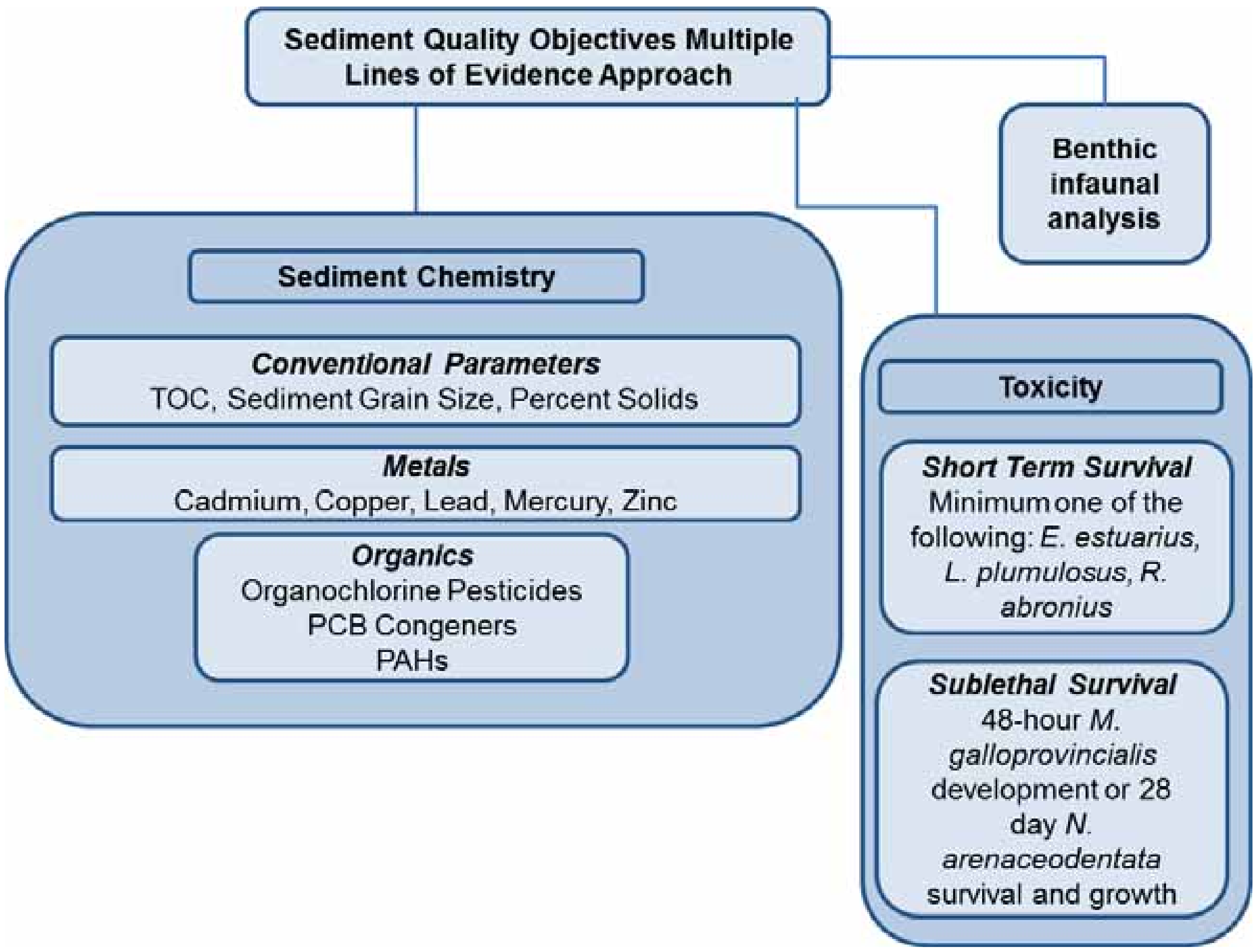


Figure P-16
Sediment Quality Indicators

P.1.7 Sediment TMDL Monitoring

Overview

Objectives

- Evaluate the ecological health of the Los Peñasquitos Lagoon.
- Evaluate how the health of the Lagoon changes with time.
- Determine progress toward ultimate restoration of the Lagoon.
- Determine what additional regulatory and implementation actions are needed to restore the Lagoon.

