Marina del Rey
Enhanced Watershed Management Program Plan

Prepared For:

Marina del Rey Enhanced Watershed Management Program Agencies

County of Los Angeles
Los Angeles County Flood Control District
City of Los Angeles
City of Culver City

Original Submittal: June 30, 2015

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Prepared By:

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ABC Laboratories	Aquatic Bioassay and Consulting Laboratories, Inc.
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
AVS	acid volatile sulfide
BMP	best management practice
BSS	City of Los Angeles Bureau of Street Services
Caltrans	California Department of Transportation
CCC	criterion continuous concentration
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CIMP	Coordinated Integrated Monitoring Program
CMP	Coordinated Monitoring Plan
CMC	criterion maximum concentration
CNG	compressed natural gas
County	County of Los Angeles
CSM	continuous simulation model
CTR	California Toxics Rule
CWA	Clean Water Act
DDT	dichlorodiphenyltrichloroethane
EMC	event mean concentration
ER-L	effects range low
EWMP	Enhanced Watershed Management Program
EWRI	Environmental and Water Resources Institute
FCG	fish contaminant goal
FHWA	Federal Highway Administration
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program - FORTRAN
LACDBH	Los Angeles County Department of Beaches and Harbors
LACFCD	Los Angeles County Flood Control District
LADPW	Los Angeles County Department of Public Works
LAUSD	Los Angeles Unified School District
LARWQCB	Los Angeles Regional Water Quality Control Board
LAX	Los Angeles International Airport
LCC	life cycle cost
LDCP	City of Los Angeles Department of City Planning
LDL	low detection limit
LFD	low flow diversion
LID	Low Impact Development
LSPC	Loading Simulation Program in C++
MAL	Municipal Action Level
MCM	Minimum Control Measure
MDL	method detection limit
MdR	Marina del Rey
MdRH	Marina del Rey Harbor
MLE	multiple lines of evidence
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
MS4 Permit	Municipal Separate Storm Sewer System Permit
NOI	Notice of Intent

NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
OEHHA	Office of Environmental Healy Hazard Assessment
p,p'-DDE	p,p'-dichlorodiphenyldichloroethylene
PCB	polychlorinated biphenyl
PIPP	public information and participation program
POTFW	wash-off potency factor
PVS	Palos Verdes Shelf
RAA	Reasonable Assurance Analysis
RCP	reinforced concrete pipe
ROW	right of way
RV	recreational vehicle
RWL	Receiving Water Limitation
SEM	simultaneously extracted metals
SQO	Sediment Quality Objective
State	State of California
TMDL	Total Maximum Daily Load
TSO	Time Schedule Order
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
WESTON®	Weston Solutions, Inc.
WLA	waste load allocation
WMA	Watershed Management Area
WMMS	Watershed Management Modeling System
WQBEL	water quality based effluent limitations

ES.0 EXECUTIVE SUMMARY

ES.1 Introduction

The Marina del Rey (MdR) watershed is a small sub-watershed located in the larger, Santa Monica Bay watershed. The Marina del Rey Harbor (MdRH) was officially opened in 1965 and is the world's largest man-made small craft harbor. The tributary area served by a municipal separate storm sewer system (MS4) that drains to MdRH is approximately 1,409 acres and consists of portions of the cities of Culver City, Los Angeles, as well as portions of the unincorporated County of Los Angeles (County). The MdR Watershed Management Area (WMA) is one of the smallest WMAs in the County of Los Angeles, but it is also one of the most important and active watersheds.

The MdR watershed has one of the most aggressive Total Maximum Daily Load (TMDL) schedules for both Toxics and Bacteria and often leads the way in TMDL implementation for the rest of the County. The MdR watershed is subject to three TMDLs; the Santa Monica Bay Nearshore Debris TMDL (Debris TMDL), the Marina del Rey Harbor Mother's Beach and Back Basin Bacteria TMDL (Bacteria TMDL), and the Toxic Pollutants in Marina del Rey Harbor (MdRH) TMDL (Toxics TMDL). A fourth TMDL, the Santa Monica Bay DDTs and PCBs TMDL was established by the EPA and provides general implementation guidelines to calculate load allocations through applicable permits and TMDLs for the various watersheds in the Santa Monica Bay. For the MdR watershed, these loads were defined as part of the MdR Toxics TMDL. The interim and final compliance schedules differ for each of the applicable TMDLs.

The extensive ongoing efforts of the County, Los Angeles County Flood Control District (LACFCD), and the cities of Culver City and Los Angeles to improve water quality in the MdR watershed include conducting activities and implementing best management practices (BMPs) to help reduce pollutants from stormwater runoff from the watershed to the harbor. Over the past 10 years, the responsible agencies in the MdR watershed have spent tens of millions of dollars in special studies, low-flow diversions, non-structural BMPs, structural BMPs, and monitoring efforts.

The water quality in the harbor has significantly improved due to the cooperative efforts of the the County, the LACFCD, and the cities of Culver City and Los Angeles (collectively known as the MdR Enhanced Watershed Management Program [EWMP] agencies). The MdR EWMP agencies look forward to working with interested stakeholders and the Los Angeles Regional Water Quality Control Board (LARWQCB) to further improve water quality in the watershed.

On December 28, 2012, National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Permit (MS4 Permit) became effective upon adoption by the Los Angeles Regional Water Quality Control Board (LARWQCB). This new MS4 Permit establishes the waste discharge requirement for stormwater and non-stormwater discharges within the watersheds of Los Angeles County. The MS4 Permit includes provisions that allow Permittees to voluntarily choose to implement an Enhanced Watershed Management Program (EWMP).

ES.2 Water Quality Characterization and Priorities

One of the initial steps prescribed by the Permit in developing an EWMP is to characterize existing water quality conditions using data from relevant studies and monitoring completed within the past 10 years. In accordance with Section VI.C.5.a of the MS4 Permit, water-body pollutant combinations were classified into one of the following three categories (Table ES-1):

1. Category 1 (Highest Priority) – Pollutants with receiving water limitation or water-quality-based effluent limits (WQBEL) as established in Part V1.E and Attachments L through R of the MS4 Permit.

2. Category 2 (High Priority) – Pollutants in the receiving water that are listed as §303(d) and for which MS4 discharges may be causing or contributing to the impairment.

3. Category 3 (Medium Priority) – Pollutants with insufficient data to list as §303(d) but which exceed receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance.

Table ES-1: Waterbody Pollutant Categorization

Waterbody	Pollutant	Classification
Marina del Rey Harbor	Dissolved Copper	Category 1
	Copper	Category 1
	Lead	Category 1
	Zinc	Category 1
	Total PCBs	Category 1
	Total DDTs	Category 1
	p,p'-DDE	Category 1
	Chlordane	Category 1
	Fecal coliform	Category 1
	Enterococcus	Category 1
	Total coliform	Category 1
	Trash/Debris	Category 1
	Fish consumption advisory	Category 1*
	Sediment toxicity	Category 1*
Ballona Lagoon/Venice Canal	Total PCBs	Category 1
	DDT	Category 1
	Trash/Debris	Category 1

* Sediment toxicity and fish consumption advisory are being addressed by the Toxics TMDL

Based on the source assessment, priorities within the MdR watershed were assessed and sequenced in accordance with section VI.C.5.a.iv of the MS4 Permit (Table ES-2). As specified in the MS4 Permit, the highest priority (1) is assigned to those pollutants with TMDLs according to the following criteria:

a. Controlling pollutants for which there are established WQBELS, or receiving water limitation with interim or final compliance deadlines within the current MS4 Permit term, or whose TMDL deadlines have passed without achieving the limitations,
b. Controlling pollutants for which there are established WQBELs or receiving water limitations with compliance deadlines (interim or final) between September 6, 2012 and October 25, 2017.

The second highest (2) priorities are established for pollutants for which receiving water limitations are exceeded, or impairment is implicated as a result of discharges from the MS4. For purposes of the prioritization, third priority (3) will be attributed to controlling pollutants with TMDL compliance dates beyond the term of the MS4 Permit.

Table ES-2: Marina del Rey Watershed Priorities

Priority	Waterbody	Pollutant	Compliance Deadlines	Priority Sources*
1a	MdRH Back Basins	Bacteria (summer and winter dry weather)	March 18, 2007 Final Compliance (TSO Final Compliance December 28, 2017). July 10, 2014 – December 27, 2017 TSO Interim Compliance Period	Birds, anthropogenic sources
1b	MdRH Back Basins	Copper	Interim compliance March 22, 2016 Final compliance March 22, 2018.	Boats, residential, stormwater runoff
		Lead		Legacy sediment, stormwater runoff (suspended sediment)
		Zinc		Commercial contributions, stormwater runoff
		PCBs		Legacy sediment, boats, stormwater runoff (suspended sediment)
		DDTs		Legacy sediment, stormwater runoff
		p,p'-DDE		Legacy sediment, stormwater runoff
		Chlordane		Legacy sediment, stormwater runoff (suspended sediment)
		Trash	Final compliance September 30, 2015	Stormwater*
	MdRH Front Basins	Trash	Final Compliance September 30, 2015	Stormwater*
	Subwatershed 2	Trash	Final compliance September 30, 2015	Stormwater*
		DDT	Final Compliance March 23, 2023	Legacy sediment, stormwater runoff
		PCBs	Final Compliance March 23, 2034	Legacy sediment, boats, stormwater runoff (suspended sediment)

Priority	Waterbody	Pollutant	Compliance Deadlines	Priority Sources*
3	MdRH Back Basins	Bacteria (wet weather)	July 15, 2021 final wet weather and geometric mean.	Birds, stormwater runoff, anthropogenic sources
	MdRH Front Basins	Copper	Interim Compliance March 22, 2019 Final compliance March 22, 2021.	Boats, residential, stormwater runoff
		Lead		Legacy sediment, stormwater runoff (suspended sediment)
		Zinc		Commercial contributions, stormwater runoff
		PCBs		Legacy sediment, boats, stormwater runoff (suspended sediment)
		DDTs		Legacy sediment, stormwater runoff
		p,p'-DDE		Legacy sediment, stormwater runoff
		Chlordane		Legacy sediment, stormwater runoff (suspended sediment)

*Although stormwater is not a primary source of pollutants, it is a conveyance mechanism and is treated as a point source for purposes of the Toxicity TMDL and the Trash TMDL.

ES.3 Compliance Strategy

Section VI.C.5.b of the MS4 Permit requires the identification of control measures, strategies and BMPs within the watershed with the goal of creating an efficient program to focus resources on the watershed priorities identified above.

Under the MS4 Permit, compliance with the sediment waste load allocations (WLAs) for copper, lead, zinc, chlordane, p'p-DDE and total DDT in the Toxics TMDL may be demonstrated via any one of three different means: (a) qualitative sediment condition of unimpacted or likely unimpacted based on the interpretation and integration of multiple lines of evidence being met, (b) sediment numeric targets are met in bed sediments, or *(c) final sediment WLAs are met*.

A Time Schedule Order (TSO) was recently adopted for the Bacteria TMDL, which allows for achievement of the WLAs for *Enterococcus*, fecal coliform, and total coliform by December 28, 2017 for the dry weather WLAs. The final compliance point for wet weather and geometric mean WLAs is July 15th, 2021.

This EWMP focuses on demonstrating that compliance may be achieved through meeting final sediment WLAs for the contaminants in the MdR Toxics TMDL through the implementation of structural and non-structural control measures. However, compliance based on implementation of control measures is one part of a three-pronged compliance strategy. Special studies carried out in support of TMDL implementation will be used to update compliance strategies through the adaptive management approach. A Stressor ID Study is required under the Toxics TMDL and is planned to be conducted in the MdR Harbor in the year 2016. This study will identify stressors causing toxicity to biological organisms in the harbor. Results from this study, and others, may impact compliance strategies and BMPs specified in this EWMP. Special studies related to dissolved copper are also planned in the Harbor, as well as a bacteria source identification study as part of the Bacteria TMDL TSO. Outcomes of the special studies, Permit-required and TMDL-required monitoring will be assessed as part of the Adaptive Management Process and the EWMP will be adapted, if necessary, to enable compliance through the most efficient means possible. Figure ES-1 illustrates this multi-pronged compliance strategy.

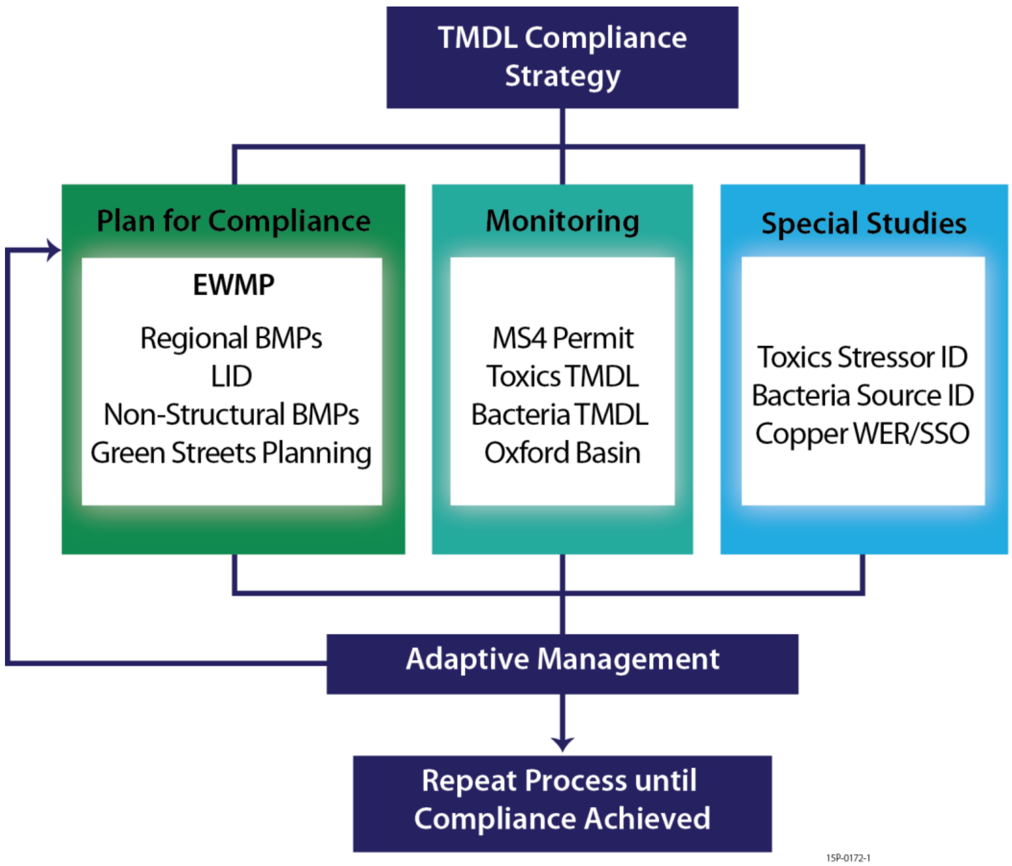


Figure ES-1: Compliance Strategy

In accordance with the MS4 Permit the objectives of the Watershed Control Measures shall include:

1. Prevent or eliminate non-stormwater discharges to the MS4 that are a source of pollutants conveyed by the MS4 to the receiving waters.
2. Implement pollutant controls necessary to achieve all applicable interim and final water quality-based effluent limitations and/or receiving water limitations pursuant to corresponding compliance schedules.
3. Ensure that discharges from the MS4 do not cause or contribute to exceedances of receiving water limitations."

The EWMP Agencies have previously implemented numerous structural and non-structural BMPs to improve water quality in the MdR watershed. However, based on the reasonable assurance analysis results, in order to address attainment of the stormwater volume and pollutant loading reductions necessary for compliance a combination of regional BMPs, green streets, LID, and non-structural BMPs will be necessary to achieve WQBELs.

Proposed priority projects include a public-private partnership regional project with Costco in the City of Culver City; and the Venice Boulevard Neighborhood Regional Distributed Green Streets Project (Venice Neighborhood Project) located in Subwatershed 4. Other projects include regional BMPs at four parks in the watershed (Triangle, Canal, Via Dolce, and Venice of America Centennial Parks) and green streets throughout the watershed. Figure ES-2 below shows the proportion of expected load reductions achieved through implementation of each category of BMP. Table ES-3 lists the expected volumes of stormwater mitigated. Figure ES-3 shows the locations of the proposed BMPs.

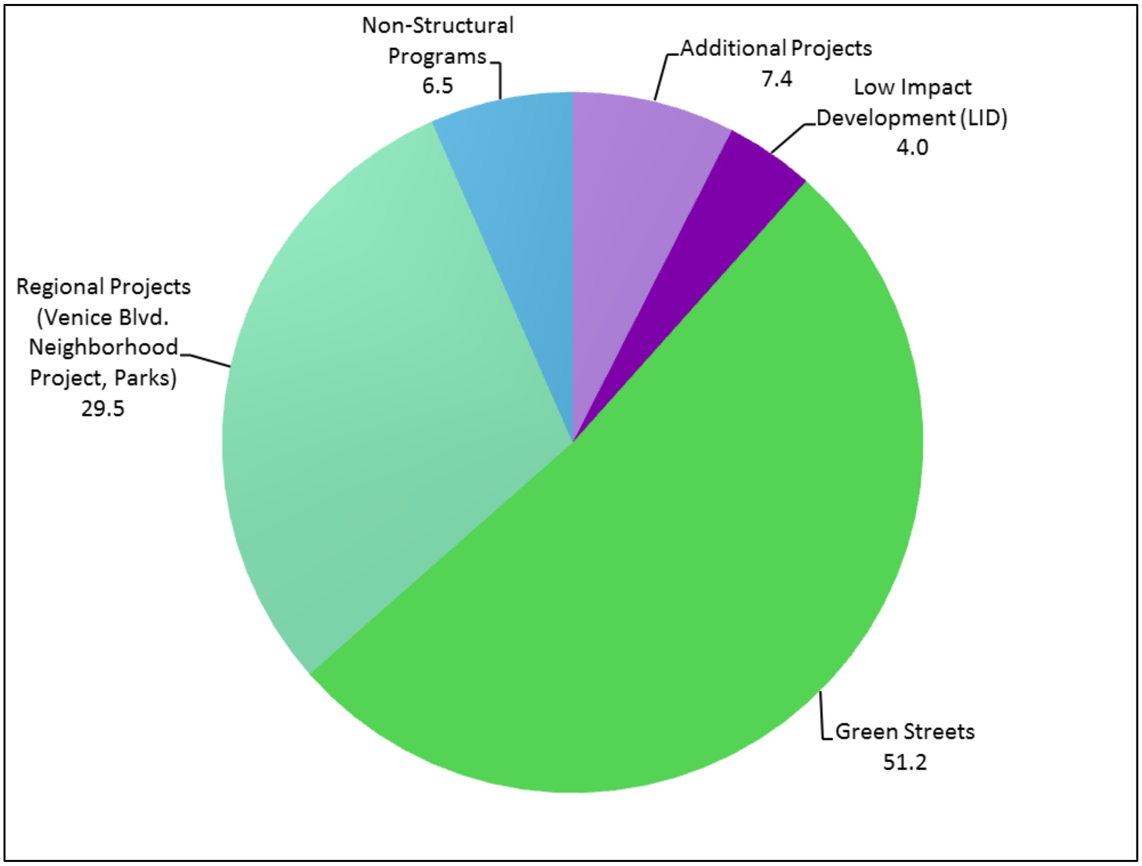


Figure ES-2: Percent Load Reduction by BMP Category

Table ES-3: Volume of Stormwater Captured/Treated by BMP Type for all Subwatersheds in the Marina del Rey Watershed

Project Type	Volume Stormwater (acre feet/wet year)
Regional Projects (Costco, Parks, Venice Neighborhood Project)	160.7
Green Streets	351.3
Low Impact Development (LID)	159.8
Additional BMPs*	1.3
Non-Structural Programs	0
Total	**673.1**

*Includes existing low flow diversions, does not include potential diversions that may be implemented based on the adaptive management approach

Figure ES-3: Proposed Regional BMPs

ES.4 Reasonable Assurance Analysis

The MdR EWMP Agencies have selected the Los Angeles County Watershed Management Modeling System (WMMS) as the model to be used for the development of the Reasonable Assurance Analysis (RAA) in support of the MdR EWMP. WMMS is one of the models described in the MS4 Permit and conforms to the modeling system selection criteria set by the LARWQCB–led RAA committee and is based on a regional modeling approach that was developed to simulate the hydrology and transport of sediment and metals. Based on available data and modeling results, zinc loading requires the largest load reduction and is thus the compliance driver for the Toxics TMDL (i.e., based on available data, if BMPs are implemented to achieve zinc WLA, then other pollutant loads would also be below WLAs). An analysis was also conducted to determine the required bacteria load reduction, and the findings indicate that a smaller volume and load reduction is necessary to achieve Bacteria TMDL compliance when compared to the Toxics TMDL. Therefore, achieving the required load reductions by the interim and final Toxic TMDL compliance dates will result in achieving compliance with the Bacteria TMDL as well.

The RAA delivers a quantitative demonstration that proposed BMPs will achieve interim and final WLAs through stormwater capture, filtration, and diversion, and associated TSS loading reductions.

ES.5 Implementation Plan and Schedule

Given that the compliance schedule for the Toxics TMDL is the most aggressive TMDL schedule applicable to the MdR watershed, the Toxics WLAs were used as the primary scheduling driver for BMP implementation. As previously mentioned, the MdR EWMP agencies have elected to demonstrate Toxics TMDL compliance through meeting final sediment WLAs for the contaminants in the TMDL.

Figure ES-4 illustrates the load reduction schedule based on the RAA that will be necessary to achieve Toxics TMDL interim and final milestones. The required bacteria load reductions are less than the reductions required for the Toxics TMDL, and therefore the structural and non-structural proposed BMPs and RAA schedule will also lead to achievement of the required Bacteria TMDL load reductions.

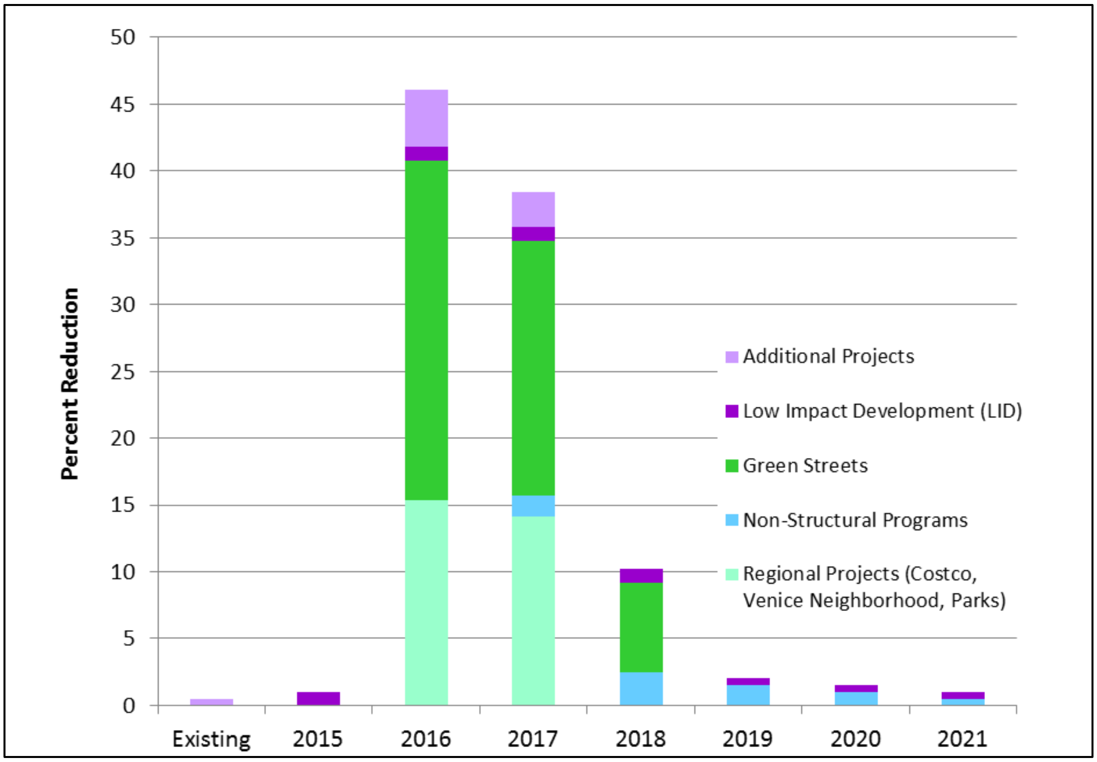


Figure ES-4: RAA Load Reduction Schedule

This schedule uses a phased implementation approach using a combination of structural and nonstructural strategies designed specifically to reduce toxic pollutant and bacterial loading to MdR while also allowing for consideration of special studies to determine the most efficient means of compliance. In parallel to implementation of the proposed BMPs, the MdR EWMP agencies will continue to conduct TMDL-required studies, including a stressor identification study, a site specific objective dissolved copper study, and a bacteria source identification study. These studies are expected to provide additional information, and may lead to TMDL compliance through alternative means of compliance, as previously discussed, which would significantly impact the implementation of BMPs proposed in this EWMP.

The proposed schedule strategy for 2016 includes completion of the Oxford Basin Multi-Use Enhancement Project (which began in 2015), sediment monitoring in Oxford Basin per the Toxics TMDL, and completion of the TMDL Stressor ID Special Study. The Oxford Basin Multi-Use Enhancement Project is not represented in the schedule above as the project was initiated separately from the EWMP process. However, this project is anticipated to provide multiple benefits to the MdR watershed through enhanced water circulation, contaminated soil removal, bioswale construction as well as, native and drought resistant landscaping. An expected outcome of the project is a reduction of pollutants discharged to Marina del Rey Harbor Basin E from Oxford Basin which will be confirmed with compliance monitoring.

Planning for the Costco Regional Project, a public-private partnership between the City of Culver City and Costco, began in 2015. Construction on the project will occur in 2016 and 2017 with project completion tentatively scheduled for December 2017.

ES.6 Financial Strategy

Estimated costs for compliance with the 2012 MS4 Permit through the implementation of the Marina del Rey Watershed EWMP are approximated at $392 million (Table ES-4), including costs associated with Subwatershed 2 (a non-TMDL area). If costs associated with Subwatershed 2 are not included in the calculation, the total costs for BMP implementation based on the RAA are estimated at $363 million. All costs are presented in 2015 dollars using the net present worth analysis and an average inflation rate of 3 percent. The costs associated with compliance may be much different than those projected in the table below and could be significantly lower based on the results of ongoing and future studies that will be incorporated into the adaptive management process.

The EWMP Agencies will follow a multi-pronged financial strategy to maximize potential funding opportunities in support of EWMP implementation. This approach includes, but is not limited to the pursuit of grants (including Prop 1 funding), the investigation of potential fees and other charges, as well as legislative strategies.

Table ES-4: Estimated Implementation Costs by Jurisdiction

MdR Watershed	Structural BMPs	Nonstructural BMPs	Operations & Maintenance	Total Cost
City of Los Angeles	$249,052,873	$2,923,268	$32,499,182	$284,475,323
County of Los Angeles	$87,412,319	$1,190,913	$12,001,036	$100,604,268
City of Culver City	$6,669,040	$127,009	$38,556	$6,834,605
Total Cost (2015 dollars)	**$343,134,232**	**$4,241,190**	**$44,538,774**	**$391,914,197**

The LACFCD will work with the WMG in their efforts to address source controls; assess, develop, and pursue funding for structural BMPs, and promote the use of water reuse and infiltration. As regional project scopes are further refined, the LACFCD will determine on a case-by-case basis their contribution to the projects.

Estimated costs for implementation according to the RAA schedule to meet the interim and final compliance milestones are identified in Figure ES-5 below.

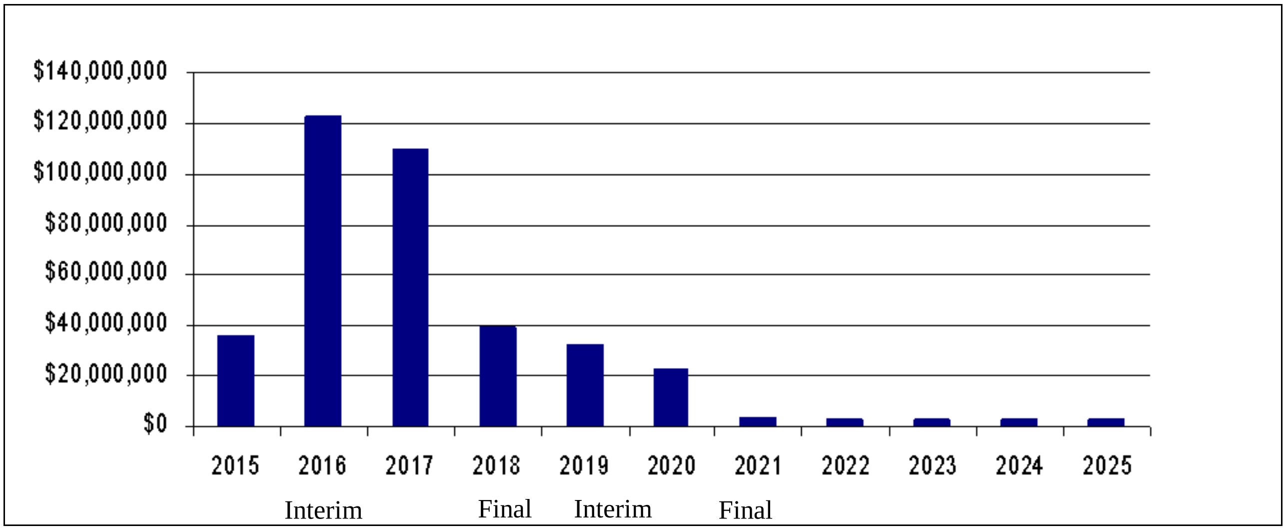


Figure ES-5: Cost Schedule based on RAA to Meet Interim and Final TMDL Schedule

ES.7 Adaptive Management

Adaptive management is a key component for the successful implementation, assessment and refinement of the MdR EWMP. Adaptive management is the process by which data are continually assessed in the context of improving and adapting programs to ensure the most effective strategies are implemented. In accordance with the MS4 Permit, every two years as data become available through Coordinated Integrated Monitoring Program (CIMP) monitoring, BMP effectiveness studies, special studies such as the Toxics TMDL required Stressor ID Study, Oxford Basin monitoring, and other scientific studies, it will be integrated and assessed to determine if programs in the EWMP should be altered to enable compliance in the most efficient manner. Additionally, public participation and LARWQCB recommendations will also be included in the adaptive management process. The adaptive management framework will allow the EWMP Agencies to develop an overall program consisting of efficient solutions based on evolving watershed priorities.

1.0 INTRODUCTION

The Marina del Rey (MdR) watershed is a small subwatershed located in the larger Santa Monica Bay watershed. The Marina del Rey Harbor (MdRH) was officially opened in 1965 and is the world's largest man-made small craft harbor. The tributary area served by a Municipal Separate Storm Sewer Sysem (MS4) that drains to MdRH is approximately 1,409 acres and consists of portions of the cities of Culver City and Los Angeles, as well as portions of the unincorporated County of Los Angeles (County). The MdR Watershed Management Area (WMA) is one of the smallest WMAs in the County of Los Angeles, but it is also one of the most important and active watersheds.

The MdR watershed has one of the most aggressive Total Maximum Daily Load (TMDL) schedules for both toxics and bacteria and often leads the way in TMDL implementation for the rest of the County.

The extensive ongoing efforts of the County, Los Angeles County Flood Control District (LACFCD), and the cities of Culver City and Los Angeles (collectively known as the MdR Enhanced Watershed Management Program [EWMP] Agencies) to improve water quality in the MdR watershed include implementing best management practices (BMPs) to reduce pollutants from stormwater runoff to the harbor. Over the past 10 years, the responsible agencies in the MdR watershed have spent tens of millions of dollars in special studies, low-flow diversions, non-structural BMPs, structural BMPs, and monitoring efforts. The water quality in the harbor has significantly improved as a result of the cooperative efforts of the MdR EWMP Agencies.

1.1 Enhanced Watershed Management Plan Overview

On December 28, 2012, the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Permit (MS4 Permit) became effective upon adoption by the Los Angeles Regional Water Quality Control Board (LARWQCB). This new MS4 Permit establishes the waste discharge requirement for stormwater and non-stormwater discharges within the watersheds of Los Angeles County. The MS4 Permit includes provisions that allow Permittees to voluntarily choose to implement an EWMP.

The EWMP for the MdR watershed is a collaborative effort of the EWMP Agencies, comprised of the County, LACFCD, and the cities of Los Angeles and Culver City. The MdR EWMP will cover the areas owned by the MS4 Permittees within the watershed (Figure 1-1). The WMA does not include the area adjacent to the Ballona Wetlands owned by the State of California (State) nor does it include the California Department of Transportation (Caltrans) right-of-way (ROW) areas because these agencies are not members of the MdR EWMP Agencies. The WMA also does not include the water areas within the MdR watershed because they are considered non-point sources and are not covered by the MS4 Permit.

Figure 1-1: Marina del Rey Watershed Jurisdictional Boundaries

Development of the MdR EWMP in accordance with the MS4 Permit includes the following elements:

1. Identification of water quality priorities, including an evaluation the of existing water quality conditions, classification of pollutants, assessment of known and suspected pollutant sources in the watershed, and prioritization of water quality issues in the watershed.
2. Characterization of the existing and potential control measures within the watershed.
3. Addressing the approach to incorporate reasonable assurance analysis (RAA) in the optimization of MdR watershed control measures.
4. Development of an EWMP implementation schedule.
5. Public and stakeholder input.
6. Adaptive management framework.
7. Estimation of implementation costs and financial strategy

1.2 MdR Watershed Land Use and Drainage Characteristics

The MdR watershed is bordered by the Santa Monica Bay Watershed to the west and the Ballona Creek watershed to the north and east. The MdRH is open to the Santa Monica Bay through the main channel and shares a common breakwater with Ballona Creek. The MdR watershed consists of four subwatersheds, referred to as Subwatersheds 1 to 4 (Figure 1-2). Table 1-1 summarizes the MdR watershed acreage by subwatershed.

The MdRH is an active harbor for pleasure craft, consisting of the main channel and eight basins (A to H). Basins A, B, C, G, and H are known as the Front Basins. Basins D, E, and F are known as the Back Basins and are located in Subwatershed 1. The MdR Watershed Management Area also includes the Venice Canals and the tributary area to the Ballona Lagoons, which discharge to the MdRH, near the exit to the Santa Monica Bay (Subwatershed 2). The Caltrans ROW areas, which are located mainly within the City of Los Angeles in Subwatersheds 1 and 4, and the portions of the Ballona Wetland (49.3 acres) located on State land in Subwatershed 1 are outside the boundaries of the MdR EWMP MS4 Permit area.

Figure 1-2: MdR Land Use and Subwatersheds

Table 1-1: Summary of Marina del Rey Subwatershed Acreage

Agency	EWMP MS4 Permittee	Sub-watershed 1 (acres) (Harbor)	Sub-watershed 2 (acres) (Ballona Lagoon)	Sub-watershed 3 (acres) (Boone Olive)	Sub-watershed 4 (acres) (Oxford Basin)	EWMP Watershed (acres)	% EWMP Watershed Area
City of Los Angeles	Yes	32.9	278.1	70.5	589.8	971.3	69%
County of Los Angeles	Yes	336.2	46.8	0.0	12.7	395.7	28%
City of Culver City	Yes	0.0	0.0	0.0	42.2	42.2	3%
Los Angeles County Flood Control District	Yes	N/A	N/A	N/A	N/A	N/A	N/A
Area of EWMP Agencies		**369.1**	**324.9**	**70.5**	**644.7**	**1409**	**100%**
Caltrans	No	5.4	0.0	0.0	26.4	31.8	NA
State of California (Ballona Wetland)	No	49.3	0.0	0.0	0.0	49.3	NA
MdRH Watershed Area		**423.8**	**324.9**	**70.5**	**671.1**	**1490**	**-**

The following land uses are found in the MdR watershed:

- The MdRH land area in Subwatershed 1 (369.1 acres) is almost entirely composed of unincorporated County land and has many small drains that discharge into all the basins. The MdR Small Drain Survey, completed for the Los Angeles County Department of Beaches and Harbors (LACDBH, 2004a), identified approximately 724 small outfalls that discharge directly into MdRH, the majority of which serve the individual parcels and small roads among the basins. The remaining drains are located in the streets surrounding the basins. The City of Los Angeles, Caltrans, and the City of Culver City are not responsible for any outlets that drain directly to the harbor.
- Subwatershed 2 (324.9 acres) does not drain into the MdRH Front or Back Basins, but drains into the Venice Canal and the Ballona Lagoon, which discharge into the MdRH main channel mouth.
- Boone Olive Pump Plant serves Subwatershed 3, a tributary area of 70.5 acres that lies entirely within the boundaries of the City of Los Angeles. The pump station discharges into Basin E.
- Subwatershed 4 lies primarily within the jurisdiction of the Cities of Los Angeles and Culver City and totals approximately 644.7 acres (excluding Caltrans areas). Its corresponding runoff discharges into the Oxford Basin, a man-made flood control basin occupying approximately 10 acres within the County. Situated north of the Back Basins, Oxford Basin is operated by the LACFCD. It drains into Basin E through two tide gates and storm drain piping. The Oxford Retention Basin Multi-Use Enhancement Project is currently underway. Once completed this project will provide multiple benefits through enhanced water circulation, contaminated soil removal, bioswale construction as well as native and drought resistant landscaping. An expected

outcome of the project is a reduction of pollutants discharged to Marina del Rey Harbor Basin E from Oxford Basin.

Table 1-2 presents the land use acreages by subwatershed and Table 1-3 shows the land use acreages by jurisdiction.

Table 1-2: Land Use Acreages by Subwatershed (acres)

Land Use Class	Subwatershed Acreage*								Total (acres)	Percent EWMP Watershed Area
	1		2		3		4			
	acres	% of Subwatershed	acres	% of Subwatershed	acres	% of Subwatershed	acres	% of Subwatershed		
Single-Family Residential	1.8	0.5%	45.8	14.1%	22.9	32.5%	167.2	25.9%	237.7	16.9%
Multi-Family Residential	149.9	40.6%	131.8	40.6%	21.1	29.9%	96.8	15.0%	386.3	27.4%
Institutional/Public Facilities	8	2.2%	10.1	3.1%	2.6	3.7%	67.2	10.4%	87.9	6.2%
Commercial and Services	107.2	29.0%	22.8	7.0%	1.6	2.3%	123.7	19.2%	268.6	19.1%
Industrial/Mixed with Industrial	0.2	0.1%	0.2	0.1%	0.3	0.4%	27	4.2%	27.7	2.0%
Transportation/Road ROW	38.2	10.3%	83.3	25.6%	22	31.2%	153.8	23.9%	297.3	21.1%
Developed Recreation/Marina Parking	41.6	11.3%	0.7	0.2%	0	0.0%	1.9	0.3%	44.2	3.1%
Beach	8.2	2.2%	0	0.0%	0	0.0%	0	0.0%	8.2	0.6%
Water**	6.4	1.7%	30.3	9.3%	0	0.0%	7.1	1.1%	43.8	3.1%
Vacant	7.6	2.1%	0	0.0%	0	0.0%	0	0.0%	7.6	0.5%
Total	**369.1**	**100%**	**325**	**100%**	**70.5**	**100%**	**644.7**	**100%**	**1409**	**100%**

*Acreage excludes Caltrans and State owned land (Ballona Wetland) not in EWMP Area

**Marina Boat Area and MdRH Water not included in "Water" class acreage provided here. Water class includes Ballona Lagoon (14.4 acres), Venice Canals (15.9acres), Oxford Basin (7.1 acres), and Ballona Shoreline and other water (6.4 acres)

Table 1-3: Land Use Acreages by EWMP Agency Jurisdiction

Land Use Class	EWMP Agencies Jurisdictional Areas (Acres)*			
	City of Culver City	City of Los Angeles	County of Los Angeles	Total
Single-Family Residential	6.8	230.6	0.3	237.7
Multi-Family Residential	0	229.4	170.2	399.6
Institutional/Public Facilities	0	83.7	4.2	87.9
Commercial and Services	24.3	122.3	108.7	255.3
Industrial/Mixed with Industrial	0	27.7	0	27.7
Transportation/Road ROW	11.1	246.4	39.8	297.3
Developed Recreation/Marina Parking	0	0.9	43.3	44.2
Beach	0	0	8.2	8.2
Water**	0	30.3	13.5	43.8
Vacant	0	0	7.6	7.6
Total	42.2	971.3	395.7	1409

*Acreage excludes Caltrans and State-owned land (Ballona Wetland) not in EWMP Area.

**Marina Boat Area and MdRH Water not included in "Water" class acreage provided here. Water class includes Ballona Lagoon (14.4 acres), Venice Canals (15.9acres), Oxford Basin (7.1 acres), and Ballona Shoreline and other water (6.4 acres)

2.0 LEGAL AUTHORITY

Section VI.A.2.b of the MS4 Permit requires each of the EWMP agencies to provide documentation that they have the necessary legal authority to implement the provisions of the Permit. EWMP agencies must also provide documentation that they have the legal authority to implement the control measures identified in the EWMP (Permit Section VI.C.5.b.iv.6). This documentation is included in Appendix D.

3.0 REGULATORY BACKGROUND

3.1 Section 303(d) List 2010

The federal Clean Water Act (CWA), Section §303(d), requires states to identify waters that do not meet applicable water quality standards despite the treatment of point sources by the minimum required levels of pollution control technology. States are required not only to identify these "water quality limited segments" but also to prioritize such waters for the purpose of developing TMDLs. A TMDL is defined as the "sum of the individual waste load allocations (WLAs) for point sources and load allocations for nonpoint sources and natural background" (40 Code of Federal Regulations [CFR] 130.2), such that the capacity of the waterbody to assimilate constituent loads (the loading capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (U.S. Environmental Protection Agency [USEPA], 2000).

The §303(d) list, which was last updated in 2010 identified a number of constituents of concern for the MdRH Back Basins and Marina Beach (Table 3-1). Marina Beach is also commonly known as Mother's Beach.

Table 3-1: Summary of Section 303(d) Listings

Water Body	Constituent	Final Listing Decision
Marina del Rey Harbor - Back Basins	Chlordane (tissue and sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Copper (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	DDT* (tissue)	Do Not Delist from §303(d) list (TMDL required list)
	Dieldrin* (tissue)	Do Not Delist from §303(d) list (TMDL required list)
	Fish Consumption Advisory	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Indicator bacteria	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Lead (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	PCBs (tissue and sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Sediment toxicity	Do Not Delist from §303(d) list (being addressed with USEPA-approved TMDL)
	Zinc (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
Marina del Rey Harbor Marina Beach	Indicator bacteria	List on §303(d) list (being addressed by USEPA-approved TMDL)

*USEPA-approved TMDL has made a finding of non-impairment for this constituent.
DDT - dichlorodiphenyltrichloroethane

3.2 Existing TMDLs Summary

The Marina del Rey watershed is subject to five TMDLs; the Santa Monica Bay Nearshore Debris TMDL (Debris TMDL), the Ballona Creek Trash TMDL (Trash TMDL), the Marina del Rey Harbor Mother's Beach and Back Basin Bacteria TMDL (Bacteria TMDL), the Toxic Pollutants in Marina del Rey Harbor TMDL (Toxics TMDL), and the EPA established Santa Monica Bay TMDL for DDTs and PCBs (SMB Toxics TMDL).

The compliance schedules for the applicable TMDLs are presented in Table 3-2.

Table 3-2: TMDL Compliance Schedules

TMDL	Matrix	Parameters	Goal	Compliance Date
Marina del Rey Harbor Toxic Pollutants TMDL	Harbor water	Dissolved Copper (from boats)	Meet LAs	3/22/2024
	Harbor sediments (Back Basins)	Copper, lead, zinc, chlordane, PCBs, DDTs, p'p-DDE	Interim Sediment Allocations	3/22/2016*
			Final Compliance	3/22/2018
	Harbor sediments (Front Basins)		Interim Sediment Allocations	3/22/2019
			Final Compliance	3/22/2021
Marina del Rey Mother's Beach and Back Basins Bacteria TMDL	Harbor water	Total coliform, fecal coliform, *Enterococcus*	Interim time frame for compliance with allowable exceedance days for summer and winter dry weather	12/28/2017**
			Original final and TSO final dates for compliance with allowable exceedance days for summer and winter dry weather	12/28/2017**
			Compliance with allowable exceedance days for wet weather and geometric mean targets	7/15/2021
Santa Monica Bay TMDLs for DDTs and PCBs	Water column	Total DDTs and Total PCBS	Numeric targets in Santa Monica Bay	3/22/2014 for DDTs 3/22/2014 for PCBs
	Fish tissue		Numeric targets in Santa Monica Bay	3/22/2023 for DDTs 3/22/2034 for PCBs
	Bay sediment		Numeric targets in Santa Monica Bay	3/22/2023 for DDTs 3/22/2034 for PCBs
Ballona Creek Trash TMDL[Ω]	Trash		0 discharge of trash or 0% of the baseline load	9/30/2015
Santa Monica Bay Nearshore and Offshore	Trash		20% reduction	3/20/2016
			40% reduction	3/20/2017

TMDL	Matrix	Parameters	Goal	Compliance Date
Debris TMDL*			60% reduction	3/20/2018
			80% reduction	3/20/2019
			100% reduction	3/20/2020

PCB – polychlorinated biphenyls
p,p'-DDE – p,p'-dichlorodiphenyldichloroethylene
* Interim milestone occurs prior to EWMP approval.
**Deadline or time frame identified in Bacteria TDML Time Schedule Order No. R4-2014-0142
ΩTMDL complied with through the Ballona Creek Trash TMDL

3.2.1 Santa Monica Bay Nearshore Debris TMDL & Ballona Creek Trash TMDL

The Santa Monica Bay Nearshore Debris TMDL was adopted by the LARWQCB on November 4, 2010 (Resolution No. R10-010) and became effective upon adoption by the USEPA on March 20, 2012. Responsible agencies identified for the Debris TMDL include, among others, the County, the City of Culver City, and the City of Los Angeles. The Debris TMDL established numeric targets and waste load allocations of zero discharge of trash and plastic pellets to waterbodies within the Santa Monica Bay WMA, which includes MdRH. The trash WLA applicable to the MS4 Permittees shall be complied with through the Ballona Creek Trash TMDL (Resolution No. R08-007).

The Ballona Creek Trash TMDL was adopted by the LARWQCB on September 19, 2001, and became effective on August 28, 2002, The TMDL was amended in 2004 and the amended TMDL became effective on August 11, 2005. On June 11, 2015 the LARWQCB adopted a second revision to the Trash TMDL but as the writing of this MdR EWMP, the revised TMDL has yet to be approved by the State Water Resources Control Board, the Office of Administrative Law (OAL) or by the USEPA. The TMDL established WLAs of zero discharge of trash and set a final compliance deadline of September 30, 2015. The MdR WMG agencies have met the final compliance deadline in the TMDL, and corresponding schedule in the 2012 MS4 Permit, through installation of full capture devices. In the City of Los Angeles area of the MdR watershed, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens).The City of Culver City has retrofitted four catch basins and the County has retrofitted 40 catch basins in the MdR with full-capture devices.

3.2.2 Bacteria TMDL

The Bacteria TMDL was originally adopted by the LARWCQB on August 7, 2003 (Resolution No. 2003-012) and became effective on March 18, 2004 upon approval by the USEPA. The Bacteria TMDL was revised by the LARWQCB on June 7, 2012 (Resolution No. R12-007) and a Time Schedule Order (TSO) was approved on July 10, 2014 (TSO No. R4-2014-0142). The responsible agencies identified for the Bacteria TMDL include the County, LACFCD, City of Los Angeles, the City of Culver City, and Caltrans.

The Bacteria TMDL established numeric bacterial compliance targets based on the acceptable health risk for marine recreational waters as defined by the USEPA. The numeric targets are expressed as both single sample limits and rolling geometric means (Table 3-3).

Table 3-3: Bacteria TMDL Numeric Targets

Indicator	Rolling 30-Day Geometric Mean Limit*	Single Sample Limit
Total coliform	1,000 MPN/100 mL	1,000 MPN/100 mL if fecal > 10% of total, or 10,000 MPN/100 mL**
Fecal coliform	200 MPN/100 mL	400 MPN/100 mL
Enterococcus	35 MPN/100 mL	104 MPN/100 mL

*The geometric mean is calculated weekly as a rolling geometric mean using 5 or more samples, for 6-week periods starting all calculation weeks on Sunday.
** Total coliform single sample limit of 10,000 most probable number (MPN) decreases to 1,000 when the fecal coliform value is greater than 10% of total coliform value.

The TMDL WLAs are expressed as allowable exceedance days, or the number of days on which sampling results can surpass the numeric targets and WLAs. For single sample targets, allowable exceedance days are specified by three defined seasons (summer dry, winter dry, and wet weather) and vary by monitoring site. Each season has its own compliance dates (interim and final), requirements, and limits, as presented in Table 3-4.

Table 3-4: Bacteria TMDL Compliance Seasons

Compliance Season	Summer Dry Weather April 1 – October 31		Winter Dry November 1- March 31		Wet Weather Rain Event*	Geometric Mean Year Round
Deadline	December 28, 2017**		December 28, 2017**		July 15, 2021	
Compliance Monitoring Location	Allowable Exceedance Days/Year					
	TSO Interim Compliance	Final Compliance	TSO Interim Compliance	Final Compliance	Final Compliance	Final Compliance
Daily Sampling						
MdRH-1^Ω	22	0	60	9	17	0
Weekly Sampling						
MdRH-2	11	0	19	2	3	0
MdRH-3	12	0	12	2	3	0
MdRH-4 (S)	3	0	5	2	3	0
MdRH-4 (D)	2	0	3	2	3	0
MdRH-5	5	0	3	2	3	0
MdRH-6 (S)	3	0	5	2	3	0
MdRH-6 (D)	4	0	4	2	3	0
MdRH-7	4	0	5	2	3	0
MdRH-8 (S)	1	0	2	2	3	0
MdRH-8 (D)	2	0	2	2	3	0
MdRH-9 (S)	1	0	2	2	1	0
MdRH-9 (D)	0	0	2	2	1	0

*Rain event ≥ 0.1 inches at LAX rain gauge, and 3 days following the end of the rain event.
** Deadline identified in Bacteria TDML Time Schedule Order No. R4-2014-0142
^Ω MdRH-1 is sampled Monday-Saturday while MdRH-2 is sampled Monday and Saturday. All other locations are sampled weekly on Mondays. MDRH-1 exceedances days are based on daily sampling while the other monitoring stations exceedance days are based on weekly sampling.

3.2.3 Santa Monica Bay TMDL for DDTs and PCBs

The Santa Monica Bay TMDL for DDTs and PCBs was approved by the USEPA on March 26, 2012. The TMDL set numeric targets for the water column, sediment and fish tissue in the Bay (Table 3-5).

Table 3-5: Santa Monica Bay TMDL for DDTs and PCBs Numeric Targets

TMDL Target	Total DDTs	Total PCBs
Water Column	0.17 ng/L	0.019 ng/L
Fish Tissue	40 ng/g	7 ng/g
Sediment (normalized for organic carbon)	2.3 µg/g OC	0.7 µg/g OC

The TMDL set stormwater waste load allocations at existing estimated pollutant levels (which were lower than the calculated total allowable loads needed to achieve sediment targets) and therefore this TMDL is referred to as an anti-degradation TMDL. The WLA for the Los Angeles County MS4 was set at 27.08 g/year of DDT and 140.25 g/year for PCBs (Table 3-6). The reduction in stormwater volume that will occur through implementation of the BMPs proposed in this EWMP will reduce stormwater loading of DDTs and PCBs to Santa Monica Bay below current conditions and will therefore satisfy the requirements of this anti-degradation TMDL.

Table 3-6: Los Angeles County MS4 Permit Stormwater Waste Load Allocations from the Santa Monica Bay DDTs and PCBs TMDL

Permit	Total DDTs	Total PCBs
Los Angeles County MS4 Permit	27.08 g/yr	140.25 g/yr

3.2.4 Toxics TMDL Summary

The Toxics TMDL was adopted by the Regional Board on October 6, 2005 (Resolution No. 2005-012), and was approved by USEPA and became effective on March 22, 2006. The responsible agencies identified for the Toxics TMDL include the County, LACFCD, City of Los Angeles, City of Culver City, and Caltrans. The Toxics TMDL originally addressed certain metals and organics in the Back Basins of MdRH (Basins D, E, and F) but was amended in 2014 to include the Front Basins of MdRH (Basins A, B, C, G, and H). Interim and Final compliance milestones are provided in the TMDL, and the compliance schedule is included in Table 3-2.

The constituents addressed by the Toxics TMDL are copper, lead, zinc, chlordane, total polychlorinated biphenyls (PCBs), p,p'-dichlorodiphenyldichloroethylene (p,p'-DDE), and total dichlorodiphenyltrichloroethanes (DDTs). Under the MS4 Permit, compliance with the sediment WLAs for copper, lead, zinc, chlordane, p'p-DDE and total DDT may be demonstrated via any one of three different means: (a) qualitative sediment condition of unimpacted or likely unimpacted via the interpretation and integration of multiple lines of evidence is met (b) sediment numeric targets are met in bed sediments, or *(c) final sediment WLAs are met*.

This EWMP focuses on demonstrating that compliance may be achieved through meeting final sediment WLAs for the contaminants in the MdR Toxics TMDL through the implementation of structural and non-structural control measures. However, compliance based on implementation of control measures is one part of a three-pronged compliance strategy. Special studies carried out in support of TMDL implementation will be used to update compliance strategies. A Stressor ID Study is required under the Toxics TMDL and is planned to be conducted in the MdR Harbor in the year 2016. This study will identify stressors causing toxicity to biological organisms in the harbor. Results from this study, and others, may impact compliance strategies and BMPs specified in this EWMP. Special studies related to dissolved copper are also planned in the Harbor, as well as a bacteria source identification study. Outcomes of the special studies, Permit-required and TMDL-required monitoring will be assessed as part of the Adaptive Management Process and the EWMP will be adapted, if necessary, to enable compliance through the most efficient means possible. Figure 3-1 illustrates this multi-pronged compliance strategy.

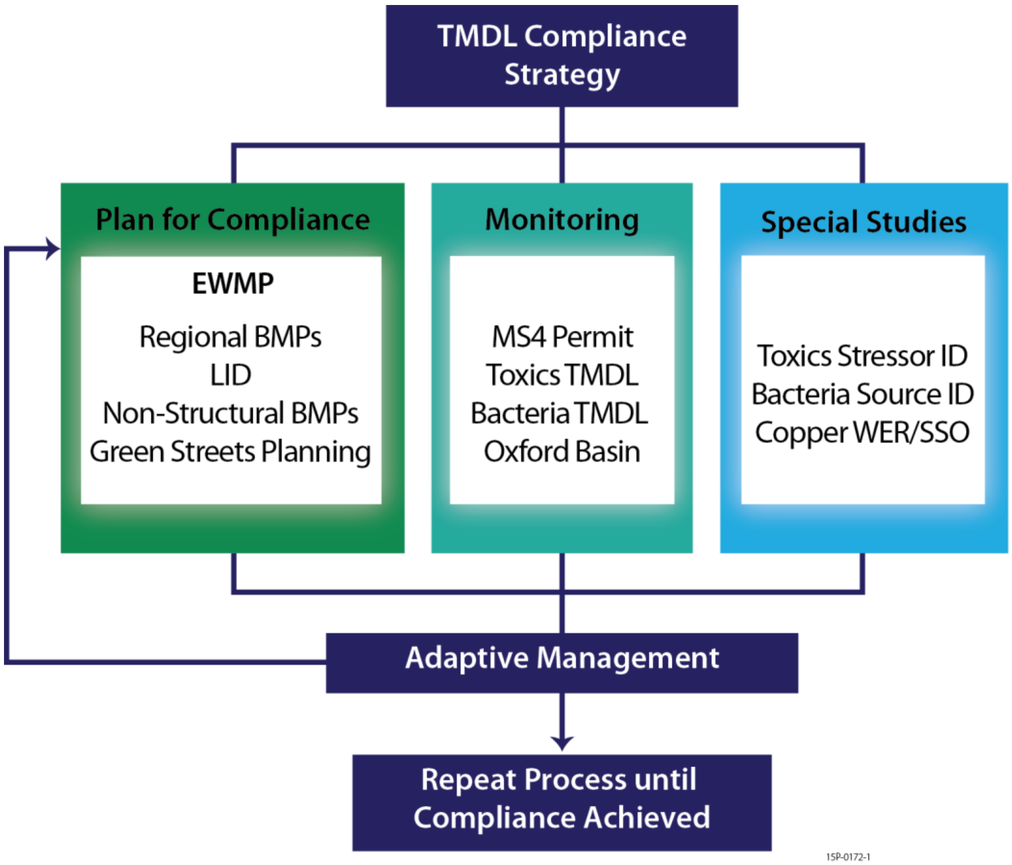


Figure 3-1: TMDL Compliance Strategy

3.2.4.1 Sediment Numeric Targets

The Toxics TMDL established sediment numeric targets using the effects range low (ER-L) (Long et al., 1995) guidelines for copper, lead, zinc, chlordane, total DDTs, and p,p'-DDE. The sediment numeric target for total PCBs in sediments was selected to protect human health from consumption of contaminated fish (Table 3-7).