Sampling Locations

Table P-5
Sediment TMDL Compliance Monitoring Stations

Station Name	Waterbody	Subwatershed	Latitude	Longitude
CC	Carroll Canyon Creek	Carroll Canyon Creek	32.8981	-117.2212
CV	Carmel Valley Creek	Carmel Valley Creek	32.9297	-117.2412
LP	Los Peñasquitos Creek	Los Peñasquitos Creek	32.9046	-117.2229

Sampling Program

- Three (3) wet weather monitoring events per site per year
- Annual vegetation monitoring in Los Peñasquitos Lagoon based on aerial imagery

Monitoring Methods Reference

- Los Peñasquitos Lagoon Total Maximum Daily Load Sediment Monitoring Draft Compliance Monitoring Plan (www.projectcleanwater.org)

Monitoring Approach

Monitoring Activities

- Time-weighted pollutograph sampling analyzed for Suspended Sediment Concentration
- Bedload sampling
- Pebble Count – pre-wet season and post-storm event
- Volumetric stream bed sampling
- Extended flow monitoring
- Photo documentation

P.1.8 Bacteria TMDL Monitoring (Permit Attachment E)

Overview

Objectives

- ❖ Determine whether the TMDL numeric targets for bacteria indicators are being met at the compliance monitoring locations
- ❖ Evaluate whether bacteria levels are improving at the compliance monitoring locations

Sampling Locations

Table P-6
Bacteria TMDL Monitoring Location

Site ID	Site Name	Site Type	Latitude	Longitude
FM-100*	Los Peñasquitos River Outlet/Beach	Pacific Shoreline	32.934	-117.261

Notes:
* 25 meter down current of river outlet.

Monitoring Methods Reference

- ❖ Los Peñasquitos Bacteria TMDL Monitoring Plan (www.projectcleanwater.org)

Sample Collection

Monitoring Program

- ❖ Dry weather monitoring to overlap with the AB411 Monitoring Program during AB411 season, when feasible
  - ➢ Weekly samples from April 1 through October 31
  - ➢ Monthly samples from November 1 through March 30
- ❖ Wet weather monitoring during three (3) storm events per wet season, spread throughout the wet season as follows, to the maximum extent practicable:
  - ➢ Storm Event 1 (October to November)
  - ➢ Storm Event 2 (December to January)
  - ➢ Storm Event 3 (February to April)

P.2 MS4 Outfall Discharge Monitoring

P.2.1 Dry Weather MS4 Outfall Discharge Monitoring (Permit Prov. D.2.b.(1))

Overview

Objectives

- Identify non-storm water and illicit discharges within jurisdiction per Provision E.2.c
- Determine which discharges are transient vs. persistent flows
- Prioritize persistent dry weather MS4 discharges to investigate/eliminate per Provision E.2.d

Sampling Locations

- The outfalls below will be field screened following an antecedent dry period of ≥72 hours following a rainfall event >0.1"

Table P-7
MS4 Outfalls for Field Screening

Jurisdiction	Number of MS4 Outfalls for Field Screening
City of Del Mar	2 (1)[(a)]
City of Poway	30 (37)[(a)]
City of San Diego	198 (198)[(b)]
County of San Diego	0 (0)[(c)]

Notes:
(a) For Copermittees with fewer than 125 major outfalls in the WMA, 80% of major outfalls must be screened twice per year. The total number of outfalls in each Jurisdiction is provided in parentheses.
(b) For Copermittees with portions of the jurisdictions in more than on WMA and more than 500 major MS4 outfalls in its jurisdiction, at least 500 major outfalls must be inspected once per year.
(c) No major outfalls have been identified in this jurisdiction for Los Peñasquitos WMA.

Sample Analysis

- Field Screening Observations (Shown in Figure P-17)
- Based on Results of Visual Screening
  - Identify persistent non-storm water discharges
  - Prioritize persistent non-storm water discharges to investigate/eliminate per provision E.2.d

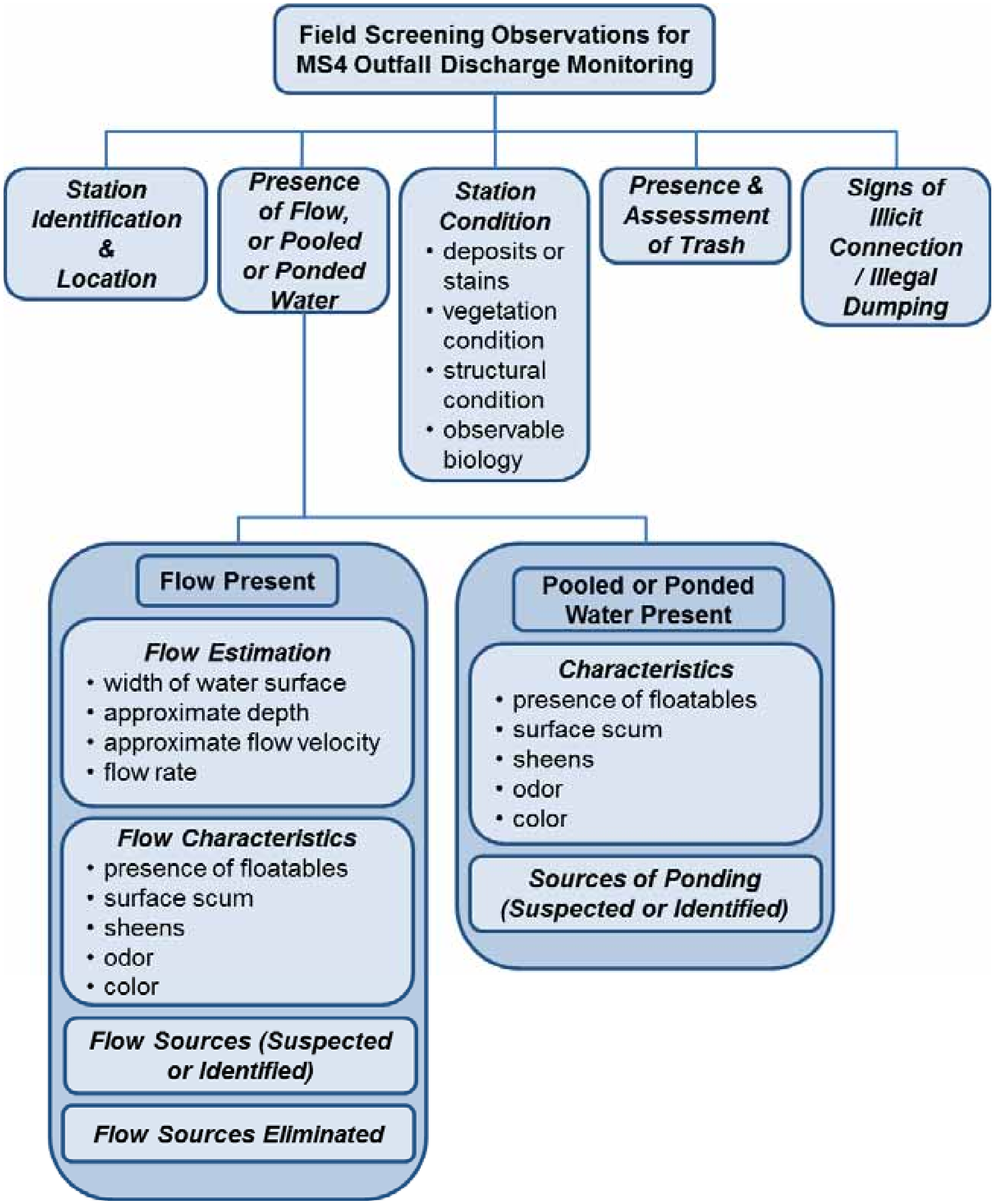


Figure P-17
Field Screening Visual Observations for MS4 Outfall Discharge Monitoring Stations

P.2.2 Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring (Permit Prov. D.2.b.(2))

Overview

Objectives

- ❖ Determine which persistent non-storm water discharges contain concentrations of pollutants below non-storm water action levels (NALs) (Permit Provision C.1)
- ❖ Determine the relative contribution of MS4 outfalls to priority water quality conditions during dry weather
- ❖ Investigate the sources of persistent non-storm water flows

Sampling Locations

- ❖ The persistently flowing outfalls below will be monitored following an antecedent dry period of ≥72 hours following a rainfall event >0.1"

Table P-8
MS4 Outfalls for Dry Weather Monitoring

Jurisdiction	MS4 Outfalls for Dry Weather Monitoring
City of Del Mar	1 (S-12)
City of Poway	5 (282-1749,1; 282-1749,2; 282-1749,3; 298-1749,4; 298-1749,5)
City of San Diego	5 (DW0025, DW0247, DW0036, DW0024, DW0429)
County of San Diego	0[(a)]

Notes:
(a) No major outfalls have been identified in this jurisdiction for Los Peñasquitos WMA.

Number of Sampling Events

- ❖ Two events/year during dry weather conditions

Monitoring Methods Reference

- ❖ Los Peñasquitos WMA MS4 Outfall Monitoring Plan (www.projectcleanwater.org)

Prepare Map

- ❖ Identify locations of highest priority non-storm water persistent flow MS4 outfall monitoring stations on map per Provision E.2.b
- ❖ Map to specify which MS4 outfalls are being monitored for compliance with a TMDL

Sample Collection (Shown in Figures P-18 through P-20)

- Field Parameter Grab Samples
- Analytical Parameter Grab Samples
- Receiving Water Grab Samples