Table 3-7: Toxics TMDL Sediment Numeric Targets

Constituent	Numeric Target for Sediment
Chlordane	0.5 µg/kg
Total PCBs	3.2 µg/kg
Total DDTs	1.58 µg/kg
p-p'-DDE	2.2 µg/kg
Copper	34 mg/kg
Lead	46.7 mg/kg
Zinc	150 mg/kg

3.2.4.2 Water Column Numeric Targets

The Toxics TMDL established a final numeric target for PCBs in the water column using the California Toxics Rule (CTR) criterion for the protection of human health from the consumption of aquatic organisms. A numeric target for dissolved copper in the water column was also established based on the CTR Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) (Table 3-8). The MS4 Permittees are not subject to this criteria.

Table 3-8: Toxics TMDL Water Column Numeric Targets

TMDL Phase	Numeric Target (µg/L)
Total PCBs	0.00017*
Dissolved copper	Acute – 4.8/Chronic – 3.1

*Receiving water quality samples shall be collected monthly and analyzed for total PCBs at detection limits that are at or below the minimum levels. The minimum levels are those published by the State Water Resources Control Board in Appendix 4 of the Policy for the Implementation of Toxic Standards for Inland Surface Water, Enclosed Bays, and Estuaries of California, March 2, 2000. Special emphasis should be placed on achieving detection limits that will allow evaluation relative to the CTR standards.

3.2.4.3 Fish Tissue Numeric Targets

The Toxics TMDL fish tissue numeric target of 3.6 µg/kg for total PCBs is the Office of Environmental Health Hazard Assessment (OEHHA) Fish Contaminant Goal (FCG).

3.2.4.4 Sediment Waste Load Allocations

Loading capacity was estimated based on the annual average total suspended solids (TSS) loads into MdRH under the assumption that the finer sediments transport the majority of constituents. The Toxics TMDL for sediment was calculated based on the estimated loading capacity and the numeric sediments targets (Table 3-9).

Table 3-9: Toxics TMDL Numeric Targets and Loading Capacity

Metals	Numeric Target (Load Allocation) ER-L(mg/kg)	TMDL Loading Capacity(kg/year)
Copper	34	2.88
Lead	46.7	3.95
Zinc	150	12.69
Organics	**ER-L (µg/kg)**	**TMDL (g/year)**
Chlordane	0.5	0.04
PCBs	3.2	1.92
Total DDTs	1.58	0.13
p-p'-DDE	2.2	0.19

3.2.4.5 Water Column Load Allocations

The load allocation for dissolved copper from boats is a reduction of 85% from the baseline copper load from boats of 3,609 kg/year. The MS4 Permittees are not subject to this criteria and this load reduction is not included in the EWMP.

3.2.4.6 Stormwater Waste Load Allocations

WLAs for stormwater are also included in the Toxics TMDL for each of the MS4 Permittees (Table 3-10).

Table 3-10: Toxics TMDL Stormwater Waste Load Allocations

Permittees	Copper (kg/year)	Lead (kg/year)	Zinc (kg/year)	Chlordane (g/year)	Total PCBs (g/year)	Total DDT (g/year)	p'p-DDE (g/year)
MS4	2.26	3.10	9.96	0.0332	1.51	0.10	0.15
Caltrans	0.036	0.05	0.16	0.0005	0.024	0.0017	0.0024
General construction	0.23	0.32	1.02	0.0034	0.16	0.011	0.015
General industrial	0.012	0.016	0.053	0.0002	0.008	0.0006	0.0008
Total	**2.54**	**3.49**	**11.2**	**0.04**	**1.70**	**0.12**	**0.16**

4.0 IDENTIFICATION OF WATER QUALITY PRIORITIZATION

4.1 Approach to Data Compilation and Analysis

In accordance with the MS4 Permit, existing water quality conditions were characterized using all available data from relevant studies and monitoring completed within the past 10 years to determine the pollutants of concern.

The EWMP Agencies have conducted extensive monitoring in the harbor. Table 4-1 provides a summary of the data and studies used in this evaluation. Additional information and detailed data analysis are presented in the Marina del Rey EWMP Work Plan (Appendix F) and Appendix G

Table 4-1: Summary of Data and Studies Used in the Evaluation

Report	Parameters	Stormwater / MS4	Harbor Water	Sediment	Sediment Cores	Fish Tissue
Toxics TMDL Monitoring (2010-2013)	Organics	x	-	x	-	x
	Metals	x	x	x	-	-
	Conventional	x	-	x	-	-
	Toxicity	-	-	x	-	-
Storm-Borne Sediment Monitoring (2011)	Organics	x	-	-	-	-
	Metals	x	-	-	-	-
	Conventional	x	-	-	-	-
Special Study – Low Detection Limits (2011)	Organics	x	-	x	-	-
Special Study - Partitioning Coefficient (2011)	Organics	x	-	x	-	-
	Metals	x	x	x	-	-
	Conventional	x	x	x	-	-
MdRH Annual Reports – ABC Laboratories (2002-2007)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	x	-	-	-
	Bacteria	-	x	-	-	-
MdRH Sediment Characterization Study (2008)	Organics	-	-	x	x	-
	Metals	-	-	x	x	-
	Conventional	-	x	x	-	-
	Toxicity	-	-	x	-	-
Oxford Basin Study (2010)	Organics	-	x	x	x	-
	Metals	-	x	x	x	-
	Conventional	-	x	x	x	-
	Bacteria	-	x	x	-	-
Bight '03 (2003)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	-	x	-	-
	Toxicity	-	-	x	-	-
Bight '08 (2008)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	-	x	-	-
	Toxicity	-	-	x	-	-
Bacteria TMDL Monitoring (2007-2013)	Bacteria	-	x	-	-	-

Report	Parameters	Stormwater / MS4	Harbor Water	Sediment	Sediment Cores	Fish Tissue
Nonpoint Source Bacteria Study (2006)	Bacteria	x	x	x	-	-
Small Drain Survey	Assessment of outfalls	-	x	-	-	-
Vessel Discharge Report	Vessels/use of pump-outs	-	x	-	-	-
IC/ICDE Programs		x				

4.2 Summary of Findings

The Marina del Rey EWMP Work Plan (Appendix F) and Appendix G contain detailed findings of the data compilation and analysis, including a summary of the findings by study. All available data were analyzed (both MS4 and receiving water) to determine the pollutants of concern. Dry weather MS4 data were not available, as most flows are directed to the sanitary sewer through low-flow diversion devices. The following section offers a concise summary of the detailed information contained in the Work Plan and Appendix G. Findings are summarized by matrix below.

4.2.1 Stormwater

Stormwater monitoring was conducted as part of the Toxics TMDL coordinated monitoring plan at five stations (Figure 4-1). A total of 23 storms were monitored in accordance with the Toxics TMDL Coordinated Monitoring Plan (CMP) during the 3-year period (2010 to 2013). Two special studies and one pilot study were also conducted; the Low Detection Limit (LDL) Special Study (Brown & Caldwell 2011a); the Partitioning Coefficient Special Study (Brown & Caldwell 2011b); and the Storm-borne Sediment pilot study (Brown & Caldwell 2013).

Because the Toxics TMDL targets for stormwater are sediment based, it is not feasible to make an assessment of water quality exceedances based on water column data. For this report, the data were compared to the CTR water column criteria to provide a general sense of the water quality conditions in the stormwater to help guide the prioritization of water quality issues. Key findings include the following:

- Dissolved copper and dissolved zinc frequently exceeded the CTR CMC in Toxics TMDL monitoring, whereas dissolved lead rarely exceeded the CTR CMC (one sample exceeded at CTR CMC at MdR-C-2 on 3/8/2013).
- Partitioning Coefficient Study results for copper in stormwater showed that concentrations were above background levels and may be contributing to copper in the MdRH.
- Chlordane was not detected in any of the Toxics TMDL monitoring samples above the Method Detection Limit (MDL). The MDLs were below the CTR CMC for acute toxicity for freshwater (2.4 µg/L). The LDL Special Study results for chlordane in stormwater achieved lower MDLs. The low MDL results confirmed that chlordane levels were below the applicable criterion.
- Total PCBs were not detected above the MDL for the first two monitoring years of Toxics TMDL monitoring. During the third year of monitoring total PCBs were detected during two events at all stations. The field trip blank also had total PCB results above the MDL for each of those events.
- LDL Special Study results for total PCBs achieved lower MDLs. The results showed that all samples exceeded the harbor water numeric target of 0.00017 µg/L by a factor of at least 12.

Figure 4-1: Toxics and Bacteria TMDL Monitoring Locations

4.2.2 Harbor Water

Water quality samples have been collected in MdRH for more than 25 years as part of the Annual Report Monitoring for MdRH (Aquatic Bioassay & Consulting Laboratories, Inc. [ABC Laboratories] 2001 to 2008). Samples were analyzed for indicator bacteria and physical parameters (e.g., temperature, salinity, dissolved oxygen). A bacteria non-point source special study was conducted in 2006 (Weston Solutions, Inc. [WESTON], 2007) and monitoring under the Bacteria TMDL began in 2007, with more frequent sampling and observational data collection. In 2010, copper, lead, zinc, total PCBs, and chlordane were added to the list of constituents and monitored monthly as part of the Toxics TMDL CMP.

Dissolved copper concentrations in the water column exceeded the Toxics TMDL numeric target (4.8 µg/L) at all stations during all years, with the exception of MdRH-F-4 and MdRH-F-5 in 2011. Concentrations were comparable within the Front and Back Basins, particularly between stations MdRH-B-1, MdRH-B-2, MdRH-F-1, and MdRH-F-2 (Basin D, Basin E, Basin A, and Basin B, respectively). The Partitioning Coefficient Special Study collected samples at the same stations as the Toxics TMDL monitoring at surface, mid-depth, and at-depth (Brown and Caldwell, 2011). The results showed that copper concentrations were higher near the surface and lowest at the deepest sample depths.

There were no exceedances of the Toxics TMDL water column PCB numeric target for the Toxics TMDL monitoring. However, as part of the LDL Special Study, lower MDLs were achieved. It was determined that all samples collected as part of the LDL study exceeded the final Toxics TMDL numeric target of 0.00017 µg/L by at least a factor of 12. The highest concentrations were observed in Basin F.

Chlordane results exceeded the saltwater CTR CMC for one sample, MdRH-B-1 in October 2011. Chlordane was also analyzed as part of the LDL Special Study, and lower MDLs were achieved (0.028 ng/L). Only one result was above the CTR for Human Health; however, the trip blank associated with the sample also had detection greater than the CTR for Human Health. These results are therefore qualified because of the results of the field blank analysis.

Bacteria TMDL monitoring began in 2007 with monitoring of nine compliance stations and five ambient stations. In 2009 monitoring at the ambient stations was discontinued due to the low bacteria concentrations observed during the first two years of monitoring. The Bacteria TMDL requires daily or weekly monitoring at the nine compliance stations within the MdRH, along with samples collected at depth at four stations. Historical bacteria data are also available from monitoring conducted prior to 2007 as part of the MdRH Annual Monitoring conducted by the LACDBH. A Non-Point Source Study was conducted in 2006 to assess the potential sources of bacteria from within the MdRH. The findings of the study showed that birds were a likely source of bacteria to the MdRH.

The Bacteria TMDL is split into three seasons: summer dry, winter dry, and wet weather. Data were analyzed and presented for each season. The highest proportion of exceedance days from the Bacteria TMDL monitoring during dry weather occurred at stations MdRH-5 and MdRH-7. Historically, the greatest proportion of exceedance days during the summer dry season occurred at MdRH-5 and MdRH-6 (MdRH-7 was not monitored prior to 2007). During winter dry weather, the highest proportion of exceedance days occurs at stations MdRH-1, MdRH-2, and MdRH-3, which are different stations from those with the most often exceedances during the summer dry season. .

Observational data are collected as part of the Bacteria TMDL monitoring. These data were assessed for patterns relating to the observed indicator bacteria concentrations. A slight correlation was observed between the animal and/or bird observation data and indicator bacteria results, with slightly higher concentrations of indicator bacteria occurring when the number of birds and/or animals observed was higher.

The MdR Small Drain Survey (LACDBH, 2004a), prepared as a requirement of the Bacteria TMDL, identified approximately 724 small outfalls that discharge directly into MdRH, the majority of which serve the individual parcels and small roads among the basins. The remaining drains are located in the streets surrounding the basins. The City of Los Angeles, Caltrans, and the City of Culver City are not responsible for any outlets that drain directly to the harbor. LACFCD owns 20 storm drain outlets, including two storm drain inlets that flow into the Oxford Basin. No entity was assigned responsibility for four storm drain outlets. LACDBH is responsible for approximately 700 storm drain outlets associated with leased parcel sites.

The Marina del Rey Vessel Discharge Report (Discharge Report, [LACDBH, 2004c]) was also prepared to meet requirements in the Bacteria TMDL. The Discharge Report assessed the number of live-aboard vessels in the MdRH, the use of and capacity of pump-out stations for marine sewage devices (MSDs), as well as the likelihood that fish waste could be contributing to elevated bacteria in the MdRH. The report concluded that existing pump-out stations were sufficient to meet public demand but to ensure boater convenience; the LACDBH planned to add requirements to lease extensions and new leases to provide at least one MSD pump-out station in each marina. The report also concluded that fish waste does not appear to be a likely contributor to elevated bacteria counts on the basis of charter boat practices, fish cleaning station availability and the Harbor Masters response to violations.

4.2.3 Sediment

Annual sediment monitoring and chemical testing has been conducted by the LACDBH for more than 25 years at 20 monitoring stations within the MdRH. In addition to the annual monitoring program, which ended in 2007; Bight ‘03, Bight ‘08, Bight ’13, the Oxford Basin Special Study (2010), the MdRH Sediment Characterization Study (2008), the Toxics TMDL Monitoring (2010-present), and two special studies (Brown and Caldwell 2011a, 2011b) have been conducted.

In addition to the chemistry monitoring that has been conducted, toxicity testing and benthic infauna identification have also been conducted as part of Bight ‘03, Bight ‘08, the MdRH Sediment Characterization Study (2008), and Toxics TMDL Monitoring (2010 to present). It is important to assess the chemistry along with the toxicity and biological data to gain a broader understanding of the impacts of chemistry results in the environment.

During Bight ’08, acid-volatile sulfide (AVS) and simultaneously extracted metals (SEM) analyses were conducted, as well as analysis of total organic carbon. These additional chemistry parameters allowed an assessment of the bioavailability of metals in the samples. The bioavailability analysis of the results showed that although these divalent metals occur at high concentrations within the MdRH, they are not likely bioavailable because of the high levels of sulfides and carbon also present in the sediments.

Toxicity results for the Bight ’08 support the AVS:SEM analyses, which indicated non-toxic levels at three of the five stations, low toxicity at one of the five stations, and moderate toxicity at one station. The Toxics TMDL monitoring toxicity results were also low for *E. estuarius* and *M. galloprovincialis;* however, *L. plumulosus* chronic testing showed toxicity to the sediments. The causes of the toxicity are not clear, although they do not appear to be due to metals.

A spatial assessment was completed using all available data for metals (WESTON, 2014a). Based on this assessment, metals concentrations within the MdRH were determined to be higher in the basins and main channel adjacent to the basins. Copper concentrations in MdRH were highest in the Back Basins along the back of Basin G and in the middle portion of Basin B. Lead concentrations were highest in Basin B, the main channel toward the harbor entrance, and in some samples collected near the entrance to the MdRH. Zinc concentrations followed a similar spatial pattern when compared to the copper concentrations, with the highest concentrations in Basin E, the back of Basin D, and Basin B.

Total PCBs (Aroclors and congeners separately), DDTs, and p,p'-DDE were also assessed for spatial patterns within the MdRH. Bight monitoring data, along with the 2008 Sediment Characterization data, used a sum of PCB congeners to calculate total PCBs. The Toxics TMDL monitoring uses a sum of Aroclors to calculate total PCBs. These two methods are not directly comparable; in fact, the total PCB results can be quite different. Therefore, the results were considered separately. The concentrations of Aroclor total PCBs were highest in Basin C and Basin E; however, samples exceeded the TMDL numeric target throughout the MdRH. Congener total PCB concentrations were highest in the main channel between Basins D and F, in Basin E, and at the back of Basin C. Some higher concentrations were also detected near the mouth of the harbor in the main channel; however, several samples near the mouth of the MdRH were below the TMDL numeric target, so the sediments are likely heterogeneous.

The highest single results for total DDTs were from the main channel near the mouth of the harbor and Basin E. Results were also high throughout the main channel and into Basins F and G. The p,p'-DDE results follow a pattern similar to that observed for total DDTs. The highest concentrations were in Basin E, Basin G, and near the mouth of MdRH.

4.2.4 Trash

The Ballona Creek Trash TMDL established WLAs of zero discharge of trash or zero percent of the baseline load with a final compliance deadline of September 30, 2015. The MdR WMG agencies have met the final compliance deadline in the TMDL, and corresponding schedule in the 2012 MS4 Permit, through installation of full capture devices. In the City of Los Angeles area of the MdR watershed, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens). The City of Culver City has retrofitted four catch basins and the County has retrofitted 40 catch basins in the MdR with full-capture devices

4.3 Waterbody – Pollutant Classification

In accordance with the MS4 Permit, Section VI.C.5.a, water-body pollutant combinations were classified into one of the following three categories (Table 4-2):

1. Category 1 (Highest Priority) – Pollutants with receiving water limitations or water-quality-based effluent limits (WQBEL) as established in Part V1.E and Attachments L through R of the MS4 Permit.
2. Category 2 (High Priority) – Pollutants in the receiving water that are listed as §303(d) and for which MS4 discharges may be causing or contributing to the impairment.

3. Category 3 (Medium Priority) – Pollutants with insufficient data to list as §303(d) but which exceed receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance.

4.3.1 MdR WMA Pollutant Classification

Category 1 (highest priority) pollutants are defined by the MS4 Permit as those constituents that have been addressed with receiving water limitations or WQBELs established through a TMDL. The Toxics TMDL, as described in Section 3.2.4, establishes waste load allocations for chlordane, total PCBs, total DDTs, p-p'-DDE, copper, lead and zinc. In addition, the TMDL establishes numeric targets for dissolved copper and total PCBs in the water column in MdRH. The TMDL also addresses the fish consumption advisory and the sediment toxicity listing on the 303(d) list. As a result of the establishment of the TMDL for these constituents, they are classified in accordance with the MS4 Permit as Category 1 pollutants for MdRH (Table 4-2). Trash is also classified as a Category 1 pollutant due to the Santa Monica Bay Debris TMDL which is complied with through the Ballona Creek Watershed Trash TMDL (Section 3.2.1).The Bacteria TMDL as described in Section 3.2.2 established numeric bacterial compliance targets for fecal coliform, *Enterococcus*, and total coliform in MdRH. As a result of the TMDL, these constituents are classified in accordance with the MS4 Permit as Category 1 pollutants for MdR (Table 4-2).

Table 4-2: Waterbody – Pollutant Classification

Waterbody	Pollutant	Classification
Marina del Rey Harbor	Dissolved Copper	Category 1
	Copper	Category 1
	Lead	Category 1
	Zinc	Category 1
	Total PCBs	Category 1
	Total DDTs	Category 1
	p,p'-DDE	Category 1
	Chlordane	Category 1
	Fecal coliform	Category 1
	Enterococcus	Category 1
	Total coliform	Category 1
	Trash/Debris	Category 1
	Fish consumption advisory	Category 1*
	Sediment toxicity	Category 1*
Ballona Lagoon/Venice Canal	Total PCBs	Category 1
	DDT	Category 1
	Trash/Debris	Category 1

* Sediment toxicity and fish consumption advisory are being addressed by the Toxics TMDL

Category 2 constituents are defined in the MS4 Permit as pollutants in the receiving water that are listed as §303(d) and for which MS4 discharges may be causing or contributing to the impairment. Dieldrin is the only §303(d) listed constituent for MdRH that has not already been addressed by a TMDL (Table 3-1), however, the USEPA made a finding of non-impairment for this constituent so it will not be considered a Category 2 pollutant.

Category 3 constituents are those pollutants with insufficient data to list as §303(d) but which exceed receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance. The detailed data evaluation, of all available sources of data from relevant studies and monitoring completed within the past 10 years, that was conducted and described in the Work Plan (Appendix F) and in Appendix G did not result in any constituents being classified as a Category 3 constituent. Table 4-1 lists the studies that were used in this comprehensive data compilation and analysis.

The categorizing of constituents is intended for use in guiding the implementation schedule and priority BMPs for the EWMP. If additional data becomes available to indicate additional constituents should be added to the priority list, or if updates are made to the §303(d) list by the SWRCB, the categorization and prioritization may be updated.

The Ballona Lagoon is the only waterbody other than MdRH that falls within the MdR WMA. However, there are no available data concerning the receiving water or discharges to the receiving water.

4.4 Pollutant Source Assessment

After characterizing water quality conditions in the watershed and classifying water body-pollutant combinations into the three Permit defined categories, a pollutant source assessment was carried out to identify potential sources of pollutants in the three categories in accordance with section VI.C.5.a.iii of the Permit which states:

> "(1) Permitees shall identify known and suspected storm water and non-storm water pollutant sources in discharges to the MS4 and from the MS4 to receiving waters and any other stressors related to tMS4 discharges causing or contributing to water quality priorities. The identification of known and suspected sources of the highest water quality priorities shall consider the following:
>
> (a) Review of available date, including but not limited to:
> - (i) Findings from the Permittees' Illicit Connections and Illicit Discharge Elimination Programs;
> - (ii) Findings from the Permittees' Industrial/Commercial Facilities Programs;
> - (iii) Findings from the Permittees' Development Construction Programs;
> - (iv) Findings from the Permittees' Public Agency Activities Programs;
> - (v) TMDL source investigations;
> - (vi) Watershed model results;
> - (vii) Findings from the Permittees' monitoring programs, including but not limited to TMDL compliance monitoring and receiving water monitoring; and
> - (viii) Any other pertinent data, information, or studies related to pollutant sources and conditions that contribute to the highest water quality priorities.
>
> (b) Locations of Permittees' MS4s including, at a minimum, all MS4 major outfalls and major structural controls for storm water and non-storm water that discharge to receiving waters.
>
> (c) Other known and suspected sources of pollutants in non-storm water or storm water discharges from the MS4 to receiving waters within the WMA.

The findings of the pollutant source assessment as described in Section VI.C.5.a.iii(1)(a) and (c) are summarized in the following sections first by constituent and then by harbor based and stormwater based sources. Additional detailed information can be found in the Work Plan (Appendix F) and Appendix G. Section VI.C.5.a.iii(1)(b) is addressed in Section 5.1 of this EWMP.

4.4.1 Metals

A spatial assessment was completed using all available data for metals (WESTON, 2014a). Based on this assessment, metals concentrations in MdRH sediments were determined to be higher in the basins and main channel adjacent to the basins. Copper concentrations in MdRH were highest in the Back Basins along the back of Basin G and in the middle portion of Basin B. Lead concentrations were highest in Basin B, the main channel toward the harbor entrance, and in some samples collected near the entrance to the MdRH. Zinc concentrations followed a similar spatial pattern when compared to the copper concentrations, with the highest concentrations in Basin E, the back of Basin D, and Basin B.

The sources of these metals were generally identified by multiple studies as maritime activities (e.g., hull leachate), discharge from storm drains into the receiving water, and atmospheric deposition (ABC Labs, 2001-2008, Weston 2008, SCCWRP, 2003, SCCWR, 2008).

The Oxford Retention Basin Sediment and Water Quality Characterization Study (WESTON, 2010a) provided insights into the potential for the Oxford Basin to act as a reservoir and potential source for contaminated sediments entering Basin E. The results of the study indicated low concentrations of metals, except chromium and lead, suggesting that re-suspension of sediments in Oxford Basin is not likely to be a source of metals in Basin E. Post-project monitoring of The Oxford Basin Multi-Use Enhancement Project should provide additional information helpful in evaluating the potential for pollutant loading from Oxford Basin.

4.4.2 Fecal Indicator Bacteria

Water quality has been comprehensively assessed throughout the MdRH as special studies and as part of continuous monitoring programs. As a result of these studies, a number of constituent sources have been identified.

Assessments of bacterial contributions to Basin E were consistent among the majority of projects, with the Oxford Basin and Boone Olive Pump Station identified as a source of bacterial loads during wet weather. The most recent study did not indicate that the Oxford Basin was a predominant contributor to bacteria concentrations in Basin E during dry-weather flows (the Oxford Retention Basin Sediment and Water Quality Characterization Study [WESTON, 2010a]). This study was undertaken after the installation of a dry-weather diversion which redirects dry weather flows entering Oxford Basin and diverts them to the sanitary sewer.

In the bacterial source identification study (WESTON, 2007), birds were identified as a key contributor throughout MdRH during both dry (non-stormwater) and wet weather and management actions targeting this source were recommended (Figure 4-2). Anthropogenic sources and transport mechanisms included boat-related maintenance activities, trash and food waste, washing activities (restaurants, restrooms, parking areas, and buildings), landscaping, and the MS4. Another key factor in the presence of bacteria within MDRH is the limited flow through the marina waters. This lack of circulation increases the potential for bacterial reservoirs to be found in locations such as pier supports and boat hulls. These locations are also prone to limited ultraviolet (UV) penetration and subsequently allow increased microbial longevity.

Bacterial concentrations in sediments were found to be very low in all studies, suggesting that marina sediments do not act as a significant reservoir of fecal indicator bacteria.

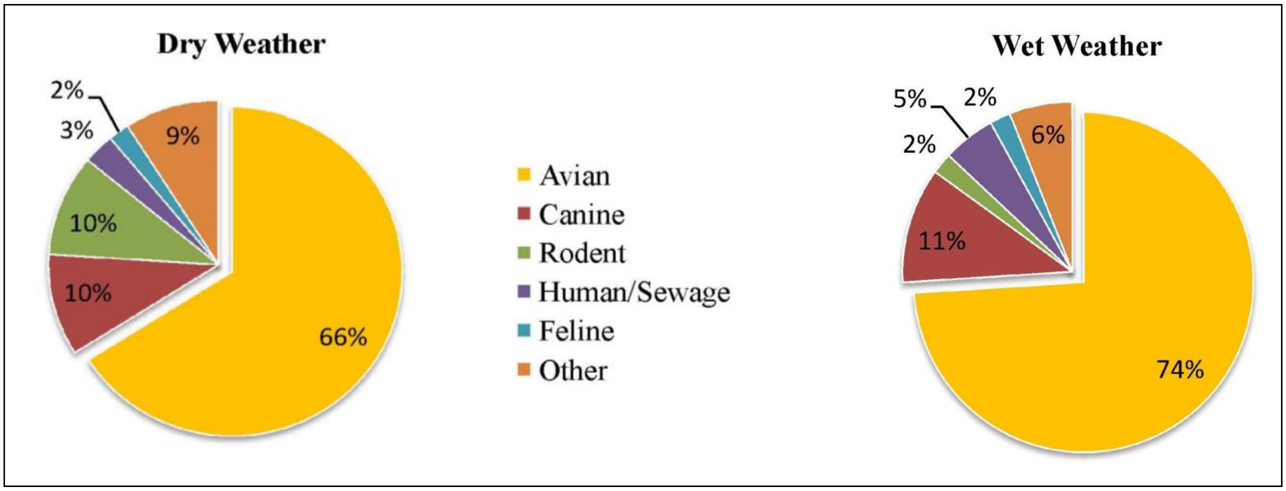


Figure 4-2: Ribotyping Results for Wet Weather and Dry Weather (WESTON, 2007)

4.4.3 Chlordane, PCBs, and DDTs

The pesticide chlordane was widely used for food crops and lawn care until 1978 when use was limited to termite control. In 1988 chlordane use was banned in the United States. Assessment of sediment in MdRH found concentrations of chlordane to be highest in the main channel, near the mouth of the harbor (WESTON 2014, SCCWRP, 2011).

Before the pesticide DDT was banned by the USEPA in 1972, DDT was widely used for vector control applications in agricultural, commercial and residential settings (USEPA, 2015a). The Montrose Chemical Corporation manufactured DDT from 1947- 1983 at its plant near Torrance, CA. It is estimated that the facility discharged wastewater containing 800 to 1,000 tons of DDT into Los Angeles sewers and ultimately into the Pacific Ocean on the PVS. Groundwater and surface soil near the Montrose facility was also contaminated as a result of the DDT manufacturing process Other nearby industries discharged PCBs into the sewer system and PVS via outfall pipes. As a result, the sediment of the PVS is contaminated with DDT- and PCBs with the highest concentrations in a thin layer, approximately, 2 inches to 2 feet thick that is buried under a layer of cleaner sediment. (USEPA, 2015b). Fish exposed to the PVS sediments may bioaccumulate PCBs and DDTs, and when captured in the MdRH, have high levels of these pollutants even though this exposure may not have occurred in the MdRH. DDT and its metabolites may be transported from one medium to another by the processes of solubilization, adsorption, remobilization, bioaccumulation, and volatilization. It can also be transported by currents, winds, and diffusion (USEPA, 2012).

Prior to the use of copper and tributyltin as anti-fouling paints, PCBs were used in boat hull paint. It is possible that historical contamination from boat hulls may be contributing to high levels of PCBs in the Back Basins (Weston 2008b).

4.4.4 Trash

The Ballona Creek Trash TMDL (Section 3.2.1) source analysis indicated that stormwater discharges are the major source of trash in Ballona Creek (LARWQCB, 2015). Additionally, the Santa Monica Bay Trash and Debris TMDL indicates that more than half of the debris in marine environments on the West

Coast originates from land based sources with the majority being transmitted via storm drains (LARWQCB, 2010). The TMDL also indicates that the primary sources of trash transported via storm drains are "litter, debris from commercial establishments and public venues, industrial discharges, garbage transportation, landfills and construction" (LARWQCB, 2010).

The Ballona Creek Trash TMDL established WLAs of zero discharge of trash and set a final compliance deadline of September 30, 2015. The MdR WMG agencies have met the final compliance deadline in the TMDL, and corresponding schedule in the 2012 MS4 Permit, through installation of full capture devices. In the City of Los Angeles area of the MdR watershed, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens). The City of Culver City has retrofitted four catch basins and the County has retrofitted 40 catch basins in the MdR with full-capture devices.

4.4.5 Harbor-Based Sources

Likely sources of bacteria, copper, lead, zinc, total PCBs, total DDTs, p,p'-DDE, and total chlordane that have been identified within the MdRH include the following:

- **Boats**: Several studies attributed the higher metal concentrations found in the main channel and in the mouths of each Back Basin as being sourced from maritime activities. Anti-fouling, copper-based hull paint was specifically identified as a source of higher copper in the MdRH. This source is being addressed through the revised Toxics TMDL (ABC Labs, 2001-2008, Weston 2008b)
- **Legacy Sediments**: Several studies have characterized the unconsolidated and consolidated sediments of the harbor and found higher concentrations of metals, PCBs, chlordane, and DDT. Disturbance of these sediments could cause resuspension in the water column and transport to other areas of the MdRH (ABC Labs, 2001-2008, Weston, 2008b, SCWWRp 2011, SCCWRP 2007).
- **Boone Olive Pump Station**: During wet weather, this site was identified as a source of fecal indicator bacteria contributing to higher bacterial loads to Basin E (Weston, 2008a).
- **Oxford Basin**: This water body was identified as a potential source of metals and bacteria in a number of studies conducted prior to the installation of dry weather diversions. Assessment within Oxford Basin in 2010 during dry and wet weather suggested that Oxford Basin was not a significant contributor of pollutants (particularly metals). Dry-weather bacteria contributions from Oxford Basin appear to have decreased with the construction of the dry-weather diversions. The Oxford Basin Low Flow Diversion (LFD) came online in January 2009 and the Washington LFD in December 2006. Further Best Management Practices (BMP) evaluation may be required to assess the effectiveness of the diversions. During wet weather, Oxford Basin has been found to contribute to bacteria concentrations in Basin E. Oxford Basin is currently undergoing a restoration, which is anticipated to improve water quality in Oxford Basin. Additional data will be evaluated once it becomes available.
- **Natural Sources**: Birds have been found to be a significant source of fecal indicator bacteria to MdRH (Weston, 2007, Weston, 2008). Within the unincorporated areas of the county the impact of this natural source can be limited through structural BMPs such as bird controls, nonstructural BMPs, and bird waste management programs.

4.4.6 Watershed-Based Sources

Likely sources of bacteria, copper, lead, zinc, total PCBs, total DDTs, p,p'-DDE, and total chlordane from the watershed to the MdRH include the following:

- **Stormwater Runoff**: Stormwater monitoring conducted under the Toxics TMDL has shown that copper, lead, and zinc are being transported into the MdRH during storm events. Storm borne sediment monitoring has shown that chlordane and PCBs are transported by suspended sediment in stormwater.
- **Residential Contributions**: Use of certain building materials can contribute loads of copper and zinc (from structures such as roofing materials, gutters, and fencing) through urban runoff (Weston, 2010). Non-stormwater discharges such as over-irrigation and wash water can provide a transport mechanism for pollutants and provide a reservoir for bacteria growth and/or regrowth in soils and the MS4. Control of these sources may include structural solutions, such as aggressive street and parking lot sweeping, covering and containing trash, proper recycling of yard waste, controlled/reduced pesticide and fertilizer applications, and additional nonstructural solutions, such as targeted educational and enforcement programs for irrigation and washing activities and/or facilities.
- **Commercial Contributions**: Certain commercial practices, including poorly managed restaurant wash-down and trash storage, can impact water quality. These facilities may also attract birds, and their waste may contribute to bacterial concentrations in MdRH. Management actions could include targeted trash inspection programs to correct pollutant loading activities, education to improve housekeeping and trash containment and cover activities, and bird exclusion devices.
- **Atmospheric Deposition**: Atmospheric deposition of metals has been found to be a significant source of copper (brake pads) and zinc (brake pads and tires) (Weston, 2009). Improvements to loads from these sources can be achieved through true source control activities, such as the Brake Pad Partnership and product substitution and structural solutions, such as targeted aggressive street and parking lot sweeping.
- **Anthropogenic Fecal Sources**: Fecal sources can include poorly contained pet waste, bird attractants (e.g., open trash receptacles), and public restrooms. Another key anthropogenic source may be the illegal dumping of boat waste into the harbor. Solutions may include outreach regarding pet waste, RV waste and boat waste disposal, enforcement programs, trash inspection programs, targeted restaurant inspections, and containment of wash-down water used for restroom facility cleaning.

4.5 Prioritized Sources

Based on the source assessment, priorities within the MdR watershed were assessed and sequenced in accordance with section VI.C.5.a.iv of the MS4 Permit (Table 4-3). As specified in the MS4 Permit, the highest priority (1) is assigned to those pollutants with TMDLs according to the following criteria:

1a) Controlling pollutants for which there are established WQBELS, or receiving water limitation with interim or final compliance deadlines within the current MS4 Permit term, or whose TMDL deadlines have passed without achieving the limitations,

1b) Controlling pollutants for which there are established WQBELs or receiving water limitations with compliance deadlines (interim or final) between September 6, 2012 and October 25, 2017.

The second highest (2) priorities are established for pollutants for which receiving water limitations are exceeded, or impairment is implicated as a result of discharges from the MS4. For purposes of the prioritization, third priority (3) will be attributed to controlling pollutants with TMDL compliance dates beyond the term of the MS4 Permit.

Table 4-3: Marina del Rey Priorities

Priority	Waterbody	Pollutant	Compliance Deadlines	Priority Sources*
1a	MdRH Back Basins	Bacteria (summer and winter dry weather)	March 18, 2007 Final Compliance (TSO Final Compliance December 28, 2017). July 10, 2014 – December 27, 2017 TSO Interim Compliance Period	Birds, anthropogenic sources
1b	MdRH Back Basins	Copper	Interim compliance March 22, 2016 Final compliance March 22, 2018.	Boats, residential, stormwater runoff
		Lead		Legacy sediment, stormwater runoff (suspended sediment)
		Zinc		Commercial contributions, stormwater runoff
		PCBs		Legacy sediment, boats, stormwater runoff (suspended sediment)
		DDTs		Legacy sediment, stormwater runoff
		p,p'-DDE		Legacy sediment, stormwater runoff
		Chlordane		Legacy sediment, stormwater runoff (suspended sediment)
		Trash	Final compliance September 30, 2015	Stormwater*
	MdRH Front Basins	Trash	Final Compliance September 30, 2015	Stormwater*
	Subwatershed 2	Trash	Final compliance September 30, 2015	Stormwater*
		DDT	Final Compliance March 23, 2023	Legacy sediment, stormwater runoff
		PCBs	Final Compliance March 23, 2034	Legacy sediment, boats, stormwater runoff (suspended sediment)
3	MdRH Back Basins	Bacteria (wet weather)	July 15, 2021 final wet weather and geometric mean.	Birds, stormwater runoff, anthropogenic sources
	MdRH Front Basins	Copper	Interim Compliance March 22, 2019 Final compliance March 22, 2021.	Boats, residential, stormwater runoff
		Lead		Legacy sediment, stormwater runoff (suspended sediment)
		Zinc		Commercial contributions, stormwater runoff
		PCBs		Legacy sediment, boats, stormwater runoff (suspended sediment)
		DDTs		Legacy sediment, stormwater runoff
		p,p'-DDE		Legacy sediment, stormwater runoff

Priority	Waterbody	Pollutant	Compliance Deadlines	Priority Sources*
3 (cont.)	MdRH Front Basins (cont.)	Chlordane	Interim Compliance March 22, 2019 Final compliance March 22, 2021.	Legacy sediment, stormwater runoff (suspended sediment)

*Although stormwater is not a primary source of pollutants, it is a conveyance mechanism and is treated as a point source for purposes of the Toxicity TMDL and the Trash TMDL.

5.0 STRUCTURAL AND NON-STRUCTURAL CONTROL MEASURES

Section VI.C.5.b of the MS4 Permit requires the identification of control measures, strategies and BMPs within the watershed with the goal of creating an efficient program to focus resources on the watershed priorities identified in Section 3.0 above. In accordance with the MS4 Permit, the objectives of the Watershed Control Measures shall include:

1. Prevent or eliminate non-stormwater discharges to the MS4 that are a source of pollutants from the MS4 to the receiving waters.
2. Implement pollutant controls necessary to achieve all applicable interim and final water quality-based effluent limitations and/or receiving water limitations pursuant to corresponding compliance schedules.
3. Ensure that discharges from the MS4 do not cause or contribute to exceedances of receiving water limitations."

The MdR watershed is very different from the other Los Angeles area watersheds because it is small and highly urbanized, with a large portion of the lower watershed within a high groundwater and tidally influenced former estuary. A combination of regional, distributed regional, and non-structural best management practices (BMPs) will be required to address attainment of the pollutant loading reductions necessary for compliance.

The following section discusses the BMPs necessary and sufficient to be implemented within the MdR WMA to achieve the estimated contaminant load reductions from the MS4 into the receiving water required for the MdR EWMP Agencies' compliance with applicable WQBELs and/or receiving water limitations (RWLs) for each TMDL, §303(d) listing, and receiving water exceedance. The analysis takes into consideration existing and planned BMPs, priority regional BMPs (Costco and the Venice Neighborhood Project), other potential regional BMPs, green streets BMPs, planned development and redevelopment projects, as well as nonstructural BMPs.

5.1 Existing BMPs

The extensive ongoing efforts of the County, LACFCD, and the cities of Culver City and Los Angeles to improve water quality in the MdR watershed include implementing various structural and non-structural BMPs to reduce pollutants from stormwater runoff to the harbor. Over the past 10 years, these responsible agencies in the MdR watershed have spent tens of millions of dollars in special studies, low-flow diversions, non-structural BMPs, structural BMPs, and monitoring efforts. The water quality in the harbor has significantly improved as a result of these cooperative efforts.

This section summarizes the existing structural and non-structural BMPs that are already in effect or are under development within the MdR watershed. This information was compiled from the Notices of Intents (NOIs), Time Schedule Orders (TSOs), MdR Bacteria and Toxics Implementation Plans, and information submitted directly by the MdR EWMP Agencies for the purpose of this EWMP development.

5.1.1 Existing Structural BMPs

Existing BMPs that have already been implemented or are in progress in the MdR watershed include the following:

- Existing sewers in MdR have been lined since 1993 to reduce sanitary sewer leaks. Since 2007, the County has lined and rehabilitated 11 miles of sewer lines and 208 manholes in the MdR watershed. – *Completed*
- Three low-flow diversions (92,000, 20,000, and 288,000 gal/day) were installed in 2006-2010 by the LACFCD at three locations to divert dry-weather non-stormwater urban runoff to a sanitary sewer flowing into the Hyperion Treatment Plant, to comply with the MdR Dry Weather Bacteria TMDL. The diversions serve 61, 310, and 148 acres, respectively. – *Completed*
- Five bioretention filter tree wells (Filterra) were installed in 2007 by LACFCD as an additional measure to prevent pollutants from entering Back Basin E. Each has a footprint of 6.5 ft by 4 ft to collect and treat dry weather runoff and stormwater, serving three subdrainage areas of 0.3, 14.1, and 16.5 acres, for a total of 30.9 acres. – *Completed*
- In the City of Los Angeles area, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens). Catch basin cleaning has been conducted at a typical frequency of at least 2 times per year. The City of Culver City has retrofitted four catch basins with full capture devices. The County retrofitted 40 catch basins in the MdR with full-capture devices. – *Completed*
- Marina Beach Water Quality Improvement Project – In 2006 a mechanical circulator was installed in Back Basin D near Marina (Mother's) Beach. A stormwater diversion and collection system was constructed in 2007 to redirect all stormwater sheet flows from impervious areas from Parking Lot 10 and 11 which drained into Marina Beach and Back Basin D into Basin C. – *Completed*
- LACFCD is constructing seven bioretention areas on Admiralty Way as part of the Oxford Retention Basin Project Multi-Use Enhancement Project. – *In Progress*
- The retrofitting of three parking lots (Parking Lot 5, 7, and 9) and the library facility in MdR is underway based on the multi-pollutant implementation plan developed in 2011 for MdR (LADPW, 2012). The retrofitting will incorporate various treatment BMPs such as bioretention planters, biofiltration systems, porous pavement, and rain barrels. – Parking Lot 5 & 7 are *Complete*, the remaining are *In Progress*
- Oxford Basin Multi-Use Enhancement Project is currently underway. Elements of this project are designed to enhance flood protection, improve habitat, reduce runoff pollution, and improve water quality through increased circulation in the basin.- *In Progress*

Locations of existing structural control measures (that can be easily shown on a map), are shown in Figure 5-1 and are listed in Table 5-1. Figure 5-1also includes the MS4 lines and major outfalls. Table 5-1 includes BMPs with their general types, date implemented, status, responsible agency, and a descriptive summary.

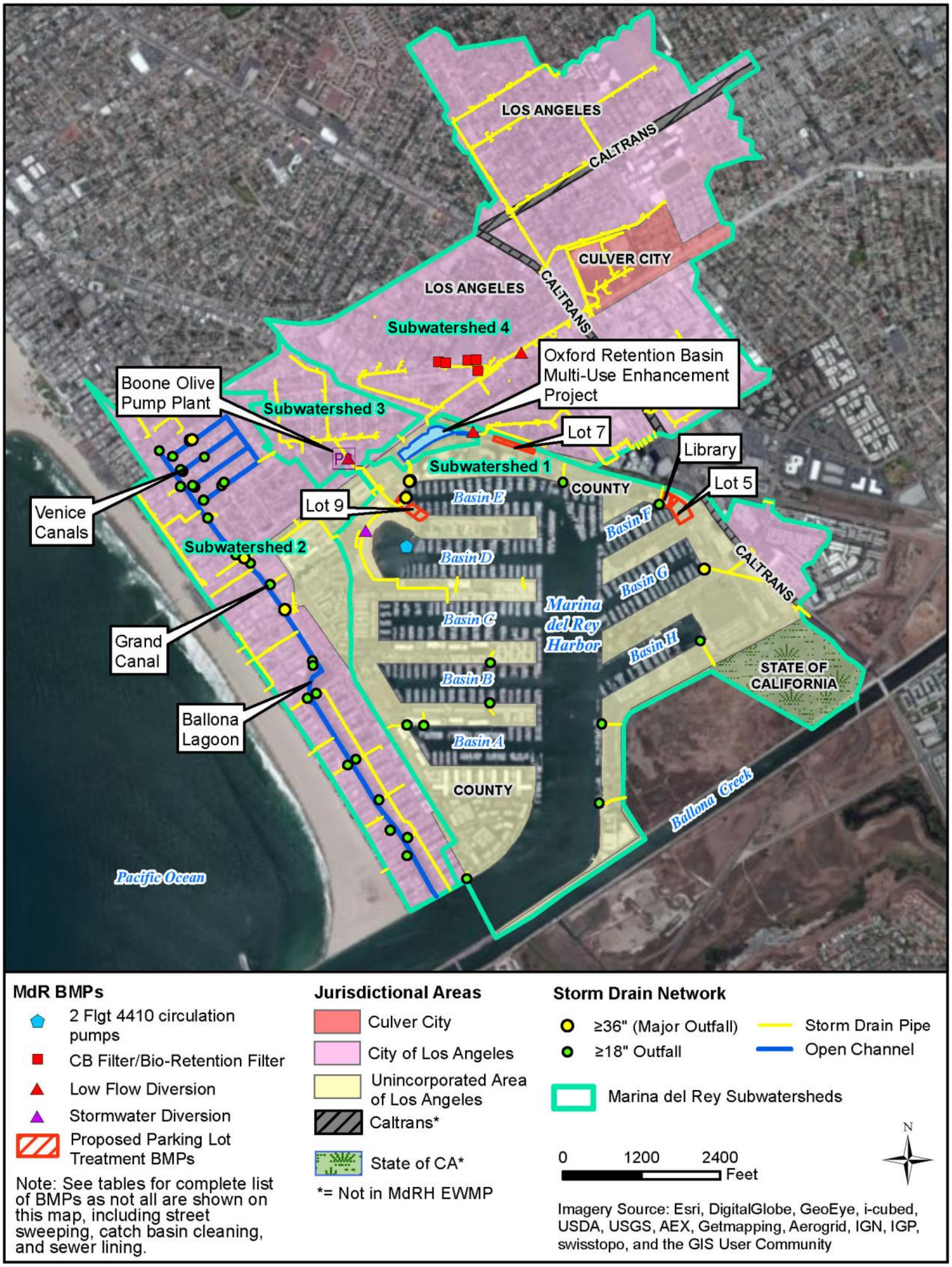


Figure 5-1: Existing Structural MCMs within MdR Watershed

Table 5-1: List of Existing Structural BMPs in the Marina del Rey Harbor EWMP Agencies WMA

Project Title	BMP Type	Status	Date	Agency	Location	Description
Marina Beach Water Quality Improvement Project – Phase I	Mechanical Circulation Device	Complete	10/2006	County, LACDBH	Basin D / Marina Beach	Two subsurface water circulators (2 Flygt 4410 circulation pumps) with 55-inch-diameter banana propellers were installed in Basin D just offshore from Marina Beach, attached under a special dock at Parcel No. 91. The circulators pump water toward the beach face at a rate of 60,000 gallons per minute (gpm) (30,000 gpm each).
Marina Beach Water Quality Improvement Project – Phase II	Stormwater Diversion	Complete	8/2007	County, LACDBH	Basin D / Marina Beach	A stormwater collection system was constructed to redirect all stormwater sheet flows from impervious areas from Parking Lot 10 and 11 currently draining into Marina Beach and Back Basin D into Basin C.
Tree Wells (5)	Bio-Retention Filter (Filterra)	Complete	1/2007	LACFCD	West and east side of Garfield Ave West and east side of Coeur D'Alene Abbot Kinney	Five bioretention filters were installed upstream of Project No. 5243 as an additional measure to prevent pollutants from entering Back Basin E. Each has a footprint of 6.5 ft by 4 ft to collect and treat dry weather runoff and stormwater serving three subdrainage areas of 0.3, 14.1, and 16.5 acres, for a total of 30.9 acres.
Project 3874, 5243, 3872	Low Flow Diversion	Complete	3/2007	LACFCD	539 Washington St. 3874 Boone-Olive Pump Station 3872 Oxford Pump Station	Three low-flow diversions (92,000, 20,000 and 288,000 gal/day) were installed at three locations to divert dry-weather non-stormwater urban runoff to a sanitary sewer flowing into Hyperion Treatment Plant, to comply with the MdRH Dry Weather Bacteria TMDL. The diversions serve 61, 310, and 148 acres, respectively.
Sanitary Sewer and Manhole Lining		Complete	1993	County, City of Los Angeles	Surrounding Basins D, E, and F	Existing sanitary sewers in MdRH have been lined since 1993 to reduce sanitary sewer leaks. Since 2007, the County has lined and rehabilitated 11 miles of sewer lines and 208 manholes in the MdRH watershed.
Catch Basin Retrofit		Complete/In Process	2011	County, City of Los Angeles, City of Culver City	Across MdR	In the City of Los Angeles area, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens). Catch basin cleaning has been conducted at a typical frequency of at least 2 times/year. The City of Culver City has retrofitted four catch basins with full capture devices. The County retrofitted 40 catch basins in the MdR with full-capture devices.
Parking Lot Retrofits		In Process, Lots 5 and 7 Complete.	Yearly until 2017	County	Parking Lots 5, 7, 9, and Library	The retrofitting of three parking lots and the library facility in MdR is underway based on the multi-pollutant implementation plan developed in 2011 for MdR. The retrofitting will incorporate various BMPs such as bioretention planters, biofiltration systems, porous pavement, and rain barrels. The goal of these parking lot projects is to treat runoff coming from the County facilities before it enters the harbor.
Bird Spikes		Complete		County	Parking Lots 5, 7, 10 and 11.	On all light standards in County owned parking lots including Lots 5, 7, 10, and 11, which discharge into Basin D, E, and F.
Oxford Retention Basin Multi-Use Enhancement Project		In Process	Fall 2015	County, LACFCD	Oxford Retention Basin	This project, scheduled to begin construction in 2015, is designed to enhance flood protection, reduce runoff pollution, and significantly improve the quality of plant and wildlife habitat within the facility, as well as its aesthetic appeal. Diseased trees and non-native plants will be replaced with native, more drought-tolerant species. The project will also provide new recreational and safety amenities, including a walking path, observation areas, wildlife-friendly lighting, and more attractive tubular fencing. The project will improve water quality by increasing circulation and dissolved oxygen levels of the water in the basin by constructing a circulation berm.
Tree Wells		Proposed / In Process	Within 60 months of TSO adoption	City of Los Angeles, LACFCD	To Be Decided	LACFCD is constructing seven bioretention areas on Admiralty as part of Oxford Retention Basin project.

5.1.2 Existing Non-Structural BMPs

The EWMP Agencies have implemented numerous non-structural BMPs to improve water quality in MdRH. These BMPs are classified as planning, enforcement, monitoring, source control, and Public Information and Participation Program (PIPP) (i.e., education, outreach, and incentives). Existing non-structural BMPs are summarized in detail in Table 5-2.

The EWMP Agencies are continuing to implement MCMs required under the 2001 MS4 Permit and will continue to do so until the EWMP is approved by the Regional Board. See Section 5.5 for discussion of MCMs and customizations proposed in this EWMP, in accordance with the 2012 Permit.

Table 5-2: List of Existing Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies WMA

Project Title	BMP Type	Status	Regulatory Driver / TMDL	Date	Agency	Description
PLANNING						
Marina del Rey Bacteria TMDL Implementation Plan (Marina del Rey Watershed Responsible Agencies [MDRWRA], 2007)	Planning Compliance	Complete	Bacteria	01/2007	County, Multiple	The plan includes procedures, plans, programs, and actions to be carried out throughout the MdR watershed to reduce bacteria concentrations at this impaired water body to comply with the Bacteria TMDL requirements.
Marina del Rey Multi-Pollutants Implementation Plan (LADPW, 2012)	Planning Compliance	Complete	Toxics, Trash	03/2011	County	The plan includes procedures, plans, programs, and actions to be carried out throughout the unincorporated area of MdR watershed to reduce toxics and bacteria concentrations at this impaired waterbody to comply with the Toxics and Bacteria TMDL requirements.
Marina del Rey Toxics Implementation Plan (City of Los Angeles, 2011)	Planning Compliance	Complete	Toxics	03/2011	City of Los Angeles, Multiple	The plan includes procedures, plans, programs, and actions to be carried out throughout the MdR watershed within the City of Los Angeles, Caltrans and City of Culver City boundaries to reduce bacteria concentrations at this impaired water body to comply with the Toxics TMDL requirements.
Pollution Prevention Plan	Planning Compliance	Complete	Bacteria	9/2014	County, LACFCD City of Los Angeles	The plan includes projects and actions to be carried out as part of the Dry-Weather Bacteria TMDL TSO
ENFORCEMENT						
Illegal Connection/ Illicit Discharge (IC/ID) Program	Enforcement IC/ID	Ongoing	MS4 Permit	2001 - present	LACFCD, County, City of Los Angeles, City of Culver City	This program involves coordination of multiple departments to eliminate pollution by IC/IDs to the stormwater system. The County has an active education, response, and enforcement program. The data are tracked for the County region and for the County's Road Maintenance Division (RMD), as part of its annual pre-storm season drainage inspection program. The cities of Los Angeles and Culver City have citywide programs that have also been implemented in the MdR watershed.
Construction Inspections Industrial/Commercial Facility Inspections	Enforcement Inspections (w/ Education)	Ongoing	MS4 Permit		County, City of Los Angeles, City of Culver City	Los Angeles County MS4 Permit Program has been implemented in the MdR watershed as part of a citywide and county wide program. The City of Culver City has a citywide program that has also been implemented in the MdR watershed.
Restaurant Inspections	Enforcement Inspections (w/ Education)	Ongoing	MS4 Permit	2004	County, City of Los Angeles	Annual inspections target restaurants as a potential source of bacteria, trash and other pollutants from waste disposal. This program identifies facilities lacking minimum stormwater BMPs and housekeeping practices - for waste disposal, grease containers, mop sinks, and other housekeeping activities.
Low Impact Development (LID) ordinance	Enforcement Ordinance	Existing	MS4 Permit	Jan 2009 May 2012 November 2014	County, City of Los Angeles, City of Culver City	The City of Los Angeles is currently amending sections of the LID Ordinance, as well as its Stormwater and Urban Runoff Pollution Control Ordinance (L.A.M.C. Chapter VI, Article 4.4) to meet all the MS4 Permit requirements. The County adopted a revised LID ordinance on November 12, 2013 to meet all MS4 Permit requirements. The City of Culver City adopted a similar in November of 2014.
Green Street Policy	Enforcement Ordinance	Existing	MS4 Permit	Jul 2011 November 2014	County, City of Los Angeles, City of Culver City	The City of Los Angeles, the City of Culver City, and the County have adopted a Green Street Policy that is in compliance with the requirements of the MS4 Permit for its portion in the watershed.
Standard Urban Stormwater Mitigation Plan (SUSMP)	Enforcement Ordinance	Existing	MS4 Permit	Ongoing	City of Los Angeles	The City of Los Angeles has several projects in MdR watershed as part of its implementation of the Citywide SUSMP program.
SOURCE CONTROL						
Brake Pad Partnership	Source Control Alternative Product	Complete	MS4 Permit, Toxics TMDL	2010	Multiple	MdRH Agencies have supported the Brake Pad Partnership and the adoption process of Senate Bill (SB) 346 (adopted in 2010) through monetary contributions, in-kind technical services, and committee memberships. Caltrans, in conjunction with the State Board, contributed close to $1,000,000 to research on the impacts of brake pads to surface waters. The Brake Pad Partnership is an example of true source control that will remove copper brake pads from the market, and therefore, a source of loading to the environment. SB346 requires that brake pads contain no more than 5% copper by weight by 2021 and no more than 0.5% copper by weight by 2025.
Trash Removal and Control	Source Control	Ongoing	Trash TMDL		City of Los Angeles, County, City of Culver City	The Santa Monica Bay Debris TMDL requires responsible parties to reduce their trash contribution to the Santa Monica Bay by 10% each year for a period of 10 years with the goal of zero trash to waterbodies. The County and City of Los Angeles have achieved every yearly milestone, solely through the implementation of structural measures without having to take credit for implemented institutional measures that are also resulting in a reduction of trash. Other programs are implemented by other entities for trash control. For example, the City of Los Angeles Bureau of Street Services (BSS) offers a reward for information resulting in the identification of persons committing an act of illegal dumping.
Trash Removal	Source Control	Complete	Trash TMDL/ Bacteria TMDL	Ongoing	County	Trash is removed on a daily basis from County facilities in the Marina.

Table 5-2: List of Existing Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies WMA

Project Title	BMP Type	Status	Regulatory Driver / TMDL	Date	Agency	Description
MAINTENANCE						
Street Sweeping	Maintenance	Ongoing	Toxics TMDL, Trash TMDL, Bacteria TMDL	2008	County, Multiple	County: Streets are swept 2 times/week on Mondays and Thursdays. Parking lots are swept at least 2 times/week and up to 6 times/week. Ten sweepers are used in MdRH, 4 vacuum and 6 mechanical sweepers stationed with the RMD-3 fleet. One of each is compressed natural gas (CNG) powered versus liquefied petroleum gas (LPG) powered. Lot 15: 6times/week (winter); daily (summer), Lots 11, 13 and 16: 4times/week. City of Los Angeles / Caltrans: BSS conducts sweeping: 130 mechanical broom sweepers, 100 operators, weekly sweeping for posted streets and monthly sweeping for arterial streets. Has a delegated maintenance agreement with Caltrans to sweep Venice and Lincoln/Pacific Coast Highway. The City of Culver City has a street sweeping program that includes weekly sweeping of street in its portion of MdRH. Current schedule is side streets – Monday and Tuesday 8:00 am to 12:00 pm, Washington Boulevard – Monday through Friday 4:00 AM to 6:00 AM. The City of Los Angeles BSS currently sweeps approximately 63 curb miles (some swept weekly and some swept monthly) located within the City of Los Angeles' portion of MdRH. Maintenance responsibility of Lincoln Boulevard (State Route 1) and Venice Boulevard (State Route 187) has been delegated to the City of Los Angeles by a Delegated Maintenance Agreement. Caltrans will be working closely with the City of Los Angeles to achieve optimal maintenance performance that includes sweeping, trash pickup, and drainage cleanup.
Catch Basin Cleaning	Maintenance	Ongoing	Toxics TMDL, Trash TMDL, Bacteria TMDL	2011	City of Los Angeles, County, City of Culver City	The City of Los Angeles catch basin cleaning occurs at a typical frequency of 3 to 4 times per year, targeting trash. Within the County area, catch basins are be cleaned quarterly, semi-annually or every year depending on the prioritization of each catch basin. The City of Culver City cleaning occurs 3-7 times per year.
County Beaches - Sanitation Program	Maintenance	Ongoing	MS4 Permit, Bacteria TMDL		County	County staff "sanitizes" the beach 7 days a week, provided the sand is not wet. A tractor with rake and screen system is used to collect trash and turn over the beach sand. This process removes solids and debris and allows the sun to "sanitize" the sand during the day. Operations are between 5 am and 1:30 pm daily.
PUBLIC INFORMATION AND PARTICIPATION PROGRAM						
Billboard Educational Campaign	PIPP Outreach, Education	Complete	MS4 Permit, Toxics TMDL	Feb 2012		This program was a countywide, 8-week billboard campaign designed to promote protective waste management practices. A used motor oil educational advertisement was displayed on 20 billboards throughout the County.
Boating Clean and Green Campaign	PIPP Outreach, Incentive	Ongoing	Toxics TMDL, Bacteria TMDL	Apr 1997	County	This statewide educational and outreach program is designed to educate boaters about environmentally sound boating practices. The County held a focus group session to bring boaters together to openly share observations on boater behavior and motivations as they relate to water pollution. The boaters shared their observations on what is needed to better enforce current boater regulations as well as what visual messages would be most effective in influencing boater behavior. Based on the results of the Boater Focus Group, the County started the "Boaters Help Keep Marina del Rey and Santa Monica Bay Clean" campaign. A series of posters were created and posted at strategic sites in the harbor.
Dock Walker Training	PIPP Education, Outreach	Ongoing	Bacteria TMDL		LACDBH	This program consists of volunteers who inspire and educate boaters and other recreational users to be safe and environmentally sound while boating in California. Through this program, general boater educational materials were developed.
Clean LA	PIPP Education, Outreach	Ongoing	Bacteria and Toxics TMDLs	2002	County	County of Los Angeles portal to a number of award-winning programs that help residents, businesses, and government keep the County clean and sustainable.
School Outreach	PIPP Education, Outreach	Ongoing	MS4 Permit, Bacteria TMDL, Toxics TMDL, Trash TMDL		City of Los Angeles, LACFCD	Los Angeles County MS4 Permit and MdRH Bacteria TMDL Implementation Plan Programs: These program includes making targeted phone calls to all public and private K-12 schools within the MdRH to notify them of the availability of environmental education programs offered by the LACFCD and City of Los Angeles, emphasizing to school administrators that these programs comply with State curriculum standards and provide opportunities to fulfill service-learning requirements.
Clean Marinas Program	PIPP Outreach, Incentive	Ongoing	Bacteria TMDL, Trash TMDL	Apr 2006	County	This program is a partnership among private marina owners, government marina operators, and yacht clubs that was developed to provide clean facilities to the boating community.

Table 5-2: List of Existing Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies WMA

Project Title	BMP Type	Status	Regulatory Driver / TMDL	Date	Agency	Description
Smart Gardening	PIPP Education, Outreach, Incentive	Ongoing	Toxics TMDL, Bacteria TMDL		County	This program targets businesses, schools, and homeowners through outreach and education materials for water-wise gardening. Topics covered include drought-tolerant plants and native plants, irrigation methods and associated water use/savings, irrigation management, and structural BMPs (i.e., rain barrels, cisterns, green roofs). The program includes educational workshops, training events, and the design/build of demonstration gardens targeting local residences and businesses. The County operates 12 Learning Centers throughout the County. They are equipped with educational and demonstration materials designed for program workshops. Each is landscaped with various backyard and drought-tolerant plants. Some of the centers also include grass recycling demonstrations. The County is partnering with the University of California Cooperative Extension "Master Gardeners" volunteers from the community. The volunteers are trained to promote environmentally responsible and sustainable horticultural practices in the home, community, and school landscapes by conducting workshops and demonstrations; speaking to community groups; educating teachers and parents at school gardens; and answering gardening questions at fairs and farmers markets as well as staffing email and phone helplines.
Marina Beach Education and Outreach Plan	PIPP Education, Outreach	Ongoing	Bacteria TMDL	12/2014	County, LACFCD, City of Los Angeles	Education and outreach plan targeting residents and visitors to Marina Beach, informing the targeted audience of potential public health risks associated with elevated levels of bacteria and the overall efforts to address impact to water qualify from bacteria as well as individual actions that can be taken. The plan was prepared as part of the dry-weather Bacteria TMDL TSO efforts.

5.2 EWMP Structural BMPs

The structural BMPs proposed in this EWMP include two priority regional BMPs; the Costco public-private partnership project and the Venice Blvd. Neighborhood Project. Additional regional projects proposed include four regional parks (Triangle, Canal, Via Dolce, and Venice of America Centennial Parks). Non-regional projects, including green streets and LID (development/redevelopment) are also important aspects of the structural BMP strategy. Implementation of Regional BMPs and Green Streets will address non-stormwater as well as storm water runoff to comply with WLAs. Based on the Adaptive Management Process, additional structural BMPs may be pursued to meet TMDL requirements including centralized BMPs on private property, and if necessary to achieve compliance, detention basins under streets that divert stormwater to the sanitary sewer (diversions) are feasible projects that can be implemented in Subwatershed 1A, 1B and sections of Subwatershed 4.

5.2.1 Regional BMPs Selection Criteria

BMP selection involves many factors such as physical site characteristics, water quality objectives, multi-benefits potential, aesthetics, safety, maintenance requirements, and cost that provide opportunities for BMP or constrain BMP selection. Typically, there is not a single answer but rather multiple solutions ranging from stand-alone regional or localized BMPs to treatment trains that combine multiple BMPs to achieve water quality objectives as well as other benefits such as flood control and recreation.

Many factors were considered during the structural BMP selection process. Five geological and hydrological characteristics were identified as important in determining the feasibility of BMP scenarios in terms of BMP type and site selection evaluation. These characteristics are depth to bedrock, type of bedrock, soil characteristics, depth to water table, and land use. In addition, other factors affecting the implementation of a BMP include compatibility with the surrounding area, health and safety, maintenance considerations, cost feasibility, and performance and risk analysis. The factors are further discussed below. Existing maps of these five characteristics, when applicable, were used whenever possible, along with Geographic Information System (GIS) analysis and aerial photography and/or remote sensing to assist in BMP site and type selection. The integration of surface and subsurface information to map such parameters will provide more data that are directly relevant in the decision-making process of urban and county planners, engineers and developers, and geotechnical investigators.

1. Type of and Depth to Bedrock—Bedrock that is commonly fractured, such as shallow dolomite or limestone, is highly susceptible to contamination. The fractures provide direct and rapid pathways for contaminants to reach the water table. Groundwater within sandstone formations is less susceptible because sandstone contains fewer well-connected fractures. Soil and sediment overlying bedrock slows seepage to the water table. A greater depth to bedrock increases groundwater protection. The depth-to-bedrock value limits capabilities and activities on the surface.

2. Soil Type—Soils are classified by the Natural Resource Conservation Service into the four Hydrologic Soils Groups (A, B, C and D). Soil A has the smallest runoff potential, and highest infiltration rate and Ds generally have the greatest runoff potential and lowest infiltration rate and include soils with a permanent high water table, soils with high swelling potential, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. Soils A and B are well-suited for infiltration-based BMPs such as rain gardens, permeable pavement systems, sand filter, grass swales, and buffers, often without the need for an underdrain system.

3. Depth to the Water Table—Shallow groundwater may limit the ability to infiltrate runoff. In addition, groundwater quality protection is an issue that should be considered for infiltration-based BMPs. For example, infiltration BMPs should be avoided for land uses that involve storage or use of materials that have the potential to contaminate groundwater underlying a site, such as runoff from fueling stations or materials storage areas. In addition, the deeper the groundwater table, the better the opportunity for contaminants to be filtered or to degrade.

4. Land Use—Land use cover identifies potential areas where regional and localized BMP implementation might be feasible. In addition, it allows the quantification of the degree of urbanization and imperviousness, both important factors affecting BMP type and location selection. Space constraints are frequently cited as feasibility issues for BMPs, especially for high-density, lot-line-to-lot-line development and redevelopment sites, where there is a limited amount of publicly owned land available to implement the larger scale projects that would be necessary to capture and/or reuse runoff. The primary focus will be to identify opportunities to retrofit existing conveyance systems, parks, and other recreational areas with water quality protection measures.

5. Existing Utilities—Utilities are frequently located below ground, which coincides with the feasible locations for stormwater BMPs. Typically, water and sewer piping, natural gas lines, and telephone and electrical conduits are located in the public ROW and on individual parcels. BMPs will require modification to fit into the limited available space without disrupting existing utilities, or utilities will require relocation for BMP installation.

6. Compatibility with Surroundings—Stormwater quality areas can add interest and diversity to a site, serving multiple purposes. Gardens, plazas, rooftops, and parking lots can become amenities and provide visual interest while performing stormwater quality functions and reinforcing urban design goals for the neighborhood and community. The integration of BMPs and associated landforms, walls, landscape, and materials can reflect the standards and patterns of a neighborhood and help to create lively, safe, and pedestrian-oriented districts. The quality and appearance of stormwater quality facilities should reflect the surrounding land use type, the immediate context, and the proximity of the site to important civic spaces. The standard of design and construction should maintain and enhance property values without compromising function. In addition, construction staging should be sited in a way to minimize the effect of construction mobilization and noise to adjacent tenants.

7. Health and Safety—Stormwater quality facilities must be designed and maintained in a manner that does not pose health or safety hazards to the public. The potential for nuisances, odors, and prolonged soggy conditions should be evaluated for BMPs, especially in areas with high pedestrian traffic or visibility. Urban areas are heavily populated, which adds to safety concerns when considering potential BMPs such as ponds, wetlands, and surface sand filters. Open surface systems may require additional measures such as fencing to ensure public safety and reduce vandalism. Often the only feasible location for BMPs in developed areas is underground, which presents more complex maintenance issues that trigger worker safety requirements. The installation of subsurface BMPs may require maintenance activities to be performed in confined spaces. Confined spaces have specific entry requirements to ensure safety that would need to be followed each time BMPs are inspected or maintained.

8. Maintenance—BMPs can be more effectively maintained when they are designed to allow easy access for inspection and maintenance and to take into consideration property ownership, easements, visibility from easily accessible points, slope, vehicle access, and other factors. Clear, legally-binding written

agreements assigning maintenance responsibilities and committing adequate funds for maintenance are also critical. Maintenance requirements must be carefully planned and implemented when access to subsurface BMPs is limited to manhole openings or requires the removal of grates and panels. Subsurface BMPs may be considered confined spaces and require additional measures to ensure safe access for inspection or maintenance. As a result of these potential restrictions and/or additional measures, BMP technologies that require maintenance on an annual or semiannual basis are often preferred to those requiring more frequent maintenance. Difficulty in performing the maintenance (increased level of effort) can increase the cost of the required maintenance.

9. Watershed Characteristics—The contributing drainage area is an important consideration both on the site level and at the regional level. On the site level, there must be a practical minimum size for certain BMPs related to the ability to drain and treat the associated runoff over the required drain time. On the regional level, there must be a limit on the maximum drainage area for a regional facility to assure adequate treatment of rainfall events. In addition, in a highly urbanized setting, small drainage areas and undefined outfalls limit the number of treatment strategies that can be used to treat stormwater runoff.

10. BMP Categories—BMPs can be categorized based on their functionality (storage versus conveyance) and design strategy (stand-alone versus in series; online versus offline). Storage-based BMPs provide volume reduction benefits and include bioretention and/or rain gardens, extended detention or dry basins, sand and/or media filters, constructed wetland ponds, retention or wet ponds, and permeable pavement systems. Conveyance-based BMPs include grass swales, grass buffers, constructed wetlands channels, and other BMPs that improve quality and reduce volume but only provide incidental storage. Ideally, a combination of conveyance-based and storage-based BMPs can be used to allow the implementation of multiple benefits BMPs. Given the natural variability of the volume, rate and quality of stormwater runoff, and the variability in BMP performance, using multiple practices in a treatment train that links complementary processes can expand the range of pollutants that can be treated and increase the overall efficiency of the system for pollutant removal and provide system redundancy. In addition, the land requirements for a combined facility are lower than for two separate facilities. BMPs may be designed to be online such that all of the off-site runoff from the upstream watershed and site runoff is intercepted and treated by the BMP. Locating BMPs offline requires that all on-site catchment areas flow though a BMP prior to combining with flows from the upstream off-site watershed.

11. BMP Performance—BMP performance evaluation is not required for Regional BMPs, except to the extent that they capture the 24-hour 85^{th} percentile storm. Performance of various BMPs depends on numerous factors, such as BMP type, design, site, storm characteristics, monitoring methodology, performance measures, and pollutant loadings. The reported effectiveness data varies widely between and among different BMPs.

12. Cost Estimates—Cost effectiveness is an essential component in BMP planning and selection, especially with the stricter regulations and leaner budgets imposed on stormwater management programs. Life cycle cost (LCC), which refers to all costs that occur during the economic life of a project, should be optimized. Generally, the components of the LCC for a constructed facility include construction, engineering and permitting, contingency, land acquisition, routine operation and maintenance, and major rehabilitation costs minus salvage value. It is also recommended that the cost of administering a stormwater management program be included as a long-term cost for BMPs. One method to assess and compare the LCC of various BMPs is to use the net present value (NPV) of the whole life costs of the BMP(s) implemented, the average annual mass of pollutant removed, and the average annual volume of

surface runoff reduced to compute a unit cost per pound of pollutant or cubic feet of runoff removed over the economic life of the BMP.

13. Risk Assessment—A risk assessment was conducted for the selected BMP systems by evaluating estimated reduction efficiencies, treatment capacity, whether or not a BMP can be integrated with other BMPs, likelihood of failure, and ease of adaptive customization.

14. Other Factors—California Environmental Quality Act (CEQA) environmental consideration not listed above including but not limited to cultural resources, greenhouse gas emissions, air quality, and traffic. These considerations will be preliminarily assessed for potentially significant impact to identify permitting and potential mitigation requirements at this early assessment phase.

5.2.2 Regional BMP Selection

Using the selection criteria described above, a total of 23 potential regional BMP locations within the MdR WMA were identified. This preliminary list consisted of the Costco site, the Venice Blvd. Neighborhood Project, green streets, parks, diversions of stormwater into the sanitary sewer, and public schools. These were further evaluated and ranked based on various criteria, including depth to groundwater, public acceptance, infrastructure disturbance, maintenance factors, as well as others (Section 5.2). The resulting 18 potential regional BMP implementation sites are listed in Table 5-3. The location of the parks, the Venice Blvd. Neighborhood Project and the Costco site are shown in Figure 5-2. As mentioned previously, if additional load reductions are required after implementation of the priority projects (Costco and the Venice Blvd. Neighborhood Project) additional BMPs may be pursued to meet TMDL requirements including centralized BMPs on private property, and if necessary to achieve compliance, detention basins under streets that divert stormwater to the sanitary sewer (diversions) are feasible projects that can be implemented in Subwatershed 1A, 1B and sections of Subwatershed 4.

Table 5-3: Ranking of Potential Regional BMPs within the MdR WMA

Ranking	Site	Land -Use	Subwatershed	Jurisdiction	Agencies	Groundwater Depth (feet)
1	Costco	Private	4	City of Culver City	Costco	20-30
2	Triangle Park	Public	4	City of LA	Parks	10-19
2	Venice of America Centennial Park	Public	3	City of LA	Parks	10-19
4	Venice Blvd. Neighborhood Project (high[a])	Public/ROW	4	City of LA	LADOT	20-39
5	Green Streets[b] (medium[a])	Public/ROW	4	City of LA / City of Culver	LADOT	10-19
5	Green Streets[b] (medium[a])	Public/ROW	2	City of LA	LADOT	10-19
7	Green Streets[b] (low[a])	Public	1	County	LADOT	<10
8	Green Streets[b] (medium[a])	Public/ROW	3	City of LA	LADOT	10-19
8	Canal Park	Public	2	City of LA	Parks	10-19
8	Via Dolce Park	Public	2	City of LA	Parks	10-19
11	Twain Middle School	Public	4	City of LA	LAUSD	20-39
12	Green Streets[b] (low[a])	Public/ROW	2	City of LA	LADOT	<10
13	Green Streets[b] (low[a])	Public/ROW	4	City of LA	LADOT	<10
14	Venice High School	Public	4	City of LA	LAUSD	20-39
15	Coeur D'Elene Elementary School	Public	4	City of LA	LAUSD	10-19

Table 5-3: Ranking of Potential Regional BMPs within the MdR WMA

Ranking	Site	Land -Use	Subwatershed	Jurisdiction	Agencies	Groundwater Depth (feet)
16	Westside Leadership Magnet	Public	2	City of LA	LAUSD	10-19
17	Sanitary Sewer Diversion (1a and 1b)	Public/Private				
17	Sanitary Sewer Diversion (4)	Public/Private				

Color Code Subwatershed 1 – Subwatershed 2 – Subwatershed 3 – Subwatershed 4

[a] Referring to groundwater depth

[b] For green streets refer to the Green Streets section below

Parks - City of Los Angeles Parks and Recreation

The Costco site, although not a public site, ranked first because of its relatively large drainage area and potential capture volume, the entire City of Culver City portion of the WMA. Venice of America Centennial Park and Triangle Park were the next highest ranked sites. Venice Park ranked high because of its potential to capture a large portion of its corresponding Subwatershed 3 drainage area. Other factors include the apparent lack of potential public opposition, lower infrastructure disturbance potential, and lower implementation cost. Siting a regional BMP in Triangle Park, despite its small drainage area, results in minimal negative impacts based on the ranking criteria.

Distributed regional green streets in the high groundwater depth areas in Subwatershed 4 were ranked next because of their capture and infiltration potential. Although not able to capture and retain the 85th percentile storm, green streets in Subwatersheds 4, 2, and 3 ranked high because of the large drainage area they can treat. Green street BMPs throughout the subwatersheds can result in significant volume and load reductions in the WMA, but with the greatest infrastructure disturbance and potentially the highest costs. Canal Park and Via Dolce Park are also in the top 10 BMPs.

Finally, although Twain Middle School may capture a large percentage of the 1.1-inch storm runoff volume corresponding to the drainage area of Subwatershed 4, the local school district has been reluctant in past discussions to accept offsite stormwater runoff due to concerns about costs, liability and public perception. The City of Los Angeles has continued a dialog with the school district under One Water LA 2040. The same concerns apply to citing a regional BMP at Venice High School.

A public workshop was held on November 20, 2014 and provided updates and opportunity for public input/comment on the EWMP as well as the proposed priority projects (Section 8.0).

The benefits of the above-mentioned BMPs, when applicable, extend beyond reduction of sediment loads, toxic pollutants, and bacterial loads. Benefits may include community enhancement through beautification, property value increase, improved beach tourism, ecosystem protection, and groundwater recharge.

Figure 5-2: Proposed Structural Control Measures and Regional Projects in MdR Watershed

5.2.3 Regional Priority Projects

The structural BMPs proposed in this EWMP include two priority regional BMPs; the Costco public-private partnership project and the Venice Blvd. Neighborhood Project. These projects will be the initial projects pursued in the EWMP and will be designed to retain the 85th percentile, 24-hour storm event as well as all non stormwater runoff from the drainage areas tributary to the projects.

5.2.3.1 Costco

A public-private partnership between the City of Culver City and Costco has been initiated to pursue implementation of this Priority Regional BMP. The Costco lot is 17.5 acres and is planned to capture the drainage from the entire Culver City portion of the MdR watershed, totaling 42 acres (Figure 5-2). In addition to providing stormwater benefits, the project is also expected to provide benefits such as groundwater recharge, improved aesthetics, as well as public education (through educational signage),

The Costco site is located within Subwatershed 4 (Figure 5-3), in an area with depth to groundwater between 20 and 30 feet. The design of a regional BMP on the site would maintain at least 10 feet between the bottom of the proposed BMP and groundwater depth, as required by the City of Culver City. This can be accomplished by designing several diversions within the storm drain network at locations closer to the source (catch basins or inlets) rather than constructing one diversion at the end of the pipe, which is fairly deep. Design considerations will be given to other geotechnical investigation factors, including the potential liquefaction hazard.

Based on the preliminary geotechnical data (Appendix E), the deep groundwater conditions at Costco Commercial Park are between 20 and 30 feet and therefore are conducive to an infiltration-type design. The geotechnical reports indicate that the top 10 to 13 feet of material directly underneath the parking lot consists of impervious clay. Approximately 3 feet of clay material below the invert of the infiltration gallery would need to be replaced with gravel or an amended soil mixture designed to allow percolation into deeper sandy soils. As a cost-saving measure, it is assumed that a portion of the excavated clay material (approximately 8,000 cubic yards) may be stockpiled on-site and then beneficially reused as backfill above the infiltration gallery. The Costco parking lot infiltration

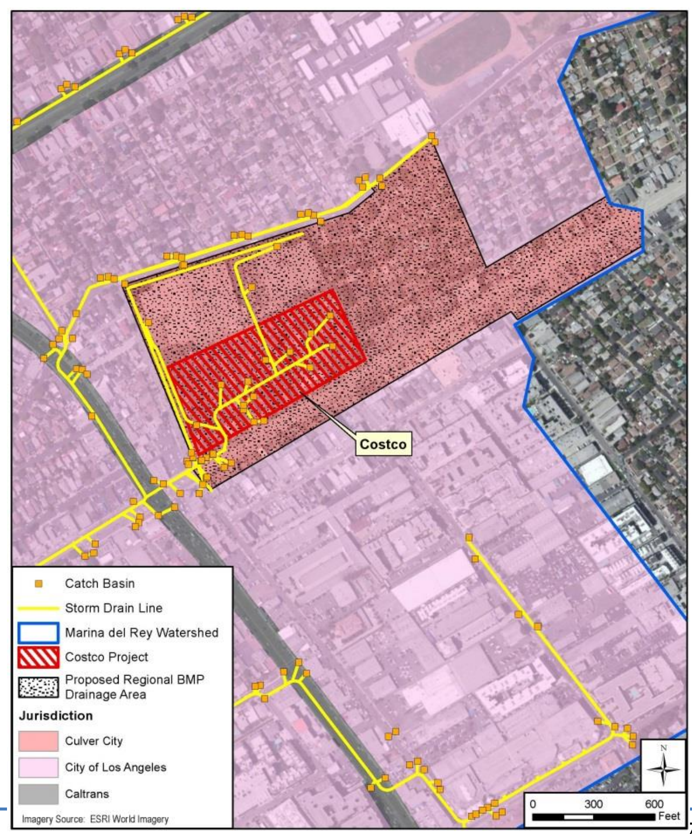


Figure 5-3: Proposed Drainage Area for Costco Regional Project

gallery would be designed to infiltrate 100% of the 85th percentile storm event runoff from the City of Culver City (design volume of 115,600 cubic feet, 42-acre drainage area). The preliminary design for this infiltration gallery consists of 757 StormChamber units installed along the edges of the parking lot (Figure 5-4). Runoff from the Costco facility (17.5 acres) would be re-directed from the existing MS4 system to the infiltration gallery. Runoff from off-site would be directed to the Costco infiltration gallery by means of a diversion structure. Detailed preliminary design estimates can be found in Appendix B.

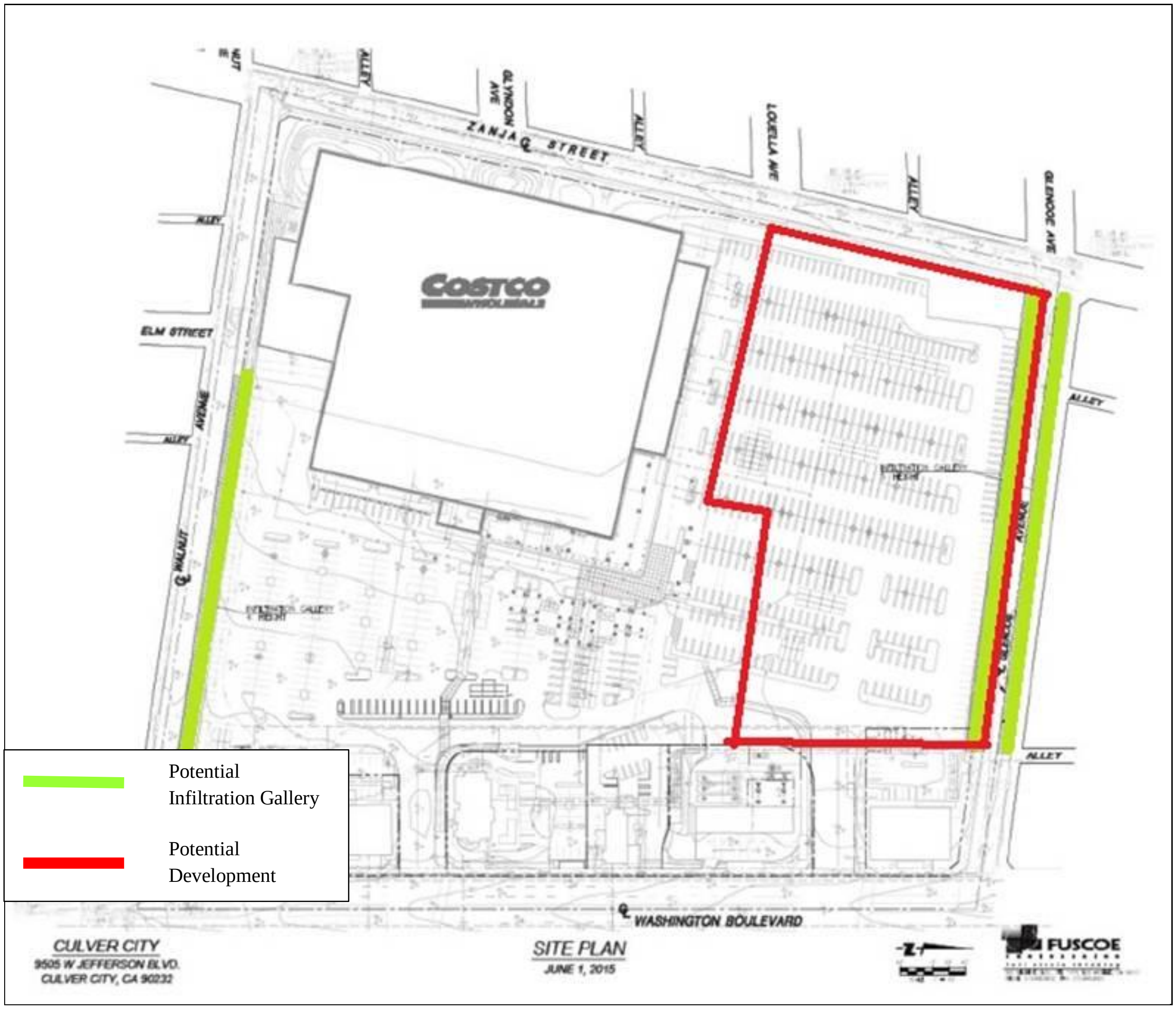


Figure 5-4: Proposed Preliminary Concept for Costco Regional BMP

Figure 5-5 provides an example of the StormChamber units proposed for the Costco infiltration gallery.

The City of Culver City is currently in negotiations with Costco to implement this multi-benefit regional project and expects to have this project completed by late 2017.

Figure 5-5: Example of StormChamber Units

5.2.3.2 Venice Boulevard Neighborhood Green Streets Regional Project

The Venice Blvd. Neighborhood Project is a multi-benefit regional project situated in the northeast section of the watershed, in Subwatershed 4 (Figure 5-2, Figure 5-3, and Figure 5-6). The project consists of green streets that are sized to capture and infiltrate the 85th percentile 24-hour storm as well as nonstormwater runoff form the drainage area tributary to the project. BMP implementation will be partly on Caltrans' right-of-way and partly on the City of Los Angeles' right-of-way. The City is currently working on a concept report to determine how much of Caltrans' right of way will be needed. Upon completion of the report, the City will discuss with Caltrans potential collaboration and/or permits necessary for project completion.

Localized green streets, referred to thereafter as green streets, (not designed to capture and infiltrate the 85th percentile storm) will be needed throughout large areas of the subwatersheds to achieve the water quality load reductions required to achieve compliance with the WLAs of the Toxics TMDL and are described in Section 5.2.4.1 below.

The feasibility of the implementation of

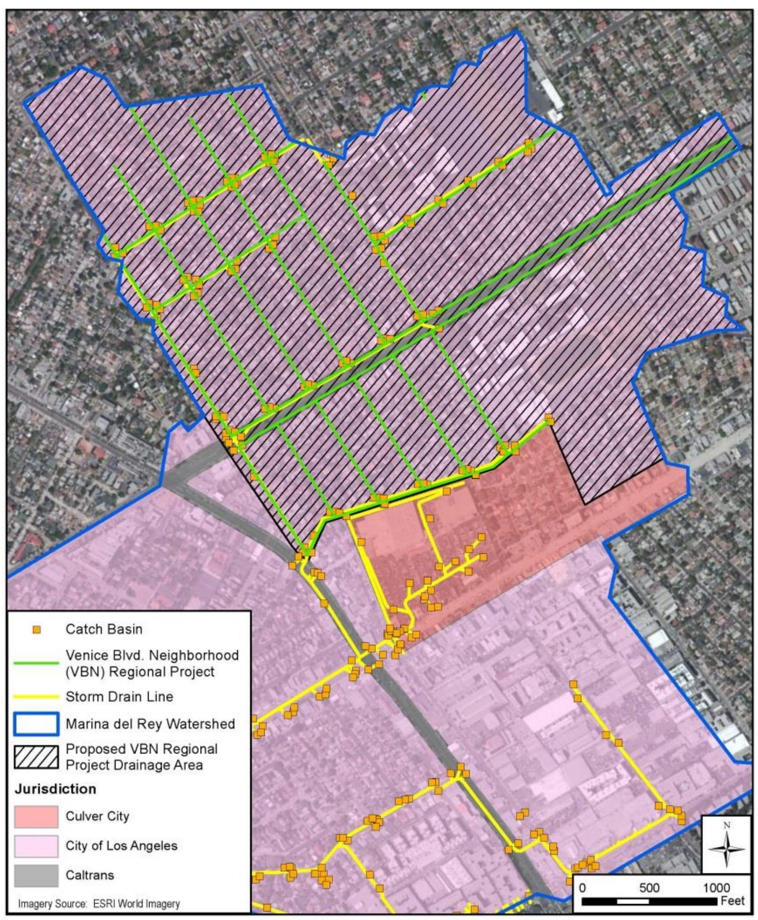


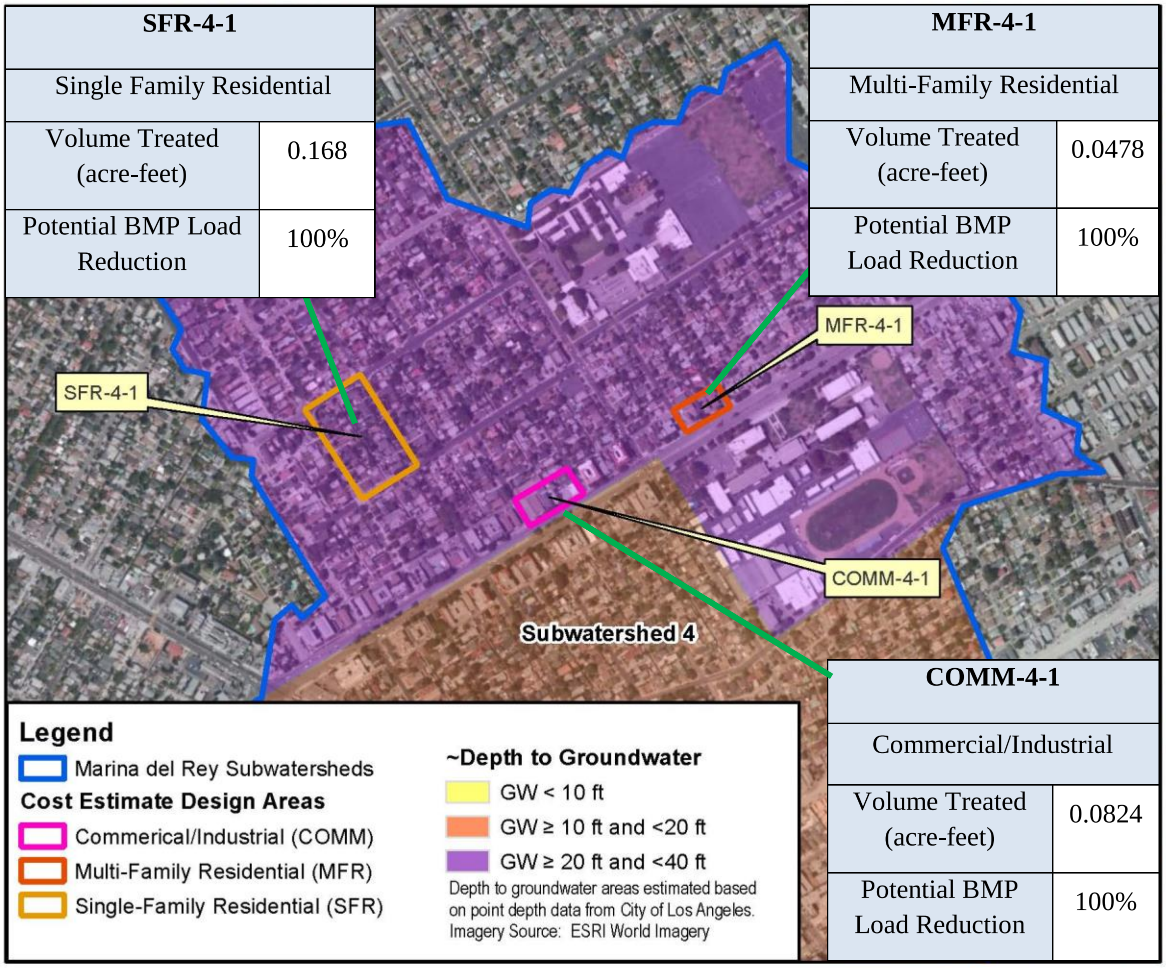
Figure 5-6: Proposed Drainage Area for the Venice Boulevard Neighborhood Green Street Regional Project

the Venice Blvd. Neighborhood Project depends upon separation from the groundwater table, spatial constraints of the project footprint and underlying soil types. Available groundwater data were used to delineate the MdR watershed into areas where infiltration would be feasible or not feasible. North of Venice Boulevard, where this project will be sited, the depth to groundwater is between 20 to 30 feet. Preliminary geotechnical investigations were performed in several areas in Subwatershed 4 (Appendix E). Where investigated, the upper 9 to 12 feet of soils consist of clayey soils that exhibit very little to no ability to infiltrate runoff. Below these clayey materials, is a layer of course sand to silty-sand materials that exhibits the ability to infiltrate water.

In addition to subsurface conditions, a multitude of other considerations affect the area available for the adaptation of green streets. Crosswalks, street furniture, bike paths, soil conditions, and utilities need to be considered, necessitating substantive area-specific analysis. To account for these factors, a targeted analysis based on landuse type was conducted and scaled-up across the subwatershed for the implementation of the infiltration type green streets that will make up the Venice Blvd. Neighborhood Project. Design areas were selected to identify and design feasible green street BMPs in three different landuses in Subwatershed 4, multi-family residential (MFR), single family residential (SFR) and commercial/industrial (COMM) (Table 5-4, Figure 5-7).

Table 5-4: Venice Blvd. Neighborhood Project Green Street Design Areas

Land Use	Area ID	Depth to Groundwater (ft)	Perimeter Available for BMPs (ft)	Drainage Area (acres)	Runoff Coefficient	Design Runoff Volume (acre-ft)
Multi-Family Residential	MFR-4-1	23 to 28	720	0.66	0.65	0.0394
Single-Family Residential	SFR-4-1	22	1640	3.65	0.5	0.1674
Commercial/Industrial	COMM-4-1	20	910	1.03	0.85	0.0804



SFR-4-1	
Single Family Residential	
Volume Treated (acre-feet)	0.168
Potential BMP Load Reduction	100%

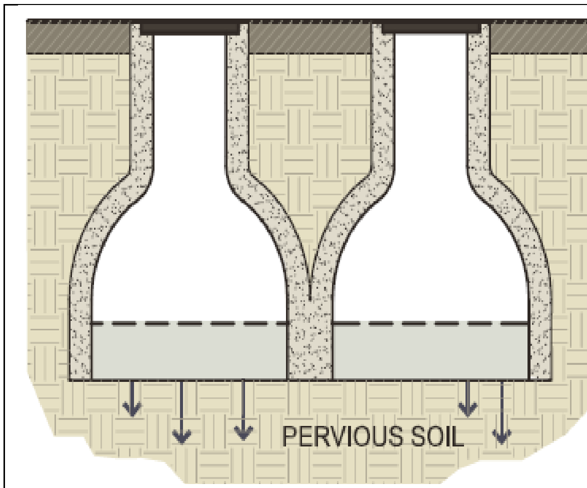
MFR-4-1	
Multi-Family Residential	
Volume Treated (acre-feet)	0.0478
Potential BMP Load Reduction	100%

COMM-4-1	
Commercial/Industrial	
Volume Treated (acre-feet)	0.0824
Potential BMP Load Reduction	100%

Figure 5-7: Venice Blvd. Neighborhood Project Design Areas

The design areas are representative of different landuse / groundwater depth combinations, public space limitations, roadway design, housing characteristics, and other factors discussed above. Drainage areas, design runoff metrics, block specific constraints, and concept BMP design assumptions were calculated for these design areas and are provided in Appendix A along with additional design parameters and detailed construction calculations.

For the design areas in the Venice Blvd. Neighborhood Project, infiltration galleries similar to those described in Section 5.2.3.1 would be feasible (Figure 5-8)



City of Los Angeles Low Impact Development Manual (City of Los Angeles, 2011a)

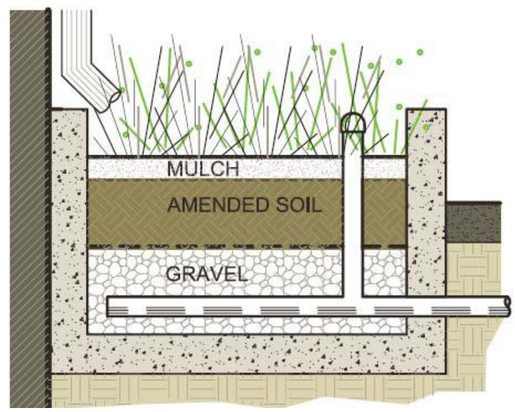
Figure 5-8: Example Infiltration Gallery

Multiple benefits in addition to stormwater management are anticipated from the implementation of the Venice Blvd. Neighborhood Project including improved community aesthetics and property values, traffic calming, public education and groundwater recharge.

5.2.4 Future Potential Projects

5.2.4.1 Green Streets

Green streets provide multiple benefits to the communities including stormwater management, groundwater recharge, improved community aesthetics and property values, and traffic calming, which in turn creates safer neighborhoods. Green Streest will be needed throughout large areas of the MdR subwatersheds to achieve the water quality load reductions required to achieve compliance with the WLAs of the Toxics TMDL. For purposes of this analysis, a green street consists of BMPs installed along the driving surface or sidewalk adjacent to the main public thoroughfare (transportation land use).



City of Los Angeles (2011a)

Figure 5-9: Sidewalk Planter BMP Example

Three main types of BMPs were included in the green street design analysis: infiltration-type BMPs (infiltration gallery – see Section 5.2.3.2 above); capture-type BMPs (sidewalk planters and downspout disconnections [Figure 5-9]) and filtration-type BMPs (sidewalk biofiltration and porous pavement with underdrains [Figure 5-10]).

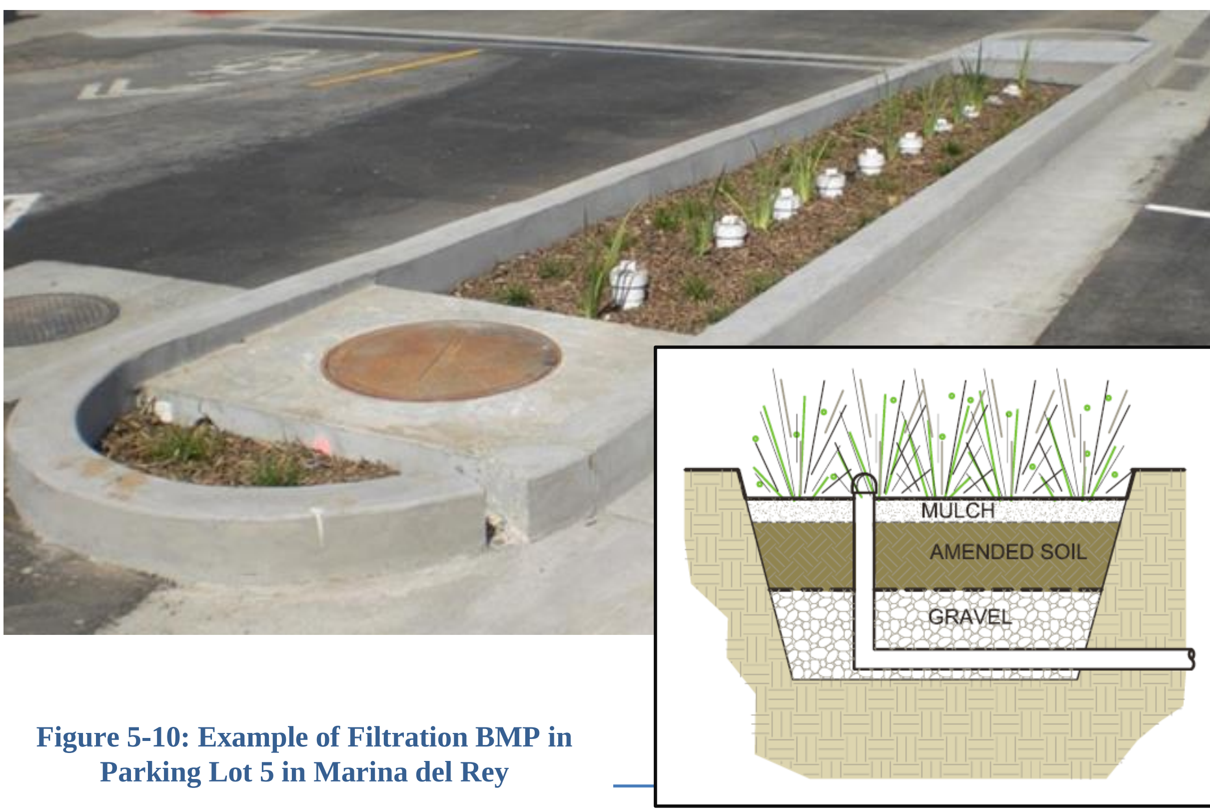


Figure 5-10: Example of Filtration BMP in Parking Lot 5 in Marina del Rey

City of Los Angeles Low Impact Development Manual (City of Los Angeles, 2011a)

The potential load reductions and design limitations associated with each of the infiltration, capture/reuse and filtration type BMPs considered for green streets in the MdR watershed are summarized in Table 5-5. Additional design parameters and detailed construction calculations are discussed in Appendix A.

Table 5-5: BMPs for Green Streets

Structural BMP	Load Reduction	Notes
Filtration- Porous Pavement (Road Design only)	63%	Filtration requires 24-72 hours and filtered flows are directed to the MS4. Volume of stormwater capture is limited to the capacity of the porous pavement. Requires routine annual sweeping. Vacuum sweeper recommended. *BMP design assumes a road grade of 1% and one 6-inch underdrain per 8-foot wide section of pavement.*
Biofiltration-Sidewalks	63%	Biofiltration requires 24-72 hours and units have effectively zero storage capacity. Stormwater attenuation by a cistern required (100% treatment volume). Flow is routed from and back into the MS4. Requires routine maintenance (weeding) and replacement of plants, as well as routine inspection and maintenance of the cistern.
Capture and Use	100%	Flow is routed from the MS4 into a subsurface cistern. Approximately 1300 square feet of vegetated area is needed to utilize the runoff volume captured in a 1000-gallon cistern within 14 days of an event. This type of BMP has limited feasibility in MdR watershed public right of way. If implemented as a downspout disconnect program on private property, a maximum load reduction of 20% is assumed to cut the runoff volume from a design area.
Infiltration-Sidewalks	100%	Flow directed from road via curb cuts. Requires routine maintenance (weeding) and replacement of plants. *BMP design assumes infiltration possible at 4 foot below grade.*
Infiltration-Porous Pavement	100%	Road level infiltration. Requires routine (at least monthly) sweeping. Vacuum sweeper recommended. *Road design assumes infiltration possible at 3-feet below grade. Sidewalk design (shallow infiltration design) assumes infiltration possible at 1.5-feet below grade. BMP design assumes a road grade of 1%.*
Infiltration-Infiltration Gallery	100%	Flow may be diverted from MS4, provided flow pre-treated by catch basin inserts. *Smallest BMP design assumes a minimum groundwater depth of 17 feet. This infiltration design was limited to the portion of subwatershed 4 with a depth to groundwater of ≥20 feet. BMP design assumes a road grade of 1%.*

The feasibility of the implementation of green streets depends upon many factors, including separation from the groundwater table, as well as spatial constraints of the project footprint and underlying soil types. In addition to subsurface conditions, a multitude of other considerations affect the area available for the adaptation of green streets. Crosswalks, street furniture, bike paths, soil conditions, and utilities need to be considered, necessitating substantive area-specific analysis.

Available groundwater data were used to delineate the MdR watershed into areas where infiltration type green streets would be feasible or not feasible based on the depth to groundwater. Near the harbor (Subwatershed 1) groundwater depths are very shallow (less than 10 feet) (Figure 5-2). The depth to groundwater increases as the distance from the harbor increases. Near the harbor, infiltration BMPs are not feasible and capture BMPs are limited to rain gardens (e.g., parkway bioretention) and cisterns or rain barrels. In these shallow groundwater areas, filtration (e.g., porous concrete with underdrain and proprietary filter devices such as the modular wetland systems) may be the predominant feasible BMP in the public thoroughfare. Additionally, porous pavement may be the only option to utilize in areas where there are no parkways. Figure 5-10 is an example of a filtration type BMP installed in a County owned parking lot (Parking Lot 5) in Marina del Rey.

Away from the harbor, where depths to ground are greater than 10 feet, there are opportunities for capture and infiltration type BMPs. Preliminary geotechnical investigations were performed in several areas in Subwatershed 4 and Subwatershed 3(Appendix E). Where investigated, the upper 9 to 12 feet of soils consist of clayey soils that exhibit very little to no ability to infiltrate runoff. Below these clayey materials, is an area of course sand to silty-sand materials that exhibits the ability to infiltrate water. North of Venice Boulevard the depth to groundwater is between 20 to 30 feet, and this area is where the infiltration green streets are proposed as the Venice Blvd. Neighborhood Project (Section 5.2.3.2 above).

As previously discussed, ground water depth is just one consideration when determining green street feasibility. Neighborhood characteristics such as street furniture, crosswalks, bike paths all need to be considered as do soil conditions and utilities. These factors necessitate substantive area-specific analysis.

In order to consider these factors, a watershed-wide, targeted analysis was conducted and scaled-up across each subwatershed for the implementation of green streets. A total of six example areas were used to develop and design feasible green streets BMPs in residential, commercial, and industrial areas representative of the conditions throughout the MdR watershed. Three of the design areas are located in Subwatershed 4 within the area for of the Venice Blvd. Neighborhood Project and are discussed in Section 5.2.3.2. The remaining design areas are listed in Table 5-6 and shown in Figure 5-7.

Table 5-6: Design Areas for Green Streets

Land Use	Area ID	Depth to Ground water (ft)	Perimeter Available for BMPs (ft)	Drainage Area (ac)	Runoff Coefficient	Design Runoff Volume (cft)
Multi-Family Residential	MFR-2	18	800	0.69	0.75	2,063
Multi-Family Residential	MFR-1	<10	300*	1.03	0.75	3,094
Single-Family Residential	SFR-3	12 to 13	1080	1.56	0.6	3,740
Commercial/Industrial	COMM-4-2	10 to 13	300**	2.86	0.85	9,701

*300ft length of road along Panay Way. No sidewalks.

**In large commercial parks, limited ROW access. Short length of block ~150ft. Driveways ~20ft.

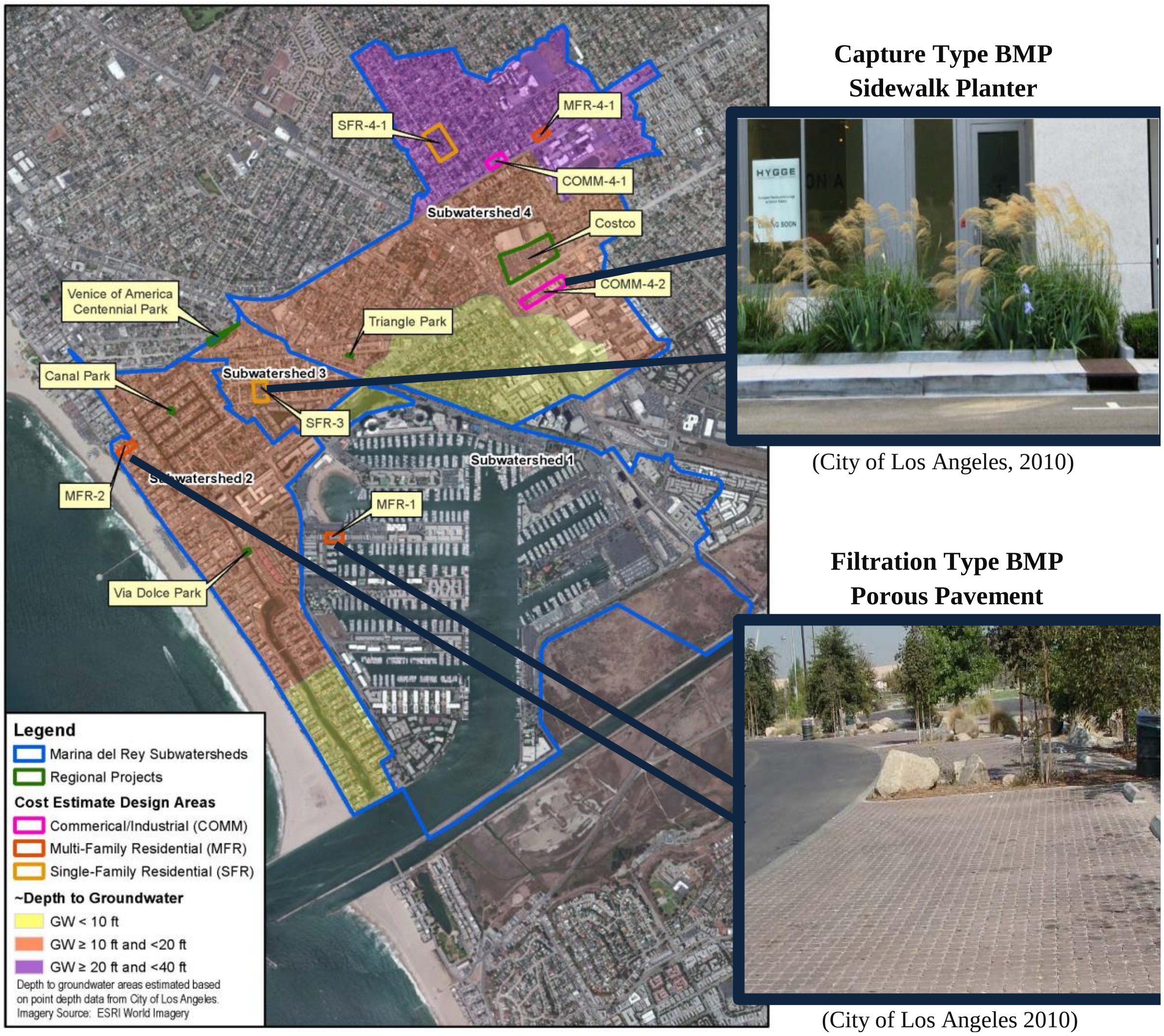


Figure 5-11: Project Design Areas and Example BMPs

The design areas are representative of different landuse / groundwater depth combinations, public space limitations, roadway design, housing characteristics, and other factors discussed above. Drainage areas, design runoff metrics, block specific constraints, and concept BMP design assumptions were calculated for these design areas. The design area analysis indicates that capture type BMPs such as sidewalk planters may be feasible at COMM-4-2 and at SFR-3 and that filtration type BMPs are feasible at MFR-2 and MFR-1 (Figure 5-11). Additional details are provided in Appendix A.

5.2.4.2 Parks

Four parks were considered for regional infiltration BMPs in the MdR watershed: Canal Park, Venice of America Park, Via Dolce Park, and Triangle Park (Figure 5-12). The specific design considerations are presented in the following subsections. A summary of the implementation costs is provided in Section 9.2.3. Detailed assumptions and calculations are provided separately in Appendix B. Each of these projects include multiple benefits in addition to stormwater management, these may include community enhancement through beautification, property value increase; improved beach tourism, ecosystem protection, and groundwater recharge.

Figure 5-12: Park Project Locations

5.2.4.2.1 Venice of America Centennial Park

Venice of America Centennial Park is located between north and south Venice Blvd., at the northern boundary of MdR watershed in Subwatershed 3 (park footprint of approximately 0.76 acres) Figure 5-12). The groundwater table is 17 feet deep; therefore, this facility could be optimally used as a subsurface infiltration gallery. The proposed design consists of 74 StormChamber infiltration units (8 rows of 9 chambers long) with a 30-inch rock bed (6 inches above the chambers and 24 inches below). The design covers a 3,463 square foot area. The proposed infiltration units will be able to capture 100% of the park drainage area, plus an additional 3.9 acres of tributary drainage area. Although the park has significantly more space available for BMP implementation, the park location near the boundary of the watershed limits the extent of the tributary drainage area (Figure 5-13).

Figure 5-13: Venice of America Centennial Park with Potential BMP Footprint Area

5.2.4.2.2 Canal Park

Canal Park is located at the intersection of Dell Avenue and Court D in Subwatershed 2 (park footprint of approximately 0.14 acres) (Figure 5-12). The groundwater table is 17 feet deep; therefore, the facility was also designed as a subsurface infiltration gallery. The proposed design consists of 58 StormChamber infiltration units within a 2,739 square foot area (52% of the park footprint) with a 30-inch rock bed (Figure 5-14).

Figure 5-14: Canal Park with Potential BMP Footprint Area

The proposed infiltration units will be designed to capture 100% of the park drainage area, plus an additional 3.3 acres of tributary drainage area. A review of the as-built drawings for the area identified existing porous pavement and infiltration-type BMPs along Carroll Canal Court at Grand Canal Court. A thorough review of existing infrastructure would be recommended as part of the planning stages of this project. Conceptually, stormwater runoff could be directed to Canal Park from the portion of Court D east of Dell Avenue.

5.2.4.2.3 Via Dolce Park

This vacant lot is located off Via Dolce in Subwatershed 2 (park footprint of approximately 0.21 acre) (Figure 5-12). The groundwater depth is 12 feet. The proposed design consists of a shallow groundwater capture and reuse system. Three 1,000-gallon subsurface cisterns may be installed below grade and plumbed to capture runoff by means of a catch basin insert installed in Via Dolce. Figure 5-15 includes a preliminary schematic of how the BMP may be placed in the park, and is shown for general illustrative purposes only. Approximately 0.14 acre of the park space (66% of the total park footprint) would be required as landscape in order to use the 85th percentile design storm. The park would be graded to capture its own runoff and may be landscaped with a combination of groundcover and native vegetation.

Figure 5-15: Via Dolce Park with Potential BMP Footprint Area

5.2.4.2.4 Triangle Park

Triangle Park is located on Marr Road in Subwatershed 4 (Figure 5-12). The park footprint is very small (approximately 0.1 acres) and includes a sand box and basketball court. Because the depth to groundwater is only 11 feet, the only non-filtration BMP option would involve replacing the sandbox area with a 900-gallon subsurface cistern and landscape area of similar design to the Via Dolce Park project (Figure 5-16). Because of the limited space available for landscaping, this site has the capacity to capture and reuse runoff from only a 0.5-acre tributary drainage area.

Figure 5-16: Triangle Park with Potential BMP Footprint Area

5.2.4.2.5 Additional Projects

If the adaptive management process (see Section 10.0) indicates additional load reductions are required after implementation of the priority projects (Costco and the Venice Blvd. Neighborhood Project) and the other BMPs described above, additional BMPs may be pursued to meet TMDL requirements. The additional BMPs considered will be based upon the adaptive management process and the required reductions needed. The additional BMPs may include BMPs on public property such as those already described in the EWMP, additional non-structural programs targeted to address needs identified in the adaptive management process, additional public-private partnerships such as the Costco-Culver City partnership and if necessary, sanitary sewer diversions which are described in detail below.

Sanitary sewer diversions would be designed to re-direct stormwater runoff to an above or below ground storage tank that would slowly discharge the stormwater to the sanitary sewer. It may be necessary to work with private land owners in order to place the storage tanks needed. Diversions would be pursued only if required watershed load reductions are not achieved after implementation of the other BMPs described in this EWMP and may be necessary to achieve WLAs in Subwatersheds 1A, 1B, and 3.