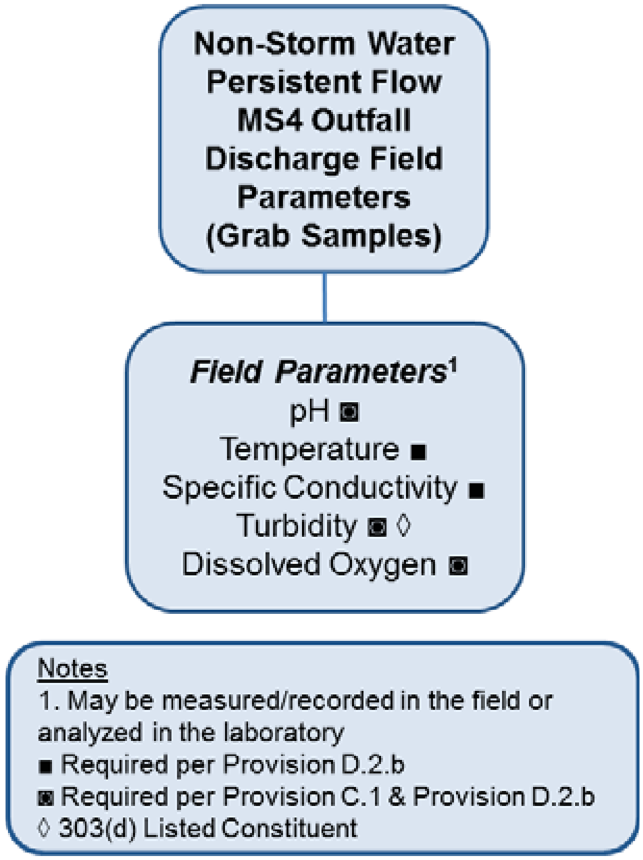


Figure P-18
Non-Storm Water Persistent Flow MS4 Outfall Field Parameters (Grab Samples)

Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring Constituents (Grab Samples)

Analytical Parameters

Conventional Parameters

- TDS ■ ◊
- TSS ■ ◊
- Turbidity[1] ○ ◊
- Total Hardness ■
- MBAS ○

Nutrients

- Total P ◙
- Ortho-P ■
- Nitrate[2] ■
- Nitrite[2] ■
- TKN ■
- Ammonia ■
- Total N ○ ◊

Metals (Total & Dissolved)

- Cadmium ◙
- Chromium ○
- Chromium III ○
- Chromium VI ○
- Copper ◙
- Iron ○
- Lead ◙
- Manganese ○
- Nickel ○
- Selenium ◊
- Silver ○
- Zinc ◙

Indicator Bacteria

- Total Coliform ◙ ◊
- *Enterococcus* ◙ ◊
- Fecal Coliform ◙ ◊

Notes
1. May be measured/recorded in the field or analyzed in the laboratory
2. Nitrate and nitrite may be combined and reported as Nitrate+Nitrite

■ Required per Provision D (Table D-7)
○ Required per Provision C.1
◙ Required per Provision C.1 & Provision D (Table D-7)
◊ 303(d) Listed Constituent

Figure P-19
Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring Constituents (Grab Samples)

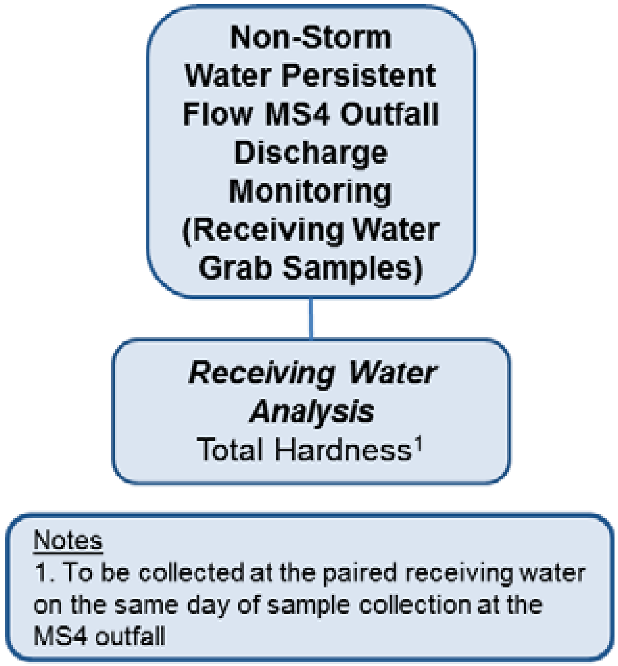


Figure P-20
Non-Storm Water Persistent Flow MS4 Outfall Discharge Monitoring Receiving Water Analysis

P.2.3 Wet Weather MS4 Outfall Discharge Monitoring (Permit Prov. D.2.c)

Overview

Objectives

- Determine which storm water discharges contain concentrations of pollutants below storm water action levels (SALs) (Permit Provision C.2)
- Determine the relative contribution of MS4 outfalls to priority water quality conditions during wet weather
- Investigate how discharge concentrations, loads, and flows change over time at representative MS4 outfalls