This type of capture-divert design could be implemented at the Boone Olive Pump Station. The existing system has the capacity to capture and treat the 85th percentile 24-hour storm event from a 3.5-acre tributary drainage area in Subwatershed 3. Runoff from an additional 31.5-acre drainage area in Subwatershed 4 may be redirected to the Boone Olive Pump Station to ensure TMDL compliance targets are met. The infrastructure necessary to divert this runoff was not assessed as part of this effort.

For Subwatersheds 1A and 1B, the maximum load reduction potential was assumed for all green street programs. For example, 100% roof runoff capture was assumed through targeted aggressive downspout disconnect programs implemented in single-family residential neighborhoods. The sanitary sewer diversion project was then sized to capture the remaining filtered stormwater runoff volume to achieve TMDL compliance targets.

The project-specific information and design parameters for each of the subwatershed sanitary sewer diversion projects are summarized in Table 5-7. The tank designs assume a 0.05 cubic foot per second discharge rate to the sanitary sewer and a drawdown period of no more than 14 days. Additional capacity was added to the tanks to account for a drawdown period of greater than 14 days. More details are presented in Appendix B.

Table 5-7: Sanitary Sewer Diversion Projects

Subwatersheds	Subwatershed 1A (Back Basins)	Subwatershed 1B (Front Basins)	Subwatershed 3 (Boone Olive) /Subwatershed 4 (Oxford Basin)
Design Treatment Area (ac)	22	48	35
Tank Capacity (gallons)	0.49 million	1.60 million	1.04 million
Redevelopment Area (acres)	0.3	0.7	0.5

5.3 Development and Redevelopment

The information presented in this section was compiled from various email communications with the County, City of Los Angeles, and City of Culver City. The projects were researched and those implemented prior to the last monitoring data used for modeling (02/02/2014) were not included in the analysis as they were already accounted for in the modeling.

The City of Los Angeles development and redevelopment acreage projections are based on projected growth percentages for each land-use type provided by the City. These percentages were used, along with the existing land use areas for each category, to project development and redevelopment project acreage for each subwatershed where the City of Los Angeles has jurisdiction. The results are summarized in Table 5-8. The area of the watershed within the jurisdiction of the City of Los Angeles is projected to include 26.29 acres of development and redevelopment land, corresponding to 2.42 % of the TMDL land area (does not include Subwatershed 2). Although the purpose of the Oxford Retention Basin Multi-Use Enhancement Project is flood control, its land area is included under the development/redevelopment projects as it is planned to manage its own stormwater runoff.

The net development and redevelopment area in the TMDL compliance area of the WMA, (i.e., Subwatershed 1, 3 and 4) is estimated to be 134.489 acres or 10.12 % of that area. Subwatershed 2 is under the jurisdiction of the City of Los Angeles (278.1 acres) and the County (46.8 acres) and has a total of 9.95 acres planned for development and/or redevelopment (Table 5-8).

Table 5-8: Potential Development and Redevelopment Projects Areas within the City of Los Angeles

Land Use Class	Yearly Rate	Area within the Jurisdiction of the City of LA	Incremental Development / Redevelopment Acreage					Cumulative Development / Redevelopment Area
	(%)	(acres)	(acres)					2015-2022
			2015	2016	2018	2021	2022	
	Subwatershed 1 (Harbor)							
Residential	0.18	12.91	0	0.02	0.02	0.02	0.02	0.09
Commercial and Services	0.15	9.31	0	0.01	0.01	0.01	0.01	0.06
Industrial/Mixed with Industrial	0.34	0.18	0	0	0	0	0	0
Education	0.16	0	0	0	0	0	0	0
Transportation	2.7	5.19	0	0.14	0.14	0.15	0.15	0.58
Total Area (acres)		27.58	0	0.18	0.18	0.19	0.19	0.73
Percent of Subwatershed 1 (%)		8.49%	0	0.05%	0.05%	0.05%	0.05%	0.20%
Percent of MdR Subwatersheds 1, 3, 4 (%)		2.54%	0	0.02%	0.02%	0.02%	0.02%	0.07%
	Subwatershed 3 (Boone Olive)							
Residential	0.18	44.03	0	0.08	0.08	0.08	0.08	0.32
Commercial and Services	0.15	1.63	0	0	0	0	0	0.01
Industrial/Mixed with Industrial	0.34	0.24	0	0	0	0	0	0
Education	0.16	0	0	0	0	0	0	0
Transportation	2.7	21.96	0	0.59	0.61	0.63	0.64	2.47
Total Area (acres)		67.86	0	0.68	0.69	0.71	0.73	2.8
Percent of Subwatershed 3 (%)		96.26%	0	0.96%	0.98%	1%	1.03%	3.97%
Percent of MdR Subwatersheds 1, 3, 4 (%)		6.26%	0	0.06%	0.06%	0.07%	0.07%	0.26%
	Subwatershed 4 (Oxford Basin)							
Residential	0.18	256.32	0	0.46	0.46	0.46	0.46	1.85
Commercial and Services	0.15	98.41	0	0.15	0.15	0.15	0.15	0.59
Industrial/Mixed with Industrial	0.34	27.03	0	0.09	0.09	0.09	0.09	0.37
Education	0.16	62.08	0	0.1	0.1	0.1	0.1	0.4
Transportation	2.7	141.75	0	3.83	3.93	4.04	4.15	15.94
Oxford Basin Project		3.6	0	3.6	3.6	3.6	3.6	3.6
Total Area (acres)		589.2	0	8.23	8.33	8.44	8.55	22.75
Percent of Subwatershed 4 (%)		91.39%	0	1.28%	1.29%	1.31%	1.33%	3.53%
Percent of MdR Subwatersheds 1, 3, 4 (%)		54.35%	0	0.76%	0.77%	0.78%	0.79%	2.10%
Total Area of MdR Subwatersheds 1, 3, 4 (acres)		684.64	0	9.08	9.21	9.33	9.47	26.29
Total Area of MdR Subwatersheds 1, 3, 4 (%)		63.16%	0	0.84%	0.85%	0.86%	0.87%	2.42%
	Subwatershed 2 (Non-TMDL Area)							
Residential	0.18	146.67	0	0.26	0.26	0.26	0.27	1.06
Commercial and Services	0.15	12.98	0	0.02	0.02	0.02	0.02	0.08
Industrial/Mixed with Industrial	0.34	0.22	0	0	0	0	0	0
Education	0.16	1.79	0	0	0	0	0	0.01
Transportation	2.7	78.21	0	2.11	2.17	2.23	2.29	8.8
Total Area Subwatershed 2 (acres)		239.88	0	2.4	2.46	2.52	2.58	9.95

Figure 5-17 presents the development and redevelopment projects planned for implementation during the timeframe of the EWMP in Subwatershed 1that are under the jurisdiction of the County of Los Angeles. Under County guidelines, these projects are required to have the capacity to treat 1.5 times the design volume of the 85th percentile 24-hour storm due to the inability to infiltrate stormwater runoff in this subwatershed due to shallow groundwater. Table 5-9 lists the project in Subwatershed 1 and 2 that the County has planned for redevelopment.

The MdR WMA is projected to have development and redevelopment projects on an estimated 79.28 acres within Subwatershed 1, under both the County and City of Los Angeles jurisdictions, corresponding to approximately 21.48 % of this subwatershed. This area includes the proposed parking lot retrofits previously mentioned in Section 5.1.1. The County has two parcels planned for redevelopment in Subwatershed 2, as summarized in Table 5-9. These redevelopment projects equate to 1.92 acres, or 0.59 percent of the subwatershed.

The City of Culver City does not have planned development and redevelopment projects during the implementation timeframe of this EWMP.

Figure 5-17: Subwatershed 1 Potential Redevelopment Parcels

Table 5-9: Subwatershed 1 and 2 Potential Development and Redevelopment Projects within the County of Los Angeles Jurisdiction

Parcel Number	Area (acres)*	Project Description
Subwatershed 1		
10	7.32	Neptune Apartments. Demolition of existing 136-unit apartment complex and development of a 400-unit complex.
15	10.44	Bar Harbor Apartments. Replace existing 288-unit apartment complex with 585-unit apartment complex.
14 /FF	2.05	Demolition of existing parking lot and development of 126-unit apartment complex.
28	8.50	Mariner's Bay. Rehabilitation.
42, 43	3.85, 2.39	Marina del Rey Hotel. Rehabilitation of the hotel and demolition and redevelopment of private boat anchorage.
44	9.72	Commercial Development BEI Project #187-07-003C. Redevelopment will include 85,069 square feet of new buildings with concrete paved parking, driveways and landscape areas.
52, GG	2.04, 0.68	Dry stack boat storage facility. Along with appurtenant office space, customer lounge, mast-up storage spaces, and parking. Sheriff's Department / Lifeguard Boatwright facility.
55, 56, W	0.51, 1.21, 4.28	Fisherman's Village. Demolition of Fisherman's village and parking, landscaping, and development of a new mixed use commercial plaza with multi-story parking structure.
7, 8, 9	5.03, 4.51, 3.68	Marriott Hotel and Wetland Park. Construction of hotel with restaurant and other auxiliary facilities. Development of public wetland and upland park.
95, LLS	1.70, 0.23	Demolition of existing office structures and development of commercial buildings and rehabilitation of existing restaurant.
145	2.08	Marina International Hotel. Interior and exterior renovation.
147/OT	1.62	Demolition of existing landside improvements and construction of 114-unit senior accommodation facility, retail space, parking structure, marine, commercial, and community park (Parcel 21).
21	2.58	Marine commercial, retail and yacht club project with a Community Park.
UR	1.82	Parking Lot Retrofit. Lot 5
Q	0.85	Parking Lot Retrofit. Lot 7.
NR	1.58	Parking Lot Retrofit. Lot 9.
40T	0.61	Parking Lot Retrofit. Library.
Total Area	**79.28**	
Percent of Subwatershed 1	**21.48%**	
Percent of TMDL AREA	**5.63%**	
Subwatershed 2		
95, LLS	1.70, 0.23	Demolition of existing office structures and development of commercial buildings and rehabilitation of existing restaurant.
Total Area (acres)	**1.92**	
Percent of Subwatershed 2	**0.59%**	
Percent of WMA	**0.14%**	

*Land area as provided in leased parcels data set.

5.4 Control Measures Type Summary

The structural BMPs described above represent many different capture, infiltration, and treatment control measure types based on the factors discussed in this section, including land use and groundwater level. Table 5-10 presents the acreage coverage corresponding to the various BMP types to be implemented within the watershed. The BMPs in these tables include all the structural measures discussed in this section, with the exception of the sanitary sewer diversions (additional BMPs).

In addition to capturing wet weather flow, the BMPs proposed in this EWMP will also treat dry weather runoff. Non stormwater management has been a priority in the Marina del Rey Watershed as evidenced by the three low-flow diversions (92,000, 20,000, and 288,000 gal/day) that were installed in 2006-2010 by the LACFCD to divert dry-weather flows to the sanitary sewer as part of the compliance strategy for the Bacteria TMDL. Additionally, the recent Bacterial TMDL TSO (No. R2-2014-0142) requires weekly dry weather flow observational monitoring at major outfalls.

Table 5-10: Summary of BMP Types by Subwatershed

BMPs	Subwatershed Area (acres)					
	1A	1B	3	4	Total TMDL Area	2
Subwatershed Total						
Regional Projects	0	0	7.4	292.9	52.9	3.5
Low Impact Development (LID)*	44.1	117.8	13.9	60.3	247.9	11.9
Green Streets**	52	132.1	49.2	285.5	854.9	85.2
Additional BMPs	0	0	0	0	0	0
Non-Structural Programs	0	0	0	0	0	0
Open Space (Misc.)	**8.2**	**14.67**	**-**	**7.06**	**29.93**	**-**
Total	**104.22**	**264.54**	**70.5**	**645.7**	**1,084.90**	**100.6**

*LID includes development/redevelopment plus downspout disconnect/cisterns

**Green streets – includes sidewalk swale, porous pavement, sidewalk filtration disconnect/cisterns

5.5 EWMP Non-Structural BMPs

The 2012 Permit Section VI.D.1 specifies that Permitees shall implement the MCMs identified in the Permit in Section VI.D.4 through VI.D.10 or "implement customized actions within these general categories of control measures". The following are the six categories of MCMs identified in the Permit:

1. Development Construction Program
2. Industrial/Commercial Facilities Program
3. Illicit Connection and Illicit Discharges Detection and Elimination Program
4. Public Agency Activities Program
5. Public Information and Participation Program (PIPP)
6. Planning and Land Development

The MdR EWMP Agencies will implement the required MCMs in Part VI.D.4 through VI.D.10 as described in the Permit, without additional customization at this time. . After the EWMP proposed BMPs and MCMs required in the 2012 Permit are implemented, customizations or additional MCMs may be identified through the adaptive management process (Section 10.0) and implemented by the EWMP Agencies.

The estimated contribution of the 2012 Permit required MCMs used in the MdR EWMP is a conservative 6.5 Percent. The load reduction contribution of some of the MCMs implemented by the WMG Agencies under the 2001 Permit may continue to increase over the period of the MS4 Permit as awareness increases and enforcement is strengthened. Other programs, such as street sweeping are assumed not to have an additional effect on water quality beyond what was already captured in the monitoring results used in the RAA effort. If, however, enhancements are made to existing programs, the load reduction apportioned to these MCMs may be increased correspondingly. One example is the potential inclusion of more advanced street sweepers (regenerative air or vacuum) that the County of Los Angeles is planning on implementing by December 2016.

The direct impact of MCMs and non-structural BMPs, (specific types of which include true source control, enhanced inspections, catch basin cleaning and runoff reduction programs) implemented as part of one of the six categories described above, is challenging to quantify. Supporting evidence and studies do exist, however, justifying the load reduction apportionment for various nonstructural programs within the MdR watershed. The Toxics TMDL assumed that non-structural BMPs would reduce loads by 30% (LARWQCB, 2005). Based on the estimates presented in the Multi-Pollutant TMDL Implementation Plan for the Unincorporated Area of Marina del Rey Harbor Back Basins (Multi-Pollutant TMDL Implementation Plan [LADPW, 2012]), the total reduction that could be achieved from non-structural BMPs was approximated to be 33%; however, the plan used a more conservative load reduction of 25%. For the purposes of the MdR EWMP, an even more conservative percent reduction, 6.5%, was used and may be modified based on the adaptive management process of BMP observed performance, evaluation, and customization (Section 10.0).

The non-structural BMP programs described in the 2012 Permit include activities such as source control programs, catch basin cleaning, industry targeted outreach, education, enforcement, and inspection programs as well as community outreach and education. These are briefly discussed below and listed in , along with the 2012 Permit MCM category that they are associated with.

Table 5-11: Non-Structural BMPs within the MdR WMA

Proposed Non-Structural MCMs	Non-Structural MCM Category 2012 Permit	Potential Contaminant Reduction (%)
Pollutant Loading Model and Database; Total Suspended Solids/Pollutant Correlations		
Source Control - Collaborative Environmentally Friendly Alternative Services Program; Product Substitution Campaign	Industrial/ Commercial Facilities Programs; Planning and Land Development; Public Agency Activities Program	4

Targeted Aggressive MS4 and Catch Basin Cleaning Program	Public Agency Activities Program	1
Code Survey and Modification; Targeted Inspections; Business-led Voluntary BMP Implementation Program	Industrial/Commercial Facilities Program; Illicit Connection and Illicit Discharges Detection and Elimination Program	1
Outreach and Education; Environmentally Friendly Boating Program; Green Gardening, and Runoff Reduction Program	PIPP; Industrial/Commercial Facilities Program; Public Agency Activities Program;	0.5
Total Contaminant Reduction (%)		**6.5**

True source control by targeting the actual pollutant source is very effective at reducing concentrations and/or loads. One example of a true source control is product substitution campaigns which involve identifying products that contribute to pollutant loading and water quality degradation and substituting products that are less harmful to water quality. One example is Senate Bill 346 that requires manufacturers to reduce the amount of copper in brake pads in California through the Brake Pad Partnership. In the urbanized Chollas Creek watershed (which is under a dissolved metals TMDL), it has been estimated that approximately 90% of the copper loading is from brake pad deposition (Weston, 2009). Under the adopted legislation, copper (and other heavy metals) in brake pads will be phased out and by 2025 will consist of only trace amounts. Nearly all the required reduction of copper to meet the Chollas Creek TMDL will therefore be achieved from this true source control strategy. In MdRH, evaluating alternative types of fencing (i.e., replacing galvanized metal products), prohibiting and/or restricting use of outdoor architectural copper, and the reduction of zinc in tires could significantly reduce the zinc load. The Rain Barrel Downspout Disconnect Program by the City of San Diego (Weston, 2010c) and the City of San Diego Aerial Deposition, Phase III Study (Weston, 2009) showed that during storm events, runoff from galvanized steel building materials can have elevated zinc concentrations, as high as 500 times the concentration seen at ground level (Weston, 2009). For the EWMP, a conservative number of 4% was used to estimate pollutant load reductions from source control efforts.

Prioritization of catch basins and targeting MS4 and catch basin cleaning efforts to the prioritized catch basins is another example of a non-structural BMP. A pilot study completed by the City of San Diego in the San Diego River watershed (Weston, 2010b) indicates that aggressive MS4 catchment cleaning (e.g., steam cleaning) is effective at removing biofilm. Based on the results of this study and the Bacteria Non-point Source Study (NPSS [Weston, 2007]), the Multi-Pollutant TMDL Implementation Plan (LADPW, 2012) estimated that an MS4 catchment cleaning program could result in a 1–3% pollutant load reduction. For the EWMP a conservative number of 1% was used to estimate potential pollutant load reductions for a targeted aggressive MS4 and catch basin cleaning program.

Institutional controls, regulatory changes and inspection and enforcement represent important aspects of MCMs necessary to achieve reductions in contaminant loading for the MdR watershed. These non-structural solutions may incentivize targeted audiences to proactively modify behaviors and operations to avoid the need for regulatory enforcement. Such measures include code modifications as well as inspection and enforcement measures to ensure restaurants, parking garages, and other commercial facilities comply with the applicable codes. A voluntary-led program may be developed, including incentives, for those facilities that voluntarily install wet-weather and dry-weather runoff BMPs. The NPSS (Weston 2007) study identified restaurant washing and waste management activities to be sources of high enterococcus. According to the Multi-Pollutant TMDL Implementation (LADPW, 2012) targeted and more-aggressive restaurant education, outreach, and incentive programs would serve as cost-effective operational source control measures for reducing loads to MdRH. The plan also indicated that there are opportunities to leverage current programs and existing efforts being conducted within the restaurant community to achieve greater behavioral change that would result in greater potential pollutant load reductions of 1-4%. (LADPW, 2012)

Under the Multi-Pollutant Implementation Plan, more-aggressive programs to increase proper containment and management of solid waste targeted to restaurants, the boating community, and parking garage facilities were estimated to achieve a conservative 5% reduction in bacteria waste loads (LADPW, 2012). The NPSS study found that parking lot wash down activities were the cause for highest bacterial concentrations measured during the study; thus targeting parking garages would likely result in comparable reduction in bacterial and metals loading. The Multi-Pollutant Implementation Plan estimated that this type of program could potentially result in a 3–6% pollutant load reduction. For the EWMP, a conservative number of only 1% was used to estimate the pollutant load reductions associated with commercial facility programs.

Outreach and education activities will have a role in enhancing community practices throughout the watershed. Examples include billboard campaigns to promote protective waste management practices such as recycling used motor oil and batteries and environmentally sound boating practices, in addition to ordinance development to promote sound irrigation practices. Based on phone interviews conducted with representatives from the Santa Monica Bay Restoration Commission (LADPW, 2012), in the recent past, the MdRH boating community has mobilized behind environmental stewardship programs (e.g., 2009–2010 Honey Pot Days and 2008–2010 bilge pad recycling program), and will likely continue to participate in these programs. Opportunities are present to leverage existing boater outreach programs to achieve land-side behavior change (i.e., trash management, reduced washing activities, product substitution, etc.). The NPSS study (Weston, 2007) also found canines to represent 11% of the wet-weather source and 10% of the dry-weather source of bacterial loading. The Multi-Pollutant TMDL Implementation Plan estimated that an aggressive dog waste management program implemented in MdR could potently achieve an approximate reduction of 2–3% of the bacterial load reduction. For the EWMP, a conservative estimate of 0.5% was used for outreach and education activities for these programs.

6.0 REASONABLE ASSURANCE ANALYSIS

6.1 Reasonable Assurance Analysis Setup

The purpose of the RAA is to quantitatively demonstrate that the proposed control measures included in the EWMP will "achieve applicable WQBELs and/or RWLs with compliance deadlines during the Permit term" (Section C.5.b.iv.(5) of the 2012 MS4 Permit). The RAA requires the development of a modeling process to support the selection of BMPs as well as an adaptive customization and scheduling process to demonstrate and address compliance with the MS4 Permit. The RAA for the MdR watershed complies with the RAA guidelines provided by the LARWQCB to the extent practicable and applicable to the watershed.

The RAA analyses involved multiple steps starting with identification of the watershed modeling tool (Watershed Management Modeling System [WMMS]), characterization of the modeled area (MdR WMA), including land-use and existing BMPs, and evaluation of water and sediment quality monitoring data available for the WMA as of the date of modeling. This information was integrated into the model data inputs and used for calibration of the model to ensure, to the extent reasonable, the accurate representation of simulated watershed conditions. Once calibrated, the model was run for the WMA at a subwatershed level.

The results from the RAA analyses were used as guidelines in the identification of BMPs, including regional BMPs, to be implemented throughout the MdR WMA. This analysis incorporates the identification of development and redevelopment projects; potential customization of existing BMPs; and potential regional, centralized, and distributed BMPs necessary and sufficient for compliance.

Detailed information on the model configuration processes and model methodology can be found in Appendix C.

6.1.1 Modeling Tool Selection

The MdR EWMP Agencies have selected the Los Angeles County WMMS as the model to be used for the development of the MdR EWMP. WMMS conforms to the modeling system selection criteria set by the LARWQCB–led RAA committee and is based on a regional modeling approach that was developed to simulate the hydrology and transport of sediment and metals. The approach is based on the Hydrologic Simulation Program–FORTRAN (HSPF) and Loading Simulation Program C++ (LSPC), a version of HSPF recoded into C++. The regional approach has been used to support metals TMDLs for Ballona Creek and the Los Angeles River. WMMS simulates hydrology, sediment, and general water quality on land and is combined with a stream fate and transport model. Additional detailed information related to the WMMS is available and can be accessed on the WMMS website (http://www.LACountyWMMS.com).

WMMS was used to estimate the wet weather loading for the MdR WMA for the constituents of concern, including copper, lead, zinc, and TSS. The results are presented in terms of hourly volumes and loads. As part of the RAA, the watershed modeling tool was first used to model the monitored storm events in order to calibrate stormwater runoff volumes and pollutant loads to available measured data. The calibrated model was then used to simulate the critical year, which was determined to be the 2009 wet season (Section 6.1.4) in order to determine the quantity of load reductions that will be necessary to meet the applicable TMDL requirements.

6.1.2 WMMS Model Calibration

Monitoring data collected as part of the Toxics TMDL CMP were used to calibrate the storm water runoff volumes and pollutant loads generated by WMMS for the MdR WMA. These monitoring data included 27 monitored storm events at 5 sites (MdR-3, MdR-4, MdR-5, MdRU-C-1, MdRU-C-2) (Figure 6-1) over 4 wet seasons (2010 – 2013) (WESTON, 2014a) (Figure 6-1).

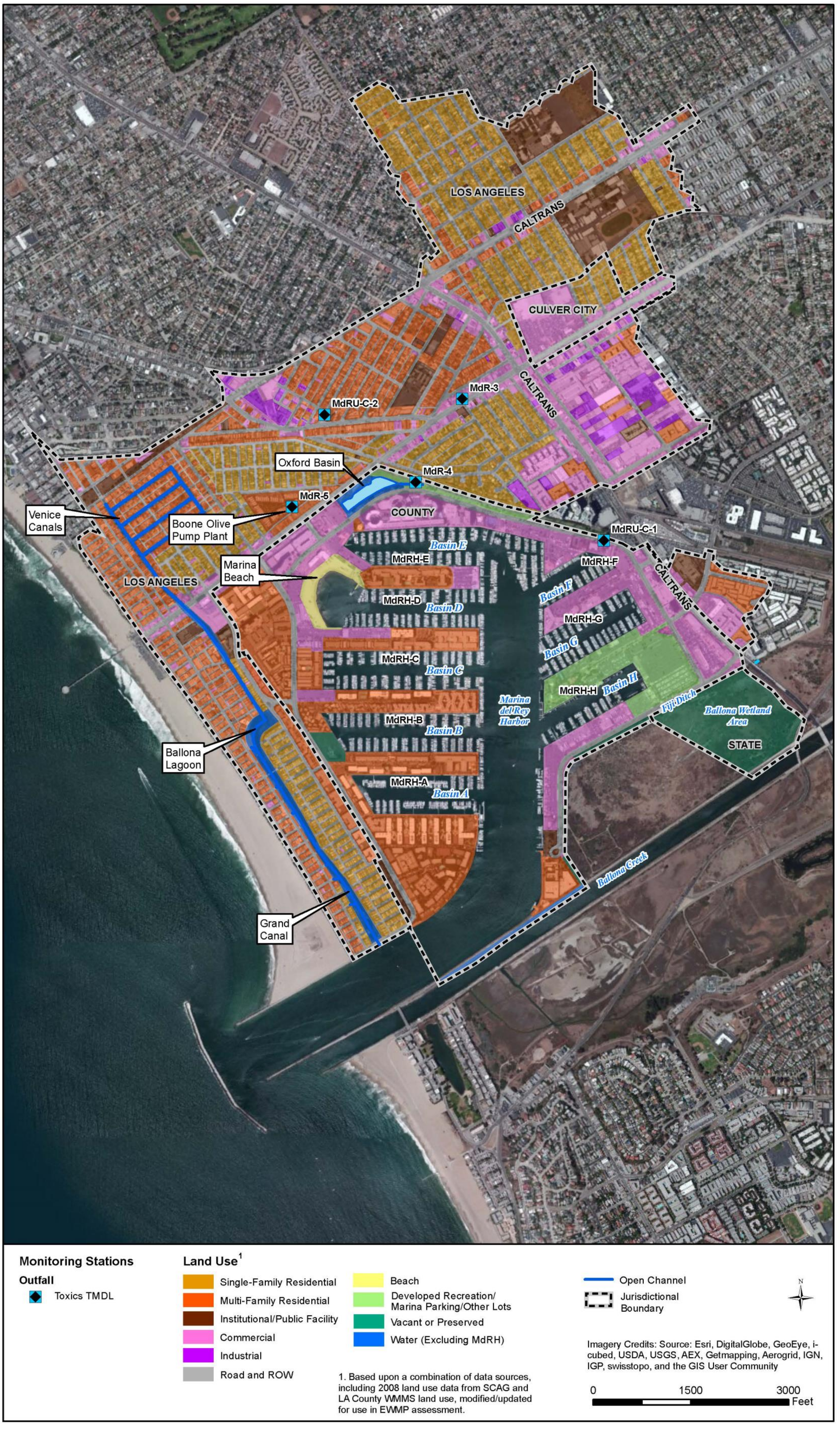


Figure 6-1: Toxics TMDL Outfall Monitoring Locations

At the time of modeling, WMMS rain gauge data were available through April 2012; therefore hourly data recorded at the Electric Avenue Pumping Plan (Gauge AL461) were obtained and incorporated into WMMS. Land use values for the drainage area to each monitored site were also incorporated into the model. The summary of the land use for the drainage area to each monitored location is provided in Table 6-1. Detailed information is presented in the MdR Coordinated Integrated Monitoring Program (CIMP). WMMS model runs were performed for the monitoring periods for each monitored site drainage area.

Table 6-1: Monitoring Locations – Land Use Summary

Land Use Type	MdR-3	MdR-4	MdR-5	MdRU-C-1	MdRU-C-2
High Density Single-Family Residential	114.2	27.8	22.9		
Low Density Single-Family Residential Moderate		0.8			
Multi-Family Residential	54.6	15.1	21.1		4.5
Commercial	42.5	29.8	2.9	0.3	
Institutional	57.8		1.4		
Industrial	0.8	50.1	0.2		
Secondary Roads	106.5	29.2	22.0	2.3	2.0
Vacant		0.6			
Total	**376.4**	**153.4**	**70.5**	**2.6**	**6.5**

6.1.2.1 Runoff Volume Calibration

The modeled stormwater runoff volumes were compared to the measured volumes. Calibration of the model was performed by changing the percentages of impervious cover associated with the various land use types for each drainage area (e.g., if the model overestimated runoff, then the overall percent of impervious cover was reduced proportionally for all applicable land use types). Validation of the model was performed by running the models with the new impervious percentages and comparing the model results to the measured results. The summary of the storm water runoff volume calibration is provided in Table 6-2. Post calibrated results all fall into the RAA Guidance "Very Good" category (<10% difference)

Table 6-2: Stormwater Runoff Volume Calibration Summary

Site	Area (acres)	Uncalibrated Results		Impervious Correction Factor	Calibrated Results	
		Impervious Percentage	Runoff Volume Percent Difference		Impervious Percentage	Runoff Volume Percent Difference
MdR-3	376.4	63.4%	24.3%	0.81	51.4%	2.1%
MdR-4	153.4	75.9%	38.8%	0.72	54.6%	-0.5%
MdR-5	70.5	47.2%	-19.0%	1.20	57.4%	-0.2%
MdRU-C-1	2.6	66.6%	-11.6%	0.784	52.2%	1.4%
MdRU-C-2	6.5	56.4%	15.9%	0.863	48.7%	0.7%

6.1.2.2 Toxic Metals Loading Calibration

Toxic metal constituents copper, lead, and zinc were calibrated in the model based on a comparison between baseline (or initial) model results and the CMP results. Modeled flow volumes were combined with CMP measured toxic metals concentrations to compute the applicable loading for the monitored storm events. Using the modeled flows eliminated the potential to introduce error based on the difference between modeled and measured flow volumes for individual storm events. This method also resulted in improved model fits. The measured load was compared to modeled toxic metals loads for these monitored storm events. A correction factor was computed based on the proportion of measured load to modeled load for each monitored site for each of the toxic metals. This correction factor was used to make adjustments to the WMMS wash-off potency factor (POTFW) constant loading parameter values. Modeling was performed with these new POTFW parameters, and the modeled loads were again compared to the measured loads to verify that the modeling was calibrated for the each toxic metal. The storm water runoff volume calibration is summarized in Table 6-3. Modeling results were within the RAA process guidelines, and the % difference was less than those listed in the RAA guidance for very good.

Table 6-3: Stormwater Runoff Zinc Loading Calibration Summary

Site	Area (acres)	Uncalibrated Loading Percent Difference	Modeling Correction Factor	Post-Calibration Loading Percent Difference*
Copper				
MdR-3	376.4	-55.4%	2.24	<1%
MdR-4	153.4	3.3%	0.97	<1%
MdR-5	70.5	18.1%	0.85	<1%
MdRU-C-1	2.6	-59.6%	2.47	<1%
MdRU-C-2	6.5	-51.5%	2.06	<1%
Lead				
MdR-3	376.4	3.3%	0.97	<1%
MdR-4	153.4	48.1%	0.68	<1%
MdR-5	70.5	-36.0%	1.56	<1%
MdRU-C-1	2.6	-68.8%	3.21	<1%
MdRU-C-2	6.5	-80.3%	5.07	<1%
Zinc				
MdR-3	376.4	-29.5%	1.42	<1%
MdR-4	153.4	55.8%	0.64	<1%
MdR-5	70.5	137.6%	0.42	<1%
MdRU-C-1	2.6	20.5%	0.83	<1%
MdRU-C-2	6.5	26.3%	0.79	<1%

*Load modeling calibration was based on modeled flows and measured concentrations from storm events over a four year period, and therefore adjustments of model parameters (POTFW values) resulted in percent difference values of less than 1%, which is defined as "very good."

6.1.2.3 TSS Calibration

The Toxic TMDL is a sediment-based TMDL that considers the reduction in TSS equivalent to toxic pollutants reductions. WMMS was, therefore, also calibrated for the constituent TSS. Modeled flow volumes were combined with CMP-measured TSS concentrations to compute the sediment loading for the monitored storm events. The loading was compared to modeled TSS loads for these monitored storm events. A correction factor was computed based on the proportion of measured TSS load to modeled TSS load for each monitored site. The WMMS coding does not have POTFW parameter for TSS; therefore, the computed TSS correction factor for each monitored site was applied to the model output using a spreadsheet (post-process adjustment). The modeling results, with the TSS correction factor applied, were compared to the measured TSS load to verify modeling was calibrated for the TSS. The stormwater runoff volume calibration is summarized in Table 6-4.

Table 6-4: Stormwater Runoff TSS Loading Calibration Summary

Site	Area (acres)	Uncalibrated TSS Loading Percent Difference	TSS Modeling Correction Factor	Post-Calibration TSS Loading Percent Difference*
MdR-3	376.4	-39.2%	1.644	<1%
MdR-4	153.4	65.3%	0.605	<1%
MdR-5	70.5	136.4%	0.423	<1%
MdRU-C-1	2.6	-40.6%	1.685	<1%
MdRU-C-2	6.5	-19.2%	1.24	<1%

*load modeling was based on modeled flows, and therefore the percent difference values were very low, less than 1% and defined as "very good."

6.1.3 Subwatershed Modeling Parameters

The MdR WMA applicable to the EWMP consists of approximately 1,409 acres divided into four subwatershed areas (Figure 1-2). For more information regarding modeling land-use see Appendix C.

Table 6-5 provides a summary of the land use associated with each subwatershed area. Subwatershed 1 is divided into Subwatershed 1A, which drains to the Back Basins of the harbor (Basins D, E, and F) and Subwatershed 1B, which drains to the Front Basins of the harbor (Basins A, B, C, G, and H).

Table 6-5: Subwatershed Land Use Summary

Land Use Type	Subwatershed 1A (Front Basins)		Subwatershed 1B (Back Basins)		Subwatershed 2 (Ballona Lagoon)		Subwatershed 3 (Boone Olive)		Subwatershed 4 (Oxford Basin)	
	Area (acres)	Imp. %	Area (acres)	Imp. %	Area (acres)	Imp. %	Area (acres)	Imp. %	Area (acres)	Imp. %
High Density Single-Family Residential	-	-	-	-	45.8	42.2%	22.9	49.3%	166.3	33.9%
Low Density Single-Family Res. Moderate	0.4	6.0%	1.4	19.3%	-	-	-	-	0.8	7.9%
Multi-Family Res.	17.3	63.3%	119.8	62.3%	131.8	59.8%	21.1	48.3%	96.3	44.7%
Commercial	65.6	70.6%	94.3	63.8%	23.2	92.6%	2.9	95.0%	129.7	69.3%
Institutional	0.7	71.3%	8.2	63.3%	10.2	85.3%	1.4	95.0%	63.6	64.4%
Industrial	-	-	-	-	0.2	0.0%	0.2	95.0%	27.0	69.8%
Secondary Roads	11.8	59.8%	26.2	53.6%	83.3	67.9%	22.0	67.0%	154.8	53.5%
Vacant/ Open Space	8.2	0%	14.7	0%	33.3	0.0%	0.0	0.0%	7.1	0.0%
Total	**104.2**		**264.5**		**327.7**		**70.5**		**645.7**	

IMP - Impervious

Subwatershed 2 is not included as part of the Toxic TMDL or the Bacteria TMDL, and no CMP monitoring locations were located in the Subwatershed 2 area. Subwatershed 2 is included in the Santa Monica Bay DDT and PCBs TMDL; however, as discussed in Section 3.2.3, the WLA for stormwater was set at existing levels (anti-degradation). The expected stormwater volume reductions anticipated to occur from proposed BMPs in this EWMP will reduce the loading of DDT and PCBs below current levels, therefore preventing degradation.

Subwatershed 2 area was modeled without changing the calibration parameters established during the development of WMMS. The results of the Subwatershed 2 modeling are presented in this document to provide an approximate estimate of the existing conditions. Future monitoring may allow for calibration of WMMS specific to Subwatershed 2.

The calibration parameters (correction values) determined for the monitoring sites were applied to the respective subwatershed areas. The MdRU-C-1 Site is located within the Subwatershed 1 area (Figure 6-1); therefore, the MdRU-C-1 correction factors were used for Subwatershed 1. Subwatershed 3 corresponds directly to MdR-5. Subwatershed 4 includes MdR-3, MdR-4, and MdRU-C-2, and an additional 126.3 acres of unmonitored area (Figure 6-1). Therefore, modeling for Subwatershed 4 included performing four different models, including one for each of the three monitored drainage areas with the corresponding correction factors determined through the calibration process and a fourth model that included the unmonitored areas with correction factors based on the area-weighted average of the correction factors for the three monitored drainage areas. A summary of the correction factors associated with the monitored locations and subwatershed areas is provided in Table 6-6.

The results of the subwatershed modeling using WMMS were used as the foundation to perform calculations that included the existing pollutant loading, required load reductions, as well as load reductions possible using various types of BMPs. Modeling data (input and output files) are presented in Appendix C.

Table 6-6: Modeling Correction Factor Summary

Site	Area (acres)	Impervious Correction Factor	Copper Correction Factor	Lead Correction Factor	Zinc Correction Factor	TSS Correction Factor
MdR-3	376.4	0.81	2.24	0.97	1.42	1.64
MdR-4	153.4	0.72	0.97	0.68	0.64	0.605
MdR-5	70.5	1.20	0.85	1.56	0.42	0.423
MdRU-C-1	2.6	0.784	2.47	3.21	0.83	1.685
MdRU-C-2	6.5	0.863	2.06	5.07	0.79	1.24
Subwatershed 1A	104.2	0.784	2.47	3.21	0.83	1.685
Subwatershed 1B	264.5	0.784	2.47	3.21	0.83	1.685
Subwatershed 2	327.7	1.0	0.85	1.56	1.0	1.0
Subwatershed 3	70.5	1.195	1.87	0.94	0.421	0.423
Subwatershed 4	645.7	0.785	2.47	3.21	1.19	1.338

6.1.4 Toxic Pollutants Critical Period

In accordance with the Toxics TMDL and the RAA Guidance Document, the critical period for toxic pollutants for the MdR WMA was determined to be the 2009 rainfall year (July 1, 2009 to June 30, 2010). An analysis of the Los Angeles International Airport (LAX) rain gauge data spanning from 1948 to 2000 indicates that the average rainfall year is 12.43 inches. Based on the available LAX data (1940 to 2013) the rainfall year closest to this average value is 2009, with rainfall of 12.42 inches. The rain gauge data used by WMMS for 2009 have a total rainfall year value of 14.63 inches. More information on the critical year determination is provided in Appendix C.

6.1.5 Bacteria Critical Year

The critical year for bacteria is defined in the Bacteria TMDL as the year 1993. This year was used to model the Back Basin drainage area in WMMS.

6.1.6 Continuous Simulation Model (Toxic Pollutants)

To analyze the load reductions that may be achieved through implementing BMPs other than those designed to capture and infiltrate or reuse runoff associated with the 85th percentile storm event, continuous simulations models (CSMs) of the four watersheds were prepared to simulate how the combination of various types of BMPs would function to reduce pollutant loads during the critical year.

Consistent with the output of WMMS, the CSMs were prepared based on hourly time steps throughout the critical year. The CSMs exclude the portion of the subwatersheds that drain to BMPs designed to capture and infiltrate or reuse the 85th percentile storm event. For the remainder of the subwatershed, the CSMs perform calculations at each time step for different types of BMPs that may be implemented, including filtration (flow through treatment) BMPs, BMPs that capture runoff first and then perform treatment, BMPs that capture and infiltrate or reuse (with varying capture capacity), and areas where no BMPs are proposed, if applicable. These time step calculations include computing the portion of runoff generated in the drainage areas that would be treated or captured, whichever is applicable, by the proposed BMPs, the load remaining in the runoff after treatment, and the runoff and load that would bypass the BMPs (exceed the capacity of the selected BMPs). For BMPs that incorporate runoff capture, the CSM computes the recharge or drawdown volume of the systems that occurs during each time step.

The programing allows the user to vary certain parameters associated with the BMPs, including the drainage area (acres), treatment maximum flow rate if applicable (inches per hour associated with rainfall), BMP load reduction effectiveness, storage capacity if applicable (inches of rainfall), drainage area runoff coefficient, and maximum drawdown time (units of days) for BMPs that include capture. The user is provided a calculation summary that is dynamically linked to the time step calculations. The summary also includes the total modeled zinc load in the subwatershed, the targeted load reduction based on the Toxics TMDL waste load allocation allotted to the subwatershed, and the load reduction achieved through the combination of user-selected BMPs. The user can then make adjustments of the various BMP parameters until the desired load reductions are achieved.

More details including the key parameters used and the calculation methods relating to the CSMs are provided in Appendix C.

6.1.7 Continuous Simulation Model (Bacteria)

A bacteria CSM was prepared to calculate the existing fecal coliform loading into the Back Basins of the harbor. The bacteria CSM performs hourly time step calculations based on WMMS output data. WMMS provides data on fecal coliform loading from modeled watersheds; however, the CMP was focused on toxic pollutants and did not include sampling for and analyzing bacteria. Therefore, data are not currently available to calibrate the WMMS tool. The suggested average event mean concentrations (EMCs) for fecal coliform provided in the RAA Guidance Document were used to calculate a composite (or comingled) EMC for the Back Basin drainage area based on the suggested EMC, land use area, and land use impervious cover percentage. The data used and the results of these composite EMC calculations are provided in Table 6-7. The bacteria CSM used the composite EMC to calculate the bacteria loading being discharged from the subwatersheds based on the modeled runoff volume and composite EMC value. Load reductions were based on the volume of runoff reduction (capture) achieved by the selected BMPs for the bacteria analysis. The target load reduction analysis is discussed in more detail in Appendix C.

Table 6-7: Fecal Coliform Event Mean Concentration Calculation Summary

Land Use Type	Fecal Coliform EMC* (MPN/ 100 ml)	Subwatershed 1A		Subwatershed 3		Subwatershed 4		Back Basin Drainage Area	
		Area (acres)	Imp. Cover	Area (acres)	Imp. Cover	Area (acres)	Imp. Cover	Area (acres)	Imp. Cover
High Density Single-Family Residential	3.11E+04	0.0	32.9%	22.9	49.3%	166.3	33.9%	189.3	35.7%
Low Density Single-Family Residential Moderate	3.11E+04	0.4	6.0%	0.0	0.0%	0.8	7.9%	1.3	7.2%
Multi-Family Residential	1.18E+04	17.3	63.3%	21.1	48.3%	96.3	44.7%	134.7	47.7%
Commercial	7.99E+04	65.6	70.6%	2.9	95.0%	129.7	69.3%	198.2	70.1%
Institutional	7.99E+04	0.7	71.3%	1.4	95.0%	63.6	64.4%	65.7	65.1%
Industrial	3.76E+03	0.2	42.0%	0.2	95.0%	27.0	69.8%	27.4	69.8%
Secondary Roads	1.68E+03	11.8	59.8%	22.0	67.0%	154.8	53.5%	188.6	55.5%
Vacant	6.31E+03	8.2	0.0%	0.0	0.0%	7.1	0.0%	15.3	0.0%
Total		**104.2**	**62.3%**	**70.5**	**57.4%**	**645.7**	**51.4%**	**820.4**	**53.3%**
Composite EMC (MPN/ 100 ml)		**5.98E+04**		**2.02E+4**		**3.89E+4**		**4.03E+4**	

* Source LARWQCB, 2014
IMP = Impervious

The total bacteria load and reduction in bacteria needed to obtain compliance with the Bacteria TMDL allowable exceedance days was calculated using the CSM described above. Additional details of this analysis can be found in Appendix C and in Section 6.2.3.

6.2 Reasonable Assurance Analysis Existing Conditions and Top Down Estimation of Best Management Practices

The calibrated WMMS model and the CSMs prepared for the MdR subwatersheds were used to estimate the current annual loading and associated required load reductions. Based on the estimated required load reductions, hypothetical quantities of various types of BMPs were selected and incorporated into the CSM. The CSM allowed BMP quantities and capacities to be varied until the required load reductions were achieved in the model. This is considered a top down approach, because it focuses on the volume of storm runoff that is required to be captured or treated and the associated BMPs needed to do so. The top down approach does not consider site constraints, such as geology, depths to groundwater, existing infrastructure, costs, and other important factors. The top-down approach is useful for providing managers with an understanding of the types of BMPs that may be used to achieve the required load reductions in an unconstrained environment. There are many site constraints within the MdR watershed, which are discussed in more detail in Section 4and were considered during BMP selection.

6.2.1 Toxic Pollutants Critical Constituent Analysis

The constituent requiring that greatest load reduction, in percentage, is considered to be the critical constituent of the toxic pollutants. The strategy of the RAA was to focus on the critical constituent. By addressing the constituent with the largest required load reduction, the other constituents, with less required load reductions, would also be addressed (See Appendix C for more detailed discussion). Critical period (2009 rainfall year) modeling results for copper, lead, and zinc loading were compared to Toxics TMDL listed WLAs to determine the load reduction required for each. The summary of these results are provided in the Table 6-8. The results indicate that zinc is the critical constituent of the toxic pollutants.

Table 6-8. Summary of Toxic Pollutants Required Load Reductions

Subwatershed	Area (ac)	Copper	Lead	Zinc
		(Kg/year)		
Subwatershed 1A	104.2	8.78	10.22	26.6
Subwatershed 1B	264.5	16.92	20.18	52.11
Subwatershed 3	70.5	1.13	2.04	5.29
Subwatershed 4	645.7	21.68	9.87	131.92
Total	**1,084.9**	**48.51**	**42.31**	**215.92**
Toxics TMDL MS4 WLA		2.26	3.1	9.96
Required Load Reduction		46.25	39.21	205.96
Required Load Reduction (%)		**95.3%**	**92.7%**	**95.4%**

6.2.2 Toxics TMDL Existing Conditions Water Quality Modeling

As previously described in more detail, the WMMS tool was calibrated and used to model existing conditions within the MdR WMA. The output data from WMMS were then used in a CSM prepared for each subwatershed to determine the load reduction required to achieve compliance with applicable TMDLs and the various combinations of BMPs (besides those designed to capture and infiltrate or reuse the 85th percentile storm event) that could be used to achieve those load reductions. Scenarios were evaluated for each subwatershed area that included (1) 0% of the area draining to BMPs that capture and infiltrate or reuse and 100% of the area draining to other types of BMPs and (2) 50% of the area draining to BMPs that capture and infiltrate or reuse and 50% of the area draining to other types of BMPs. For each of these scenarios, the amount of drainage area treated by filtration type MCMs was varied to include the following factors: zero filtration, medium amount of area treated by filtration BMPs, and the maximum amount of area that could be treated by filtration BMPs. Details of the analysis can be found in Appendix C.

6.2.3 Bacteria TMDL Load Reduction Analysis

An analysis of historic rainfall data paired with bacteria monitoring results was performed based on the premise that a correlation between storm size and bacterial exceedances existed, and therefore a distinction between storms that exceeded TMDL criteria and storms that did not exceed TMDL criteria could be established. The analysis focused on determining the "cutoff" value between smaller and larger rainfall events for (1) the historical number of exceedances and (2) the allowable number of exceedances. The difference between these two cutoff values was determined to be the amount of rainfall that currently needs to be captured in order to meet bacteria compliance (i.e., the difference is the amount of rainfall that if captured would result in the cutoff rainfall value for the future historical exceedances being in alignment with the allowable exceedance cutoff rainfall value). Results of this analysis (details of this analysis can be found in Appendix C) indicate that a reduction in volume equivalent to capturing the runoff from 0.3-in storm is required.

The total bacteria load and reduction in bacteria load for BMPs designed to capture the runoff associated with a 0.3-inch storm event were estimated using the prepared CSM (Section 6.1.7, Appendix C). The Back Basin drainage area was modeled using WMMS for the critical year of 1993 (the critical year identified in the TMDL 6.1.5). The WMMS tool output was used as the foundation to prepare the bacteria CSM. The CSM was used to estimate the flow reduction that would be achieved through the implementation of BMPs designed to capture and infiltrate or reuse the storm water runoff associated with 0.3 inch of rainfall. To calculate the load, the applicable volume was used along with the estimated fecal coliform EMC value for this watershed (the EMC from the RAA Guidance Document was used). The results of these calculations are provided in Table 6-9. The CSM assumed capture-type BMPs with 100% reduction of the loads for the captured volume. However, the treatment BMPs that achieve the same load reductions could be implemented to meet the TMDL compliance (e.g., treatment BMPs with twice the capacity and 50% effectiveness would theoretically accomplish the load reduction target).

Table 6-9 Bacteria Loading and Required Reduction

Parameter	Total Modeled	Required Reduction	Percent Reduction
Volume	55,536,480 cf	13,494,920 cf	24%
Fecal Coliform Load	6.26E+14 MPN	1.52E+14 MPN	24%

6.2.4 Bacteria TMDL Existing Conditions Water Quality Modeling

The WMMS tool was calibrated and used to model existing conditions within the MdR WMA. The total bacteria load and reduction in bacteria needed to obtain compliance with the Bacteria TMDL (Section 6.2.3) allowable exceedance days was calculated using the CSM described in Section 6.1.7. Additional details of this analysis may be found in Appendix C. The results of the analysis of the rainfall data paired with monitoring data indicate that the Bacteria TMDL is less of a driver for the implementation of the structural BMPs than the Toxics TMDL. The results indicated that a reduction of 24% (Table 6-9) would be necessary to achieve compliance with the Bacteria TMDL The load reduction associated with meeting the WLA for zinc requires capture and/or treatment of much greater volumes (95% reduction) of runoff than that generated by a 0.3 inch storm event (which is the size of the storm event that the Bacteria analysis indicated needed to be captured to meet Bacteria TMDL compliance [Section 6.2.3]). Therefore, BMPs will be designed to address the greater reduction requirement of the Toxics TMDL, which will also treat the waters for bacteria at a level greater than the required load reduction. This effectiveness of this approach will be reassessed as part of the overall watershed adaptive management process, which may include evaluation of collective BMP effectiveness data and bacteria monitoring results. Details of the analysis can be found in Appendix C

6.3 Selected BMPs Reasonable Assurance Analysis Results

As discussed in Section 3.2.3, under the MS4 Permit, compliance with the sediment WLAs for copper, lead, zinc, chlordane, p'p-DDE, and total DDT may be demonstrated by any one of three different means: (a) qualitative sediment condition of unimpacted or likely unimpacted by the interpretation and integration of multiple lines of evidence is met, (b) sediment numeric targets are met in bed sediments, or *(c) final sediment WLAs are met*. Also under the MS4 Permit, compliance with the sediment WLAs for PCBs may be demonstrated by any of four different means: (a) fish tissue targets are met in species resident to the waterbody, *(b) final sediment allocations are met*, (c) sediment numeric targets to protect fish tissue are met in bed sediments, or (d) demonstrate that the sediment quality condition protective of fish tissue is achieved in accordance with the Statewide Enclosed Bays and Estuaries Plan, as amended to address contaminants in resident finfish and wildlife..

This EWMP focuses on demonstrating that compliance may be achieved through meeting final sediment WLAs for the contaminants in the MdR Toxics TMDL. This RAA delivers a quantitative demonstration, in accordance with the MS4 Permit, that the proposed BMPs will achieve interim and final WLAs. This analysis aims to provide reasonable assurance that the BMPs selected for the MdR WMA will be sufficient to meet the interim and final numeric WLAs, through stormwater capture, filtration, and diversion, and associated TSS loading reductions. In addition to the BMPs selected based on the RAA analysis, ongoing projects, including the Oxford Basin Multi-Use Enhancement Project, will provide additional water quality benefits, such as serving as a sink for sediment-bound contaminants from the watershed. Oxford Basin is located to the north of Basin E, and receives wet weather runoff from Subwatershed 4. The RAA analysis does not include any benefits from the Oxford Basin project, as the project is still under construction. Therefore, the BMPs as proposed may not all be necessary to achieve TMDL compliance.

The proposed BMPs will be implemented where feasible and within budgetary constraints. As additional data become available through monitoring and the completion of applicable special studies, the MdR EWMP Agencies may elect to demonstrate compliance through one of the above-mentioned other means.

The effectiveness of the selected BMPs and control measures will be verified through the monitoring program developed separately under the CIMP. Based on the monitoring data analysis and results, the implemented BMPs will be adjusted as necessary to ensure adequate performance and the overall BMPs implementation schedule will be reassessed.

The diagram presented in Figure 6-2 depicts the iterative multistage nature of the BMP selection process necessary to ensure that optimal BMP strategies combinations are selected while accounting for the complex relational dynamics between the different selection considerations, such as cost, risk, and effectiveness.

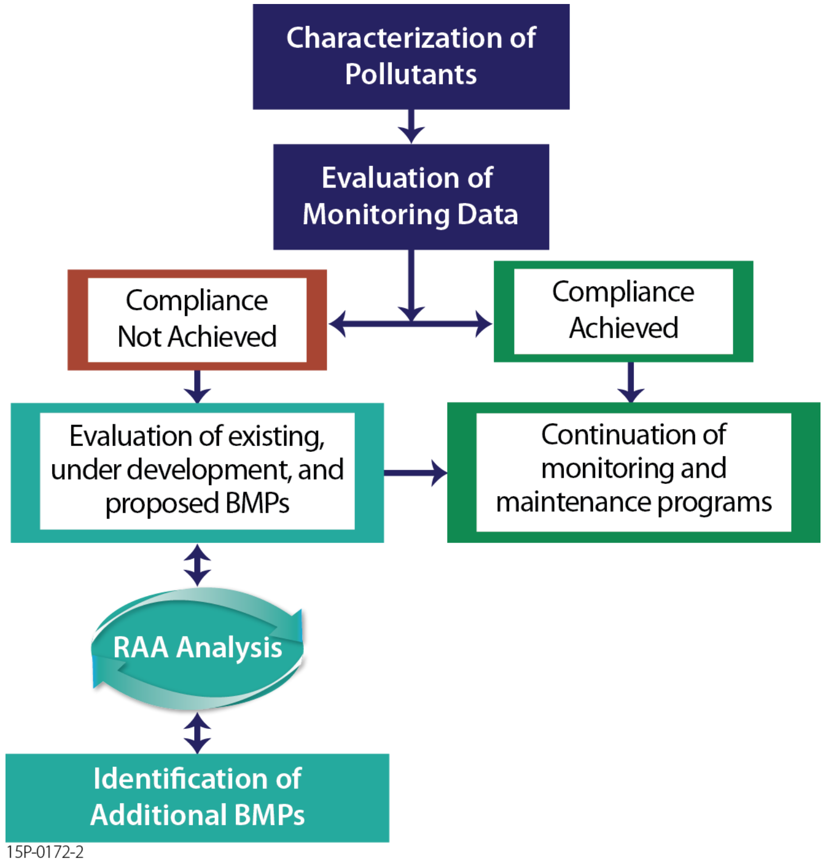


Figure 6-2: Conceptual Diagram of EWMP BMPs Implementation Analysis

The selected BMPs listed in Section 5.0 were modeled to estimate the annual capture (i.e. groundwater recharge) and treatment volumes and load reductions for the critical wet year (2009). The WMMS tool was used, and the WMMS output was incorporated into the CSM for each subwatershed (see Appendix C for details). The annual results are summarized in Table 6-10.

For the non-TMDL applicable Subwatershed 2 the selected BMPs listed in Section 6.3 were modeled to estimate the annual capture and treatment volumes and load reductions for the critical wet year (2009). Similar to the modeling for drainage areas to the Front and Back Basins, Subwatershed 2 was modeled using WMMS, and the output was incorporated into the CSM to estimate BMP volumes and load reductions. Results of the analysis are included in Table 6-10.

Table 6-10: Basins Drainage Area Summary of Modeled Volumes and Load Reduction – Critical Wet Year

Parameter (units)	Sub-Watershed 1A (Back Basins)	Sub-Watershed 1B (Front Basins)	Sub-Watershed 3 (Boone Olive)	Sub-Watershed 4 (Oxford Basin)	TMDL Runoff Area Total	Sub-Watershed 2 (Non-TMDL)
Total Area (acres)	104.2	264.5	70.5	645.7	1,084.9	327.7
Runoff Area (acres)	96.0	249.9	70.5	638.6	1,054.9	294.4
Total Rainfall (in)	14.6	14.6	14.6	14.6	14.6	14.6
Total Runoff (acre-ft)	71.9	171.8	44.7	369.9	658.3	203.9
Drainage Area TSS Load (kg TSS)	7,759	18,729	1,327	36,698	64,513	14,194
Target Load Reduction	96.4%	95.3%	87.8%	95.5%	95.4%	21.5%
Regional BMPs (Costco, Parks, and Venice Blvd. Neighborhood Project)						
Capture Area (acres)	-	-	7.4	292.9	300.3	3.5
Capture Area (%)	-	-	10.5%	45.9%	28.5%	1.2%
Volume Capture (acre-ft)	-	-	3.7	155.5	159.2	1.5
Volume Capture (%)	-	-	8.3%	42.0%	24.2%	0.8%
Capture Load Reduction (kg TSS)	-	-	122	14,687	14,810	36.0
Capture Load Reduction	-	-	9.2%	40.0%	23.0%	0.3%
Green Streets BMPs						
Capture Area (acres)	52	132.1	49.2	285.5	518.7	85.2
Capture Area (%)	54.1%	52.9%	69.8%	44.7%	49.2%	29.0%
Volume Capture (acre-ft)	37.0	86.9	27.2	153.3	304.4	46.9
Volume Capture (%)	51.5%	50.6%	60.9%	41.4%	46.2%	23.0%
*Capture Load Reduction (kg TSS)	2,680	6,327	713	14,089	23,810	2,836
Capture Load Reduction	34.5%	33.8%	53.8%	38.4%	36.9%	20.0%
Low Impact Development (LID) BMPs						
Filtration Area (acres)	44.1	117.8	13.9	60.3	236.0	11.9
Filtration Area (%)	45.9%	47.1%	19.7%	9.4%	22.4%	4.0%
Volume Treated (acre-ft)	31.9	79.4	7.6	31.9	150.7	9.0
Volume Treated (%)	44.3%	46.2%	16.9%	8.6%	22.9%	4.4%
Filtration Load Reduction (kg TSS)	2,741.9	6,573.8	220.2	2,899.4	12,435	396.0
Filtration Load Reduction	35.3%	35.1%	16.6%	7.9%	19.3%	2.8%
Diversion BMPs						
Total Diverted Volume (acre-ft)	-	-	8.4	-	-	-
Not Previously Treated Diverted Volume (acre-ft)[3]			1.3			
Diverted Volume (%)[3]	-	-	2.9%	-	-	-
Diverted Load Reduction (kg TSS)	1,553**	3,730**	87.0	985.3**	6,356**	-
Diverted Load Reduction (%)	-	-	6.6%	-	-	-
Non-Structural BMPs						
Load Reduction (kg TSS)	504.3	1,217.4	86.3	2,385.4	4,193.4	-
Subwatershed Totals						
BMP Area (acres)	96.0	249.9	70.5	638.7	1,055.0	100.6
BMP Area (%)	100.0%	100.0%	100.0%	100.0%	100.0%	34.2%
BMP Volume (acre-ft)	68.9	166.2	39.8	340.7	615.6	57.5
BMP Volume (%)	95.8%	96.8%	89.0%	92.1%	93.5%	28.2%
BMP Load Reduction (kg TSS)	7,480†	17,849†	1,229	35,047†	61,604†	3,268
BMP Load Reduction	**96.4%†**	**95.3%†**	**92.7%**	**95.5%†**	**95.5%†**	**23.0%**

*In accordance with the RAA Guidance document, capture load reduction calculations are based on the drainage area achieving annual load reduction targets (i.e., designed for the 85th percentile event and thus in compliance with guidance).

**These additional reductions necessary to achieve compliance may include diversions, and will be determined based on the adaptive management process results.

Note 3: Both untreated and treated (discharged from filtration MCMs) flows are diverted and treated; however, “Not Previously Treated” refers to flows that have not passed through a filtration MCM. Discharges from filtration MCMs treated by diversion are accounted for within the applicable MCM (e.g., Green Street and LID MCMs) and not by the diversion (i.e., not counted twice).

†Includes additional reductions through diversions that will be determined based on adaptive management process.

7.0 MdR EWMP IMPLEMENTATION PLAN AND SCHEDULE

As previously mentioned, the MdR watershed is subject to subject to five TMDLs; the Santa Monica Bay Nearshore Debris TMDL, Ballona Creek Trash TMDL, Santa Monica Bay DDT & PCBs TMDL, the Marina del Rey Harbor Mother's Beach and Back Basin Bacteria TMDL, and the Toxic Pollutants in Marina del Rey Harbor TMDL. Because the compliance schedule for the Toxics TMDL is the most aggressive, the Toxics WLAs were used as the primary scheduling driver for BMP implementation. . Once projects were scheduled in accordance with the Toxics TMDL goals (Table 7-1), Trash TMDL and Bacterial TMDL load reduction goals were evaluated, and additional structural and/or non-structural controls, were identified. It is worth noting that MdR EWMP Agencies have elected to demonstrate Toxics TMDL compliance through meeting final sediment WLAs for the contaminants in the TMDL. Further studies, including a planned Stressor ID Study in 2016 or effectiveness monitoring at the Oxford Basin Multi-use Enhancement Project, may indicate Toxics TMDL compliance through alternative means and may impact the implementation schedule.

To meet the compliance milestones, a phased implementation approach using a combination of structural and non-structural strategies designed specifically to reduce toxic pollutant and bacterial loading to MdR will be implemented. As detailed in the RAA section, zinc loading requires the largest load reduction and is thus the compliance driver for the Toxics TMDL (i.e., based on available data, if BMPs are implemented to achieve zinc WLA, then other toxic pollutant loads would also be below WLAs).

Table 7-1: Summary of Marina del Rey Subwatershed RAA-Required Zinc Load Reductions

	Subwatershed					EWMP Watershed[1]	
	1A	1B	2	3	4	Back Basins[2]	Front Basins[3]
Required Zinc Percent Load Reduction	96.4	95.3	21.5	87.8	95.5	95.4	95.3
Interim / Final Toxics TMDL Compliance Date	2016* /2018	2019/ 2021	NA	2016*/ 2018	2016*/ 2018	2016*/ 2018	2019/ 2021

* Interim milestone occurs before EWMP approval.
[1]Excludes Subwatershed 2 area since it is outside the geographical area of MdR subject to TMDL compliance
[2]Tributary drainage area of Subwatersheds 1A, 3, and 4
[3]Tributary drainage area of Subwatershed 1B

7.1 Load Reduction Schedule

The requirements under the Toxics TMDL vary for the four subwatersheds constituting the MdR watershed. Subwatershed 1 is divided into two areas, Subwatershed 1A (area draining into back basins E, D, and F) and Subwatershed 1B (area draining into front basins A, B, C, G, H) because they have different target compliance dates in the Toxics TMDL. Subwatershed 2 is considered separately in this EWMP as it is outside the boundaries of the TMDL compliance area of the MdR WMA.

Table 7-1 lists the target Zinc load reductions and Toxics TMDL compliance dates for the various subwatersheds. The Toxics TMDL WLA compliance schedule uses a phased approach, where interim compliance is achieved through either demonstrating that 50% of the total drainage area served by the MS4 is meeting the WLA for sediment or alternatively, a 50% load reduction is achieved. Final compliance is demonstrated through 100% of the total area served by the MS4 meeting the WLA for sediment. The final compliance point occurs in 2018 for the Back Basins of the harbor and in 2021 for the Front Basins.

Under the Bacteria TMDL, the final compliance date for single sample summer and winter dry weather WLAs, expressed as allowable exceedance days (Section 3.2.2), is December 28, 2017. The final compliance point for wet weather and geometric mean bacteria WLAs is July 15, 2021.

7.2 Structural BMP Schedule

Attaining the TMDLs' water quality goals will require significant infrastructure throughout the MdR watershed. This section presents the implementation schedules required for regional and localized structural BMPs to meet the WLA by the specified interim and final compliance dates. The Toxics TMDL compliance points for the Back Basins are on a more accelerated schedule than the Front Basins, therefore projects within the subwatersheds that drain to the Back Basins (Subwatersheds 1A, 3 and 4) are given priority in the implementation schedule. It should be noted that the first interim milestone for the Toxics TMDL (3/22/2016) occurs prior to the final approval timeline for the EWMP.

Based on the existing pollutant loads, estimated by the WMMS model, a total zinc load reduction of approximately 95.4% and 95.3% will be required to meet the zinc WLA for the Back Basins (Subwatersheds 1A, 3, and 4) and Front Basins (Subwatershed 1B), respectively. These load reductions modeled through the RAA are used in the selection, design, scheduling, and costing, of the structural and non-structural BMPs. A detailed description of design, load reduction, implementation, and cost methodology and results are found in Appendix A and Appendix B.

The expected load reduction schedule is shown as well as the applicable TMDL compliance points (both interim and final) are shown in Table 7-2. Expected load reductions from non-structural BMPs are also included in Table 7-2.

In addition to capturing wet weather flow, the BMPs proposed in this EWMP will also treat dry weather runoff. Non stormwater management has been a priority in the Marina del Rey Watershed as evidenced by the three low-flow diversions (92,000, 20,000, and 288,000 gal/day) that were installed in 2006-2010 by the LACFCD to divert dry-weather flows to the sanitary sewer as part of the compliance strategy for the Bacteria TMDL. Additionally, the recent Bacterial TMDL TSO (No. R2-2014-0142) requires weekly dry weather flow observational monitoring at major outfalls.

The actual implementation schedule may vary depending on the results of monitoring efforts currently underway (i.e., Coordinated Monitoring Plan), planned monitoring (Coordinated Integrated Monitoring Plan), future special studies, and future BMP effectiveness analysis, environmental documentation, stakeholder process, and funding availability. Based upon an adaptive management strategy, as more watershed-specific information relating to pollutant loads is available, more detailed schedules may be developed using this basic framework. If the adaptive management process (see Section 10.0) indicates additional load reductions are required after implementation of the priority projects (Costco and the Venice Blvd. Neighborhood Project) and the other BMPs described in Section 5.2, additional BMPs may be pursued to meet TMDL requirements. The additional BMPs considered will be based upon the adaptive management process and the required reductions needed.

Table 7-2: RAA Load Reduction Schedule for MdR Watershed Back Basins and Front Basins BMPs

Area	Percent Reduction							
	Existing	2015	2016	2017	2018	2019	2020	2021
Back Basins								
Back Basins (Subwatersheds 1A, 3, 4)			**Interim**		**Final**			
Regional Projects (Costco, Parks, and Venice Neighborhood)			15.36	14.16	0.01			
Green Streets			25.43	19.1	6.67			
Low Impact Development (LID)		1.01	1.01	1.01	1.01			
Additional BMPs	0.43		4.27	2.68				
Non-Structural Programs				1.5	2.5	1.5	1	
Annual Load Reduction	**0.43**	**1.01**	**46.08**	**38.45**	**10.19**	**1.5**	**1.0**	**0**
Toxics TMDL Load Reduction-Cumulative Goal = 95.4%	**0.43**	**1.44**	**47.51**	**85.97**	**96.16**	**97.66**	**98.66**	**98.66**
Subwatershed 1A								
Green Streets			40.24	13.33				
Low Impact Development (LID)		4.45	4.45	4.45	4.45			
Additional BMPs				22.91				
Non-Structural Programs				1.5	2.5	1.5	1	
Annual Load Reduction	**0**	**4.45**	**44.7**	**42.2**	**6.95**	**1.5**	**1**	**0**
Toxics TMDL Load Reduction-Cumulative Goal = 96.4%	**0**	**4.45**	**49.15**	**91.34**	**98.29**	**99.79**	**100**	**100**
Subwatershed 3								
Regional Projects (Venice of America Park + Triangle Park)			5.48		0.08			
Green Streets			37.01	28.87	9.48			
Low Impact Development (LID)		0.63	0.63	0.63	0.63			
Existing BMP - Boone Olive Diversion	4.97							
Non-Structural Programs				1.5	2.5	1.5	2	
Annual Load Reduction	**4.97**	**0.63**	**43.11**	**30.99**	**12.69**	**1.5**	**1**	**0**
Toxics TMDL Load Reduction-Cumulative Goal = 87.8%	**4.97**	**5.59**	**48.7**	**79.7**	**92.38**	**93.88**	**94.88**	**94.88**
Subwatershed 4								
Regional Projects (Costco and Venice Neighborhood)			19.13	18.19				
Green Streets			22.54	19.35	7.52			
Low Impact Development (LID)		0.56	0.56	0.56	0.56			
Additional BMPs			5.48					
Non-Structural Programs				1.5	2.5	1.5	2	
Annual Total	**0**	**0.56**	**47.71**	**39.6**	**10.58**	**1.5**	**1**	**0**
Toxics TMDL Load Reduction-Cumulative Goal = 95.5%	**0**	**0.56**	**48.27**	**87.87**	**98.45**	**99.95**	**100**	**100**
Front Basins								
Subwatershed 1B						**Interim**		**Final**
Green Streets				7.85	12.97	16.07	13.01	0.43
Low Impact Development (LID)		3.36	3.36	3.36	3.36	3.36	3.36	
Additional BMPs						8.8	10.4	
Non-Structural Programs				1.5	1.5	1.5	2	
Annual Total	**0**	**3.36**	**3.36**	**12.71**	**17.83**	**29.73**	**28.78**	**0.43**
Toxics TMDL Load Reduction-Cumulative Goal = 95.3%	**0**	**3.36**	**6.72**	**19.43**	**37.25**	**66.99**	**95.77**	**96.2**
Non-TMDL Area								
Subwatershed 2, Green Streets, Canal Park, and Via Dolce Park scheduled after 2021								
Regional Projects (Canal Park + Via Dolce Park)								1.17^
Green Streets								19.00^
Low Impact Development (LID)		0.38	0.38	0.38	0.38	0.38	0.38	
Non-Structural Programs				1.5	1.5	1.5	2.0	
Annual Total	**0**	**0.38**	**0.38**	**1.88**	**1.88**	**1.88**	**2.38**	**20.17****
Water Quality Load Reduction-Cumulative Goal = 21.5%*	**0**	**0.38**	**0.76**	**2.64**	**4.52**	**6.4**	**8.78**	**28.95**

This table is based on the percent watershed area treated by BMPs (proportional load reduction for 85th percentile storm event).
*Additional load reduction is required to meet the TMDL WLA for the critical year and/or the interim target
** Scheduled after 2021, depending on results of the Adaptive Management Process
^Structural BMPs are estimated at the total load reduction required (21.5%) to ensure that planning is in place to meet potential load reduction requirements, exclusive of non-structural and development/redevelopment BMP programs.
GW = groundwater

Table 7-3: RAA Volume (acre-feet) Reduction Schedule for MdR Watershed Back Basins and Front Basins BMPs

Area	Existing	2015	2016	2017	2018	2019	2020	2021
Back Basins								
Back Basins (Subwatersheds 1A, 3, 4)			**Interim**		**Final**			
Regional Projects (Costco, Parks, and Venice Blvd)	0.0	0.0	82.8	76.3	0.1	0.0	0.0	0.0
Green Streets	0.0	0.0	108.0	81.1	28.3	0.0	0.0	0.0
Low Impact Development (LID)	0.0	17.9	17.9	17.9	17.9	0.0	0.0	0.0
Additional BMPs	0.1	0.0	0.8	0.5	0.0	0.0	0.0	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**0.1**	**17.9**	**209.4**	**175.8**	**46.2**	**0.0**	**0.0**	**0.0**
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**0.1**	**17.9**	**227.4**	**403.2**	**449.4**	**449.4**	**449.4**	**449.4**
Subwatershed 1A								
Green Streets	0.0	0.0	27.8	9.2	0.0	0.0	0.0	0.0
Low Impact Development (LID)	0.0	8.0	8.0	8.0	8.0	0.0	0.0	0.0
Additional BMPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**0.0**	**8.0**	**35.8**	**17.2**	**8.0**	**0.0**	**0.0**	**0.0**
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**0.0**	**8.0**	**43.7**	**60.9**	**68.9**	**68.9**	**68.9**	**68.9**
Subwatershed 3								
Regional Projects (Venice of America Park + Triangle Park)	0.0	0.0	3.6	0.0	0.1	0.0	0.0	0.0
Green Streets	0.0	0.0	13.4	10.4	3.4	0.0	0.0	0.0
Low Impact Development (LID)	0.0	1.9	1.9	1.9	1.9	0.0	0.0	0.0
Existing BMP - Boone Olive Diversion	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**1.3**	**1.9**	**18.9**	**12.3**	**5.4**	**0.0**	**0.0**	**0.0**
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**1.3**	**3.2**	**22.1**	**34.4**	**39.8**	**39.8**	**39.8**	**39.8**
Subwatershed 4								
Regional Projects (Costco and Venice Blvd)	0.0	0.0	79.7	75.8	0.0	0.0	0.0	0.0
Green Streets	0.0	0.0	69.9	60.0	23.3	0.0	0.0	0.0
Low Impact Development (LID)	0.0	8.0	8.0	8.0	8.0	0.0	0.0	0.0
Additional BMPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**0.0**	**8.0**	**157.6**	**143.8**	**31.3**	**0.0**	**0.0**	**0.0**
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**0.0**	**8.0**	**165.6**	**309.4**	**340.7**	**340.7**	**340.7**	**340.7**
Front Basins								
Subwatershed 1B						**Interim**		**Final**
Green Streets	0.0	0.0	0.0	13.6	22.4	27.7	22.5	0.7
Low Impact Development (LID)	0.0	13.2	13.2	13.2	13.2	13.2	13.2	0.0
Additional BMPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**0.0**	**13.2**	**13.2**	**26.8**	**35.6**	**41.0**	**35.7**	**0.7**
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**0.0**	**13.2**	**26.5**	**53.3**	**88.9**	**129.9**	**165.6**	166.3
Non-TMDL Area								
Subwatershd 2, Green Streets, Canal Park, and Via Dolce Park scheduled after 2021								
Regional Projects (Canal Park + Via Dolce Park)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Green Streets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.9
Low Impact Development (LID)	0.0	1.5	1.5	1.5	1.5	1.5	1.5	0.0
Non-Structural Programs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Volume Reduction	**0.0**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**48.4****
Toxics TMDL Cumulative Volume Reduction (Acre-ft)	**0.0**	**1.5**	**3.0**	**4.5**	**6.0**	**7.5**	**9.0**	**57.4**

This table is based on the percent watershed area treated by BMPs (proportional load reduction for 85th percentile storm event).

*Additional load reduction is required to meet the TMDL WLA for the critical year and/or the interim target

** Scheduled after 2021, depending on results of the Adaptive Management Process

^Structural BMPs are estimated at the total load reduction required (21.5%) to ensure that planning is in place to meet potential load reduction requirements, exclusive of non-structural and development/redevelopment BMP programs.

GW = groundwater

7.3 Non–Structural BMP Implementation

The combined non-structural programs/projects required by the 2012 MS4 Permit and included in this EWMP are estimated to reduce up to 6.5% of the pollutant loading to MdR. The non-structural programs/projects will be implemented early to maximize the cumulative pollutant load removals throughout the implementation period.

The non-structural BMP programs in this EWMP include modeling updates and other studies, source control, catch basin cleaning, and industry targeted outreach and education, enforcement, and inspection programs. The EWMP proposed implementation schedule for non-structural BMPs is shown in Table 7-4.

Table 7-4: Implementation Schedule for Non-Structural BMPs within the MdR WMA

Permit Category	Non-Structural Solution	Potential Contaminant Reduction (%)					
		2015	2016	2017	2018	2019	2020 - 2025
Watershed Studies	**Pollutant Loading Model and Database**						
	Long-Term Implementation and Updates						
	Total Suspended Solids/Pollutant Correlations						
Industrial/ Commercial Facilities Programs; Planning and Land Development; Public Agency Activities Program	**Collaborative Environmentally Friendly Alternative Services Program**				1	1	2
	Planning & Assessment						
	Long-Term Implementation						
	Product Substitution Campaign				0.5	1	2
	Planning & Assessment						
	Long-Term Implementation						
Public Agency Activities Program	**Targeted Aggressive MS4 and Catch Basin Cleaning Program**				1	1	1
	Planning & Assessment						
	Long-Term Implementation						
Industrial/Commercial Facilities Program; Illicit Connection and Illicit Discharges Detection and Elimination Program	**Code Survey and Modification**						
	Targeted inspections			0.5	0.5	0.5	0.5
	Evaluation/Assessment/Modification						
	Business-led Voluntary BMP Implementation Program			0.5	0.5	0.5	0.5
	Feasibility Evaluation						
	Incentive Program						
PIPP; Industrial/Commercial Facilities Program; Public Agency Activities Program;	**Outreach and Education**			0.5	0.5	0.5	0.5
	Environmentally Friendly Boating Program						
	Green Gardening and Runoff Reduction Program						
Total Contaminant Reduction (%)				**1.5**	**4**	**4.5**	**6.5**
(dark blue)	Represents overall project schedule.						
(light blue)	Provides additional information regarding project implementation schedule.						

8.0 PUBLIC & AGENCY PARTICIPATION

In accordance with the 2012 MS4 Permit, local stakeholders were engaged in the EWMP development process. The MdR EWMP Agencies held joint EMWP workshops with WMGs from four other Santa Monica Bay watersheds (Upper Los Angeles River, Santa Monica Bay J2/J3, Dominguez Channel, and Ballona Creek). The workshop meetings each focused on a different aspect of the EMWP development process and each provided opportunity for public comment and question and answer sessions. The first meeting took place on April 10th, 2014 and included an overview of the entire EWMP process and key milestones (Work Plan, CIMP, and EWMP). The second meeting occurred on November 20, 2014 and provided updates on the EWMP development progress, proposed priority projects, and opportunity for public comment and questions. The third public participation workshop/meeting was held on March 19, 2015 and included presentation of the proposed projects, as well as estimated costs for implementation.

Another agency that is involved in the development of the EWMP is CalTrans. CalTrans representatives initially attended the WMG meetings but did not join the WMG. The WMG is continuing to discuss opportunities for collaboration with CalTrans representatives. Additional State agency input was not sought due to the exclusion from the EWMP of the section of the State owned Ballona Creek wetlands within the MdR watershed (Figure 5-1).

9.0 IMPLEMENTATION COSTS AND FINANCIAL STRATEGY

As mentioned in the previous sections, the Toxics TMDL compliance schedule is used in the selection and scheduling of BMPs in the MdR WMA. The Toxics TMDL compliance schedule provides for multiple pathways to achieve compliance with the sediment TMDL, including achieving designated WLAs, or alternatively demonstrating attainment of the SQOs. For the purpose of this EWMP, compliance with WLAs is used for costing and scheduling but further studies, including a planned Stressor ID Study in 2016, may show TMDL compliance through SQOs.

Life cycle costs (LCC) incorporated into project cost estimates include materials, construction, engineering design, CEQA and permitting, contingency, land acquisition, 20 years of routine operations and maintenance (O&M), and major rehabilitation costs. The cost of administering a stormwater management program for post-construction effectiveness assessment during 3 storm events was also included in this estimate. Construction costs were applied to the year in which a load reduction credit was assigned. Planning and engineering design costs were assumed to require up to 2 years of lead-time prior to the start of construction. The cost of post-construction stormwater monitoring was distributed over 3 years following project completion. The annual O&M cost was equally distributed over the remaining project schedule following project completion. All costs were translated into 2015 dollars using net present worth analysis and an average inflation rate of 3%. These values were used based on a similar methodology employed to develop the San Diego Quality of Life Initiative (SANDAG Equinox Center, 2008) and the Multi-Pollutant TMDL Implementation Plan for the Unincorporated Area of MdR Harbor Back Basins (LADPW, 2012). Additional information regarding green street project designs, design areas, cost estimates, and this methodology is presented in Appendix A. The costs shown in this EWMP are estimates only and will change based on site-specific conditions and refinement of parameters as the EWMP is implemented.

9.1 BMP Implementation Cost Summary

The cumulative costs associated with the implementation of the BMPs discussed in Section 5.0 based on the schedule presented in Section 7.0 are summarized in Table 9-1. The results are presented by jurisdiction and type of BMP (structural versus nonstructural). Total costs for implementation of the BMPs proposed in this EWMP are estimated at $391,914,197. In Table 9-2 implementation costs are broken out by drainage area (Back Basins, Front Basins and non-TMDL area) separately because they follow different TMDL compliance schedules. Costs associated Subwatersheds 1A, 3, and 4 are presented under the Back Basins and those for Subwatershed 1B are shown under Front Basins. Subwatershed 2 does not drain to either the Back Basins or the Front Basins, and is therefore not subject to the TMDL compliance schedule; its BMPs associated costs are presented separately. Table 9-2 also shows the cumulative load reduction associated for each BMP type discussed in the EWMP for each of the subwatersheds, including nonstructural BMPs.

Table 9-1: MdR Watershed BMPs Cost Estimate Schedule by Jurisdiction

MdR Watershed	Structural BMPs	Nonstructural BMPs	20 Year Operations & Maintenance	Total Cost
City Of Los Angeles	$249,052,873	$2,923,268	$32,499,182	$284,475,323
County Of Los Angeles	$87,412,319	$1,190,913	$12,001,036	$100,604,268
City Of Culver City	$6,669,040	$127,009	$38,556	$6,834,605
Total Cost (2015 dollars)	**$343,134,232**	**$4,241,190**	**$44,538,774**	**$391,914,197**

The annual breakdown of the costs for the whole WMA by BMP type and by jurisdiction are summarized in Table 9-7 and Table 9-8, for structural BMPs, and Table 9-9 and Table 9-10, for nonstructural BMPs.

Table 9-2: Load Reduction and Cost for Required Load Reductions for Back Basins and Front Basins

BMP Type	Cumulative Load Reduction Percentage	Cumulative Cost*
Back Basins (Subwatersheds 1A, 3, 4)		
Structural BMPs Total	**92.16**	**$290,406,761**
Nonstructural BMPs Total	**6.5**	**$2,524,452**
Subwatershed 1A		
Green Streets	6.27	$22,526,910
Development/Redevelopment	2.08	-
Potential Sanitary Sewer Diversion	2.68	$7,443,462
Structural BMPs Total	**11.04**	**$29,970,372**
Subwatershed 3		
Green Streets	6.47	$21,482,683
Development/Redevelopment	0.22	-
Venice of America Park	0.47	$681,486
Triangle Park	0.01	$195,464
Existing BMP - Boone Olive Diversion	0.43	-
Structural BMPs Total	**7.59**	**$22,359,634**
Subwatershed 4		
Venice Neighborhood Project (GW≥20ft)	23.93	$90,699,592
Green Streets (20ft>GW)	38.46	$127,753,965
Development/Redevelopment	1.75	-
Costco Parking Lot	5.12	$6,707,597
Sanitary Sewer Diversion	4.27	$12,915,601
Structural BMPs Total	**73.53**	**$238,076,755**
Front Basins (Subwatershed 1B)		
Subwatershed 1B		
Green Streets	50.33	$51,278,322
Development/Redevelopment	20.16	-
Sanitary Sewer Diversion	19.21	$18,194,233
Structural BMPs Total	**89.70**	**$69,472,555**

Table 9-2: Load Reduction and Cost for Required Load Reductions for Back Basins and Front Basins

BMP Type	Cumulative Load Reduction Percentage	Cumulative Cost*
Nonstructural BMPs Total	**6.5**	**$800,437**
Non TMDL Compliance Area		
Subwatershed 2		
Green Streets	24.55	$26,980,294
Development/Redevelopment	2.54	-
Canal Park	1.11	$492,869
Via Dolce Park	0.06	$320,529
Structural BMPs Total	**28.27**	**$27,793,692**
Nonstructural BMPs Total	**6.5**	**$916,301**

*Cost includes planning, design, O&M, and BMP effectiveness monitoring through 2034.

9.2 Structural BMPs Implementation Cost

9.2.1 Green Streets BMPs

Implementation of green street BMPs as well as the Venice Blvd. Neighborhood Regional Project, is constrained to the limited regions within the public domain available for implementation of structural BMP projects. Many considerations affect the extent of area available for the implementation of these BMPs within the public ROW (e.g., utilities, crosswalks, soil conditions); therefore, the design areas used to develop example BMP implementation scenarios and design were also used to test feasibility of implementation (e.g., adequate space for implementation, sufficient utility separation). Projected costs are based on the implementation of various BMPs by land use and subwatershed. The results of this analysis are provided in more detail in Appendix A.

The cost of implementation for these design area BMP projects was normalized by acreage treated in order to obtain a value (cost per acre treated) that could be scaled watershed-wide. This normalized value was used to apportion cost by land use and groundwater depth. Table 9-3 summarizes these costs for each of the subwatersheds in MdR.

Table 9-3: Green Streets BMPs Costs for the MdR Watershed

BMP Type	Cumulative Cost (2015 dollars)
REGIONAL PROJECTS	$90,699,592
Venice Blvd. Neighborhood Project (GW≥20ft, Subwatershed 4)	$90,699,592
GREEN STREETS	$250,022,174
Subwatershed 1A	$22,526,910
Subwatershed 1B	$51,278,322
Subwatershed 2	$26,980,294
Subwatershed 3	$21,482,683
Subwatershed 4	$127,753,965
CUMULATIVE COST (2015 $)	**$340,914,197**

9.2.2 Costco

The estimated implementation cost for the Costco regional BMP is presented in Table 9-4. The design assumptions and cost estimates for the Costco Parking Lot Infiltration Project Design are presented in Appendix B.

Table 9-4: Costco Parking Lot Implementation Cost

BMP Design	Regional Project ID	Treatment Area (ac)	Planning/ Design Cost	Construction Cost	20-Year O&M Cost	Monitoring Cost
Storm Chamber Infiltration Gallery	Costco Parking Lot	42	$1,546,000	$5,533,429	$64,000	$120,000

9.2.3 Parks

Four parks were considered for Regional BMPs in the MdR watershed: Canal Park, Venice of America Park, Via Dolce Park, and Triangle Park. The specific design considerations are presented in the following subsections. A summary of the implementation costs is provided in Table 9-5 below. Detailed assumptions and calculations are provided separately in Appendix B.

Table 9-5: Implementation Costs for Regional Projects - Parks

BMP Design	Regional Project ID	Treatment Area (ac)	Planning/ Design Cost	Construction Cost	20-Year O&M Cost	Monitoring Cost
Storm Chamber Infiltration Gallery	Canal Park	3.3	$139,000	$397,143	$20,000	$18,000
	Venice of America Park	3.9	$168,000	$502,176	$20,000	$36,000
Subsurface Cistern w/ Capture/Reuse	Via Dolce Park	0.18	$88,000	$214,308	$110,000	$18,000
	Triangle Park	0.05	$51,000	$80,621	$110,000	$18,000

9.2.4 Potential Sanitary Sewer Diversion Projects

The costs and project specific information for the design parameters of each of the potential subwatershed sanitary sewer diversion projects are summarized in Table 9-6. More details are presented in Appendix B.

Table 9-6: Sanitary Sewer Diversion Projects Implementation Cost

Subwatershed	Subwatershed 1A (Back Basins)	Subwatershed 1B (Front Basins)	Subwatershed 3 (Boone Olive/ Subwatershed 4 (Oxford Basin)
Design Treatment Area (ac)	22	48	35
Tank Capacity (gallons)	0.49 million	1.60 million	1.04 million
Redevelopment Area (acres)	0.3	0.7	0.5
Planning/ Design Cost	$354,000	$998,000	$338,000
Construction Cost	$7,309,020	$17,899,145	$12,604,729
20-Year O&M Cost	$596,010	$4,295,301	$1,115,655
Monitoring Cost	$60,000	$60,000	$60,000

Because of the exact drainage areas to be diverted and the tank locations are significant unknown variables, the sanitary sewer diversion project costs are limited in scope to the above ground concrete tank (rectangular), with 5-foot perimeter beyond the edge of the tank foundation, and one controller pump/diversion to connect to the sanitary sewer and a limited suite of construction BMPs. The O&M costs include inspection and maintenance of the tank, as well as an average annual sewer discharge fee (assuming 7 storms per year).

This type of project is expensive as a result of the redevelopment costs associated with obtaining property to site the tank. The lower reaches of the MdR watershed consist mainly of high-density multi-family residential land uses. These properties range in size from 0.15 acre lots with 2-3 story condominiums, to skyscrapers with hundreds of individual units and the average cost per acre is above $20,000,000. The tank design assumptions and cost estimates are presented with the regional projects designs in in Appendix B.

9.3 Non-Structural BMPs Implementation Cost

The non-structural cost estimates consist of a one-year initial pilot study cost, including project start-up and assessment, and if applicable given the type of project/program ongoing O&M costs. An inflation rate of 3% per year was used. These values were used based on a similar methodology employed for the MdR Multi-Pollutant Implementation Plan (LADPW, 2012). All non-structural costs are reported in 2015 dollars. The total cost of implementing the nonstructural programs is approximately $4.24 million, as summarized in Table 9-10.

Table 9-7: MdR Watershed Structural BMPs Cost Estimate Schedule by BMP Type

MdR Watershed	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	O&M 2026-2034	Total Cost
Venice Blvd. Neighborhood Project (GW≥20 ft)	$11,276,106	$47,900,775	$24,011,959	$1,328,876	$1,322,717	$395,180	$383,669	$372,495	$361,645	$351,112	$340,885	$2,654,171	**$90,699,590**
Green Streets (20 ft>GW)	$21,392,161	$72,313,721	$60,838,013	$36,646,653	$22,426,618	$14,011,168	$2,913,191	$2,105,757	$1,694,678	$1,645,318	$1,597,396	$12,437,500	**$250,022,174**
Potential Sanitary Sewer Diversions	$515,000	$485,437	$18,680,557	$554,934	$7,828,309	$7,600,300	$260,472	$252,886	$245,520	$223,487	$216,978	$1,689,414	**$38,553,294**
Costco	$773,000	$728,627	$5,063,871	$38,383	$37,265	$36,179	$2,602	$2,526	$2,453	$2,381	$2,312	$18,000	**$6,707,599**
Canal Park	$0	$0	$63,602	$61,750	$342,579	$5,862	$5,692	$5,526	$766	$744	$722	$5,625	**$492,868**
Via Dolce Park	$0	$0	$0	$0	$37,955	$216,329	$9,351	$9,078	$8,814	$4,093	$3,973	$30,937	**$320,530**
Venice of America Park	$84,000	$552,527	$11,897	$11,550	$11,214	$837	$813	$789	$766	$744	$722	$5,625	**$681,484**
Triangle Park	$0	$24,036	$23,336	$71,631	$9,920	$9,631	$9,351	$4,342	$4,215	$4,093	$3,973	$30,937	**$195,465**
Annual Cost (2015 dollars, $)	$34,040,268	$122,005,124	$108,693,236	$38,713,777	$32,016,577	$22,275,487	$3,585,141	$2,753,399	$2,318,858	$2,231,972	$2,166,963	$16,872,208	
Cumulative Cost (2015 dollars, $)	**$34,040,268**	**$156,045,392**	**$264,738,627**	**$303,452,404**	**$335,468,981**	**$357,744,468**	**$361,329,609**	**$364,083,008**	**$366,401,865**	**$368,633,837**	**$370,800,799**		**$387,673,007**

Table 9-8: MdR Watershed Structural BMPs Cost Estimate Schedule by Jurisdiction

MdR Watershed	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	O&M 2026-2034	Total Cost
City of Los Angeles	$28,222,625	$105,911,250	$83,471,079	$24,834,315	$11,212,248	$7,285,645	$2,272,044	$1,884,855	$1,610,630	$1,557,927	$1,512,551	$11,776,886	$281,552,055
County of Los Angeles	$5,044,643	$15,365,247	$20,158,285	$13,841,080	$20,767,065	$14,953,663	$1,310,495	$866,018	$705,775	$671,663	$652,100	$5,077,322	$99,413,355
City of Culver City	$773,000	$728,627	$5,063,871	$38,383	$37,265	$36,179	$2,602	$2,526	$2,453	$2,381	$2,312	$18,000	$6,707,599
Annual Cost (2015 dollars, $)	$34,040,268	$122,005,124	$108,693,235	$38,713,777	$32,016,577	$22,275,487	$3,585,141	$2,753,399	$2,318,858	$2,231,971	$2,166,963	$16,872,208	
Cumulative Cost (2015 dollars, $)	**$34,040,268**	**$156,045,392**	**$264,738,627**	**$303,452,404**	**$335,468,981**	**$357,744,467**	**$361,329,608**	**$364,083,007**	**$366,401,865**	**$368,633,836**	**$370,800,799**		**$387,673,007**

Table 9-9: MdR Watershed Non-Structural BMPs Cost Estimate Schedule by Jurisdiction

MdR Watershed	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total Cost
City of Los Angeles	$1,156,986	$597,275	$424,479	$195,335	$129,973	$69,870	$69,870	$69,870	$69,870	$69,870	$69,870	**$2,923,268**
County of Los Angeles	$471,347	$243,325	$172,929	$79,578	$52,950	$28,464	$28,464	$28,464	$28,464	$28,464	$28,464	**$1,190,913**
City of Culver City	$50,267	$25,950	$18,442	$8,487	$5,647	$3,036	$3,036	$3,036	$3,036	$3,036	$3,036	**$127,009**
Annual Cost (2015 dollars, $)	$1,678,600	$866,550	$615,850	$283,400	$188,570	$101,370	$101,370	$101,370	$101,370	$101,370	$101,370	
Cumulative Cost (2015 dollars, $)	**$1,678,600**	**$2,545,150**	**$3,161,000**	**$3,444,400**	**$3,632,970**	**$3,734,340**	**$3,835,710**	**$3,937,080**	**$4,038,450**	**$4,139,820**		**$4,241,190**

Table 9-10: Cost Schedule for Non-Structural BMP s within the MdR WMA by BMP Type

Non-Structural Solution Category	Non-Structural BMP	Cost (2015 $)							
		2015	2016	2017	2018	2019	2020	2021	2022-2025
Watershed Studies	Pollutant Loading Model and Database	0	21,800	21,800	21,800	21,800	21,800	21,800	87,200
	Total Suspended Solids/Pollutant Correlations	0	0	54,500	0	54,500	0	0	0
Industrial/ Commercial Facilities Programs; Planning and Land Development; Public Agency Activities Program	Collaborative Environmentally Friendly Alternative Services Program	327,000	136,250	109,000	32,700	5,450	5,450	5,450	21,800
	Product Substitution Campaign	408,750	147,150	152,600	109,000	65,400	32,700	32,700	130,800
Public Agency Activities Program	Targeted Aggressive MS4 and Catch Basin Cleaning Program	218,000	109,000	81,750	27,250	10,900	10,900	10,900	43,600
Industrial/Commercial Facilities Program; Illicit Connection and Illicit Discharges Detection and Elimination Program	Code Survey and Modification	109,000	81,750	21,800	5,450	1,090	1,090	1,090	4,360
	Targeted inspections	70,850	49,050	21,800	16,350	16,350	16,350	16,350	65,400
	Business-led Voluntary BMP Implementation Program	299,750	179,850	87,200	32,700	6,540	6,540	6,540	26,160
PIPP; Industrial/Commercial Facilities Program; Public Agency Activities Program	Environmentally Friendly Boating Program	109,000	54,500	27,250	27,250	3,270	3,270	3,270	13,080
	Green Gardening and Runoff Reduction Program	136,250	87,200	38,150	10,900	3,270	3,270	3,270	13,080
Total Cost		1,678,600	866,550	615,850	283,400	188,570	101,370	101,370	405,480
Cumulative Cost		1,678,600	2,545,150	3,161,000	3,444,400	3,632,970	3,734,340	3,835,710	4,241,190

9.4 Financial Strategy

Estimated costs for compliance with the 2012 MS4 Permit through the implementation of the Marina del Rey Watershed EWMP are approximated at $400 million. The EWMP Agencies will follow a multi-pronged financial strategy to maximize potential funding opportunities in support of EWMP implementation. The California Contract Cities Association and the League of California Cities, Los Angeles Division City Managers Committees commissioned a report on stormwater funding options in the Los Angeles region. The resulting report, "Stormwater Funding Options – Providing Sustainable Water Quality Finding in Los Angeles County" (Farfsing and Watson, 2014) provided a useful framework for potential funding options, which is incorporated in this section.

9.4.1 Grant Programs

The financial strategy for the EWMP includes pursuing available grant programs that may be used for implementation of EWMP components.

The City of Culver City applied for and was awarded a 2015 Countywide Competitive Grant Program Grant for the Culver City-Costco Infiltration System Project. The grant in the amount of $767,136 was approved by the County of Los Angeles Board of Supervisors on Tuesday, November 3, 2015.

The LACFCD applied for and was awarded a Proposition 84 Grant by the Santa Monica Bay Restoration Commission for the Oxford Basin Project in the amount of $2,000,000. In addition, Oxford Basin was awarded $1,500,000 as part of the Proposition 84 Integrated Regional Water Management grant program. The County of Los Angeles also contributed $1,000,000 towards this project while the LACFCD paid for the remainder of this project.

Additional grant opportunites may include (but are not limited to) those outlined in the Table 9-11.

Table 9-11: Potential Grant Programs

Grant Program
Prop 1 Water Bond (2014)
Integrated Regional Water Management Plan
USEPA 319 Grants
Clean Beaches Initiative
Federal or State Transportation Grants
Federal or State Solid Waste Grants
Federal Emergency Management Agency (FEMA) Grants
National Institute of Health (NIH) or Public Health Related Grants Proposition 84

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9.4.2 Fees and Charges

The Farfsing and Watson report also identified potential strategies to fund stormwater programs through fees and charges assessed on either a local, regional or state level. These potential fees and charges are summarized in Table 9-12.

Table 9-12: Potential Fees and Charges

Potential Fees and Charges
Local Stormwater Fees
Incorporate Fees for Street Sweeping and Trash TMDLs into Solid Waste Management Fees
Local Water Conservation Fees
Stormwater Impact Fee in LID Ordinances
Car Rental Fees
District-wide Sales Tax
Continue to Pursue Passage of County-wide Parcel Tax (Clean Water, Clean Beaches Measure)

The City Manager and Chief Financial Officer (CFO) of the City of Culver City are currently working on details of a stormwater fee program for the City. The proposed timeline for the fee includes placement on the November 2016 ballot.

9.4.3 Legislative Strategies:

Potential legislative or policy strategies that the EWMP Agencies may pursue are outlined in Table 9-13 below.

Table 9-13: Potential Legislative Strategies

Potential Legislative Strategies
Amend Prop 218 to Define Stormwater as a Traditional Utility
Formation of Water Conservation Districts
Special Assessment District for the Watershed Management Areas
Source Control Measures Modeled after SB 346
Support the California Green Chemistry Initiative Program
Pursue rate increase for projects based on Assembly Bill (AB) 2403 to avoid triggering Proposition 218 requirements.
Monetize Stormwater Capture and Infiltration
Explore Funding Through Cap and Trade Revenues

9.4.4 Financial Strategies Moving Forward

The potential financial strategies described in this EWMP serve as a framework for the EWMP Agencies to follow moving forward. These strategies, among others yet to be defined, will be adopted collaboratively by the member agencies and based on outcomes from the strategies described; the financial plan will evolve as the program moves forward.

The EWMP Agencies have sufficient funds to achieve the activities proposed within this current MS4 Permit cycle, namely implementing enhanced MCMs and green streets and regional project planning through December 2017. The following describes the current funding amount and sources for stormwater management.

The County has an ongoing collective budget of $10.1 million for 140 unincorporated areas. Additional funds for projects are allocated on an annual basis from the General Fund and other sources. In Fiscal Year 2015-16, the total allocation from the General Fund for stormwater management was $23 million.

Additional funds from other sources, including the Gasoline Tax, Solid Waste Fund, Prop C, Prop A Local Return Funds, and Measure R, provide for ongoing MCM compliance activities.

The LACFCD allocated a budget of $33 million from the Flood Fund for all LACFCD territories within Los Angeles County MS4 in Fiscal Year 2015-16.

The City of Los Angeles' current annual budget for implementation of the MS4 Permit, derived from the Stormwater Pollution Abatement Charge, is approximately $30 million citywide and includes the Marina del Rey watershed. This budget does not include the $500 million Proposition O bond program, approved by the City's voters in 2004 for the funding of capital water quality improvement projects throughout the entire City, but this program is nearing its completion and has almost fully allocated its resources. The City is currently evaluating alternative sources for funding, including the use of the State Revolving Fund, the establishment of special assessment districts or Joint Power Authorities, and applications for grants. The City has included the Marina del Rey watershed projects in its 5-year Stormwater Capital Improvement Program that was recently developed to pursue new, additional funding.

The City of Culver City will release a Request for Proposals (RFP) in February for development of a Green Streets Master Plan. Once the plan is developed, tentatively by September 2016, it will be merged with both the sanitary sewer Capital Improvement Plans (CIPs) and the engineering/streets CIPs. This will assist with the planning and allocation of green streets within the city.

Group Members will begin utilizing existing funds to implement the EWMP as well as pursue additional funding in accordance with the priorities in Table 9-14below.

Table 9-14. Funding Strategy Priorities

EWMP Agency	Funding Priorities	Integration with Existing Infrastructure Improvement Plans
County	1. Apply for grants 2. Seek allocation in the General Fund; investigate bond and loan opportunities 3. Continued participation in stormwater funding advocacy efforts led by the League of California Cities and California Contract Cities	• Development of a stormwater capital improvement plan for existing public facilities by December 2018 • Prioritize locations for green street features by December 2017. • Update infrastructure design guidelines with sustainable practices, including stormwater capture BMPs, for use in implementing green streets by December 2018.
LACFCD	1. Apply for grants 2. Seek allocation in the Flood Fund	• Development of a stormwater capital improvement plan for existing public facilities by December 2018
City of Los Angeles	1. State Revolving Fund 2. Apply for grants (Prop 1)	• Development of Stormwater Capital Improvement Program • Development of standard (design) plans for BMPs, LID and Green Streets on the public right-

		of-way • Prioritization of green streets & locations on the public right-of-way.
City of Culver City	1. Public Private Partnership 2. Apply for Grants 3. Stormwater Fee	• Development of Green Streets Master Plan • Merge Green Streets Master Plan with sanitary sewer and streets CIPs.

10.0 ASSESSMENT AND ADAPTIVE MANAGEMENT FRAMEWORK

Adaptive management is a key component to the successful implementation, assessment and refinement of the MdR EWMP. Adaptive management is the process by which data are continually assessed in the context of improving and adapting programs to ensure the most effective strategies are implemented. In accordance with the MS4 Permit, every two years from the date of EWMP approval an adaptive management process will be implemented. The process will include consideration of the progress for the following elements as described in Part V1.C.8 of the MS4 Permit:

1. "Progress toward achieving interim and/or final WQBELS or RW limitations …according to established schedules;
2. Progress toward achieving improved water quality in MS4 discharges and achieving RW limitations through implementation of the watershed control measures based on an evaluation of outfall based monitoring data and RW monitoring data;
3. Achievement of interim milestones;
4. Re-evaluation of the water quality priorities identified for the WMA based on more recent water quality data for discharges from the MS4 and the receiving water(s) and a reassessment of sources of pollutants in MS4 discharges;
5. Availability of new information and data from sources other than the Permittees' monitoring program(s) within the WMA that informs the effectiveness of the actions implemented by the Permittees;
6. Regional Water Board recommendations; and
7. Recommendations for modifications to the Watershed Management Program solicited through a public participation process."

The adaptive management framework will allow the EWMP Agencies to develop an overall program consisting of efficient solutions based on evolving watershed priorities. As additional data become available through CIMP monitoring, BMP effectiveness studies, special studies such as the Toxics TMDL required Stressor ID Study, and other scientific studies, they will be integrated and assessed to determine whether programs in the EWMP should be altered to enable compliance in the most efficient manner. In addition, recommendations from the public as well as Regional Board recommendations will be incorporated in to the adaptive management process. Figure 10-1 provides a schematic overview of the Adaptive Management Strategy.

Based on the results of the adaptive management process Permittees will include any modifications necessary to improve the effectiveness of the EWMP in the Annual Report. These modifications may include altering existing BMPs/MCMs, adding additional BMPs/MCMs, or removing BMPs/MCMs. Permittees will implement the modifications either upon approval by the Regional Board or within 60 days of submittal if there are no objections from the Regional Board.

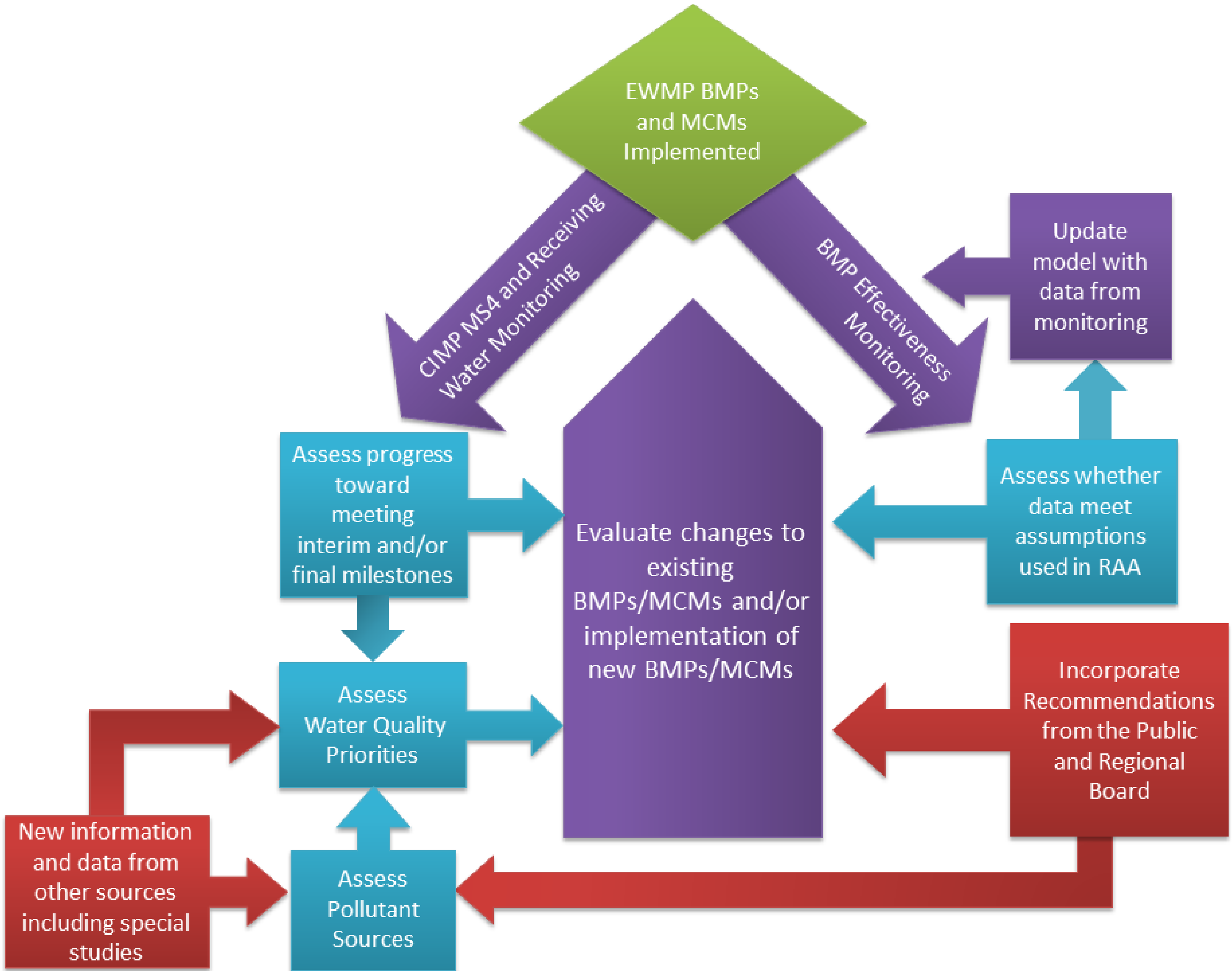

Figure 10-1: Adaptive Management Strategy

10.1 Effectiveness Monitoring

BMP effectiveness monitoring will be conducted for multiple years following BMP implementation. Monitoring will be tailored to the type of BMP and will include inflow versus outflow stormwater volume assessments as well as inflow and outflow constituent concentrations (or TSS) where applicable. Data collected will be compared to the effectiveness assumptions used in the RAA analysis and if actual effectiveness differs from effectiveness used in the model, the model will be re-run using the actual effectiveness data gathered. This will enable the adaptation of BMP strategies as they are being implemented to address TMDL compliance milestones. Ongoing CIMP monitoring, Oxford Basin monitoring, and Parking Lots 5 & 7 monitoring results will also be conducted.

10.2 CIMP Monitoring and Assessment Program

The EWMP Agencies submitted the MdR Watershed CIMP to the LARWQCB in June 2014, comments were received on December 31, 2015 and the revised CIMP will be resubmitted to the LARWQCB on February 29, 2016. One of the main objectives of the CIMP is to leverage resources and create a regionally efficient and effective monitoring program.

The integrated review of existing monitoring programs, TMDL implementation plans, the Regional Board-approved Bacteria TMDL CMP, Toxics TMDL CMPs, and the monitoring data that were used in the development of the MdR Watershed CIMP represent the "Initial Assessment" of existing conditions in the MdR watershed.

Lessons learned during planning and implementation of Year 1 of the MdR Watershed CIMP (i.e., monitoring station appropriateness and safety considerations for wet weather receiving water monitoring) will be tracked and integrated into the overall program assessment during the quality assurance/quality control review of monitoring data and annual reporting. Each Annual Report will present a summary of TMDL and Permit compliance and will provide an opportunity to identify, as appropriate, modifications to the MdR Watershed CIMP protocols based on lessons learned and monitoring data. A formal programmatic review will occur during Years 1 and 2 of the program and will be integrated into the Year 3 implementation. A more comprehensive review and update of the MdR Watershed CIMP monitoring protocols may also become necessary, especially when preparing for the Triad Sampling for SQO analysis (required once during the 5-year Permit Order period in accordance with the SQO guidance).

10.2.1 CIMP Monitoring Reports and Revision Process

Every 2 years, hence during Year 3 of the implementation of the CIMP monitoring program, available monitoring information will be reviewed in the context of the receiving water monitoring program and outfall-based monitoring objectives.

If changes are needed, at any stage of the CIMP implementation, they will be made to the CIMP, incorporated into monitoring practice, and described in the next Annual Report. Identified changes will be discussed in the Annual Report and implemented starting no later than the first CIMP monitoring event of the next monitoring year. Such changes include, but are not limited to, adding/removing monitored constituents, modifying laboratories/analytical methods, or amending sampling protocols. Should major changes to the approach be required (e.g., moving or removing a stormwater outfall or receiving water monitoring station location), the modifications will be proposed in the Annual Report and in a separate letter to the Regional Board requesting Executive Officer approval of the change.

Annual Reports for MS4 Permit compliance are required to be submitted by December 15 of every year. These Annual Reports will cover the monitoring period of July 1 through June 30. These reports shall clearly identify all data collected during the monitoring year, as well as strategies, control measures, and assessments implemented by each Permittee within its jurisdiction. Annual Reports will also present watershed-scale efforts implemented by multiple Permittees. Discussion shall be provided in accordance with the requirements laid out in MRP Section XVIII. The Annual Reports will include the following:

- Annual Assessment and Reporting
    - Stormwater Control Measures
    - Effectiveness Assessment of Storm Water Control Measures
    - Non-Stormwater Control Measures
    - Effectiveness Assessment of Non-Stormwater Control Measures
    - Integrated Monitoring Compliance Report
    - Adaptive Management Strategies
    - Supporting Data and Information
    - Municipal Action Level (MAL) Assessment and Report

Municipal Action Level (MAL) reports are required to be submitted with the Annual Report and will compare monitoring data to applicable MALs identified in Attachment G of the Permit. Subwatersheds with a running average of greater than or equal to twenty percent exceedances of the MALs will be identified and beginning in year 3, a MAL Action Plan will be required for these subwatersheds.

Additionally, semi-annual data reports will be submitted with the Annual Report, and 6 months prior to the annual report (June of each year). The June 15 data submittal will include data for the monitoring period of July 1 through December 31, and the December 15 data submittal will include data for the monitoring period of January 1 through June 30. These semi-annual analytical data reports detail exceedances applicable to WQBELs, RWLs, action levels, or aquatic toxicity thresholds, with corresponding sample dates and monitoring locations.

Monthly monitoring reports are required for Bacteria TMDL compliance and annual reports are also required for Toxics TMDL compliance. These data reports will be submitted as an attachment to MS4 Permit required annual reports.

10.3 Special Studies

Special studies carried out in support of TMDL implementation will be used to assess compliance strategies in the MdR EWMP. A Stressor ID Study is required under the Toxics TMDL and is planned to be conducted in the MdR Harbor in the year 2016. This study will identify stressors causing toxicity to biological organisms in the harbor. Bight 18 monitoring will also be conducted, and results from these studies may impact compliance strategies and programs specified in this EWMP and will be evaluated upon completion. The EWMP will be adapted, if necessary, to enable compliance through the most efficient means possible.

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APPENDIX A

Unit Designs and Costs

1.0 APPROACH – GREEN STREETS

The potential load reductions and design limitations associated with each of the infiltration, capture/reuse and filtration type BMPs considered for green streets in the MdR Watershed are summarized in Table 1. In general, infiltration or capture and infiltration/reuse BMPs were translated into 100% load reductions for the tributary design area, while filtration type BMPs were assumed to have a maximum load reduction potential of 63 percent. Downspout disconnects require BMPs to be implemented on private property. Although these systems have the potential to be highly effective and reducing the volume of runoff to the MdR harbor receiving water, implementation requires extensive outreach and coordination with private properties. Feasibility of implementation is therefore limited. This type of BMP was only incorporated into the life cycle cost (LCL) estimates for areas where groundwater levels prohibited infiltration (e.g., depth to groundwater of less than 15 feet). For residential land uses, the potential load reduction was capped at 20 percent, which translates to a maximal roof runoff capture of 60%, a very aggressive program. At commercial and industrial parks, where there are few other options, a public private partnership may be implemented to increase the roof runoff area captured and potentially treated. The unit designs and LCL assumptions for each type of BMP may be found at the end of this section.