Sampling Locations

- The outfalls below will be monitored annually by each Jurisdiction during the wet season (October 1 – April 30)

Table P-9
MS4 Outfalls for Wet Weather Monitoring

Jurisdiction	MS4 Outfalls for Wet Weather Monitoring
City of Del Mar	1 (MS4-LPC-1)[(a)]
City of Poway	3 (MS4-LPC-2 through 4)
City of San Diego	1 (MS4-LPC-5)
County of San Diego	0[(b)]

Notes:
(a) Also known as S-01.
(b) No major outfalls have been identified in this jurisdiction for Los Peñasquitos WMA.

Frequency of Events

- One wet weather event per monitoring year

Monitoring Methods Reference

- Los Peñasquitos WMA MS4 Outfall Monitoring Plan (www.projectcleanwater.org)

Sample Collection (shown in Figures P-21 through P-23)

- Time Weighted Composites
- Grab Samples
- Receiving Water Grab Samples

Sample Analysis

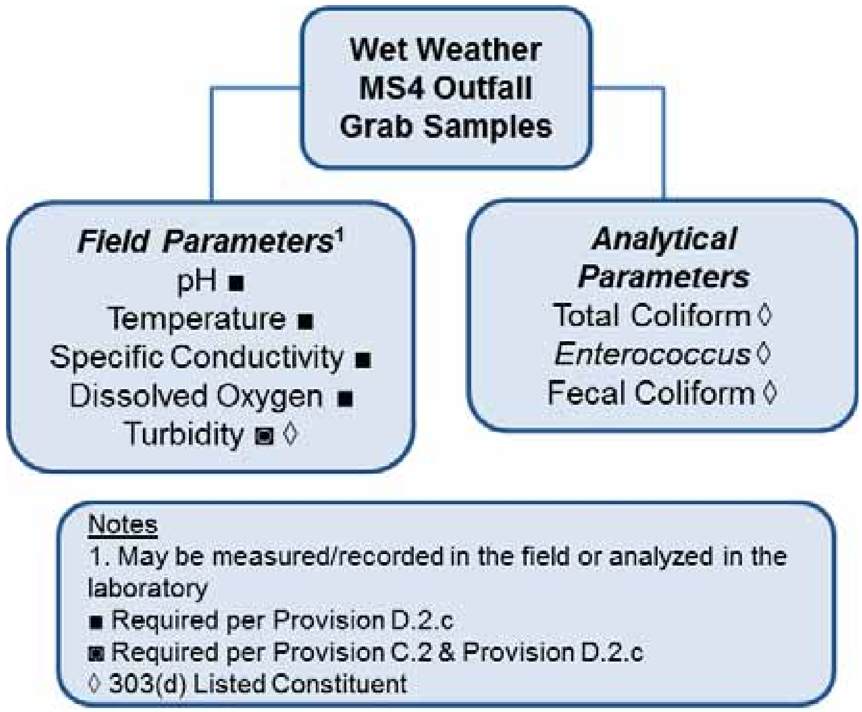
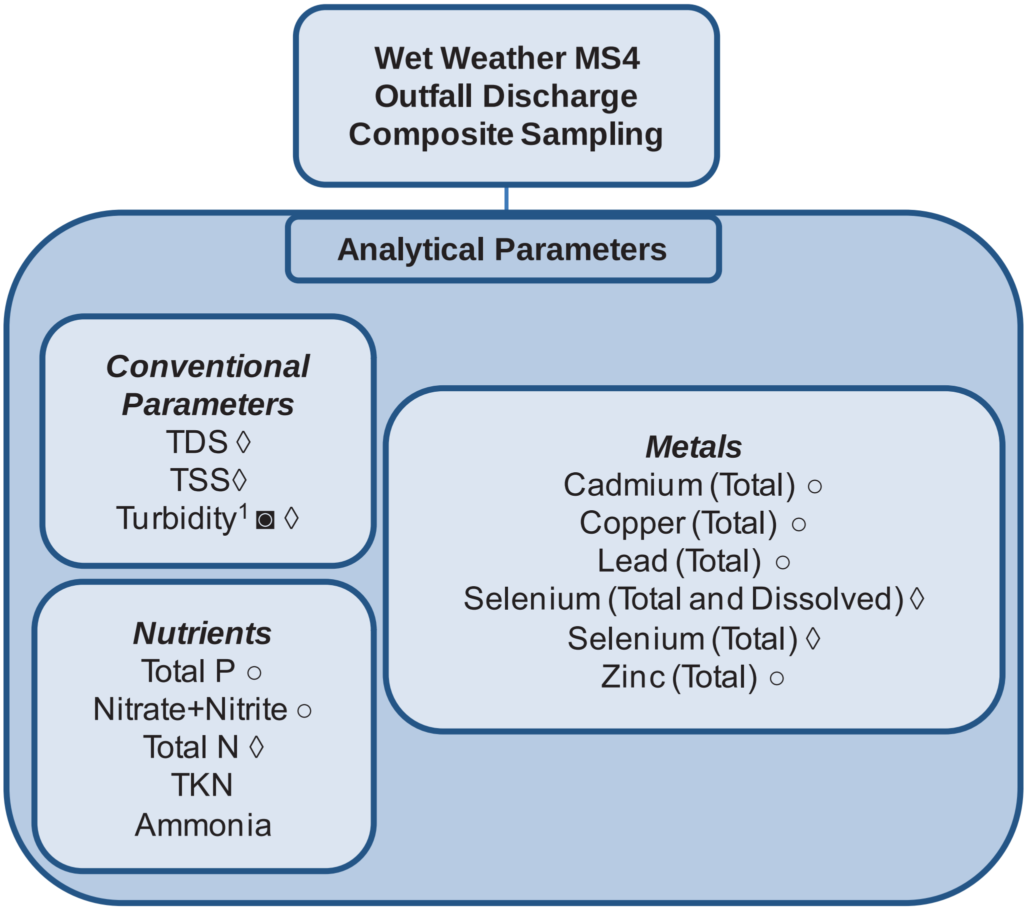


Figure P-21
Wet Weather MS4 Outfall Grab Sample Constituents



<u>Notes</u>
1. May be measured/recorded in the field or analyzed in the laboratory
◙ Required per Provision C.2 & Provision D (Table D-2)
○ Required per Provision C.2
◊ 303(d) Listed Constituent

Figure P-22
Wet Weather MS4 Outfall Discharge Monitoring Constituents

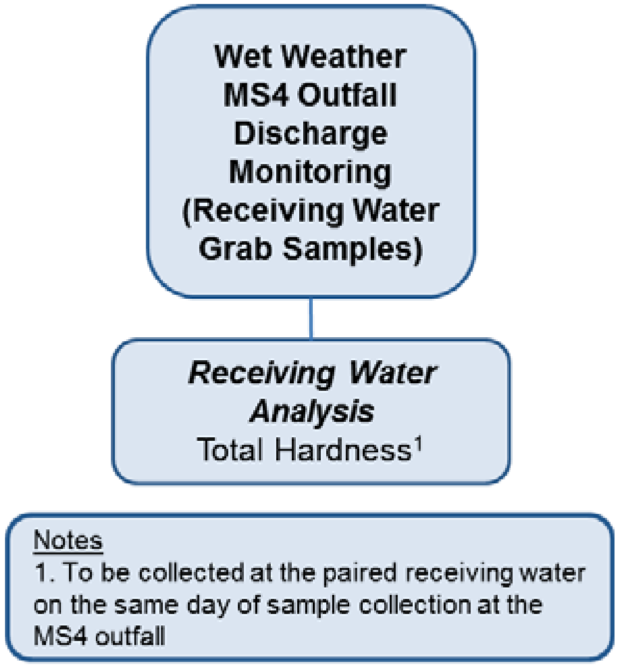


Figure P-23
Wet Weather MS4 Outfall Discharge Monitoring Receiving Water Analysis

P.3 Special Studies

P.3.1 San Diego Regional Reference Stream Study (Permit Prov. D.3)

Overview

Objectives

- Evaluate variation in Water Quality Objective (WQO) exceedance frequencies between summer dry weather, winter dry weather, and wet weather
- Evaluate variation in WQO exceedance frequencies with respect to hydrologic factors, such as:
  - Storm size (wet weather only)
  - Beginning versus end of storm season (wet weather only)
  - Discharge flow rate and volume
- Evaluate variation in WQO exceedance frequencies with respect to impact factors such as the size and geology of catchments
- Evaluate variation in WQO exceedance frequencies with respect to biotic and abiotic factors, such as:
  - Algal cover and/or biofilms
  - Water quality (temperature, conductivity, pH, dissolved oxygen, total suspended solids concentrations)

Sampling Locations

- Three (3) wet weather events at six (6) sites throughout the San Diego Region (two sites are located in San Diego County)
- Up to 40 weeks of dry weather at up to ten (10) dry weather sites

Monitoring Methods Reference

- San Diego Reference Stream QAPP (available upon request from the Regional Water Quality Control Board)

Monitoring Approach

Wet Weather Monitoring

- Time course pollutograph sampling (sampling of concentrations at multiple periods over the course of the storm) over the duration of the storm event and once per day on the following three days
- *In-situ* field measurements will be recorded at each site to coincide with each pollutograph grab sample