Table 1. Minimum Control Measures for Green Streets

Structural Minimum Control Measure	**Load Reduction**	**Notes**
Filtration- Porous Pavement (Road Design only)	63%	Filtration requires 24-72 hours and filtered flows are directed to the MS4. Volume of stormwater capture is limited to the capacity of the porous pavement. Requires routine annual sweeping. Vacuum sweeper recommended. *BMP design assumes a road grade of 1% and one 6-inch underdrain per 8-foot wide section of pavement.*
Biofiltration- Sidewalks	63%	Biofiltration requires 24-72 hours and units have effectively zero storage capacity. Stormwater attenuation by a cistern required (100% treatment volume). Flow is routed from and back into the MS4. Requires routine maintenance (weeding) and replacement of plants, as well as routine inspection and maintenance of the cistern.
Capture and Use	100%	Flow is routed from the MS4 into a subsurface cistern. Approximately 1300 square feet of vegetated area is needed to utilize the runoff volume captured in a 1000-gallon cistern within 14 days of an event. This type of BMP has limited feasibility in MdR Watershed public right of way. If implemented as a downspout disconnect program on private property, a maximum load reduction of 20% is assumed to cut the runoff volume from a design area.
Infiltration-Sidewalks	100%	Flow directed from road via curb cuts. Requires routine maintenance (weeding) and replacement of plants. *BMP design assumes infiltration possible at 4 foot below grade.*
Infiltration-Porous Pavement	100%	Road level infiltration. Requires routine (at least monthly) sweeping. Vacuum sweeper recommended. *Road design assumes infiltration possible at 3-feet below grade. Sidewalk design (shallow infiltration design) assumes infiltration possible at 1.5-feet below grade. BMP design assumes a road grade of 1%.*
Infiltration-Infiltration Gallery	100%	Flow may be diverted from MS4, provided flow pre-treated by catch basin inserts. *Smallest BMP design assumes a minimum groundwater depth of 17 feet. This infiltration design was limited to the portion of subwatershed 4 with a depth to groundwater of ≥20 feet. BMP design assumes a road grade of 1%.*

*This is a minimum feasible load reduction and is generally not additive to other BMPs. Catch basin inserts are a fundamental aspect of treatment trains.

Next, the unit BMP costs were translated into values that could be scaled across the MdR Watershed. The two variables identified as strongly impacting feasibility of BMP implementation include depth to groundwater and land use. According to the Los Angeles County BM Design Manual the invert of an infiltration type BMP and the groundwater level must have a minimum separation of 10 feet, preferably more. Historical groundwater data was used to create three groundwater classes, including

- Groundwater greater than 20 feet (infiltration feasible),
- Groundwater between 10 and 20 feet (infiltration feasible if groundwater ≥15 feet), and
- Groundwater less than 10 feet (infiltration not feasible).

The MdR Watershed is predominately residential, small intermixed sections of commercial and industrial, or larger "parks" of concentrated commercial/industrial use. Three general land use classes were determined to adequately characterize the watershed, including single family residential (SFR), multi-family residential (MFR) and a general category called commercial (COMM) that was generally applied to industrial and public facilities (similar impervious land area). The watershed acreages by land use class, groundwater class and subwatershed is summarized in Table 2 and presented in Figure 1.

Table 2. Land Uses and Depth to Groundwater by BMP Design Zone

Land Use Class #	**GW<10ft**			**10ft<GW<20ft**			**GW>20ft**	**Total Acres**
	Water-shed 1	**Water-shed 2**	**Water-shed 4**	**Water-shed 2**	**Water-shed 3**	**Water-shed 4**	**Water-shed 4**	
MFR	171.2	23.5	23.4	146.3	28.4	100.6	26.8	520
SFM	36.0	26.6	55.2	57.3	30.2	66.5	100.0	371
COMM	161.6	9.8	69.9	61.2	11.8	128.5	74.6	517
Total Land Area	368.8	59.9	148.5	264.8	70.5	295.7	201.5	**1,409**

The COMM class includes Commercial, Industrial and Public Facilities land uses. All other land uses were distributed across these three classes.

Figure 1. Potential Regional BMP Locations within the MdR WMA Watershed

Six city blocks, representing the land use and groundwater classes, were selected as representative design areas for the MdR Watershed (Table 3). These design areas were used to evaluate the number of BMPs to treat the volume of runoff from each design area. The runoff volume for each design area was calculated using the 85th percentile 24-hour storm event (1.1 inches). The number of each type of BMP needed to treat the design runoff volume was determined, assuming infiltration type BMPs were treating for the 85th percentile storm and filtration type BMPs were treating for 1.5 times the 85th percentile storm. The cost of implementation was calculated and then translated into a land use-specific cost per acre treated value for each type of BMP.

Table 3. Representative Design Areas - MdR Watershed

Land Use Class	Area Name	Location	Depth to Groundwater (ft)	Block Area (ac)	Roof as % of Area	Notes
SFR	SFR-4-1	Walnut/Glyndon/ Victoria/Lucille Avenue	22	3.96	23%	Stormwater routed via alleys to larger roads with subsurface MS4. Utilities often in alleys.
	SFR-3	Olive/Harbor/ Clement/Clarke	12 to 13	1.77	27%	
MFR	MFR-4-1	Venice Blvd/Redwood/ Ashwood/Glenco	23 to 28	0.82	54%	Stormwater routed via alleys to larger roads with subsurface MS4. Utilities often in alleys.
	MFR-2	Pacific Ave/Speedway/ 24th Ave/24th Pl	18	0.84	63%	
COMM	COMM-4-1	Venice Blvd/Louella Ave/ Penmar/Glenco	20	1.23	75%	COMM-4-1 is a mixed land use, similar to SFR and MFR.
	COMM-4-2	Beach Ave/Del Rey Ave/ Glenco/Unnamed Alley	10 to 13	3.22	71%	

Cost was scaled across each subwatershed based on land use acreage and the feasible BMPs within each groundwater class (per Table 2, above). BMP implementation was scheduled for each subwatershed based on the 75% and 100% load reduction goals established for the Toxics TMDL.

GREEN STREET BMP DESIGNS - Design By Land Use & Depth to Groundwater

DESIGN AREAS 85th % Storm (ft) = 0.09

Land Use	Area ID	Depth to Groundwater (ft)	Perimeter Available for BMPs (ft)	Drainage Area (ac)	Runoff Coefficient	Design Runoff Volume (cft)
Multi-Family Residential	MFR-4-1	23 to 28	720	0.66	0.65	1,716
Multi-Family Residential	MFR-2	18	800	0.69	0.75	2,063
Multi-Family Residential	MFR-1	<10	300*	1.03	0.75	3,094
Single-Family Residential	SFR-4-1	22	1640	3.65	0.5	7,291
Single-Family Residential	SFR-3	12 to 13	1080	1.56	0.6	3,740
Commercial/Industrial	COMM-4-1	20	910	1.03	0.85	3,502
Commercial/Industrial	COMM-4-2	10 to 13	300**	2.86	0.85	9,701

**300ft length of road along Panay Way. No sidewalks.*

***In large commercial parks, limited ROW access. Short length of block ~150ft. Driveways ~20ft.*

Infiltration Design

Due to clay material present for the top ~10-13 feet of soil, infiltration type designs assume an additional 5-ft excavation volume. This made infiltration-type porous pavement and sidewalk swales infeasible.

A minimum depth to groundwater of 15 to 16 feet is required to maintain a 10 foot separation from the BMP invert to the groundwater table.

Design	Area	Volume Treated by 102-ft Section (cft)	No. 102-ft Sections	Vol Treated (cft)	Length of BMP (ft)	Potential BMP Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
Infiltration Gallery	MFR-2	1,435	1.5	2,081	147.9	100%	Only if no sidewalk	$116,160	$446,997	$26,136	$1,452
	SFR-4-1	1,435	5.1	7,320	520.2	100%	N/A	$62,708	$337,090	$4,929	$821
	COMM-4-1	1,435	2.5	3,588	255.0	100%	Only if no parkway	$127,918	$612,191	$17,443	$3,876

Capture/Use Design

SFR-3 was considered a good representation of cost for 1-2 acre residential drainage areas where 50% of existing vegetation areas may be converted to swales.

COMM-4-1 was used to represent cost drainage areas where sidewalk would need to be converted into new vegetation areas.

Multi-family residential (MRF) land uses in subwatershed 1 and 2 generally lack sidewalks (with parkway); therefore, this type of BMP is not feasible in these areas.

Design	Area	Volume Treated by Unit Section (cft)	No. 100-ft Unit Sections	Vol Treated (cft)	Length of BMP (ft)	Potential BMP Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
Sidewalk-Swale (Capture/Use)	SFR-3	230.0	10.8	2,484	1080	100%	66%	$65,586	$139,771	$17,361	$2,411
	COMM-4-1	230.0	9.1	2,093	910	100%	60%	$115,135	$249,654	$29,189	$4,054
	COMM-4-2	230.0	3.0	690	300	100%	7%	Limited Feasibility of Implementation			

Filtration Design

Design	Area	Volume Treated by Unit Section (cft)	No. 100-ft Unit Sections	Vol Treated (cft)	Length of BMP (ft)	Potential BMP Load Reduction	Space Constraint - Feasible Max Area Treated	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)	Design Notes
Porous Pavement -Filtration (GW≥15 ft)	SFR-3	560.0	6.8	3,808	680	63%	N/A	$90,964	$263,548	$11,531	$1,281	
	MFR-2	560.0	3.7	2,072	370	63%	N/A	$132,132	$328,621	$26,136	$2,904	
	MFR-1	560.0	3.0	1,680	300	63%	34%	Limited Feasibility of Implementation				Effective area equiv to MFR-
Sidewalk Filtration-MWS	COMM-4-1	1757.5	2	3,515	-	63%	Only if no parkway	$41,670	$118,796	$17,443	$1,454	

GREEN STREET BMP DESIGNS - Design By Land Use & Depth to Groundwater

DESIGN AREAS-ROOFING

Design Criteria = 1000 gallons captured per 1000 sq foot roof drainage area

Land Use	Area ID	Unit of Roof Area (sft)	# Roofs of Similar Size	Total Roof Area (sft)	No. 1000-gal Cisterns for 20% Runoff Reduction	Vegetated Area (sft)	Vegetation as % of Drainage Area	Design Notes
Multi-Family Residential	MFR-4-1	1,875	9	16,875	3.4	6,750	23.4%	38% participation
Multi-Family Residential	MFR-2	1,750	11	19,250	3.9	7,700	25.7%	35% participation
Multi-Family Residential	MFR-1	16,500	1	16,500	3.3	6,600	14.7%	
Single-Family Residential	SFR-4-1	2,450	16	39,200	7.8	15,680	9.9%	50% participation
Single-Family Residential	SFR-3	1,500	14	21,000	4.2	8,400	12.4%	30% participation
Commercial/Industrial	COMM-4-1	4,000	10	40,000	8.0	16,000	35.6%	Not Feasible insufficient space for vegetation area
Commercial/Industrial	COMM-4-2	110,500	1	110,500	22.1	44,200	35.5%	Not Feasible insufficient space for vegetation area

Land Use	Area ID	Unit of Roof Area (sft)	# Roofs of Similar Size	Total Roof Area (sft)	No. 1000-gal Cisterns for 40% Runoff Reduction	Vegetated Area (sft)	Vegetation as % of Drainage Area	Design Notes
Single-Family Residential	SFR-4-1	2,450	16	39,200	15.7	15,680	9.9%	100% participation
Single-Family Residential	SFR-3	1,500	14	21,000	8.4	8,400	12.4%	35% participation

Area	Planning ($/ac)	Construction ($/ac)	Monitoring ($/ac)	O&M ($/ac/year)
SFR-3 Utilized existing Landscape	$31,389	$104,064	$11,531	$1,601
MFR-1 Create Landscape from Hardscape	$60,984	$323,622	$17,424	$1,936

<u>UNIT OF INFILTRATION GALLERY</u> *(1 row of chambers x 102-foot Length)*

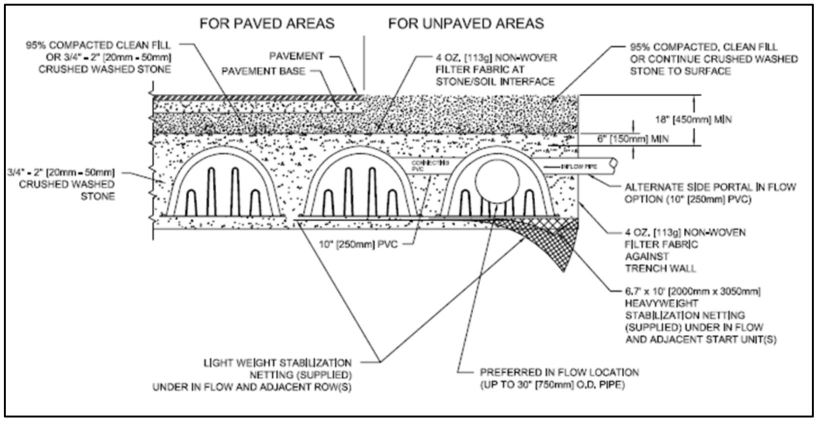
MAXIMUM METAL LOAD REDUCTION = 100%

STORMCHAMBER PARAMETERS	**Units**	**Amt**	**Notes**
Stormchamber - Depth (no stone or cover)	ft	2.8	
Stormchamber - Width	ft	5.0	
Stormchamber - Length	-	7'7" to 8'1"	
Volume of 1 Chamber	cft	75	
Cover	ft	1.5 to 2.5	MS4 connects to No.3 catch basin (V=3') via 6" pipe @ upstream end, 1% grade
Design Unit - Length	ft	102	1 row of 11 middle section chambers & 2 end chambers, footprint=719 sft
Stone Voids Ratio	-	0.35	
Design Storm - 85th Percentile	ft	0.09	(1.1 in)

DESIGN RESULTS *L=102-ft* *1% grade*

Configuration of Chamber	Capacity: 1 Chamber+ Gravel (cft)	Unit Design Capacity (cft)	Gravel Invert from Rd Surface (ft)	Min Depth to Groundwater (ft)	Excavation (cyd)	
12" Cover, with 6" Stone Above & 6" Below Chamber	110.4	1,435	4.8 to 5.8	15	134.4	Standard Design
12" Cover, with 6" Stone Above & 24" Below Chamber	134.5	1,605	6.3 to 7.3	17	181.1	
12" Cover, with 6" Stone Above & 36" Below Chamber	150.6	1,958	7.3 to 8.3	18	208.1	

**Depth of gravel gallery may be scaled based on groundwater*



Cost Estimate - Infiltration Gallery

SFR-4-1

Single-family residential

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			6" Stone Above+Below Chamber	
Construction BMP - Construction Fence	LF	$4.00	1,290.0	$5,160
Construction BMP - Gravel Bags	EA	$2.00	125.0	$250
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	624.0	$4,992
Remove Asphalt	SF	$5.00	4,360.0	$21,800
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	1,602.2	$72,099
Filter Fabric	SF	$3.00	2,090.0	$6,270
3/4-inch Gravel	CY	$125.00	400.0	$50,000
Backfill	CY	$15.00	90.0	$1,350
Import and Place Amended Soils	CY	$150.00	812.2	$121,831
Inlet Structure - Curb Inlet	EA	$6,160.00	3.0	$18,480
Catch Basin Inlet BMP	EA	$2,500.00	3.0	$7,500
Clean Out	EA	$633.00	6.0	$3,798
6-Inch SDR-35 PVC	LF	$64.00	60.0	$3,840
Storm Chamber	EA	$1,000.00	80.0	$80,000
12 inches AC over 5 inches Class II Base	SF	$8.40	4,360.0	$36,624
Subgrade preparation	SF	$0.84	4,360.0	$3,662
Striping	LF	$0.80	624.0	$499
Shoring (subsurface structure)	SF	$14.34	4,360.0	$62,522
		Subtotal	-	$503,003
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$100,000
Construction Administration			10%	$50,000
Contingency			15%	$75,000
		CONSTRUCTION SUBTOTAL	-	**$1,231,005**
Engineering Design			40%	$199,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$229,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$114,500**
Quarterly Cleaning @ Catch Basin	yr	$3,000	20	$60,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

SFR-4-1	Project Area (acres)=		3.65
PLANNING/DESIGN		$/acre	**$62,708**
CONSTRUCTION		$/acre	**$337,090**
POST CONSTRUCTION STORMWATER MONITORING		$/acre	**$4,929**
POST CONSTRUCTION (O&M)		$/acre/yr	**$821**

Cost Estimate - Infiltration Gallery

MFR-2

Multi-family residential

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			6" Stone Above+Below Chamber	
Construction BMP - Construction Fence	LF	$4.00	310.0	$1,240
Construction BMP - Gravel Bags	EA	$2.00	30.0	$60
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	156.0	$1,248
Remove Asphalt	SF	$5.00	1,040.0	$5,200
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	383.1	$17,238
Filter Fabric	SF	$3.00	500.0	$1,500
3/4-inch Gravel	CY	$125.00	100.0	$12,500
Backfill	CY	$15.00	20.0	$300
Import and Place Amended Soils	CY	$150.00	193.1	$28,960
Inlet Structure - Curb Inlet	EA	$6,160.00	1.0	$6,160
Catch Basin Inlet BMP	EA	$2,500.00	1.0	$2,500
Clean Out	EA	$633.00	2.0	$1,266
6-Inch SDR-35 PVC	LF	$64.00	20.0	$1,280
Storm Chamber	EA	$1,000.00	19.0	$19,000
12 inches AC over 5 inches Class II Base	SF	$8.40	1,040.0	$8,736
Subgrade preparation	SF	$0.84	1,040.0	$874
Striping	LF	$0.80	156.0	$125
Shoring (subsurface structure)	SF	$14.34	1,040.0	$14,914
		Subtotal	-	$125,425
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$25,000
Construction Administration			10%	$13,000
Contingency			15%	$19,000
		CONSTRUCTION SUBTOTAL	-	**$307,849**
Engineering Design			40%	$50,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$80,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$40,000**
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

MFR-2	Project Area (acres)=	0.69
PLANNING/DESIGN	$/acre	**$116,160**
CONSTRUCTION	$/acre	**$446,997**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$26,136**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,452**

Cost Estimate - Infiltration Gallery

COMM-4-1

Commercial/Industrial *(mixed neighborhood land use areas)*

			6" Stone Above+Below Chamber	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	530.0	$2,120
Construction BMP - Gravel Bags	EA	$2.00	50.0	$100
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825
Sawcut Asphalt	LF	$8.00	260.0	$2,080
Remove Asphalt	SF	$5.00	1,790.0	$8,950
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export *(limited grading)*	CY	$45.00	652.9	$29,379
Filter Fabric	SF	$3.00	860.0	$2,580
3/4-inch Gravel	CY	$125.00	170.0	$21,250
Backfill	CY	$15.00	40.0	$600
Import and Place Amended Soils	CY	$150.00	332.9	$49,931
4-inch Slotted PVC Pipe Under Drain	LF	$55.00	332.9	$18,308
Inlet Structure - Curb Inlet	EA	$6,160.00	4.0	$24,640
Catch Basin Inlet BMP	EA	$2,500.00	4.0	$10,000
Clean Out	EA	$633.00	8.0	$5,064
6-Inch SDR-35 PVC	LF	$64.00	80.0	$5,120
Storm Chamber	EA	$1,000.00	33.0	$33,000
12 inches AC over 5 inches Class II Base	SF	$8.40	1,790.0	$15,036
Subgrade preparation	SF	$0.84	1,790.0	$1,504
Striping	LF	$0.80	260.0	$208
Shoring (subsurface structure)	SF	$14.34	1,790.0	$25,669
		Subtotal	-	$257,863
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$51,000
Construction Administration			10%	$26,000
Contingency			15%	$39,000
		CONSTRUCTION SUBTOTAL	-	**$631,726**
Engineering Design			40%	$102,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$132,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$66,000**
Quarterly Cleaning @ Catch Basin	yr	$4,000	20	$80,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

COMM-4-1	Project Area (acres)=	1.03
PLANNING/DESIGN	$/acre	**$127,918**
CONSTRUCTION	$/acre	**$612,191**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,443**
POST CONSTRUCTION (O&M)	$/acre/yr	**$3,876**

UNIT OF SIDEWALK PLANTER - CAPTURE/USE

100 feet = three sidewalk planters

MAXIMUM METAL LOAD REDUCTION = 100%

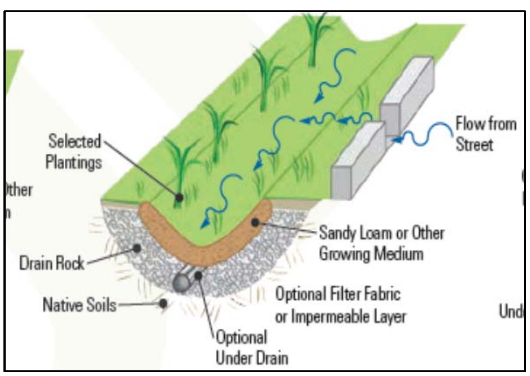
Design Sidwalk - Minor Road

Total parkway width = 10-12 ft

Sidewalk ~6-foot in COMM (0/100% parkway/walkway) and often lacking in commercial parks

SIDEWALK CAPTURE - PARAMETERS	Units	Capture/Use	Notes
Voids Ratio	-	0.35	
Planter Width	ft	4	
Total Section Length	ft	100	
No. Planters per 100-ft Sidewalk	-	3	
Planter Unit Length	*ft*	*20*	*3 ft curb cut, 17-ft swale (1% grade)*
Walking Path between Planters	ft	~13	
Total Depth	ft	2.5	
Planter Amended Soil Depth (LA BMP Manual)	*ft*	*2.0*	
Total Swale Headspace	*ft*	*0.5*	
Planter Ponding Depth	*ft*	*0.17 to 0.33*	*given 1% grade*
Gravel	*ft*	*0.5*	

DESIGN RESULT	Units	Capture/Use
Volume Treated-Unit Planter	cft	76.7
Volume Treated-100ft Section	cft	230.0



Cost Estimate - Sidewalk Capture/Use Planter
SFR-3

All Land Uses - Able to utilize 25% existing planters 648 ft of planter

			Planter Swale-Capture/Use	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	880.0	$3,520
Construction BMP - Gravel Bags	EA	$2.00	220.0	$440
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000
Demolish Sidewalk/Gutter	SF	$15.00	1,728.0	$25,920
Remove Asphalt	SF	$5.00	1,728.0	$8,640
Clear and Grubb *(salvage)*	SF	$1.50	864.0	$1,296
Tree Removal	EA	$500.00	6.0	$3,000
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export	CY	$45.00	224.0	$10,080
Excavation	CY	$5.00	64.0	$320
Backfill	CY	$15.00	64.0	$960
Filter Fabric	SF	$3.00	2,592.0	$7,776
Import and Place Amended Soils	CY	$150.00	128.0	$19,200
Construct Curb with Cuts for Runoff Flow	LF	$50.00	97.2	$4,860
Native/Drought Tolerant Landscaping	SF	$1.50	2,592.0	$3,888
Mulch	SF	$0.50	2,592.0	$1,296
New Subsurface Drip Irrigation	SF	$2.40	2,592.0	$6,221
		Subtotal	-	$100,917
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$19,000
Construction Administration			10%	$10,000
Contingency			15%	$15,000
		CONSTRUCTION SUBTOTAL	-	**$144,917**
Engineering Design			40%	$38,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$68,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$34,000**
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

	Project Area (acres)=		1.56
SFR-3	Project Area 100% Treated (acres)=		1.04
	PLANNING/DESIGN	$/acre	**$65,586**
	CONSTRUCTION	$/acre	**$139,771**
	POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,361**
	POST CONSTRUCTION (O&M)	$/acre/yr	**$2,411**

Cost Estimate - Sidewalk Capture/Use Planter
COMM-4-1

All Land Uses - Covert 100% of sidewalk to swale 546 ft of planter — Planter Swale-Capture/Use

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
Construction BMP - Construction Fence	LF	$4.00	740.0	$2,960
Construction BMP - Gravel Bags	EA	$2.00	185.0	$370
Construction BMP - Erosion Control	LS	$2,000.00	1.0	$2,000
Demolish Sidewalk/Gutter	SF	$15.00	2,184.0	$32,760
Remove Asphalt	SF	$5.00	2,184.0	$10,920
Protect Utilities in place	LS	-	1,500.0	$1,500
Excavation, Export	CY	$45.00	242.7	$10,920
Filter Fabric	SF	$3.00	2,184.0	$6,552
Import and Place Amended Soils	CY	$150.00	161.8	$24,267
Construct Curb with Cuts for Runoff Flow	LF	$50.00	81.9	$4,095
Native/Drought Tolerant Landscaping	SF	$1.50	2,184.0	$3,276
Mulch	SF	$0.50	2,184.0	$1,092
New Subsurface Drip Irrigation	SF	$2.40	2,184.0	$5,242
		Subtotal	-	$105,953
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$21,000
Construction Administration			10%	$11,000
Contingency			15%	$16,000
		CONSTRUCTION SUBTOTAL	-	**$153,953**
Engineering Design			40%	$41,000
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$71,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$35,500**
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000

	Project Area (acres)=	1.03
COMM-4-1	Project Area 100% Treated (acres)=	0.62
PLANNING/DESIGN	$/acre	**$115,135**
CONSTRUCTION	$/acre	**$249,654**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$29,189**
POST CONSTRUCTION (O&M)	$/acre/yr	**$4,054**

UNIT OF POROUS PAVEMENT

8-ft x 100 foot porous pavement section

MAXIMUM METAL LOAD REDUCTION = 63%

Design Road: Minor - 16 feet wide (8ft+8ft driving/parking lanes)

PP PARAMETERS	Units	Amt	Notes
Voids Ratio	-	0.35	
Length	ft	100.00	
Width	ft	8.00	
Depth	*ft*	*2.67*	
Capture Volume	cft	560	Based on rock reservior depth=2ft
Load Reduction	%	100%	

MATERIALS DESIGN		Amt
Road Slope	ft/ft	0.01
Excavation	cyd	93.8
Bedding Sand	cyd	4.9
Rock Reservior	cyd	74.1
Edger	ft	116.00
Filter Fabric	sft	832
6" Underdrain	ft	110

Pavement Layer Design

Pavement = 6"
Sand = 2"
Filter Fabric
Rock Reservior=2'
Underdrain-6"
Filter Fabric

Cost Estimate - Porous Pavement-Filtration
SFR-3

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
	680	ft of PP	Road Design (8ftx100ft)	
Construction BMP - Construction Fence	LF	$4.00	1,360	$5,440.00
Construction BMP - Gravel Bags	EA	$2.00	140	$280.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	680	$5,440.00
Remove Asphalt	SF	$5.00	5,440	$27,200.00
Protect Utilities in place	LS	-	1,500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	638	$28,711.11
Filter Fabric	SF	$3.00	5,658	$16,972.80
3- to 6-inch Rock Reservoir	CY	$125.00	504	$62,962.96
1.5- to 2-inch Sand Course	CY	$125.00	34	$4,250.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	750	$30,000.00
Connection to Existing Catch Basin	EA	$1,200.00	2	$2,400.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	790	$11,850.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	5,440	$87,040.00
Striping	LF	$0.80	680	$544.00
Subtotal			-	$285,415.87
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$56,000.00
Construction Administration			10%	$28,000.00
Contingency			15%	$42,000.00
CONSTRUCTION SUBTOTAL			-	**$411,416**
Engineering Design			40%	$112,000.00
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$142,000**
PLANNING/DESIGN (assumes 2-year period)			per year	**$71,000**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

SFR-3	Project Area (acres)=	1.56
PLANNING/DESIGN	$/acre	**$90,964**
CONSTRUCTION	$/acre	**$263,548**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$11,531**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,281**

Cost Estimate - Porous Pavement-Filtration

Multifamily residential	300	ft of PP	Road Design (8ftx100ft)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	600	$2,400.00
Construction BMP - Gravel Bags	EA	$2.00	60	$120.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	300	$2,400.00
Remove Asphalt	SF	$5.00	2400	$12,000.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	281.5	$12,666.67
Filter Fabric	SF	$3.00	2496	$7,488.00
3- to 6-inch Rock Reservoir	CY	$125.00	222.2	$27,777.78
1.5- to 2-inch Sand Course	CY	$125.00	15	$1,875.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	330	$13,200.00
Connection to Existing Catch Basin	EA	$1,200.00	1	$1,200.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	350	$5,250.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	2400	$38,400.00
Striping	LF	$0.80	300	$240.00
		Subtotal	-	$127,342.44
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$25,000.00
Construction Administration			10%	$13,000.00
Contingency			15%	$19,000.00
		CONSTRUCTION SUBTOTAL	-	**$184,342**
Engineering Design			40%	$50,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$80,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$40,000**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

	MFR-2		Project Area (acres)=	1.03
		PLANNING/DESIGN	$/acre	**$77,440**
		CONSTRUCTION	$/acre	**$178,443**
		POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,424**
		POST CONSTRUCTION (O&M)	$/acre/yr	**$1,936**

Cost Estimate - Porous Pavement-Filtration
MFR-2

Multifamily residential	370	ft of PP	Road Design (8ftx100ft)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	740	$2,960.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Concrete Wash Out	EA	$825.00	1	$825.00
Sawcut Asphalt	LF	$8.00	370	$2,960.00
Remove Asphalt	SF	$5.00	2960	$14,800.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	347.2	$15,622.22
Filter Fabric	SF	$3.00	3078.4	$9,235.20
3- to 6-inch Rock Reservoir	CY	$125.00	274.1	$34,259.26
1.5- to 2-inch Sand Course	CY	$125.00	19	$2,375.00
6-inch Sch. 40 PVC Under Drain	LF	$40.00	410	$16,400.00
Connection to Existing Catch Basin	EA	$1,200.00	1	$1,200.00
Concrete Edge Restraint (Containment Curb)	LF	$15.00	430	$6,450.00
Pervious Concrete Pavement - 6-inch	SF	$16.00	2960	$47,360.00
Striping	LF	$0.80	370	$296.00
		Subtotal	-	$156,322.68
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$31,000.00
Construction Administration			10%	$16,000.00
Contingency			15%	$23,000.00
		CONSTRUCTION SUBTOTAL	-	**$226,323**
Engineering Design			40%	$61,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL	-	**$91,000**
		PLANNING/DESIGN (assumes 2-year period)	per year	**$45,500**
Vaccuming Sweeper (annual)	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

MFR-2	Project Area (acres)=		0.69
PLANNING/DESIGN	$/acre		**$132,132**
CONSTRUCTION	$/acre		**$328,621**
POST CONSTRUCTION STORMWATER MONITORING	$/acre		**$26,136**
POST CONSTRUCTION (O&M)	$/acre/yr		**$2,904**

Sidewalk-Biofiltration (Modular Wetlands System or Equivalent)

MAXIMUM METAL LOAD REDUCTION = 63%

MWS PARAMETERS - MWS-L4-21	Unit	Amt
Unit Length	ft	21
Unit Width	ft	4
Unit Depth	ft	4
Peak Flow Rate (Manufacturer)	cfs	0.27
Excavation	cyd	27.1
Gravel Base	cyd	2.6
Backfill	cyd	4.1
Sidewalk Repair	sft	27

DESIGN PARAMETERS

Continuous simulation model (Day 4)	Unit	Amt
Design Storm	ft	0.09
Design Rainfall Intensity	in/hr	0.025
Time of Concentration	min	10
Design Peak Flow Rate for MWS	cfs	0.2

	SFR	MFR/COMM/IND	ROAD
	C=0.5	C=0.7	C=0.9
Tributary Drainage Area (ac)	0.90	0.65	0.5
Treated Flow (cft)	1749.5	1757.5	1750
Bypassed Flow (cft)	48	60	48
Flow Bypassed (%)	3%	3%	3%

Cost Estimate - Biofiltration by MWS or Equivalent

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			MWS	
Construction BMP - Construction Fence	LF	$4.00	100.0	$400.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Demolish Sidewalk/Gutter	SF	$15.00	220	$3,300.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	54.2	$2,439.00
1/2-inch Gravel	CY	$125.00	5.2	$650.00
Backfill	CY	$15.00	8.2	$123.00
Type I Grate Inlet Catch Basin	EA	$6,200.00	2	$12,400.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1	$2,500.00
4-inch PCC Sidewalk - Conventional	SF	$10.00	54	$540.00
6-Inch Curb & Gutter (also for Medians)	LF	$22.00	220	$4,840.00
21-ft Modular Wetland System, or Equivalent	EA	$25,000.00	2	$50,000.00
6-Inch SDR-35 PVC (MWS / Discharge Reservior)	LF	$64.00	40	$2,560.00
Native/Drought Tolerant Landscaping	SF	$1.50	168	$252.00
Controller Electrical Connection	LS	$800.00	2	$1,600.00
New Subsurface Drip Irrigation	SF	$2.40	168	$403.20
Subtotal			-	$83,587.20
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$17,000.00
Construction Administration			10%	$9,000.00
Contingency			15%	$13,000.00
CONSTRUCTION SUBTOTAL			-	**$122,587**
Engineering Design			40%	$34,000.00
CEQA + Permits			10%	$9,000.00
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$43,000**
PLANNING/DESIGN SUBTOTAL			per year	**$21,500**
Weeding + Re-planting, as needed	yr	$500	20	$10,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

COMM-4-1	Project Area (acres)=	1.03
PLANNING/DESIGN	$/acre	**$41,670**
CONSTRUCTION	$/acre	**$118,796**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,443**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,454**

UNIT OF DOWNSPOUT DISCONNECTION (CISTERNS)-CAPTURE/REUSE

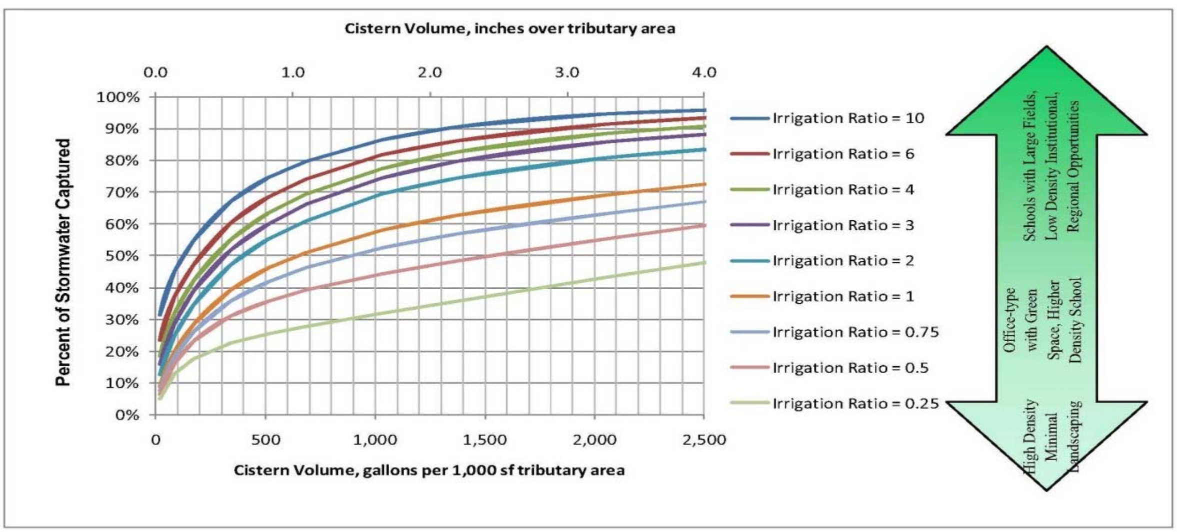
MAXIMUM METAL LOAD REDUCTION = 100%

CISTERN PARAMETERS	Unit	Above Ground	Notes
Tank Size	gal	1000	Supported by a concrete pad - 7.5ft x 7.5ft x 0.5ft
No.	-	1	
Total Tank Volume	gal	1000	
Capacity	%	90	Head space safety factor of 10%
Capture Volume / Capacity	cft	120.3	Exceeds capture need of the 85th% storm
Design Roof Area	sft	1000	
Max Roof Area Captured (85th % Design Storm)	sft	1,458	

GEOSYNTEC, 2009:
*Capture systems designed with landscape:drainage area ratios of 2 can achieve a 70% load reduction.

VEGETATION PARAMETERS*	Unit	Amt	Notes
Vegetated Area	sft	2000	Generally, loosen top 0.5-ft soil and ammend soil in place. For areas requiring new planter - 2-ft ammended soil.
Excavation Volume	cyd	148	COMM
Mulch	sft	2000	1" depth

This is generally considered to be a residential BMP - Significant space constraints make re-landscaping commercial/industrial land uses, especially large business parks, have limited feasibility.



Cost Estimate - Downspout Disconnection

SFR-3

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			1000 gal above-ground cistern, existing landscape	
Construction BMP - Construction Fence	LF	$4.00	1,000	$4,000.00
Construction BMP - Gravel Bags	EA	$2.00	100	$200.00
Loosen top 0.5" + Soil Ammendments	SF	$2.00	10,000	$20,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	10,000	$15,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	5	$10,000.00
7'X7'X0.5' Pad for Cistern	EA	$800.00	5	$4,000.00
System controller	EA	$400.00	5	$2,000.00
Irrigation Pump	EA	$600.00	5	$3,000.00
Shut Off Valve (install in irrigation system)	EA	$150.00	5	$750.00
First Flush Diversion w/ drain system	EA	$1,300.00	5	$6,500.00
Misc Rain Barrel Piping, fitting, etc.	LS	$1,000.00	5	$5,000.00
Cistern System Installation	LS	$2,000.00	5	$10,000.00
Controller Electrical Connection	LS	$1,600.00	5	$8,000.00
New Subsurface Drip Irrigation	SF	$2.40	10,000	$24,000.00
		Subtotal	-	$112,450.00
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$22,000.00
Construction Administration			10%	$11,000.00
Contingency			15%	$17,000.00
		CONSTRUCTION SUBTOTAL	-	**$162,450**
Engineering Design			40%	$44,000.00
CEQA + Permits			LS	$5,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$49,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$24,500**
Inspections / Repairs	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

SFR-3	Project Area (acres)=		1.56
PLANNING/DESIGN	$/acre		**$31,389**
CONSTRUCTION	$/acre		**$104,064**
POST CONSTRUCTION STORMWATER MONITORING	$/acre		**$11,531**
POST CONSTRUCTION (O&M)	$/acre/yr		**$1,601**

Cost Estimate - Downspout Disconnection

MFR-1

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			1000 gal above-ground cistern, hardscape to landscape	
Construction BMP - Construction Fence	LF	$4.00	800	$3,200.00
Construction BMP - Gravel Bags	EA	$2.00	80	$160.00
Demolish Sidewalk/Gutter/Pavement	SF	$15.00	8000	$120,000.00
Remove Asphalt	SF	$5.00	8000	$40,000.00
Protect Utilities in place	LS	-	1500	$1,500.00
Excavation, Export *(limited grading)*	CY	$45.00	148	$6,660.00
Import and Place Amended Soils	CY	$150.00	148	$22,200.00
Native/Drought Tolerant Landscaping	SF	$1.50	8000	$12,000.00
Mulch	SF	$0.50	8000	$4,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	4	$8,000.00
7'X7'X0.5' Pad for Cistern	EA	$800.00	4	$3,200.00
System controller	EA	$400.00	4	$1,600.00
Irrigation Pump	EA	$600.00	4	$2,400.00
Shut Off Valve (install in irrigation system)	EA	$150.00	4	$600.00
First Flush Diversion w/ drain system	EA	$1,300.00	4	$5,200.00
Misc Rain Barrel Piping, fitting, etc.	LS	$1,000.00	4	$4,000.00
Cistern System Installation	LS	$2,000.00	4	$8,000.00
Controller Electrical Connection	LS	$1,600.00	4	$6,400.00
New Subsurface Drip Irrigation	SF	$2.40	8000	$19,200.00
		Subtotal	-	$268,320.00
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$29,000.00
Construction Administration			10%	$15,000.00
Contingency			15%	$22,000.00
		CONSTRUCTION SUBTOTAL	-	**$334,320**
Engineering Design			40%	$58,000.00
CEQA + Permits			LS	$5,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$63,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$31,500**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

MFR-1Create Landscape Project Area (acres)=		1.03
PLANNING/DESIGN	$/acre	**$60,984**
CONSTRUCTION	$/acre	**$323,622**
POST CONSTRUCTION STORMWATER MONITORING	$/acre	**$17,424**
POST CONSTRUCTION (O&M)	$/acre/yr	**$1,936**

APPENDIX B

Project Designs and Cost Estimates

PROJECT DESIGN - COSTCO PARKING LOT

Area	Area (ac)	Runoff (cft)	Design Runoff (cft)
Total City	42	*115,600*	-
Costco	17.5	66,560	115,600
City (less Costco)	24.5	49,040	

Costco Property		
Lot Length (ft)	Average Lot Width (ft)	Area (ac)
930.0	820	17.5

Main Continuous Parking Lot: 930ft x 300ft			
Area (sft)	Area (ac)	Parking Aisles	Driving Lanes
279,000	*6.4*	14	15

Infiltration Gallery 25 x 30 chambers							
No Chambers	Chambers Long	~Length (ft)	Chambers Wide	~Width (ft)	Footprint (sft)	% Parking Lot	Sediment Traps
757.0	25.0	192	30.0	177.0	33,776	12.1%	4

Design Assumptions:	Units	Amt
Depth to Groundwater (ft)	ft	20 to 30
Impervious Clay Layer (ft)	ft	10 to 13

MS4 Diversion	Units	Amt			
Depth to MS4	ft	4.0			
Diversion - Length of 36" pipe from street to Infiltration Area	ft	400			
36" Diversion Bedslope	ft/ft	0.005			
36" Invert - End Diversion	ft	9.0	Gravel-CYD	Vol 36"-CYD	5"AC+5" base-CYD
Bedding Invert (6" gravel bedding)	ft	9.5	29.6	104.7	24.7
Excavation	cyd	503.7			
Reused Backfill	cyd	344.7			
		68.4%			

Infiltration Gallery	Units	Amt	Design Notes				
Infiltration Gallery MS4 Connection Invert	ft	9.0					
Cover (above chamber)	ft	7.0					
Backfill	*ft*	*6.5*					
Gravel	*ft*	*0.5*					
BMP Invert	ft	12.8					
Stormchamber	*ft*	*9.8*	At level to connect with MS4				
Amended Soils/Gravel	*ft*	*3.0*					
Capacity of one 102-ft row of 13 StormChambers: 6" above + 36" below	cft	1,958	Gravel Above Chambers-CYD	Ammended Soils/Gravel-CYD	Chambers-CYD	5"AC+5" base-CYD	Filter Fabric (sft)
No. Unit Sections required to Treat 100% Design Volume	-	59.0	625	5,153	2,083	521	33,776
Excavation	cyd	16,054.0					
Reused Backfill	cyd	7,671.4					
		47.8%					

Cost Estimate - Costco Parking Lot

DESCRIPTION	UNIT	UNIT COST	MS4 Diversion & Parking Lot Infiltration Gallery			
			Infiltration Gallery		MS4 Diversion	
			QUANTITY	TOTAL COST	QUANTITY	TOTAL COST
Construction BMP - Construction Fence	LF	$4.00	1,600.0	$6,400	800	$3,200.00
Construction BMP - Gravel Bags	EA	$2.00	100.0	$200	100	$200.00
Construction BMP - Concrete Wash Out	EA	$825.00	1.0	$825		
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000		
Demolish Sidewalk/Gutter or Parking Lot	SF	$15.00	35,375.9	$530,639	13600	$204,000.00
Remove Asphalt	SF	$5.00	35,375.9	$176,880	13600	$68,000
Protect Utilities in place	LS	-	5,000.0	$5,000	2500	$2,500
Excavation, Export	CY	$45.00	8,382.6	$377,215	159	$7,157
Excavation/Backfill	CY	$20.00	7,671.4	$153,428	345	$6,893
Filter Fabric	SF	$3.00	33,775.9	$101,328		
1/2-inch Gravel	CY	$125.00	625.5	$78,185	29.6	$3,704
Import and Place Amended Soils	CY	$150.00	5,152.5	$772,878		
Type I Grate Inlet Catch Basin	EA	$6,200.00	2.0	$12,400	1	$6,200
36-inch RCP	LF	$188.50			400	$75,400
18-inch RCP - transition from Catch Basin to Gallery	LF	$124.00	20.0	$2,480		
Cleanway Grate Inlet BMP	EA	$2,500.00	2.0	$5,000	1	$2,500
Clean Out	EA	$633.00	4.0	$2,532	4	$2,532
10-inch PVC (connecting rows of chambers)	LF	$80.64	180.0	$14,515		
Storm Chamber	EA	$1,000.00	757.0	$757,000		
StormChamber-Sediment Trap (recommend 1 @ inflow; 1 @ outflow chamber (L<120 ft)	EA	$550.00	4.0	$2,200		
5 inches AC over 5 inches Class II Base	SF	$8.40	33,775.9	$283,718	1000	$8,400
Striping	LF	$0.80	12,000.0	$9,600	400	$320
Diversion Structure	LS	$40,000.00			1	$40,000
Hydrodynamic Separator - (Bio Clean NSBB 6-12-84)	EA	$60,000.00			1.00	$60,000
Subtotal			-	$3,294,422.84	-	$491,006
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$657,000.00	20%	$98,000
Construction Administration			10%	$329,000.00	10%	$49,000.00
Contingency			15%	$493,000.00	25%	$122,000
CONSTRUCTION SUBTOTAL			-	**$4,773,423**	-	**$760,006**
Engineering Design			40%	$1,314,000.00	40%	$172,000
CEQA + Permits			LS	$30,000	LS	$30,000
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$1,344,000**	-	**$202,000**
PLANNING/DESIGN SUBTOTAL			per year	**$672,000**	per year	**$101,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000	3	$60,000
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$40,000	20	$20,000

REGIONAL PROJECTS - PARK CONCEPTUAL DESIGNS

Design Storm (ft) = 0.1

Park	Subwatershed	Park Drainage Area (ac)	Runoff C	Site Runoff Vol to be Maintained Onsite (cft)	Depth to Groundwater (ft)	Design Type	Design Notes
Venice of America Park	3	0.67	0.35	935	17	Infiltration Feasible	Assumes good soil - no need for over excavation
Canal Park	2	0.12	0.35	168	17	Infiltration Feasible	Assumes good soil - no need for over excavation
Triangle Park	4	0.09	0.35	120	11	Capture/Use Feasible	-
Via Dolce Park	2	0.21	0.35	290	12	Capture/Use Feasible	-

INFILTWATION DESIGNS

MAXIMUM METAL LOAD REDUCTION = 100%

Infiltration Design	StormChamber Dimensions	Treat Capacity per Stormchamber (cft)	MCM Invert Depth from Surface (ft)
1 layer of Stormchambers w/ 6" Stone Above, 24" Below	5ftx8.2ftx2.8ft	134.5	6.3

Park	Potential Drainage Area Treated	Targeted Capture Area (ac)	Drainage Area Runoff C	Target Runoff Volume to Be Treated (cft)	Total Design Volume (cft)	Design Notes
Venice of America Park	S. Venice Blvd, Alhambra Court, Washington Way	3.9	0.55	8,480	9,415	Located at boundary of MdR Watershed subwatersheds 3 & 4
Canal Park	Multi-family residential NE of Dell Ave (Court D)	3.3	0.55	7,189	7,357	As-Builts indicate LID redevelopment in the vicinity.

Park	No. Chambers	Max Treatment Capacity (cft)	Design Footprint	Design Footprint (sft)	Chamber Layout	Excavation (Yd³)
Venice of America Park	74	9,953	53ftx71ft	3,463	8 rows x ~9 long	805
Canal Park	58	7,801	47ftx64ft	2,739	7 rows x ~8 long	635

CAPTURE/REUSE DESIGNS

MAXIMUM METAL LOAD REDUCTION = 100%

Capture/Use Design	Landscape: Capture Area Ratio	Park	Cistern Capacity (gal)	Landscape Need (1000 ft2/1000 gal)(ac)	Tributary Drainage Area (ac) (C=0.55)
Subsurface Cistern & Irrigation w/ Park Space	~1 to 2	Via Dolce Park	3000.0	0.14	0.18
		Triangle Park	900	0.04	0.05

MATERIALS

Park	Tank Excavation Volume (cyd) (3 ft cover)	Tank Bedding-Gravel (cyd)	Backfill (cyd)
Via Dolce Park	46.9	4.3	27.8
Triangle Park	19.0	1.7	12.8

Landscape Area - Excavation Volume (cyd)	Amended Soil (cyd) - 2ft minimum depth
555.6	444.4
166.7	133.3

Cost Estimate - Infiltration Gallery @ Venice of America

			Venice of America	
			Infiltration Gallery - 24" Stone	
DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
Construction BMP - Construction Fence	LF	$4.00	180.0	$720.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Construction BMP - Erosion Control	EA	$2,000.00	1.0	$2,000.00
Protect Utilities in place	LS	-	500.0	$500.00
Excavation, Export	CY	$45.00	679.8	$30,591.91
Excavation	CY	$5.00	124.7	$623.43
Filter Fabric	SF	$3.00	776.2	$2,328.75
10-inch PVC (connecting rows of chambers)	LF	$80.64	48.0	$3,870.72
3/4-inch Gravel	CY	$125.00	474.3	$59,283.09
Backfill	CY	$15.00	124.7	$1,870.30
Type I Grate Inlet Catch Basin	EA	$6,200.00	1.0	$6,200.00
18-inch RCP to connect to Street Storm Drain	LF	$124.00	60.0	$7,440.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1.0	$2,500.00
Clean Out	EA	$633.00	2.0	$1,266.00
Storm Chamber	EA	$1,000.00	74.0	$74,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	3463.2	$5,194.85
New Subsurface Drip Irrigation	SF	$2.40	3463.2	$8,311.76
Shoring (subsurface structure)	SF	$40.25	3463.2	$139,395.22
Subtotal			-	$346,176.05
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$69,000.00
Construction Administration			10%	$35,000.00
Contingency			15%	$52,000.00
CONSTRUCTION SUBTOTAL			-	**$502,176.05**
Engineering Design			40%	$138,000.00
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$168,000**
PLANNING/DESIGN SUBTOTAL			per year	**$84,000**
Post-Construction Monitoring-3 storms	storm	$12,000	3	$36,000.00
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$20,000.00

Cost Estimate - Infiltration Gallery @ Canal Park

			Canal Park	
			Infiltration Gallery - 24" Stone	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	160.0	$640.00
Construction BMP - Gravel Bags	EA	$2.00	40.0	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1.0	$2,000.00
Protect Utilities in place	LS	-	500.0	$500.00
Excavation, Export	CY	$45.00	537.6	$24,193.11
Excavation	CY	$5.00	97.9	$489.29
Filter Fabric	SF	$3.00	652.0	$1,955.96
10-inch PVC (connecting rows of chambers)	LF	$80.64	42.0	$3,386.88
3/4-inch Gravel	CY	$125.00	376.5	$47,064.20
Backfill	CY	$15.00	97.9	$1,467.86
Type I Grate Inlet Catch Basin	EA	$6,200.00	1.0	$6,200.00
18-inch RCP to connect to Street Storm Drain	LF	$124.00	20.0	$2,480.00
Cleanway Grate Inlet BMP	EA	$2,500.00	1.0	$2,500.00
Clean Out	EA	$633.00	2.0	$1,266.00
Storm Chamber	EA	$1,000.00	58.0	$58,000.00
Native/Drought Tolerant Landscaping	SF	$1.50	2738.8	$4,108.26
New Subsurface Drip Irrigation	SF	$2.40	2738.8	$6,573.22
Shoring (subsurface structure)	SF	$40.25	2738.8	$110,238.42
Subtotal			-	$273,143.20
Bond (5%)			20%	$55,000.00
Construction Administration			10%	$28,000.00
Contingency			15%	$41,000.00
CONSTRUCTION SUBTOTAL			-	**$397,143.20**
Engineering Design			40%	$109,000.00
CEQA + Permits			LS	$30,000
PLANNING/DESIGN SUBTOTAL			-	**$139,000**
PLANNING/DESIGN SUBTOTAL			per year	**$69,500**
Post-Construction Monitoring-3 storms	storm	$6,000	3	$18,000.00
Quarterly Cleaning @ Catch Basins	yr	$1,000.00	20	$20,000.00

Cost Estimate - Infiltration Park - Triangle Park

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			Below-ground cistern / Relandscaped Park	
Construction BMP - Construction Fence	LF	$4.00	350	$1,400.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000.00
Protect Utilities in place	LS	-	500	$500.00
Excavation, Export *(limited grading)*	CY	$45.00	172.8	$7,778.23
Excavation-Reuse Material	CY	$5.00	12.8	$64.05
1/2-inch Gravel - Cistern Bedding	CY	$125.00	1.7	$215.83
Import and Place Amended Soils - Landscape	CY	$150.00	133	$20,000.00
Type I Grate Inlet Catch Basin	EA	$6,200.00	1	$6,200.00
18-inch RCP	LF	$124.00	20	$2,480.00
Catch Basin Inlet BMP	EA	$2,700.00	1	$2,700.00
Clean Out	EA	$633.00	1	$633.00
Native/Drought Tolerant Landscaping	SF	$1.50	1800	$2,700.00
1000-gallon fiberglass cistern	EA	$2,000.00	0.9	$1,800.00
System controller	EA	$400.00	1	$400.00
Irrigation Pump	EA	$600.00	1	$600.00
Shut Off Valve (install in irrigation system)	EA	$150.00	1	$150.00
Controller Electrical Connection	LS	$1,600.00	1	$1,600.00
New Subsurface Drip Irrigation	SF	$2.40	1800	$4,320.00
		Subtotal	-	$55,621.10
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$11,000.00
Construction Administration			10%	$6,000.00
Contingency			15%	$8,000.00
		CONSTRUCTION SUBTOTAL	-	**$80,621**
Engineering Design			40%	$21,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$51,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$25,500**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

Cost Estimate - Infiltration Park - Via Dolce Park

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			Below-ground cistern / Relandscaped Park	
Construction BMP - Construction Fence	LF	$4.00	400	$1,600.00
Construction BMP - Gravel Bags	EA	$2.00	40	$80.00
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000.00
Protect Utilities in place	LS	-	500	$500.00
Excavation, Export *(limited grading)*	CY	$45.00	574.7	$25,860.29
Excavation-Reuse Material	CY	$5.00	27.8	$138.91
1/2-inch Gravel - Cistern Bedding	CY	$125.00	4.3	$532.96
Import and Place Amended Soils - Landscape	CY	$150.00	444	$66,666.67
Type I Grate Inlet Catch Basin	EA	$6,200.00	1	$6,200.00
18-inch RCP	LF	$124.00	20	$2,480.00
Catch Basin Inlet BMP	EA	$2,700.00	1	$2,700.00
Clean Out	EA	$633.00	3	$1,899.00
Native/Drought Tolerant Landscaping	SF	$1.50	6000	$9,000.00
1000-gallon fiberglass cistern	EA	$2,000.00	3	$6,000.00
System controller	EA	$400.00	3	$1,200.00
Irrigation Pump	EA	$600.00	3	$1,800.00
Shut Off Valve (install in irrigation system)	EA	$150.00	3	$450.00
Controller Electrical Connection	LS	$1,600.00	3	$4,800.00
New Subsurface Drip Irrigation	SF	$2.40	6000	$14,400.00
		Subtotal	-	$148,307.83
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$29,000.00
Construction Administration			10%	$15,000.00
Contingency			15%	$22,000.00
		CONSTRUCTION SUBTOTAL	-	**$214,308**
Engineering Design			40%	$58,000.00
CEQA + Permits			LS	$30,000
		PLANNING/DESIGN SUBTOTAL (assumes 2-year period)	-	**$88,000**
		PLANNING/DESIGN SUBTOTAL	per year	**$44,000**
Inspections / Repairs	yr	$2,000	20	$40,000.00
Quarterly Cleaning @ Catch Basin	yr	$1,000	20	$20,000
Weeding + Re-planting, as needed	yr	$2,500	20	$50,000.00
Post-Construction Monitoring-3 storms	storms	$6,000	3	$18,000.00

Boone Olive - Existing Diversion to Sanitary Sewer

2015 existing BMP @ Boone Olive - Dry Weather BMP

Item	Units	Amount
Boone Olive Detention/Diversion to the Sanitary Sewer	gal	104,720.0
	cft	13,999.0
Area Treated	sft	152,716.7
	ac	3.5

Stormwater Diversion to Sanitary Sewer - Subwatershed 4

DESIGN PARAMETERS	Units	Amount
Design Area	ac	35.0
Design Storm	ft	0.09
Runoff c	-	0.65
Design Runoff Volume	cft	90,841

CISTERN DESIGN PARAMETERS	Unit	100%
Factor - Tank Capacity	-	1.1
Minim Cistern Capture Volume	cft	99,925
Discharge Rate to Sanitary Sewer (q=0.05 cfs)	cft/day	4,320
Days to Drain 100% Volume	days	23
Design Drawdown Period	days	14
Additional Tank Capacity Required	cft	39,445
Cistern Design Volume	cft	139,370
Cistern Design Volume	gallons	1,042,557

DESIGN RESULT	Unit	100%
Height	ft	10
Footprint	*sft*	*13,937*
Length	*ft*	*126.7*
Width	*ft*	*110*
Foundation	*sft*	*15,145*

REDEVELOPMENT PARAMETERS	Unit	100%
Area Needed to Redevelopment	*ac*	0.50
No. Multi-Family Residential Lots	-	4.0

Cost Estimate - Diversion to Sanitary Sewer-Subwatershed 4

DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL COST
			Capture-Sanitary Sewer Subwatershed 4 (35ac)	
Construction BMP - Construction Fence	LF	$4.00	550	$2,200
Construction BMP - Gravel Bags	EA	$2.00	150	$300
Construction BMP - Concrete Wash Out	LS	$825.00	1	$825
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000
Protect Utilities in place	LS	-	10000	$10,000
Diversion Pump & Controls	SF	$40,000.00	1	$40,000
Concrete Tank large capacity	gal	$1.34	1,042,557	$1,397,027
Foundation for Large Tank	sft	$7.75	15145	$117,377
Subtotal			-	$1,569,729
Land Purchase	ac	$20,000,000	0.5	$10,000,000
Demolition & Site Preparation 2-3 Story Condominimum	sft	$15	22,000.0	$330,000
Redevelopment Subtotal			-	$10,330,000
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$313,000
Construction Administration			10%	$157,000
Contingency			15%	$235,000
CONSTRUCTION SUBTOTAL			-	**$12,604,729**
Engineering Design			40%	$626,000
CEQA + Permits			LS	$50,000
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$676,000**
PLANNING/DESIGN SUBTOTAL			per year	**$338,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000
Parts	yr	$2,000.00	20	$40,000
Inspections	yr	$5,000.00	20	$100,000
SEWER DISCHARGE FEE - 100% Design *(empty ~7x/yr @ $5.00/HCF)*	yr	-	20	$975,655

Stormwater Diversion to Sanitary Sewer - Subwatershed 1

DESIGN PARAMETERS	Units	Amount
Design Storm	ft	0.09
Runoff c	-	0.65
Design Area-Subwatershed 1a	ac	22.0
Design Runoff Volume-Subwatershed1a	cft	57,100
Design Area-Subwatershed 1b	ac	48
Design Runoff Volume-Subwatershed1b	cft	124,582

CISTERN DESIGN PARAMETERS	Unit	Sub-1A	Sub-1B
Factor - Tank Capacity	-	1.1	1.1
Minim Cistern Capture Volume	cft	62,810	137,040
Discharge Rate to Sanitary Sewer (q=0.05 cfs)	cft/day	4,320	4,320
Days to Drain 100% Volume	days	15	32
Design Drawdown Period	days	14	14
Additional Tank Capacity Required	cft	2,330	76,560
Cistern Design Volume	cft	65,140	213,600
Cistern Design Volume	gallons	487,279	1,597,835

DESIGN RESULT	Unit	Sub-1A	Sub-1B
Height	ft	10	10
Footprint	*sft*	*6,514*	*21,360*
Length	*ft*	*76.6*	*194.2*
Width	*ft*	*85*	*110*
Foundation	*sft*	*7,347*	*22,906*

REDEVELOPMENT PARAMETERS	Unit	Sub-1A	Sub-1B
Area Needed to Redevelopment	*ac*	0.30	0.70

Cost Estimate - Diversion to Sanitary Sewer-Subwatershed 1

			Capture-Sanitary Sewer Subwatershed 1a (22ac)		Capture-Sanitary Sewer Subwatershed 1b (48ac)	
DESCRIPTION	**UNIT**	**UNIT COST**	**QUANTITY**	**TOTAL COST**	**QUANTITY**	**TOTAL COST**
Construction BMP - Construction Fence	LF	$4.00	400	$1,600	700	$2,800
Construction BMP - Gravel Bags	EA	$2.00	100	$200	200	$400
Construction BMP - Concrete Wash Out	LS	$825.00	1	$825	1	$825
Construction BMP - Erosion Control	LS	$2,000.00	1	$2,000	1	$2,000
Protect Utilities in place	LS	-	10000	$10,000	10000	$10,000
Pump & Controls for Sanitary Sewer	SF	$40,000.00	1	$40,000	1	$40,000
Concrete Tank large capacity	gal	$1.34	487,279	$652,954	1,597,835	$2,141,100
Foundation for Large Tank	sft	$7.75	7347	$56,940	22906	$177,520
Subtotal			-	$764,520	-	$2,374,645
Land Purchase	ac	$20,000,000	0.3	$6,000,000	0.7	$14,000,000
Demolition & Site Preparation 2-3 Story Condominium		$15	13500	$202,500	30500	$457,500
Redevelopment Subtotal			-	$6,202,500	-	$14,457,500
Mobilization (10%) + Construction Management (5%) + Bond (5%)			20%	$152,000	20%	$474,000
Construction Administration			10%	$76,000	10%	$237,000
Contingency			15%	$114,000	15%	$356,000
CONSTRUCTION SUBTOTAL			-	**$7,309,020**	-	**$17,899,145**
Engineering Design			40%	$304,000	40%	$948,000
CEQA + Permits			LS	$50,000	LS	$50,000
PLANNING/DESIGN SUBTOTAL (assumes 2-year period)			-	**$354,000**	-	**$998,000**
PLANNING/DESIGN SUBTOTAL			per year	**$177,000**	per year	**$499,000**
Post-Construction Monitoring-3 storms	storm	$20,000	3	$60,000	3	$60,000
Parts	yr	$2,000.00	20	$40,000	20	$800,000
Inspections	yr	$5,000.00	20	$100,000	20	$2,000,000
SEWER DISCHARGE FEE - 100% Design *(empty ~7x/yr @ $5.00/HCF)*	yr	-	20	$456,010	20	$1,495,301

Marina del Rey
Enhanced Watershed Management Program

Appendix C

Reasonable Assurance Analysis
Modeling Details

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LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Details on the modeling setup, including rainfall input, land use input, modeling output values, and continuous simulation model (CSM) development and parameters are provided in this appendix. Additionally, the modeled existing conditions and detailed descriptions of the model simulations that were run for each subwatershed along with the bacteria water quality analysis used in the modeling are also contained in this Appendix.

As briefly detailed in the Section 6.1 of the Marina del Rey (MdR) Enhanced Watershed Management Program (EWMP), the Watershed Management Modeling System (WMMS) was selected as the tool to estimate storm water runoff volumes and pollutant loading from the MdR watershed. More details on the WMMS tool are available on the WMMS website at: http://dpw.lacounty.gov/wmd/wmms/res.aspx. The WMMS tool was calibrated using monitoring data collected from 2009-2014 and as detailed in the Section 6.1.2 of the EWMP. The output from the WMMS tool was utilized as the foundation for preparing CSMs for the four subwatershed areas within the MdR watershed. The CSM served as an interface with the WMMS data in which the user was provided the ability to adjust best management practices (BMPs) parameters, such as capture capacity, drainage area, etc. The CSM performed hourly time-step calculations and provided a summary of BMP volumes and associated load reductions. The CSMs are discussed in Section 6.1.5 of the EMWP, and additional details relating to BMP calculations are provided in this appendix.

2. RAINFALL INPUT DATA

2.1 Critical Rainfall year Determination

The WMMS tool used rainfall for the critical rainfall year to estimate the existing annual toxic pollutant loads and associated required load reductions. In accordance with the Toxic Pollutants in Marina del Rey Harbor TMDL (Toxics TMDL), the average rainfall year based on LAX rainfall data from 1948 to 2000 is considered the critical period. The LAX 1948-2000 data set was obtained and evaluated to determine the average rainfall year rainfall value, and this analysis is summarized in Table 1. This analysis considers the rainfall year to be from July 1 of the wet season year to June 30 of the following calendar year (e.g., the wet season period for 1948 is considered to be July 1, 1948 to June 30, 1949).

Table 1. Summary of Rainfall year Rainfall Data for LAX 1948-2000.

Wet Year	Rainfall (in)	Wet Year	Rainfall (in)	Wet Year	Rainfall (in)	Wet Year	Rainfall (in)
1948	7.97	1962	9.29	1975	4.37	1988	6.55
1949	9.15	1963	7.51	1976	12.47	1989	6.07
1950	6.64	1964	10.27	1977	28.55	1990	8.02
1951	19.12	1965	12.62	1978	13.88	1991	14.79
1952	8.55	1966	13.54	1979	21.02	1992	23.66
1953	12.19	1967	14.5	1980	8.36	1993	8.21
1954	9.87	1968	16.18	1981	13.18	1994	22.8
1955	13.51	1969	5.67	1982	25.61	1995	10.29
1956	8.93	1970	9.92	1983	10.65	1996	13.25
1957	18.91	1971	6.43	1984	9.6	1997	31.26
1958	5.6	1972	17.35	1985	18.69	1998	9.26
1959	9.16	1973	10.93	1986	6.01	1999	10.11
1960	4.48	1974	11.28	1987	8.91	2000	15.5
1961	18.22						

Average Wet Season Rainfall = 12.43 inches

The rainfall years with rainfall values closest to the average are summarized in Table 2. The closest rainfall years are 1953 and 1974.

Table 2. LAX Rainfall years Closest to Average Value (1948-2000 Data Set)

Rainfall year	Rainfall (in)
1981	13.18
1965	12.62
1976	12.47
1953	12.19
1974	11.28
1973	10.93

The available rainfall data for WMMS includes rainfall years from 1986 through 2013, and this period does not correspond to either of the two above-mentioned years that are closest to the average rainfall year value. The LAX data set includes daily rainfall totals, whereas the WMMS requires hourly rainfall amounts in order to accurately generate runoff volumes and associated pollutant loads (i.e., the LAX data cannot be used in the WMMS tool). As such, additional LAX rainfall data, matching the years for which WMMS data is available, were reviewed beyond the period stated in the Toxic TMDL of 1948-2000. This additional data includes rainfall years from 2001 through 2013, and is summarized in Table 3.

Table 3. Summary of Rainfall Year Rainfall Data for LAX 2001-2013.

Rainfall year	Rainfall (in)	Rainfall year	Rainfall (in)
2001	4.16	2008	8.14
2002	10.38	2009	12.42
2003	7.81	2010	17.85
2004	26.51	2011	7.61
2005	10.84	2012	6.85
2006	2.63	2013	4.45
2007	10.24		

2.2 WMMS Gauge Rainfall Year Values

Based on the comparison of the average value of 12.43 inches to the LAX rainfall year rainfall data from 2001-2013, the rainfall year of 2009 (with a LAX data rainfall of 12.42 inches) was selected. The WMMS tool utilizes the closest rain gauge to the area being modeled (Marina del Rey), WMMS Gauge 042214, which measured a total rainfall of 14.63 inches for the 2009 rainfall year. In order to confirm that 2009 represents an appropriate condition for the RAA per the TMDL a statistical analysis was performed that included preparing frequency curves for the historical rainfall depth and rainfall intensity relative to the average and 50th percentile values for each metric. Figure 1 shows the historical rainfall depth frequency curve. Both the LAX and WMMS data show a similar distribution of probability (i.e., both data sets have an average value of about 12.4 inches per rainfall year); however, the WMMS data for 2009 is slightly above the average value. Within the WMMS data the rainfall years of 1995 and 2000 with 11.97 inches and 13.64 inches, respectively, are closer to the plotted average values of around 12.4 inches. As previously discussed, the 2009 rainfall year was selected based on the LAX total rainfall of 12.43 inches and based on LAX data being more robust (over 50 years of data). The use of the WMMS 2009 rainfall year data is likely conservative.

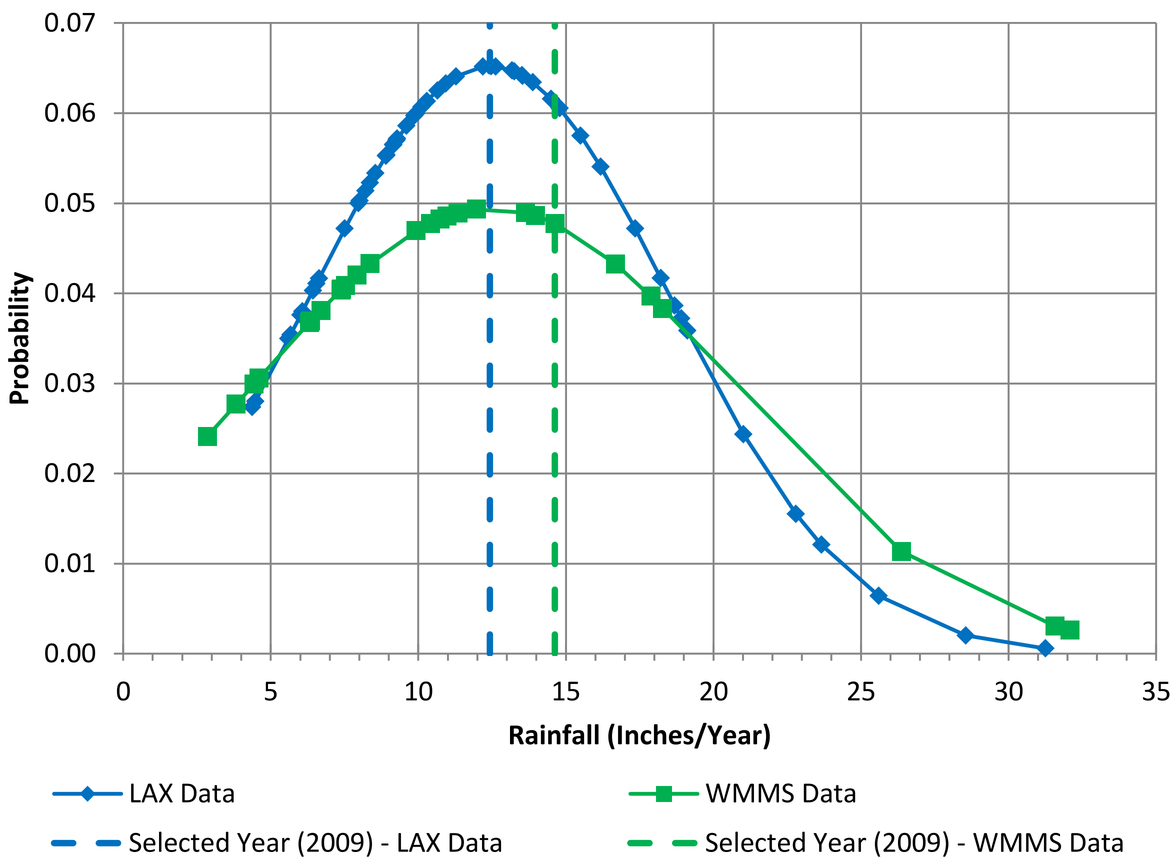

Figure 1. Historical Rainfall Depth Frequency Curves

Figure 2 shows the historical rainfall depth data in terms of percentiles. The LAX and WMMS data sets have similar appearance on the graph, and each crosses the 50 percentile just above the 10 inches per year value. The selected year of 2009 are also plotted with values of about 60 percent and 74 percent for the 2009 LAX data and 2009 WMMS data, respectively.

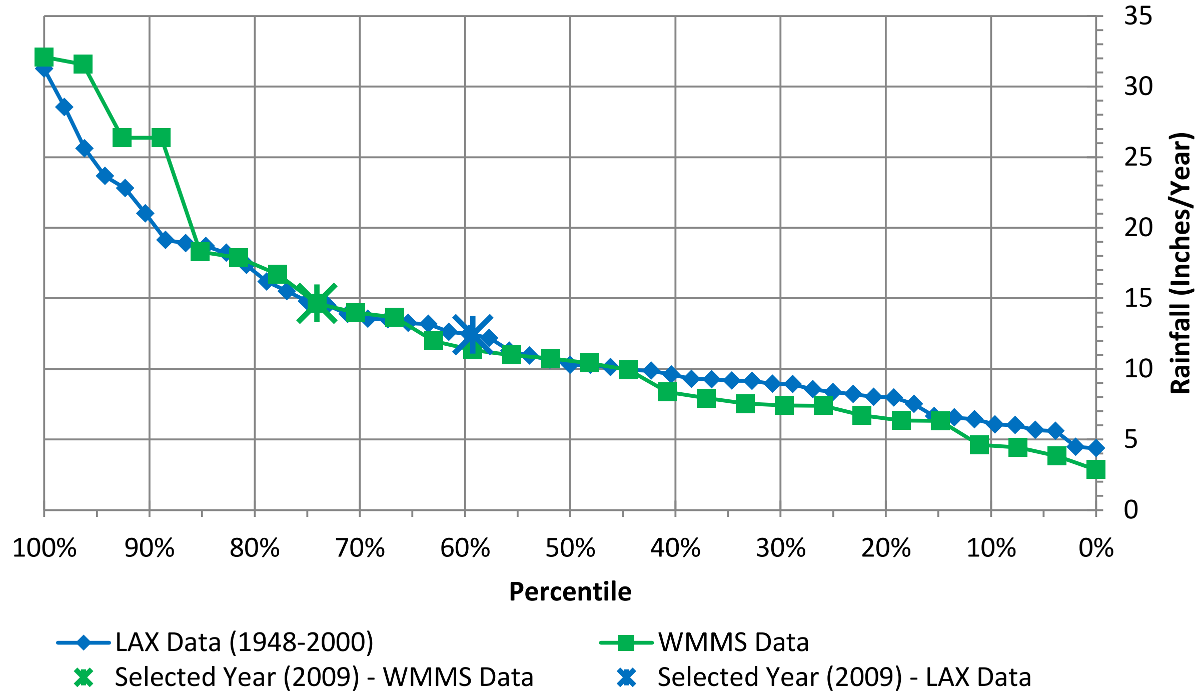

Figure 2. Historical Rainfall Depth Percentile Curves

Figure 3 and Figure 4 show the historical rainfall intensity frequency curve and percentiles, respectively. As previous explained, the LAX data consists of daily totals, whereas the WMMS data consists of hourly rainfall totals. As such the WMMS data were used to construct these figures and intensity values are based on rainfall that fell over one hour period. The frequency curve (Figure 3) shows that total data set (1986 through 2013 rainfall years) has a similar distribution as the 2009 data. The percentile values for the 2009 rainfall year plot similarly to the overall data, especially around the 50 percentile region (Figure 4). The comparison presented in both of these figures indicate that 2009 represents the an appropriate condition

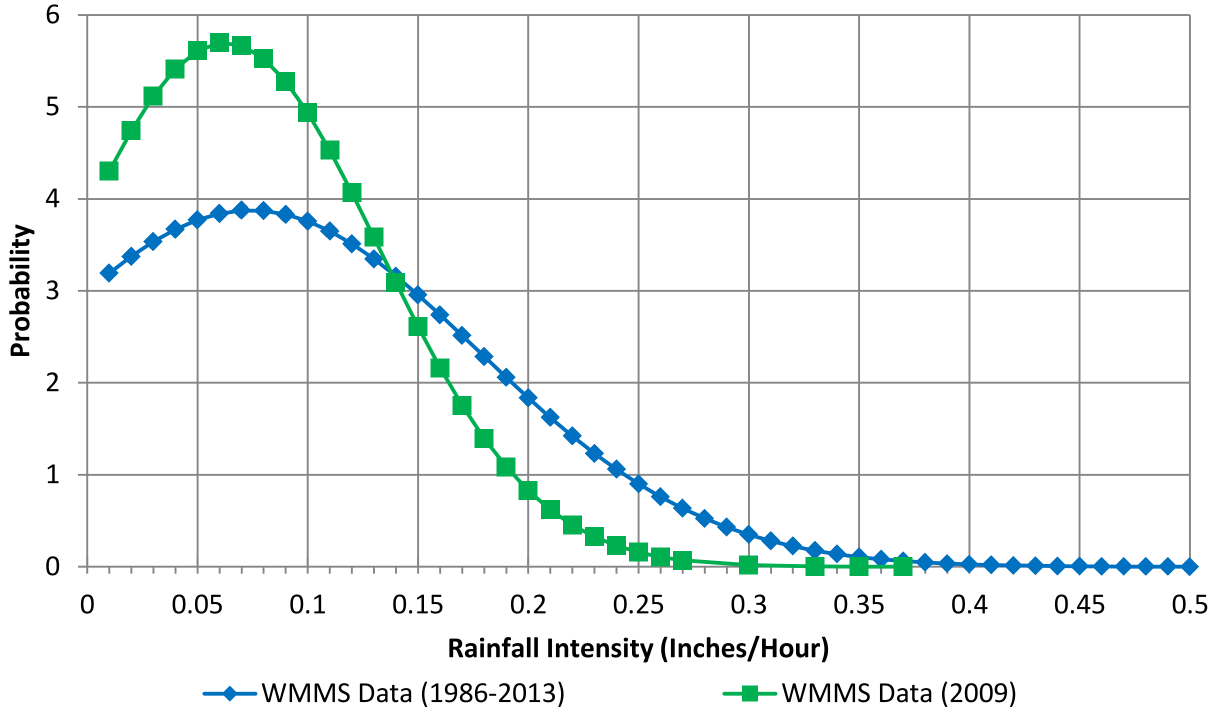

Figure 3. Historical Rainfall Intensity Frequency Curves

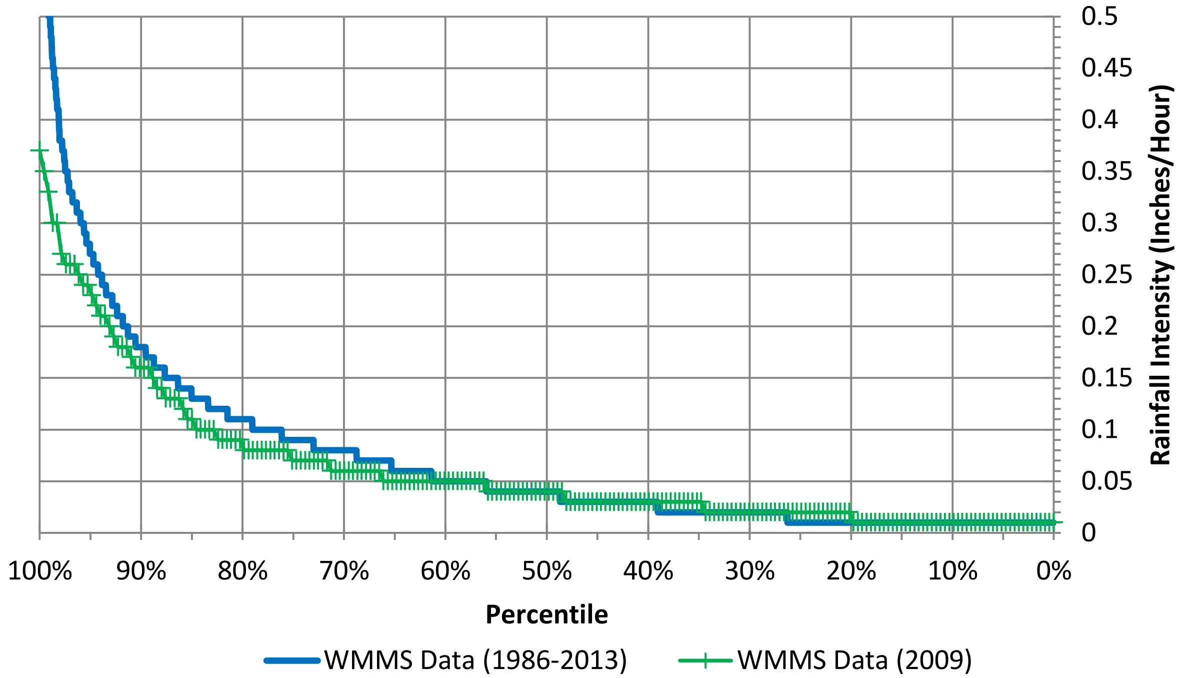

Figure 4. Historical Rainfall Intensity Percentile Curves

The data for WMMS Gauge 042214 are provided in Table 4. The hourly rainfall data along with the cumulative rainfall year rainfall are shown in Figure 5.

Table 4. 2009 Rainfall Year WMMS Gauge 042214 Rainfall

Date & Time	Rainfall (in)	Date & Time	Rainfall (in)	Date & Time	Rainfall (in)	Date & Time	Rainfall (in)
10/13/09 11:00	0.09	12/12/09 9:00	0.09	1/20/10 16:00	0.22	2/9/10 12:00	0.06
10/13/09 12:00	0.03	12/12/09 11:00	0.01	1/20/10 17:00	0.06	2/9/10 13:00	0.04
10/13/09 14:00	0.01	12/12/09 13:00	0.06	1/21/10 4:00	0.08	2/9/10 14:00	0.16
10/13/09 15:00	0.01	12/12/09 14:00	0.01	1/21/10 6:00	0.03	2/9/10 15:00	0.05
10/13/09 16:00	0.04	12/12/09 15:00	0.14	1/21/10 11:00	0.04	2/9/10 18:00	0.01
10/13/09 18:00	0.06	12/12/09 16:00	0.11	1/21/10 12:00	0.15	2/19/10 21:00	0.07
10/13/09 19:00	0.03	12/12/09 17:00	0.03	1/21/10 13:00	0.21	2/19/10 22:00	0.02
10/13/09 22:00	0.03	12/12/09 18:00	0.05	1/21/10 14:00	0.05	2/20/10 0:00	0.03
10/13/09 23:00	0.07	12/12/09 19:00	0.02	1/21/10 15:00	0.01	2/20/10 1:00	0.05
10/14/09 0:00	0.16	12/12/09 20:00	0.04	1/21/10 16:00	0.02	2/22/10 0:00	0.01
10/14/09 1:00	0.18	12/12/09 21:00	0.02	1/21/10 17:00	0.02	2/24/10 19:00	0.01
10/14/09 2:00	0.26	12/13/09 2:00	0.03	1/21/10 18:00	0.01	2/24/10 20:00	0.01
10/14/09 3:00	0.2	12/13/09 4:00	0.05	1/21/10 19:00	0.08	2/27/10 3:00	0.06
10/14/09 4:00	0.1	12/13/09 5:00	0.01	1/21/10 20:00	0.09	2/27/10 4:00	0.14
10/14/09 5:00	0.13	12/13/09 7:00	0.01	1/21/10 21:00	0.01	2/27/10 5:00	0.3
10/14/09 6:00	0.04	12/30/09 9:00	0.03	1/22/10 0:00	0.02	2/27/10 6:00	0.16
10/14/09 7:00	0.03	12/30/09 10:00	0.01	1/22/10 3:00	0.01	2/27/10 7:00	0.05
10/14/09 8:00	0.04	12/30/09 11:00	0.03	1/22/10 5:00	0.07	2/27/10 10:00	0.02
10/14/09 9:00	0.07	12/30/09 12:00	0.03	1/22/10 6:00	0.05	2/27/10 11:00	0.01
10/14/09 10:00	0.04	12/30/09 14:00	0.02	1/22/10 7:00	0.02	2/27/10 13:00	0.01
10/14/09 11:00	0.02	12/30/09 15:00	0.01	1/22/10 10:00	0.01	2/27/10 14:00	0.03
10/14/09 12:00	0.02	12/31/09 3:00	0.01	1/22/10 11:00	0.08	2/27/10 15:00	0.03
10/14/09 13:00	0.03	1/13/10 5:00	0.09	1/22/10 12:00	0.08	2/27/10 16:00	0.03
10/14/09 14:00	0.08	1/13/10 6:00	0.01	1/22/10 13:00	0.02	3/3/10 22:00	0.02
10/14/09 15:00	0.05	1/17/10 15:00	0.02	1/22/10 14:00	0.1	3/3/10 23:00	0.02
10/14/09 16:00	0.01	1/17/10 16:00	0.03	1/22/10 15:00	0.03	3/6/10 10:00	0.04
10/14/09 17:00	0.01	1/17/10 17:00	0.03	1/22/10 16:00	0.05	3/6/10 11:00	0.03
10/15/09 3:00	0.01	1/17/10 18:00	0.03	1/26/10 14:00	0.02	3/6/10 17:00	0.05
12/7/09 4:00	0.02	1/17/10 19:00	0.04	1/26/10 15:00	0.01	3/6/10 18:00	0.13
12/7/09 5:00	0.06	1/17/10 20:00	0.07	1/26/10 16:00	0.06	3/6/10 19:00	0.04
12/7/09 6:00	0.02	1/17/10 21:00	0.01	1/26/10 17:00	0.06	3/6/10 20:00	0.04
12/7/09 7:00	0.02	1/17/10 22:00	0.02	1/26/10 18:00	0.01	3/6/10 21:00	0.02
12/7/09 8:00	0.05	1/17/10 23:00	0.04	1/26/10 20:00	0.01	3/7/10 16:00	0.01
12/7/09 9:00	0.05	1/18/10 0:00	0.03	2/5/10 8:00	0.05	4/4/10 23:00	0.01
12/7/09 10:00	0.1	1/18/10 2:00	0.01	2/5/10 9:00	0.13	4/5/10 0:00	0.02
12/7/09 11:00	0.23	1/18/10 3:00	0.01	2/5/10 10:00	0.05	4/5/10 1:00	0.04
12/7/09 12:00	0.19	1/18/10 4:00	0.01	2/5/10 11:00	0.06	4/5/10 3:00	0.01
12/7/09 13:00	0.08	1/18/10 7:00	0.02	2/5/10 12:00	0.02	4/5/10 4:00	0.03
12/7/09 14:00	0.03	1/18/10 8:00	0.06	2/5/10 13:00	0.06	4/5/10 5:00	0.03
12/7/09 15:00	0.02	1/18/10 9:00	0.08	2/5/10 14:00	0.05	4/5/10 6:00	0.01
12/7/09 16:00	0.02	1/18/10 11:00	0.03	2/5/10 15:00	0.07	4/5/10 8:00	0.26
12/7/09 17:00	0.03	1/18/10 12:00	0.1	2/5/10 16:00	0.07	4/5/10 9:00	0.05
12/10/09 22:00	0.01	1/18/10 13:00	0.37	2/5/10 17:00	0.11	4/11/10 22:00	0.03
12/10/09 23:00	0.09	1/18/10 14:00	0.21	2/5/10 18:00	0.07	4/11/10 23:00	0.25
12/11/09 0:00	0.08	1/18/10 15:00	0.02	2/5/10 19:00	0.04	4/12/10 0:00	0.33
12/11/09 1:00	0.09	1/19/10 11:00	0.03	2/5/10 20:00	0.08	4/12/10 1:00	0.13
12/11/09 2:00	0.1	1/19/10 12:00	0.35	2/5/10 21:00	0.05	4/12/10 2:00	0.04
12/11/09 3:00	0.01	1/19/10 13:00	0.18	2/5/10 22:00	0.05	4/12/10 3:00	0.01
12/11/09 7:00	0.01	1/19/10 14:00	0.03	2/5/10 23:00	0.02	4/12/10 7:00	0.01
12/11/09 14:00	0.02	1/19/10 15:00	0.03	2/6/10 0:00	0.04	4/20/10 12:00	0.01
12/11/09 15:00	0.03	1/20/10 3:00	0.02	2/6/10 1:00	0.05	4/20/10 13:00	0.04
12/11/09 17:00	0.01	1/20/10 4:00	0.01	2/6/10 2:00	0.16	4/20/10 14:00	0.05
12/11/09 23:00	0.03	1/20/10 5:00	0.07	2/6/10 3:00	0.24	4/20/10 15:00	0.02
12/12/09 2:00	0.04	1/20/10 6:00	0.06	2/6/10 4:00	0.26	4/22/10 0:00	0.02
12/12/09 3:00	0.01	1/20/10 11:00	0.05	2/6/10 5:00	0.18	5/18/10 5:00	0.01
12/12/09 5:00	0.05	1/20/10 12:00	0.05	2/6/10 6:00	0.24	5/18/10 8:00	0.01
12/12/09 6:00	0.08	1/20/10 13:00	0.08	2/6/10 7:00	0.27	5/18/10 9:00	0.01
12/12/09 7:00	0.05	1/20/10 14:00	0.17	2/6/10 8:00	0.12	5/27/10 9:00	0.02
12/12/09 8:00	0.02	1/20/10 15:00	0.3			**Total**	**14.63**

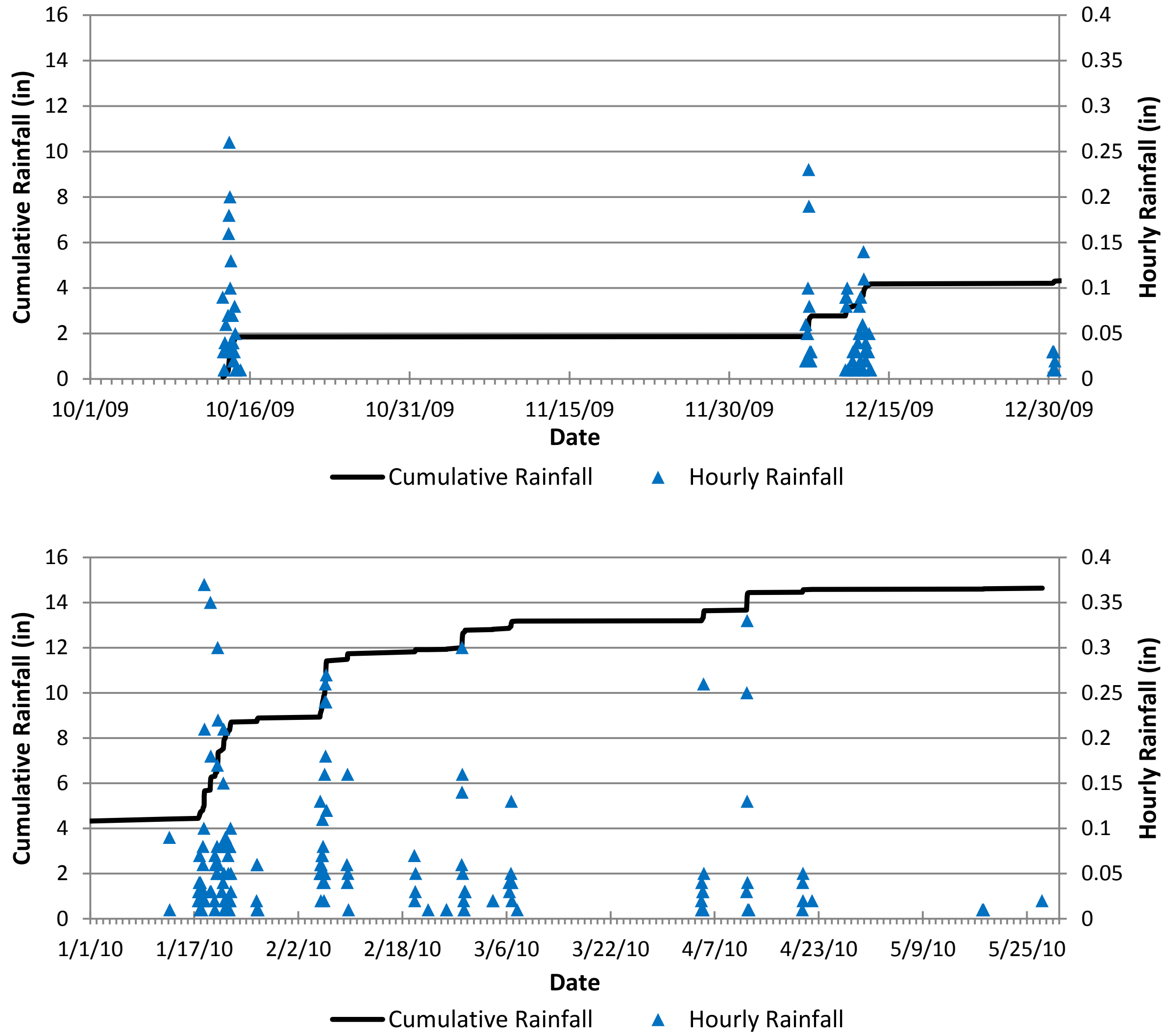

Figure 5. 2009 Rainfall Year WMMS Gauge 042214 Rainfall

2.3 WMMS Gauge 85th Percentile Event Values

Rainfall values for the 24-hour, 85th percentile storm event were used in the WMMS tool in order to estimate the associated volumes and pollutant loads for this storm event. The 85th percentile, 24-hour rain event was determined from the Los Angeles County 85th percentile precipitation isohyetal map to be 1.1 inches (LACDPW, 2004). Appendix A of the Los Angeles County Hydrology Manual (Hydrology Manual) (LACDPW, 2006) provides the temporal distribution of rainfall over a 24-hour period (Unit Hyetograph), and this distribution was used to calculate the incremental rainfall for the design storm. A watershed-specific hyetograph was created by applying 1.1 inches to the Unit Hyetograph, and the associated hourly and cumulative rainfall is shown on Figure 6.

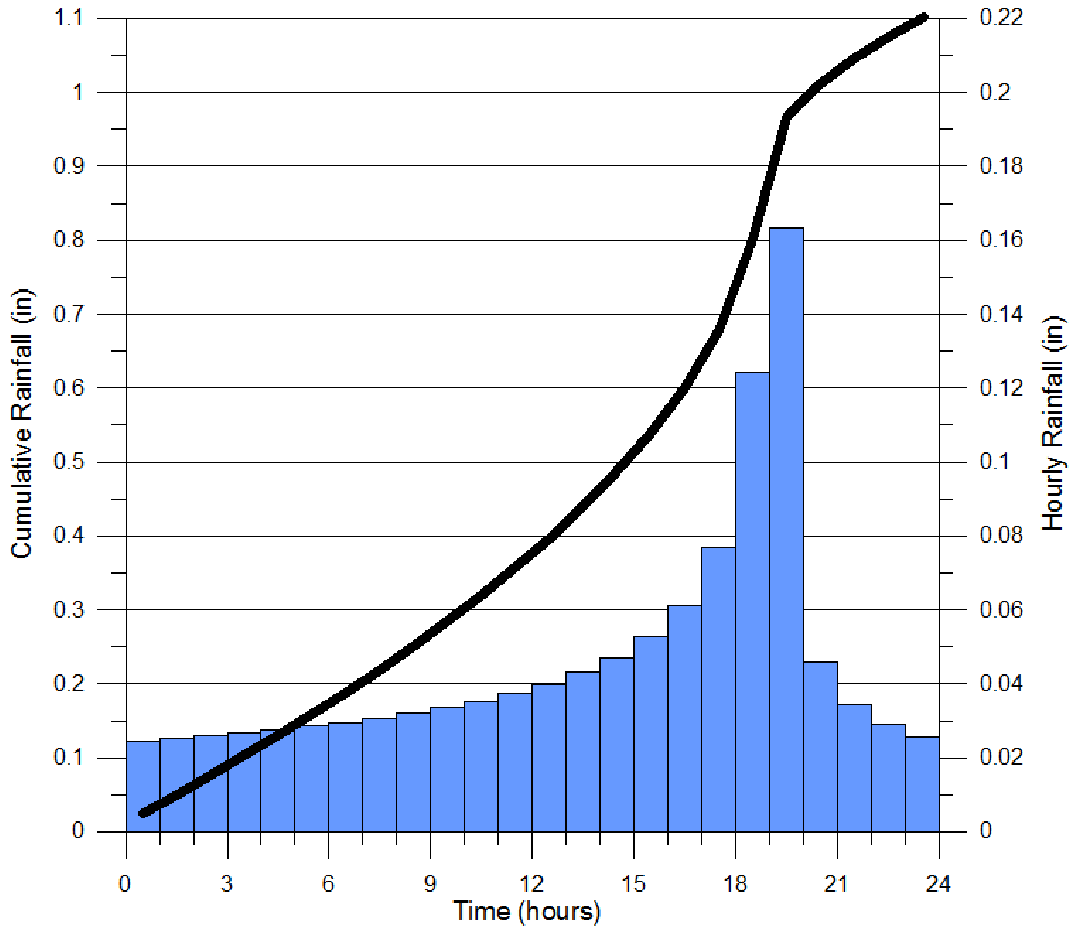

Figure 6. 85th Percentile Storm Event Rainfall

3. LAND USE INPUT DATA

The land use types and areas were determined for each MdR subwatershed based on the land use GIS layer obtained from the WMMS website. These data included both land use types and impervious cover percentages. For each area modeled and for the major land use types, composite land use areas (sum of land use areas for the specific land use types) and impervious percentage (area weighted average of impervious percentage for the specific land use types) were calculated. The land use data for each specific type were separated into impervious and pervious areas and used as input into the WMMS tool. This separating of each developed land use into two components was necessary, because WMMS considers land types as either completely impervious or pervious, and therefore the user needs to input the area, in acres, of impervious land use rather than the percentage of impervious cover. For example, if a subwatershed area contained 10 acres of single-family residential with 25 percent impervious cover, the user would need to convert that information to 2.5 acres single-family residential and 7.5 acres pervious area in order for WMMS to properly perform hydrologic and water quality calculations. Table 5 through Table 9 show the GIS land use data along with the converted values used for input into the WMMS tool.

Table 5. GIS and WMMS Input Land Use Data – Subwatershed 1A

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	0	32.9%	0.00	0.00	80%	0.00	0.00
2	LD_SF_Res_Moderate	0.43	6.0%	0.03	0.40	50%	0.20	0.20
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	17.34	63.3%	10.98	6.36	70%	4.45	1.91
5	Commercial	65.59	70.6%	46.28	19.31	85%	16.41	2.90
6	Institutional	0.73	71.3%	0.52	0.21	85%	0.18	0.03
7	Industrial	0.16	42.0%	0.07	0.09	85%	0.08	0.01
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	11.77	59.8%	7.03	4.74	20%	0.95	3.79
10	Urban_Grass_Irrigated	0		22.27	**Subtotal (ac)**		**22.27**	**8.84**
11	Urban_Grass_NonIrrigated	0		8.84				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	8.2		8.20				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**104.22**		**104.22**				

Table 6. GIS and WMMS Input Land Use Data – Subwatershed 1B

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	0	32.9%	0.00	0.00	80%	0.00	0.00
2	LD_SF_Res_Moderate	1.41	19.3%	0.27	1.14	50%	0.57	0.57
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	119.75	62.3%	74.59	45.16	70%	31.61	13.55
5	Commercial	94.28	63.8%	60.17	34.11	85%	29.00	5.12
6	Institutional	8.18	63.3%	5.18	3.00	85%	2.55	0.45
7	Industrial	0.02	0.0%	0.00	0.02	85%	0.02	0.00
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	26.23	53.6%	14.05	12.18	20%	2.44	9.74
10	Urban_Grass_Irrigated	0		66.18	**Subtotal (ac)**		**66.18**	**29.43**
11	Urban_Grass_NonIrrigated	0		29.43				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0.15		0.15				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	14.52		14.52				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**264.54**		**264.54**				

Table 7. GIS and WMMS Input Land Use Data – Subwatershed 2

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	45.78	42.2%	19.34	26.44	80%	21.15	5.29
2	LD_SF_Res_Moderate	0	0.0%	0.00	0.00	50%	0.00	0.00
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	131.76	59.8%	78.74	53.02	70%	37.11	15.90
5	Commercial	23.17	92.6%	21.45	1.72	85%	1.46	0.26
6	Institutional	10.17	85.3%	8.68	1.49	85%	1.27	0.22
7	Industrial	0.22	0.0%	0.00	0.22	85%	0.19	0.03
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	83.25	67.9%	56.50	26.75	20%	5.35	21.40
10	Urban_Grass_Irrigated	0		66.53	**Subtotal (ac)**		**66.53**	**43.11**
11	Urban_Grass_NonIrrigated	0		43.11				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	33.33		33.33				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**327.68**		**327.68**				

Table 8. GIS and WMMS Input Land Use Data – Subwatershed 3

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	22.9	49.3%	11.30	11.63	80%	9.31	2.33
2	LD_SF_Res_Moderate	0	0.0%	0.00	0.00	50%	0.00	0.00
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	21.1	48.3%	10.19	10.91	70%	7.64	3.27
5	Commercial	2.9	95.0%	2.73	0.14	85%	0.12	0.02
6	Institutional	1.4	95.0%	1.29	0.07	85%	0.06	0.01
7	Industrial	0.2	95.0%	0.23	0.01	85%	0.01	0.00
8	Transportation	0	90.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	22.0	67.0%	14.72	7.24	20%	1.45	5.79
10	Urban_Grass_Irrigated	0		18.58	**Subtotal (ac)**		**18.58**	**11.43**
11	Urban_Grass_NonIrrigated	0		11.43				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0		0.00				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	0		0.00				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**70.46**		**70.46**				

Table 9. GIS and WMMS Input Land Use Data – Subwatershed 4

GIS Analysis				WMMS Input (ac)	Calculations to Determine HRU 10 & 11			
HRU ID	HRU Description	Area (ac)	Imp. %		Pervious Area (ac)	% Irrigated	Irrigated Area (ac)	Non-Irrigated Area (ac)
1	HD_SF_Residential	166.32	33.9%	56.34	109.98	80%	87.99	22.00
2	LD_SF_Res_Moderate	0.85	7.9%	0.07	0.78	50%	0.39	0.39
3	LD_SF_Res_Steep	0	0.0%	0.00	0.00	50%	0.00	0.00
4	MF_Res	96.28	44.7%	43.08	53.20	70%	37.24	15.96
5	Commercial	129.70	69.3%	89.82	39.88	85%	33.90	5.98
6	Institutional	63.60	64.4%	40.94	22.66	85%	19.26	3.40
7	Industrial	27.00	69.8%	18.84	8.16	85%	6.93	1.22
8	Transportation	0	0.0%	0.00	0.00	85%	0.00	0.00
9	Secondary_Roads	154.83	53.5%	82.89	71.94	20%	14.39	57.55
10	Urban_Grass_Irrigated	0		200.10	**Subtotal (ac)**		**200.10**	**106.50**
11	Urban_Grass_NonIrrigated	0		106.50				
12	Agriculture_Moderate_B	0		0.00				
13	Agriculture_Moderate_D	0		0.00				
14	Vacant_Moderate_B	0		0.00				
15	Vacant_Moderate_D	0.60		0.60				
16	Vacant_Steep_A	0		0.00				
17	Vacant_Steep_B	0		0.00				
18	Vacant_Steep_C	0		0.00				
19	Vacant_Steep_D	6.50		6.50				
20	Water	0		0.00				
21	Water_Reuse	0		0.00				
	Total Area (acre)	**645.68**		**645.68**				

4. CALIBRATED WATER QUALITY PARAMETERS

Toxic metal constituents copper, lead, and zinc were calibrated in the model based on a comparison between baseline (or initial) model results and the CMP results. Modeled flow volumes were combined with CMP measured toxic metals concentrations to compute the applicable loading for the monitored storm events. Using the modeled flows eliminated the potential to introduce error based on the difference between modeled and measured flow volumes for individual storm events. This method also resulted in improved model fits. The measured load was compared to modeled toxic metals loads for these monitored storm events. A correction factor (C.F.) was computed based on the proportion of measured load to modeled load for each monitored site for each of the toxic metals. This correction factor was used to make adjustments to the WMMS wash-off potency factor (POTFW) constant loading parameter values. Modeling was performed with these new POTFW parameters, and the modeled loads were again compared to the measured loads to verify that the modeling was calibrated for each toxic metal. The summaries of POTFW values used are provided in Table 10 through Table 14.

Table 10. Water Quality Parameter (POTFW) WMMS Input Values – Subwatershed 1A

GIS Analysis			WMMS POTFW Input Values					
HRU ID	HRU Description	Area (ac)	C.F. = 2.473		C.F. = 3.206		C.F. = 0.83	
			Uncalib. Cu	Calib. Cu	Uncalib. Pb	Calib. Pb	Uncalib. Zn	Calib. Zn
1	HD_SF_Residential	0	0.8	1.978	0.8	2.565	7.5	6.225
2	LD_SF_Res_Moderate	0.43	0.6	1.484	0.2	0.641	1.2	0.996
3	LD_SF_Res_Steep	0	0.6	1.484	0.2	0.641	1.2	0.996
4	MF_Res	17.34	0.8	1.978	0.8	2.565	7.5	6.225
5	Commercial	65.59	1.14	2.819	1	3.206	10.2	8.466
6	Institutional	0.73	0.4	0.989	0.18	0.577	5.08	4.216
7	Industrial	0.16	0.4	0.989	0.18	0.577	5.08	4.216
8	Transportation	0	0.8	1.978	0.8	2.565	7.5	6.225
9	Secondary_Roads	11.77	0.8	1.978	0.8	2.565	7.5	6.225
10	Urban_Grass_Irrigated	0	0.6	1.484	0.2	0.641	1.2	0.996
11	Urban_Grass_NonIrrigated	0	0.6	1.484	0.2	0.641	1.2	0.996
12	Agriculture_Moderate_B	0	0.3	0.742	0.1	0.321	2.5	2.075
13	Agriculture_Moderate_D	0	0.3	0.742	0.1	0.321	2.5	2.075
14	Vacant_Moderate_B	0	0.012	0.030	0.002	0.006	0.05	0.042
15	Vacant_Moderate_D	8.2	0.012	0.030	0.002	0.006	0.05	0.042
16	Vacant_Steep_A	0	0.012	0.030	0.002	0.006	0.05	0.042
17	Vacant_Steep_B	0	0.012	0.030	0.002	0.006	0.05	0.042
18	Vacant_Steep_C	0	0.012	0.030	0.002	0.006	0.05	0.042
19	Vacant_Steep_D	0	0.012	0.030	0.002	0.006	0.05	0.042
20	Water	0	0	0.000	0	0.000	0	0.000
21	Water_Reuse	0	0.6	1.484	0.2	0.641	1.2	0.996
	Total Area (acre)	**104.2**						

Table 11. Water Quality Parameter (POTFW) WMMS Input Values – Subwatershed 1B

GIS Analysis			WMMS Input Values					
HRU ID	HRU Description	Area (ac)	C.F. = 2.473		C.F. = 3.206		C.F. = 0.83	
			Uncalib. Cu	Calib. Cu	Uncalib. Pb	Calib. Pb	Uncalib. Zn	Calib. Zn
1	HD_SF_Residential	0.00	0.8	1.978	0.8	2.565	7.5	6.225
2	LD_SF_Res_Moderate	1.41	0.6	1.484	0.2	0.641	1.2	0.996
3	LD_SF_Res_Steep	0.00	0.6	1.484	0.2	0.641	1.2	0.996
4	MF_Res	119.75	0.8	1.978	0.8	2.565	7.5	6.225
5	Commercial	94.28	1.14	2.819	1	3.206	10.2	8.466
6	Institutional	8.18	0.4	0.989	0.18	0.577	5.08	4.216
7	Industrial	0.02	0.4	0.989	0.18	0.577	5.08	4.216
8	Transportation	0.00	0.8	1.978	0.8	2.565	7.5	6.225
9	Secondary_Roads	26.23	0.8	1.978	0.8	2.565	7.5	6.225
10	Urban_Grass_Irrigated	0	0.6	1.484	0.2	0.641	1.2	0.996
11	Urban_Grass_NonIrrigated	0	0.6	1.484	0.2	0.641	1.2	0.996
12	Agriculture_Moderate_B	0	0.3	0.742	0.1	0.321	2.5	2.075
13	Agriculture_Moderate_D	0	0.3	0.742	0.1	0.321	2.5	2.075
14	Vacant_Moderate_B	0	0.012	0.030	0.002	0.006	0.05	0.042
15	Vacant_Moderate_D	0.15	0.012	0.030	0.002	0.006	0.05	0.042
16	Vacant_Steep_A	0	0.012	0.030	0.002	0.006	0.05	0.042
17	Vacant_Steep_B	0	0.012	0.030	0.002	0.006	0.05	0.042
18	Vacant_Steep_C	0	0.012	0.030	0.002	0.006	0.05	0.042
19	Vacant_Steep_D	14.52	0.012	0.030	0.002	0.006	0.05	0.042
20	Water	0	0	0.000	0	0.000	0	0.000
21	Water_Reuse	0	0.6	1.484	0.2	0.641	1.2	0.996
	Total Area (acre)	**264.5**						

Table 12. Water Quality Parameter (POTFW) WMMS Input Values – Subwatershed 2

GIS Analysis			WMMS Input Values					
			C.F. = 1.0		C.F. = 1.0		C.F. = 1.0	
HRU ID	HRU Description	Area (ac)	Uncalib. Cu	Calib. Cu	Uncalib. Pb	Calib. Pb	Uncalib. Zn	Calib. Zn
1	HD_SF_Residential	45.78	0.8	0.8	0.8	0.8	7.5	7.5
2	LD_SF_Res_Moderate	0	0.6	0.6	0.2	0.2	1.2	1.2
3	LD_SF_Res_Steep	0	0.6	0.6	0.2	0.2	1.2	1.2
4	MF_Res	131.76	0.8	0.8	0.8	0.8	7.5	7.5
5	Commercial	23.17	1.14	1.14	1	1	10.2	10.2
6	Institutional	10.17	0.4	0.4	0.18	0.18	5.08	5.08
7	Industrial	0.22	0.4	0.4	0.18	0.18	5.08	5.08
8	Transportation	0	0.8	0.8	0.8	0.8	7.5	7.5
9	Secondary_Roads	83.25	0.8	0.8	0.8	0.8	7.5	7.5
10	Urban_Grass_Irrigated	0	0.6	0.6	0.2	0.2	1.2	1.2
11	Urban_Grass_NonIrrigated	0	0.6	0.6	0.2	0.2	1.2	1.2
12	Agriculture_Moderate_B	0	0.3	0.3	0.1	0.1	2.5	2.5
13	Agriculture_Moderate_D	0	0.3	0.3	0.1	0.1	2.5	2.5
14	Vacant_Moderate_B	0	0.012	0.012	0.002	0.002	0.05	0.05
15	Vacant_Moderate_D	33.33	0.012	0.012	0.002	0.002	0.05	0.05
16	Vacant_Steep_A	0	0.012	0.012	0.002	0.002	0.05	0.05
17	Vacant_Steep_B	0	0.012	0.012	0.002	0.002	0.05	0.05
18	Vacant_Steep_C	0	0.012	0.012	0.002	0.002	0.05	0.05
19	Vacant_Steep_D	0	0.012	0.012	0.002	0.002	0.05	0.05
20	Water	0	0	0	0	0	0	0
21	Water_Reuse	0	0.6	0.6	0.2	0.2	1.2	1.2
	Total Area (acre)	**327.7**						

Table 13. Water Quality Parameter (POTFW) WMMS Input Values – Subwatershed 3

GIS Analysis			WMMS Input Values					
			C.F. = 0.847		C.F. = 1.562		C.F. = 0.421	
HRU ID	HRU Description	Area (ac)	Uncalib. Cu	Calib. Cu	Uncalib. Pb	Calib. Pb	Uncalib. Zn	Calib. Zn
1	HD_SF_Residential	22.9	0.8	0.678	0.8	1.250	7.5	3.158
2	LD_SF_Res_Moderate	0	0.6	0.508	0.2	0.312	1.2	0.505
3	LD_SF_Res_Steep	0	0.6	0.508	0.2	0.312	1.2	0.505
4	MF_Res	21.1	0.8	0.678	0.8	1.250	7.5	3.158
5	Commercial	2.9	1.14	0.966	1	1.562	10.2	4.294
6	Institutional	1.4	0.4	0.339	0.18	0.281	5.08	2.139
7	Industrial	0.2	0.4	0.339	0.18	0.281	5.08	2.139
8	Transportation	0	0.8	0.678	0.8	1.250	7.5	3.158
9	Secondary_Roads	22.0	0.8	0.678	0.8	1.250	7.5	3.158
10	Urban_Grass_Irrigated	0	0.6	0.508	0.2	0.312	1.2	0.505
11	Urban_Grass_NonIrrigated		0.6	0.508	0.2	0.312	1.2	0.505
12	Agriculture_Moderate_B	0	0.3	0.254	0.1	0.156	2.5	1.053
13	Agriculture_Moderate_D	0	0.3	0.254	0.1	0.156	2.5	1.053
14	Vacant_Moderate_B	0	0.012	0.010	0.002	0.003	0.05	0.021
15	Vacant_Moderate_D	0	0.012	0.010	0.002	0.003	0.05	0.021
16	Vacant_Steep_A	0	0.012	0.010	0.002	0.003	0.05	0.021
17	Vacant_Steep_B	0	0.012	0.010	0.002	0.003	0.05	0.021
18	Vacant_Steep_C	0	0.012	0.010	0.002	0.003	0.05	0.021
19	Vacant_Steep_D	0	0.012	0.010	0.002	0.003	0.05	0.021
20	Water	0	0	0.000	0	0.000	0	0.000
21	Water_Reuse	0	0.6	0.508	0.2	0.312	1.2	0.505
	Total Area (acre)	**70.5**						

Table 14. Water Quality Parameter (POTFW) WMMS Input Values – Subwatershed 4

GIS Analysis			WMMS Input Values					
			C.F. = 1.874		C.F. = 0.935		C.F. = 1.19	
HRU ID	HRU Description	Area (ac)	Uncalib. Cu	Calib. Cu	Uncalib. Pb	Calib. Pb	Uncalib. Zn	Calib. Zn
1	HD_SF_Residential	166.32	0.8	1.499	0.8	0.748	7.5	8.925
2	LD_SF_Res_Moderate	0.85	0.6	1.124	0.2	0.187	1.2	1.428
3	LD_SF_Res_Steep	0	0.6	1.124	0.2	0.187	1.2	1.428
4	MF_Res	96.28	0.8	1.499	0.8	0.748	7.5	8.925
5	Commercial	129.70	1.14	2.136	1	0.935	10.2	12.138
6	Institutional	63.60	0.4	0.750	0.18	0.168	5.08	6.045
7	Industrial	27.00	0.4	0.750	0.18	0.168	5.08	6.045
8	Transportation	0	0.8	1.499	0.8	0.748	7.5	8.925
9	Secondary_Roads	154.83	0.8	1.499	0.8	0.748	7.5	8.925
10	Urban_Grass_Irrigated	0	0.6	1.124	0.2	0.187	1.2	1.428
11	Urban_Grass_NonIrrigated	0	0.6	1.124	0.2	0.187	1.2	1.428
12	Agriculture_Moderate_B	0	0.3	0.562	0.1	0.094	2.5	2.975
13	Agriculture_Moderate_D	0	0.3	0.562	0.1	0.094	2.5	2.975
14	Vacant_Moderate_B	0	0.012	0.022	0.002	0.002	0.05	0.060
15	Vacant_Moderate_D	0.60	0.012	0.022	0.002	0.002	0.05	0.060
16	Vacant_Steep_A	0	0.012	0.022	0.002	0.002	0.05	0.060
17	Vacant_Steep_B	0	0.012	0.022	0.002	0.002	0.05	0.060
18	Vacant_Steep_C	0	0.012	0.022	0.002	0.002	0.05	0.060
19	Vacant_Steep_D	6.50	0.012	0.022	0.002	0.002	0.05	0.060
20	Water	0	0	0.000	0	0.000	0	0.000
21	Water_Reuse	0	0.6	1.124	0.2	0.187	1.2	1.428
	Total Area (acre)	**645.68**						

5. MODELING FREQUENCY CURVES

Frequency curves of runoff volume, pollutant loading, and pollutant concentrations were prepared to demonstrate that the model results of baseline conditions are based on the TMDL derived critical condition. The WMMS tool was used to model each analysis region (Subwatersheds 1A, 1B, 3, and 4) for each of the toxics metal for the rainfall season of 1986 through 2013. The annual results were used to prepare frequency curves. The annual critical condition (2009) results were plotted on the same graph as the frequency curves to allow for comparison to overall available modeled results. Additionally, the WLA and required load reductions (LR) were plotted on the frequency curves. These plots are provided in Figure 7 through Figure 19