- Flow and precipitation will be measured throughout the duration of the storm event at each reference site, when feasible
- During one wet event per site, toxicity composite sample taken over a whole day

Dry Weather Monitoring

- Up to 40 weeks
- Water grab-sampling:
  - Weekly bacteria samples will be collected such that 5 samples will occur within each 30-day period
  - Biweekly nutrient, metals, and conventionals sampling
  - Flow calculated weekly at each site using a hand-held March-McBirney flow meter. The meter measures instantaneous velocity, which will be used with cross-sectional area measurements to calculate flow
  - *In-situ* field measurements to coincide with each grab sample
- Modified algal bioassessment sampling one to two times per Reference Stream site, when feasible
  - Modified SWAMP guidelines for algae collection and stream condition parameters, including physical habitat, benthic algae and chlorophyll *a*

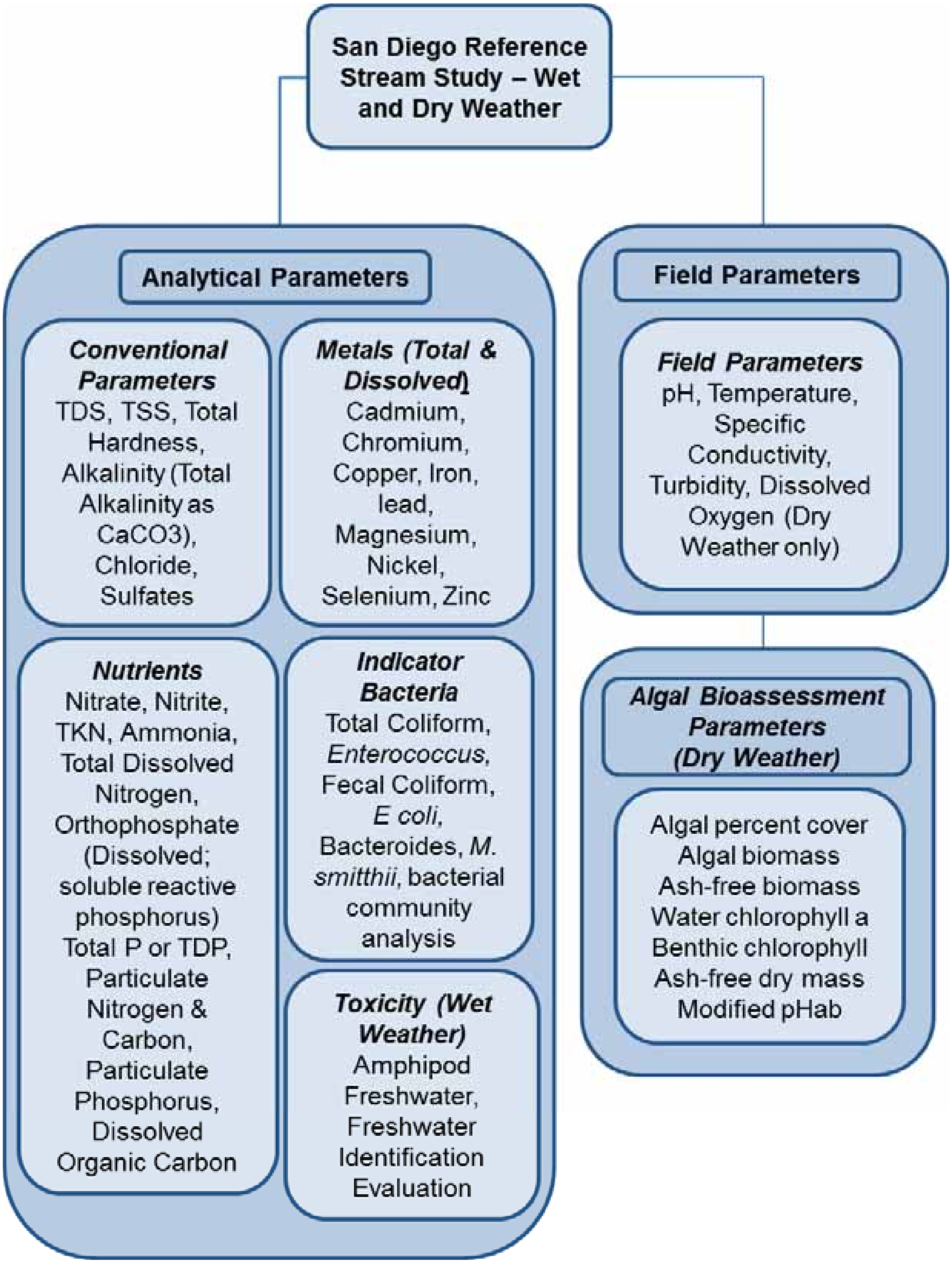


Figure P-24
San Diego Reference Stream Study Monitoring Constituents

P.3.2 San Diego Regional Reference Beach Study (Permit Prov. D.3)

Overview

Objectives

- Evaluate variation in Water Quality Objective (WQO) exceedance frequencies between summer dry weather, winter dry weather, and wet weather.
- Evaluate variation in WQO exceedance frequencies with respect to hydrologic factors, such as:
  - Discharge flow rate (wet and dry weather)
  - Status of estuary mouth, if applicable (open or closed, dry weather only)
- Evaluate wet and dry weather WQO exceedance frequencies in creeks and estuaries (if applicable).

Sampling Locations

- Three (3) wet weather events at three monitoring (3) points at one (1) site: freshwater creek, estuary, and ocean (site located in San Diego County)
- Up to 60 weeks of dry weather at two (2) to three (3) monitoring points at two (2) dry weather sites: freshwater creek, estuary (if applicable), and ocean (one in the San Diego Region; one in the Malibu Region)

Monitoring Methods Reference

- San Diego Reference Beach QAPP (available upon request from the Regional Water Quality Control Board)

Monitoring Approach

Wet Weather Monitoring

- Monitoring conducted only during storms that produce enough runoff to result in the creek actively discharging to the ocean
- One grab sample at each monitoring point on the day of the storm event and once per day on the following three days
- *In-situ* field measurements will be recorded at each monitoring point to coincide with each grab sample
- Discharge from the creek will be estimated during sampling each day throughout the duration of the monitoring event, when feasible

Dry Weather Monitoring

- Up to 60 weeks

- Water grab-sampling:
  - Weekly bacteria samples at each monitoring point will be collected such that 5 samples will occur within each 30-day period
  - Flow estimated weekly at each creek site and the flow across the beach to the ocean, if flowing.
  - *In-situ* field measurements to coincide with each grab sample
- Estuary Special Study
  - Dry weather only at San Onofre Creek (Deer Creek does not have an estuary)
  - Includes two (2) additional sample points within the estuary, for a total of three (3) sample points within the estuary (spatial variability)
  - Samples are collected once per sampling day, or twice per sampling day when open to tidal fluctuation (temporal variability)

P.3.3 Los Peñasquitos Lagoon TMDL Upper Watershed Sediment Load Monitoring (Permit Prov. D.3)

Overview

Objectives

- Determine the watershed sources of sediment affecting the health of the Los Peñasquitos Lagoon

Sampling Locations

- Streambed Sampling
  - Five (5) locations in Carroll Canyon Creek
  - Two (2) locations in Los Peñasquitos Creek
  - One (1) location in Carmel Valley Creek
- Aerial Particle Monitoring
  - One (1) location in Los Peñasquitos Lagoon
  - Four (4) locations in Carroll Canyon Creek
  - Two (2) locations in Los Peñasquitos Creek
  - One (1) location in Carmel Valley Creek

Number of Sampling Events

- Three (3) events per site at each streambed location
- Three 24-hour sample collection periods at each site during three seasonal sampling rounds at each aerial particle monitoring location

Monitoring Methods Reference

- Los Peñasquitos WMA Sediment Load Special Study Monitoring Plan (www.projectcleanwater.org)

Monitoring Approach

Stream Bed Sampling

- Time-weighted pollutograph sampling analyzed for Particle Size Distribution and Suspended Sediment Concentration
- Bedload sampling
- Pebble count – pre-wet season and post-storm event
- Volumetric stream bed sampling
- Extended flow monitoring

Aerial Particle Monitoring

- Conducted during dry weather
- Monitoring for particle monitoring with an aerodynamic diameter of ≤10 microns

P.3.4 Stream Gauge Study (Permit Prov. D.3)

Overview

Objectives

- Evaluate the level of flow in local streams
- Determine which streams are perennial and which streams are ephemeral

Sampling Locations

- Two (2) locations in the Los Peñasquitos River

Monitoring Methods Reference

- Stream Gauge Study Monitoring Plan (www.projectcleanwater.org)

Data Collection

Data Collection to Include:

- Dataloggers with five minute logging interval for:
  - Water level
  - Temperature
  - Barometric pressure
  - Conductivity (location-dependent)
- Stream cross section measurements

P.3.5 Outfall Repair and Relocation Study (Permit Prov. D.3)

Overview

Objectives

- City of San Diego study to prioritize storm water outfalls for repair or relocation throughout the Los Peñasquitos WMA. The study will look a number of factors to determine the impact of outfall repair or relocation may impact sediment load reductions.

Monitoring Methods Reference

- NA; program is under development

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