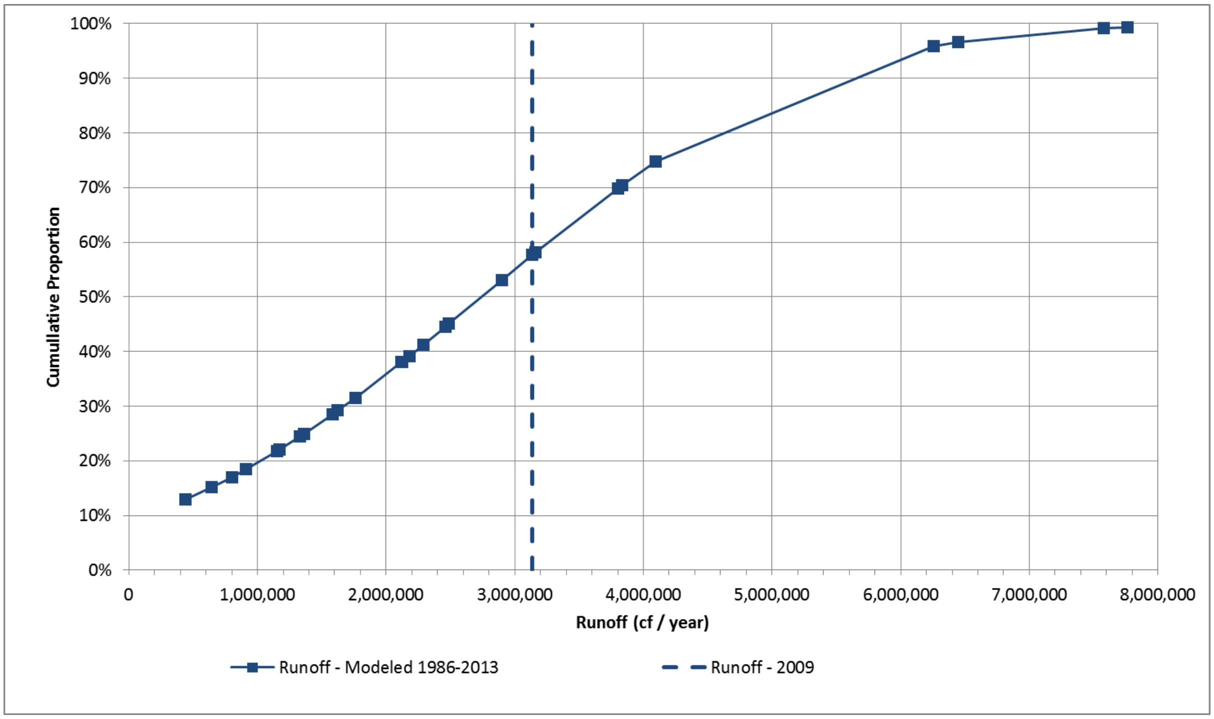

Figure 7. Subwatershed 1A (Back Basins) Runoff Frequency Curve

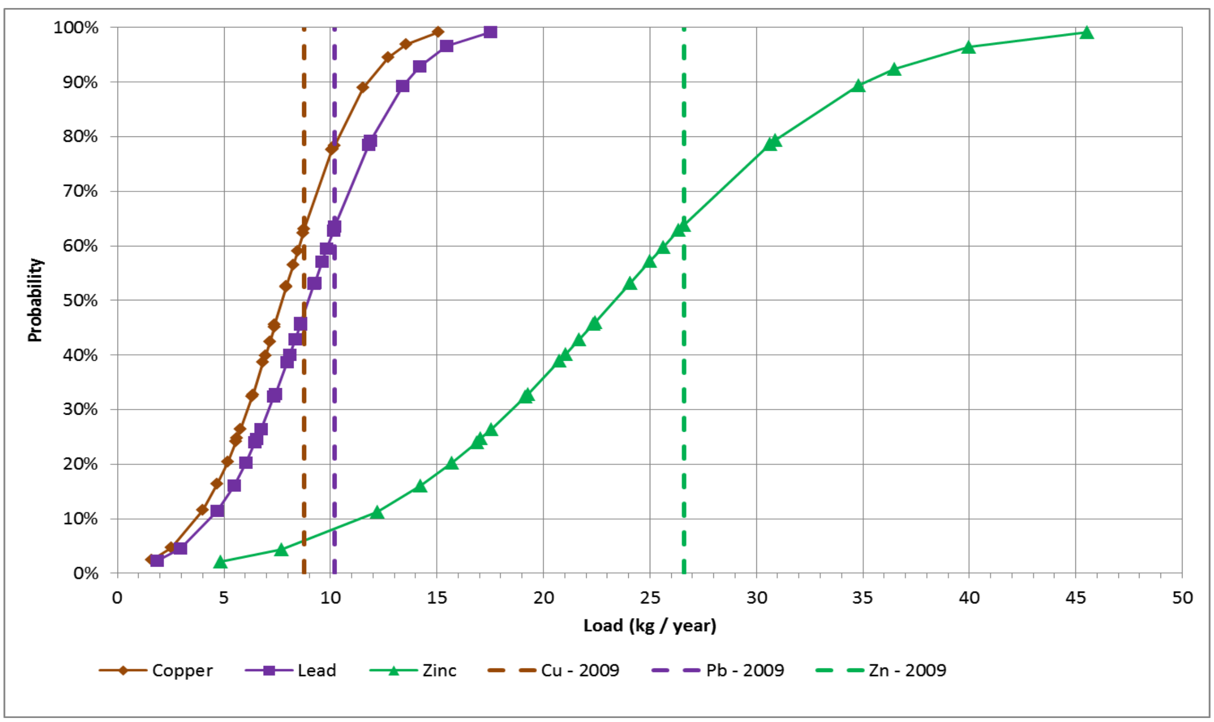

Figure 8. Subwatershed 1A (Back Basins) Pollutant Loading Frequency Curves

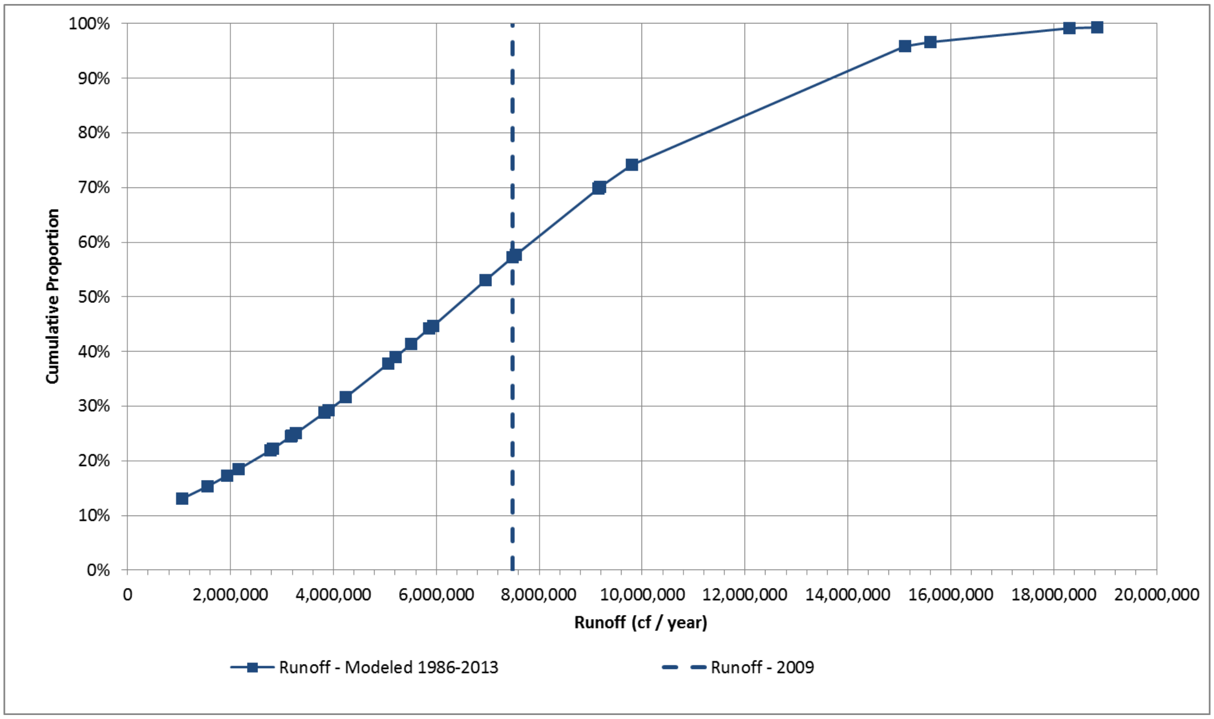

Figure 9. Subwatershed 1B Runoff Frequency Curve

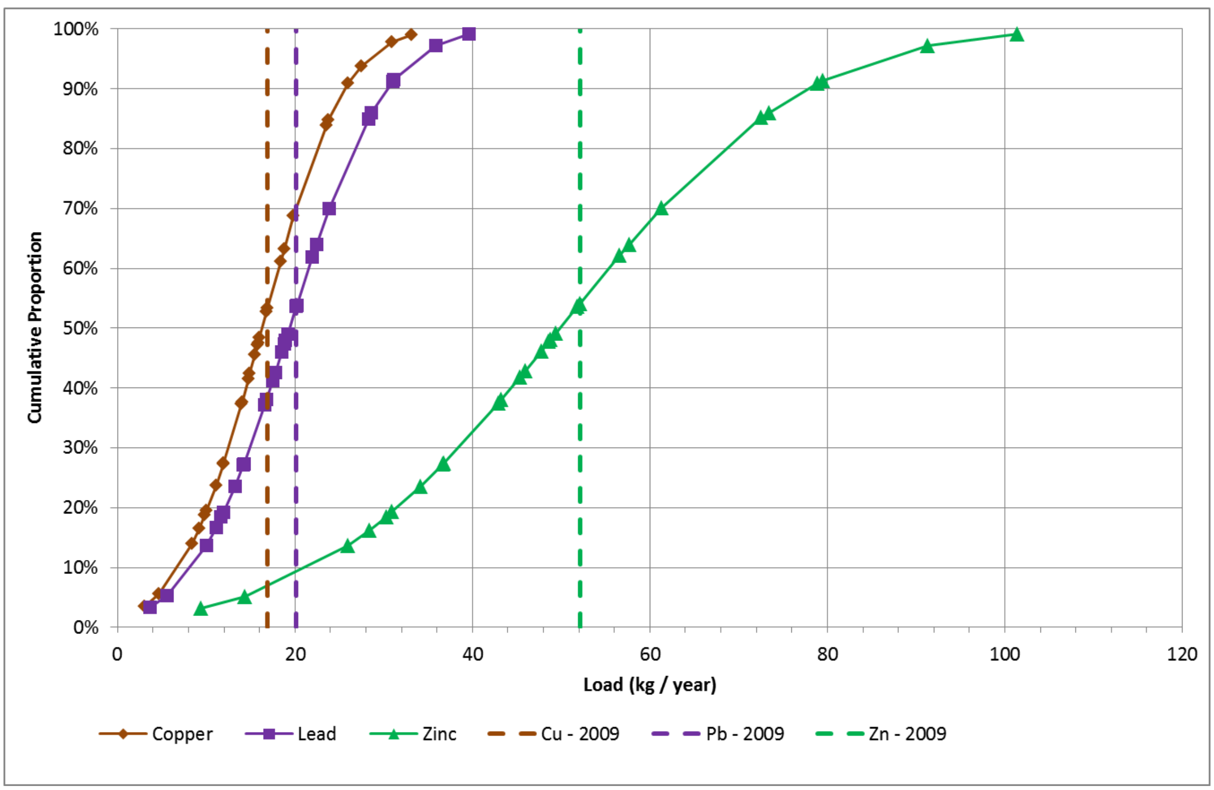

Figure 10. Subwatershed 1B Pollutant Loading Frequency Curves

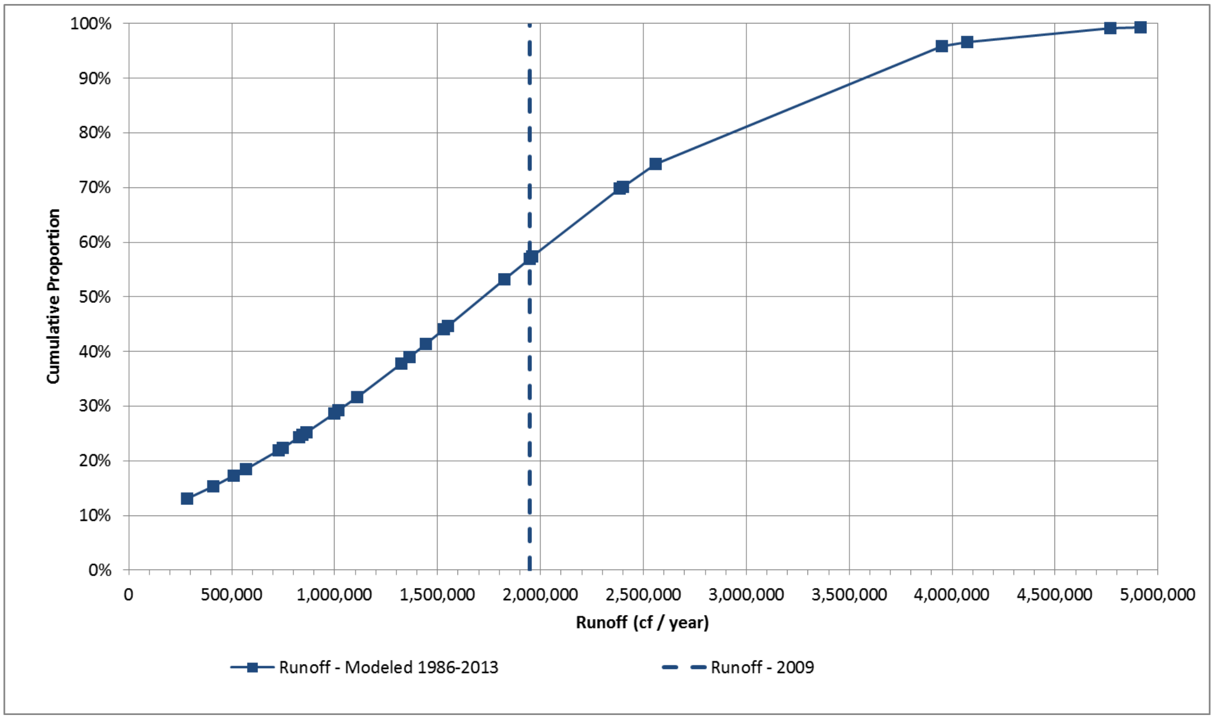

Figure 11. Subwatershed 3 Runoff Frequency Curve

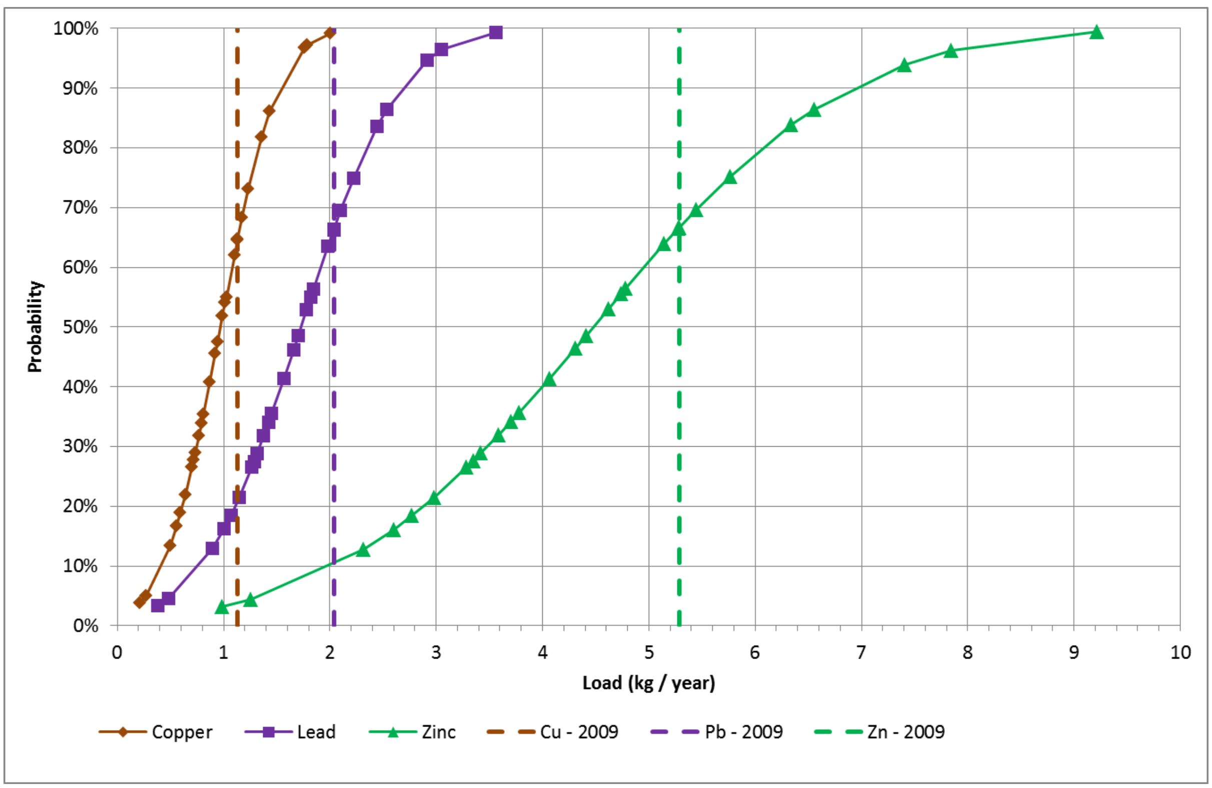

Figure 12. Subwatershed 3 Pollutant Loading Frequency Curves

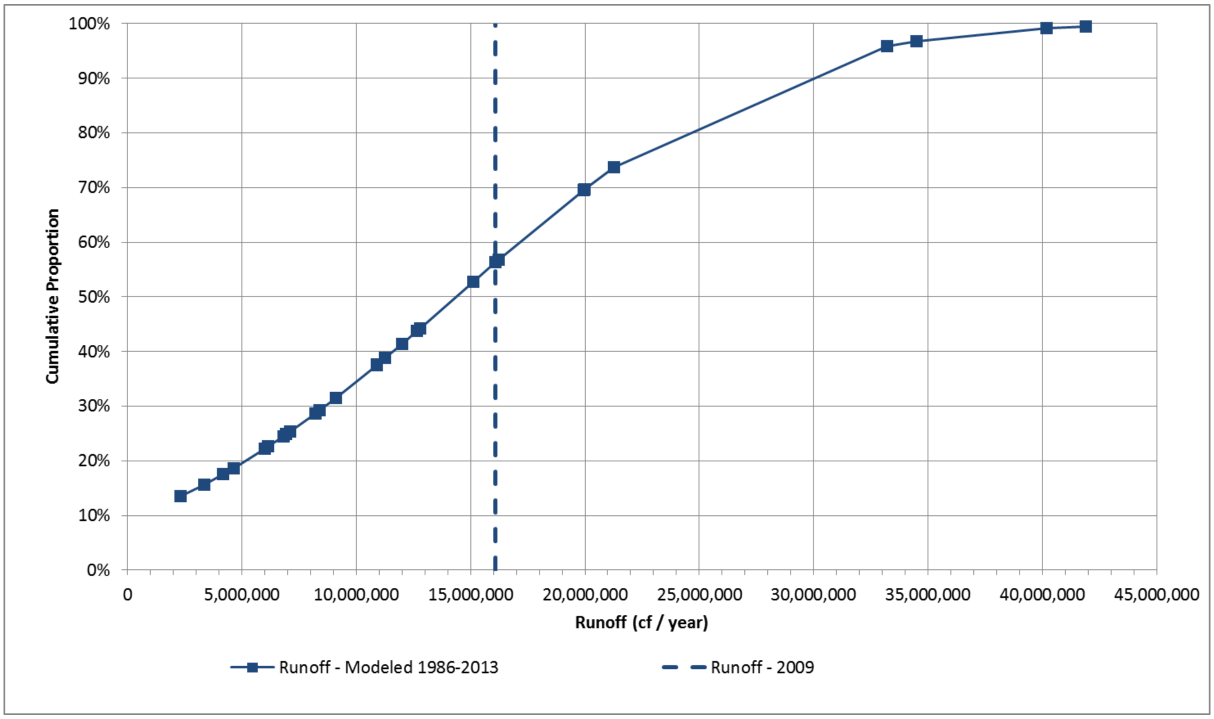

Figure 13. Subwatershed 4 Runoff Frequency Curve

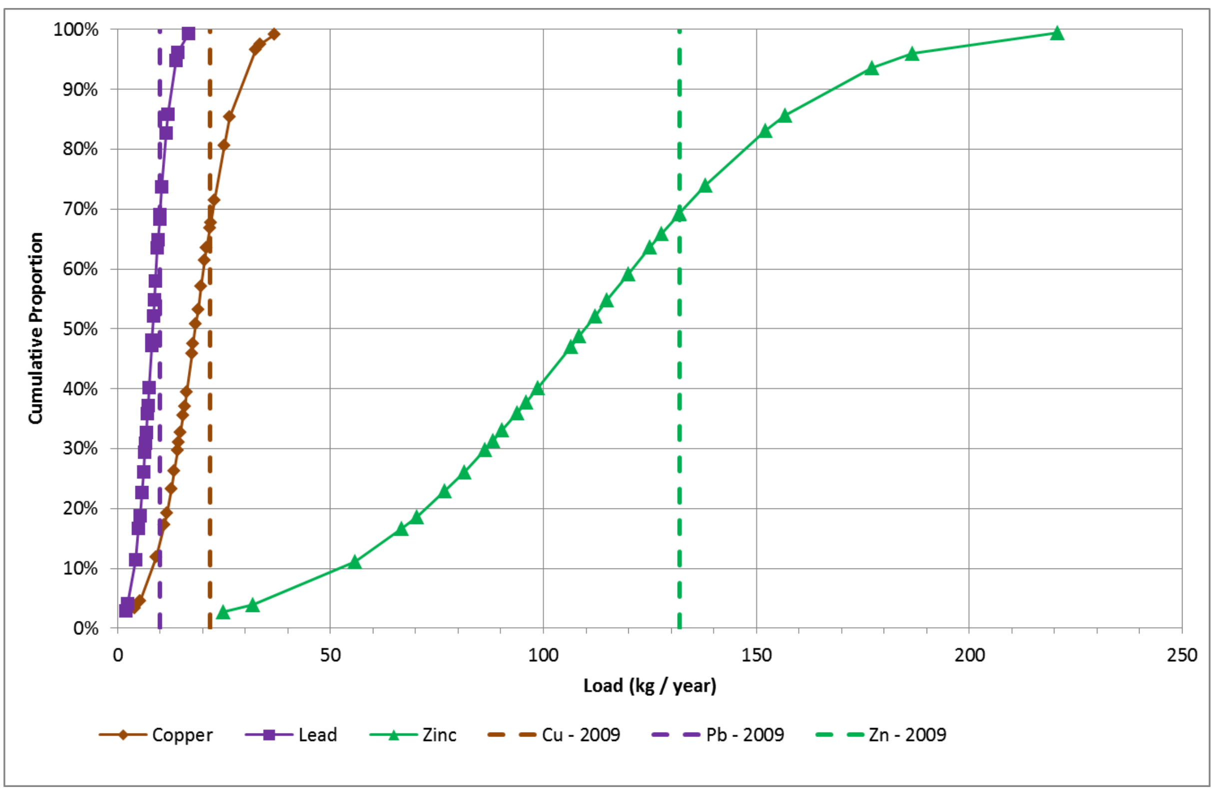

Figure 14. Subwatershed 4 Pollutant Loading Frequency Curves

6. MODELED EXISTING CONDITIONS

The WMMS tool was calibrated and used to model existing conditions within the MdR WMA. The output data from WMMS were then used in a CSM prepared for each subwatershed to determine the load reduction required to achieve compliance with applicable TMDLs and the various combinations of BMPs (besides those designed to capture and infiltrate or reuse the 85th percentile storm event) that could be used to achieve those load reductions. Scenarios were evaluated for each subwatershed area that included (1) 0% of the area draining to BMPs that capture and infiltrate or reuse and 100% of the area draining to other types of BMPs and (2) 50% of the area draining to BMPs that capture and infiltrate or reuse and 50% of the area draining to other types of BMPs. For each of these scenarios, the amount of drainage area treated by filtration type BMPs was varied to include the following factors: zero filtration, medium amount of area treated by filtration BMPs, and the maximum amount of area that could be treated by filtration BMPs.

6.1 Subwatershed Area 1A (Back Basins)

The Subwatershed 1 area was modeled using the calibrated WMMS tool and the results were used as the foundation to perform additional calculations and analysis, including the preparation of a CSM, as previously described. The summary of the existing pollutant loading and required load reductions is provided in Table 15. The WLA for zinc was calculated by allocating in the Toxics TMDL WLA value to Subwatershed 1A proportional to the area of Subwatershed 1A compared to the total area associated with that WLA. The parameters used to calculate the Subwatershed 1A WLA are provided in Table 15. Figure 15 shows the WMMS tool flow and zinc concentration output parameters.

Table 15: Subwatershed 1A (Back Basins) Modeled Existing Conditions

Parameter	Value
Modeled Runoff Volume	3,132,936 cf
Modeled Zinc Concentration	299.8 µg/L
Modeled Zinc Load	26.6 kg/year
Modeled TSS Load	7,757 kg/year
Modeled Zinc to TSS Correlation	3.43 g Zn/kg TSS
TMDL MS4 WLA	9.96 kg/year
*MS4 Drainage Area	1,085 acres*
*Subwatershed Area	104.2 acres
Subwatershed 1A Zinc WLA	0.96 kg/year
Subwatershed 1A TSS WLA (Zinc)	279 kg/year
Subwatershed 1A Zinc Load Reduction Required	96.4%

*Area excludes subwatershed 2 and permanent open space.

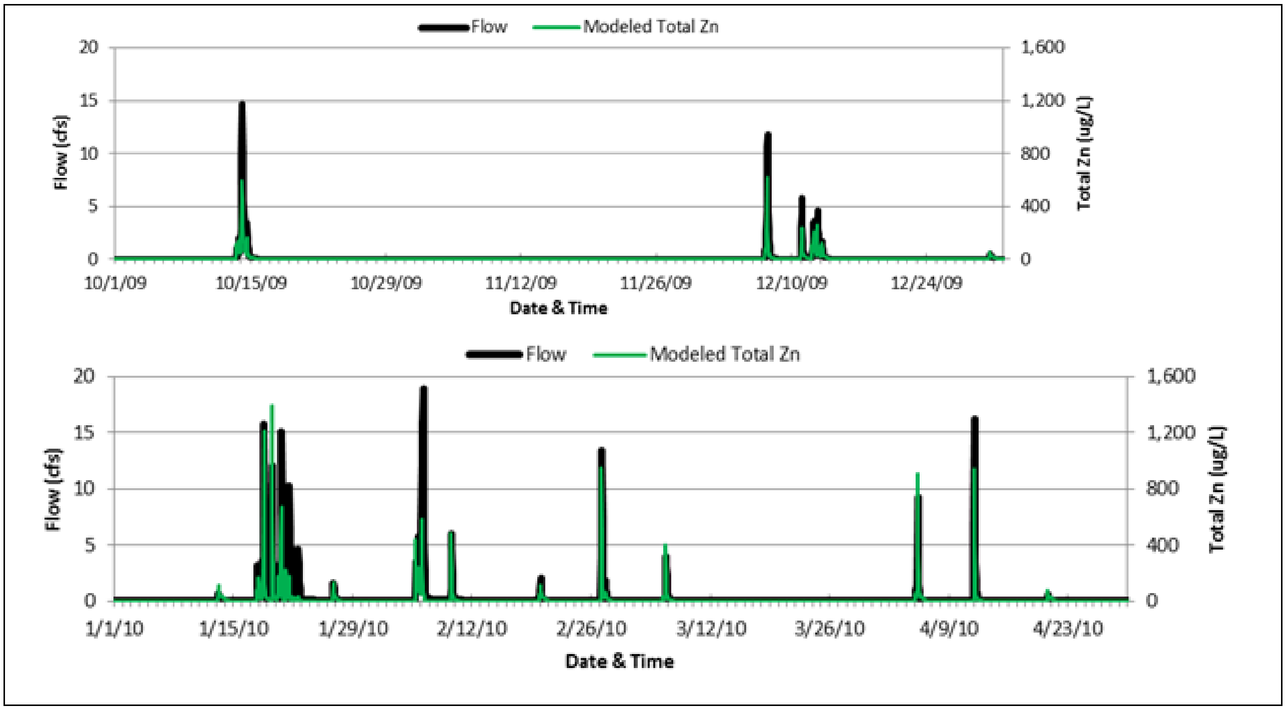

Figure 15: Subwatershed 1A (Back Basins) Modeled Flow and Zinc Graph

6.2 Subwatershed Area 1B (Front Basins)

The Subwatershed 1B area was modeled using the calibrated WMMS tool. The results were used as the foundation to perform additional calculations and analysis, including the preparation of a CSM as previously described. The summary of the existing pollutant loading and required load reductions is provided in Table 16. The WLA for zinc was calculated by allocating the Toxics TMDL WLA value to Subwatershed 1B proportional to the area of Subwatershed 1B compared to the total area associated with the WLA. The parameters used to calculate the Subwatershed 1B WLA are provided in Table 16. Figure 16 shows the WMMS tool flow and zinc concentration output parameters.

Table 16: Subwatershed 1B Modeled Existing Conditions

Parameter	Value
Modeled Runoff Volume	7,481,808 cf
Modeled Zinc Concentration	246 µg/L
Modeled Zinc Load	52.1 kg/year
Modeled TSS Load	18,725 kg/year
Modeled Zinc to TSS Correlation	2.78 g Zn/kg TSS
TMDL MS4 WLA	9.96 kg/year
MS4 Drainage Area	1,085 acres
Subwatershed Area	264.5 acres
Subwatershed 1B Zinc WLA	2.43 kg/year
Subwatershed 1B TSS WLA (Zinc)	873 kg/year
Subwatershed 1B Zinc Load Reduction Required	95.3%

*Area excludes subwatershed 2 and permanent open space.

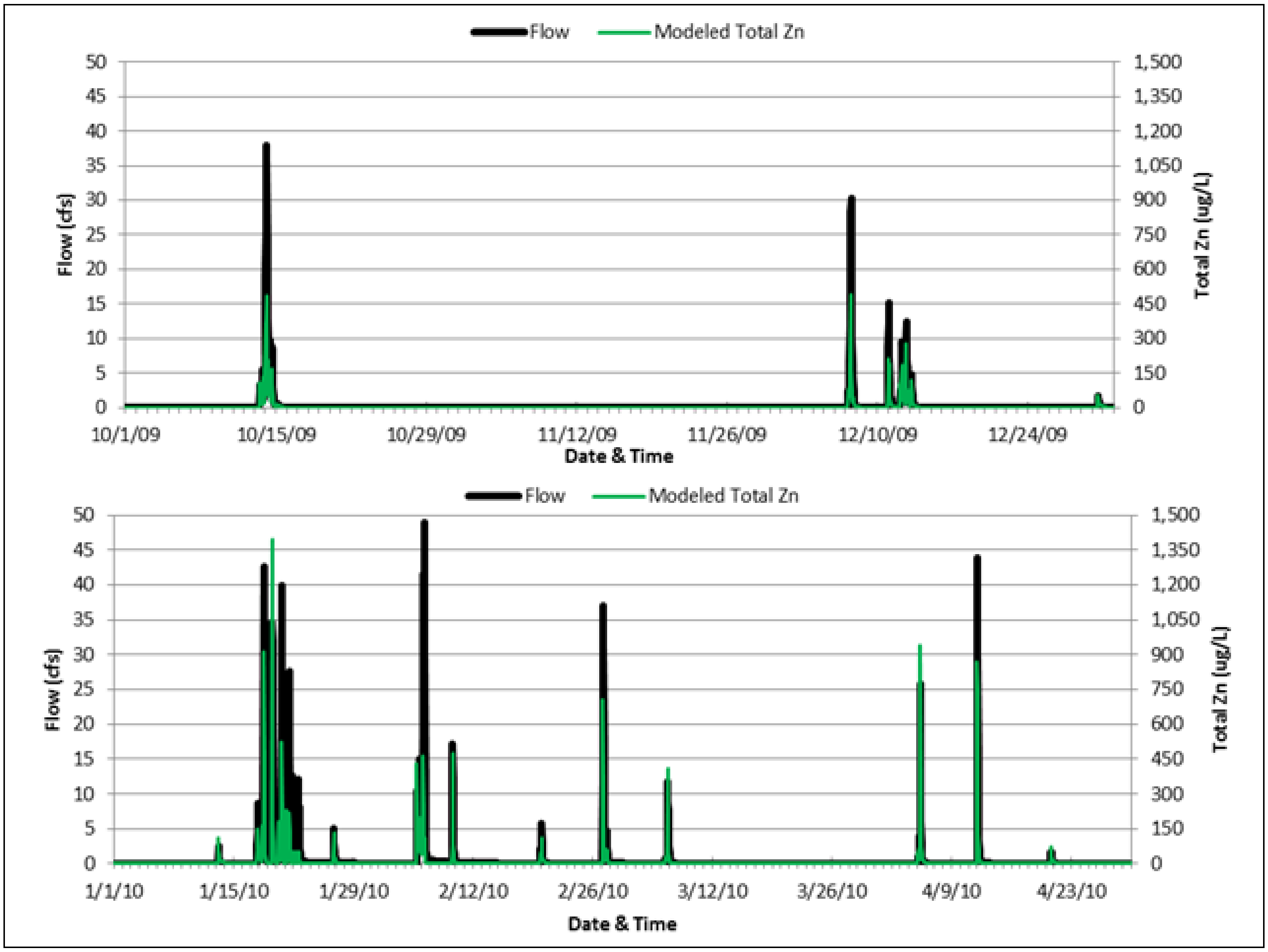

Figure 16: Subwatershed 1B Modeled Flow and Zinc Graph

6.3 Subwatershed 2 (Ballona Lagoon)Toxic Pollutant Non TMDL Water Quality Modeling Results (Subwatershed 2)

The Subwatershed 2 area was modeled using the WMMS tool. The results were used as the foundation to perform additional calculations and analysis including the preparation of a CSM as previously described. Subwatershed 2 is not part of the Toxics TMDL or Bacteria TMDL. In the absence of TMDL WLAs, for RAA purposes, model results in terms of average concentrations were compared to the Ocean Plan Table 1 instantaneous maximum values for copper, lead, and zinc. This comparison is provided in Table 17. Subwatershed 2 monitoring data are not available to allow for re-calibration of the WMMS tool for this area of the MdR WMA.

Table 17: Subwatershed 2 (Ballona Lagoon) Modeled Existing Conditions

Parameter	Copper	Lead	Zinc
Modeled Load (kg)	7.24	2.759	67.50
Modeled Average Concentration[1] (µg/L)	27.3	10.4	254.8
Instantaneous Maximum Value[2] (µg/L)	30	20	200
Required Load Reduction	-	-	21.5%

Note 1: Subwatershed 2 Modeled Runoff = 9,356,904 (2009 rainfall year)
Note 2: Ocean Plan, Table 1 Instantaneous Maximum Value (SWRCB, 2012)

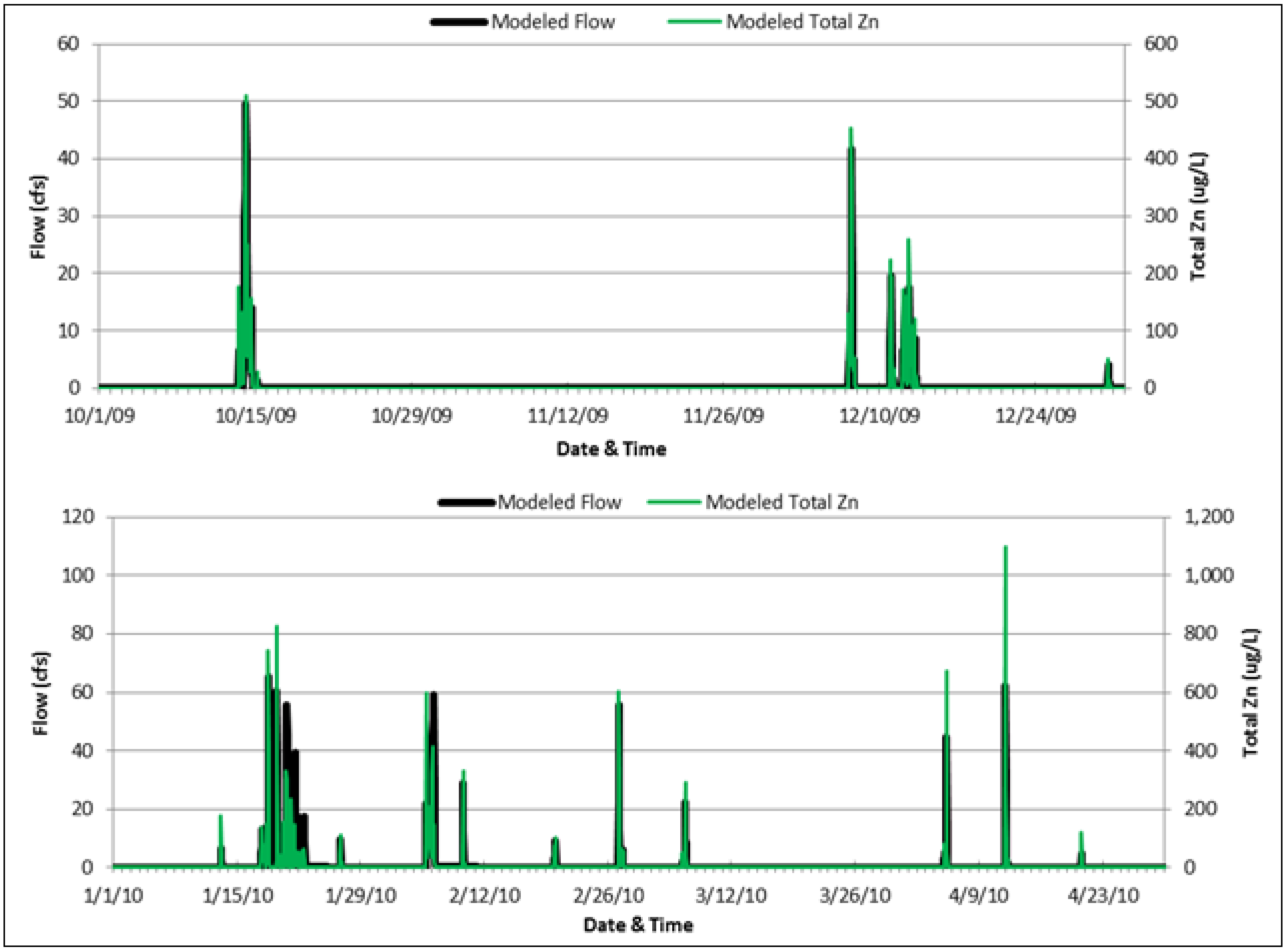

Figure 17: Subwatershed 2 Modeled Flow and Zinc Graph

6.4 Subwatershed Area 3(Boone Olive Pump Plant)

The Subwatershed 3 area was modeled using the calibrated WMMS tool. The results were used as the foundation to perform additional calculations and analysis, including the preparation of a CSM similar to those previously described with coding to estimate the load reductions achieved by the Boone Olive Pump Station low-flow diversion capacity. The summary of the existing pollutant loading and required load reductions is provided in Table 18. The WLA for zinc was calculated by allocating the Toxics TMDL WLA value to Subwatershed 3 proportional to the area of Subwatershed 3 compared to the total area associated with that WLA. The parameters used to calculate the Subwatershed 3 WLA are provided in Table 18. Figure 18 shows the WMMS tool flow and zinc concentration output parameters.

Table 18: Subwatershed 3 (Boone Olive Pump Plant)Modeled Existing Conditions

Parameter	Value
Modeled Runoff Volume	1,947,600 cf
Modeled Zinc Concentration	95.9 µg/L
Modeled Zinc Load	5.3 kg/year
Modeled TSS Load	1,327 kg/year
Modeled Zinc to TSS Correlation	3.99 g Zn/kg TSS
TMDL MS4 WLA	9.96 kg/year
MS4 Drainage Area	1,085 acres
Subwatershed Area	70.5 acres
Subwatershed 3 Zinc WLA	0.65 kg/year
Subwatershed 3 TSS WLA (Zinc)	162 kg/year
Subwatershed 3 Zinc Load Reduction Required	87.8%

*Area excludes subwatershed 2 and permanent open space.

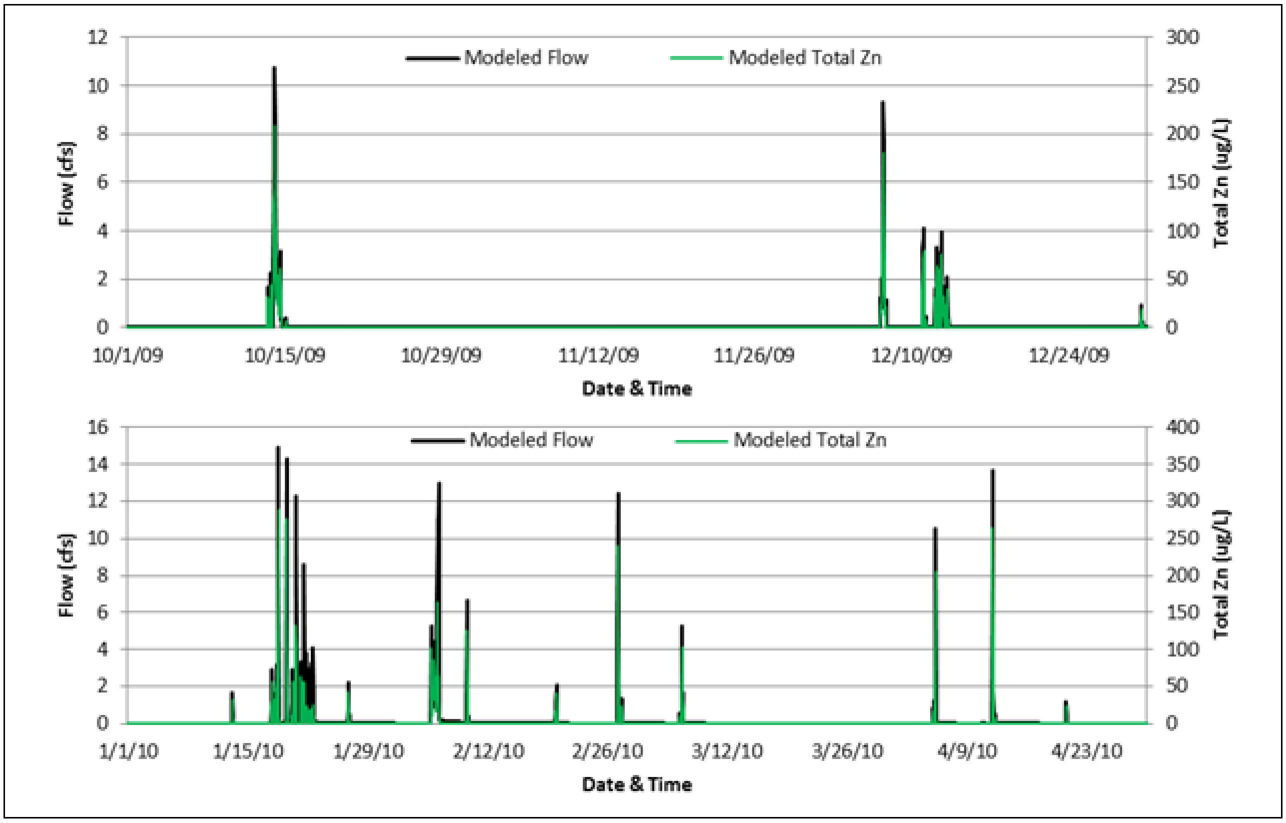

Figure 18: Subwatershed 3 (Boone Olive Pump Plant) Modeled Flow and Zinc Graph

6.5 Subwatershed Area 4(Oxford Basin)

The Subwatershed 4 area was modeled using the calibrated WMMS tool. The results were used as the foundation to perform additional calculations and analysis, including the preparation of a CSM as previously described. The summary of the existing pollutant loading and required load reductions is provided in Table 19. The WLA for zinc was calculated by allocating the Toxics TMDL WLA value to Subwatershed 4 proportional to the area of Subwatershed 4 compared to the total area associated with that WLA. The parameters used to calculate the Subwatershed 4 WLA are provided in Table 19. Figure 19 shows the WMMS tool flow and zinc concentration output parameters.

Table 19: Subwatershed 4 (Oxford Basin) Modeled Existing Conditions

Parameter	Value
Modeled Runoff Volume	16,114,176 cf
Modeled Zinc Concentration	289.1 µg/L
Modeled Zinc Load	131.9 kg/year
Modeled TSS Load	36,689 kg/year
Modeled Zinc to TSS Correlation	3.60 g Zn/kg TSS
TMDL MS4 WLA	9.96 kg/year
MS4 Drainage Area	1,085 acres
Subwatershed Area	645.7 acres
Subwatershed 4 Zinc WLA	5.93 kg/year
Subwatershed 4 TSS WLA (Zinc)	1,649 kg/year
Subwatershed 4 Zinc Load Reduction Required	95.5%

*Area excludes subwatershed 2 and permanent open space.

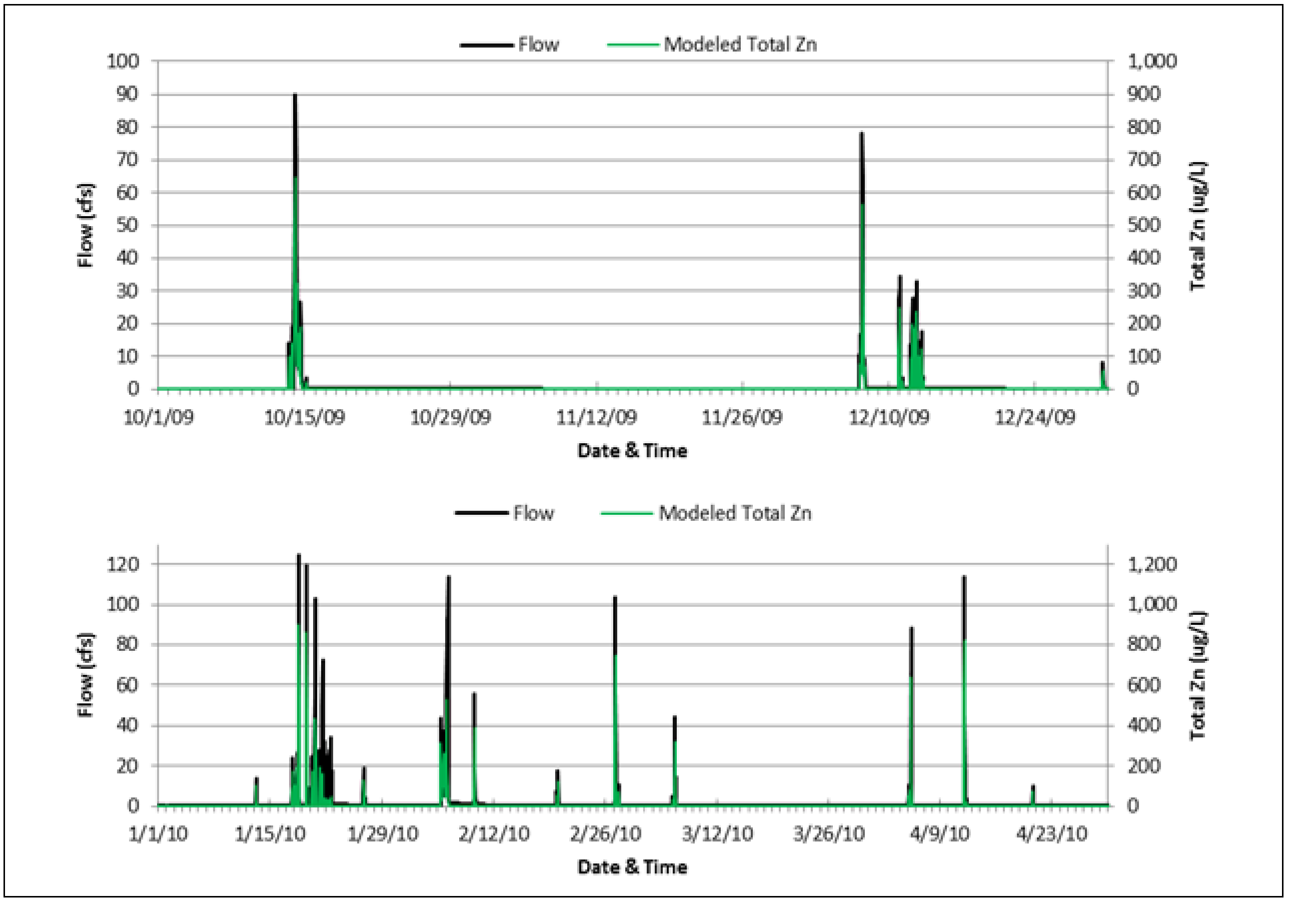

Figure 19: Subwatershed 4 (Oxford Basin)Modeled Flow and Zinc Graph

7. CONTINUOUS SIMULATION MODEL CALCULATIONS

The CSMs were prepared for the subwatersheds to (1) provide a means to sum the incremental volumes of runoff and associated pollutant loads from WMMS output data, (2) incorporate capture and treatment BMPs into the drainage areas, and (3) evaluate the load reductions achieved by those BMPs. The WMMS tool output data were used as the foundation for each CSM. The output data were converted into Microsoft Excel worksheets. Key parameters were organized into a user friendly format (arranged in adjacent columns) and included date and time, rainfall, flow, and concentrations of TSS, copper, and zinc. Calculations were programed into the CSM to determine the incremental (or time step) pollutant loading based on the WMMS output flows and applicable pollutant concentrations. The sum of these incremental time steps determined the total pollutant loading for the modeled period. Three different BMPs were incorporated into the CSM to simulate treatment, capture first followed by treatment, and capture for infiltration or reuse. In general, programing allowed the CSM user to provide the drainage size, runoff coefficient, and treatment rate or capture capacity. Based on the user provided values, the CSM performed calculations that simulated the runoff volume from drainage area to the BMP, the volume of either treatment (up to a maximum rate) or capture, and the drawdown (or recharge in capacity) for capture type BMPs. Based on the volumes simulated to be treated or capture, the pollutant concentrations, and the associated BMP effectiveness the CSM performed time step load reduction calculations. The summation of the time step load reductions provided the overall load reductions achieved with the selected BMPs for the period of the simulation. Additional details related to the BMP specific values used are provided in Table 20 through Table 25.

Table 20. Model Parameters: Curbside Filtration Device (e.g., Modular Wetland System® or Similar)

Model Parameter	Value Used	Notes
Description	n/a	These BMPs may be installed in areas just upstream of existing storm drain inlets. The BMPs were designed so that runoff from the curb and gutter would flow into the device, filtration would occur through a media (device dependent), and treated runoff would discharged into the existing storm drain system.
BMP Drainage Area	Various	Based on bottom-up approach of BMP selection. Filtration BMPs were only utilized in remaining subwatershed areas after maximizing the use of capture type BMPs. In general, these curbside device account for about 60% of the total area to be served by filtration BMPs.
Maximum Treatment Capacity	0.2 inches / hour rainfall	Each time step: For rainfall less than the 0.2 inches per hour value, calculations were performed to determine the runoff volume to the BMP (volume based on the BMP drainage area in relation to total modeled area multiplied by the modeled area total runoff). For rainfall greater than the 0.2 inches per hour, the same calculation was performed but now with a reduction factor equal to the value selected divided by the time step rainfall (e.g., with rainfall of 0.25 inches/hour calculation included 0.2/0.25 because only 80% of runoff from BMP drainage area would be treated).
BMP Pollutant Removal Effectiveness	63%	Based on International Stormwater BMP Data Base for TSS removal using media filter type measures (Geosyntec and WWE, 2008).
Load Reductions	Calculated	Load removal calculated based on time step flows and pollutant concentrations of runoff being treated by the BMP and the pollutant removal effectiveness.

Table 21. Model Parameters: Porous Concrete with Underdrain Filtration

Model Parameter	Value Used	Notes
Description	n/a	This BMP design included porous concrete installed over a gravel/rock reservoir with an underdrain system connected to the existing storm drain network (typically a catch basin box). These may be located in the roadside parking areas and would include removal of the adjacent curb and gutter and replacement with curb only so that the porous concrete could be extended to the curb. This design would allow runoff reaching the BMP from the up gradient curb and gutter to be conveyed into the system. The runoff would be temporarily stored in the underlying rock reservoir and slowly discharge through the underdrain into the nearby storm drain system. Filtration occurs both as the runoff penetrates the porous concrete and as the runoff travels through the rock reservoir towards the underdrain system.
BMP Drainage Area	Various	Based on bottom-up approach of BMP selection. Filtration BMPs utilized in remaining subwatershed area after maximizing the use of capture type BMPs. In general, porous concrete type BMPs account for about 40% of the total area to be served by filtration BMPs.
Runoff "C"	Calculated	The Runoff "C" was determined for the drainage to the BMP type based on both the drainage area impervious cover and the WMMS tool predicted runoff volume. First ***typical*** Runoff "C" values were calculated for each land use type in the overall modeled drainage area based on the impervious cover (Imp. % * 0.9 + 0.05). Next, the ***typical*** composite Runoff "C" for the modeled drainage area was determined using the area weighted average of ***typical*** Runoff "C" values. The ***typical*** composite Runoff "C" value was compared to the composite Runoff "C" determined from the WMMS output to develop an correction factor that was then applied to each of the ***typical*** Runoff "C" values previous calculated for each land use type to provide ***corrected typical*** Runoff "C" values. These adjusted Runoff "C" values were then used to estimate the Runoff "C" for the BMP drainage area based on an area weight average using the ***corrected typical*** land use Runoff "C" values..
Maximum Capture Capacity	1.1 inches of rainfall	Total BMP capacity calculated in cubic feet based on the provided rainfall capture capacity (1.1 inches), BMP drainage area, and BMP drainage area Runoff "C".
Recharge Capacity	12 hours	Conservative estimate based on the system at full capacity discharging through perforated or slotted underdrain piping. It is considered conservative because well maintained BMPs with this type of design (underdrain system) should be able to fully drain in 1 to 6 hours.
Temporary Storage	Calculated	Each time step: Similar to standard basin routing calculations the CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, treated runoff being discharged, and the net storage up to the BMP maximum capture capacity (when system at capacity runoff reaching the BMP would be bypassed and not treated).
BMP Pollutant Removal Effectiveness	63%	Based on International Stormwater BMP Data Base for TSS removal using media filter type measures (Geosyntec and WWE, 2008).
Load Reductions	Calculated	Load removal calculated based on time step flows and pollutant concentrations of runoff being treated by the BMP and the pollutant removal effectiveness.

Table 22. Model Parameters: Capture and Reuse BMP (Sidewalk Swale, Evapotranspiration)

Model Parameter	Value Used	Notes
Description	n/a	This BMP design included capture of storm water runoff within depressed landscaped areas located within parkways (BMPs also known as rain gardens or bioretention basins). Due to the poor soil conditions across the watershed (clayey soils), the primary BMP water quality mechanism for these types of BMPs would be evapotranspiration. In order to maximize capture capacity, clayey soils would be removed and replaced with amended soils down to depth of about 2.5 feet. Design would only allow minimal ponding (approximately 2 inches) when the BMP is at full capacity (most storage would be within the voids of the amended soils).
BMP Drainage Area	Various	Based on bottom-up approach of BMP selection. Capture and reuse BMPs utilized to maximum extent feasible given the site constraints of limited parkway area. Typically located to capture runoff from between 10 to 25% of the up gradient drainage area.
Runoff "C"	Calculated	Same as described in Table 21.
Maximum Capture Capacity	1.1 inches of rainfall	Rainfall value is based on the 85th percentile, 24-hour storm event. Total BMP capacity calculated in cubic feet based on the provided rainfall capture capacity, BMP drainage area, and BMP drainage area Runoff "C".
Recharge Capacity	9 days	Reasonable recharge rate based on BMP design, evapotranspiration rate, and estimate recharge determined for water harvesting BMPs (see Table 24)
Temporary Storage	Calculated	Each time step: Calculations were similar to the standard basin routing calculations. The CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, and the net storage up to the BMP maximum capture capacity (when system at capacity runoff reaching the BMP would be bypassed and not captured).
BMP Pollutant Removal Effectiveness	100%	Capture type BMP. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	**Method 1:** Calculations at each time step were performed based on volume and concentration of the runoff captured in the BMP (flow into BMP). This method utilizes the CSM calculations to estimate load reductions that would have been achieved during the critical period modeled (rainfall year 2009). **Method 2:** This method conforms to the guidance document for conducting RAA (LARWQCB, 2014). The basis of design for these modeled BMPs is that they will capture and infiltrate or reuse runoff from the 85th percentile storm event. The guidance document considers the areas served by these types of BMPs to be in compliance. Therefore, annual load reductions achieved by these BMPs are equivalent to the required load reduction as estimated through modeling of critical year (required load reduction is equal to the modeled load minus waste load allocation). **Note:** The EWMP bottom up approach BMP load reduction tables present load reductions for capture and infiltration or reuse BMPs based on Method 2 calculations. For the single storm event (85th percentile), there are no differences between Method 1 and Method 2 calculations. For the annual load reductions calculates, the differences between the two methods are minimal (between 3 to 7.5 percent, depending on the amount of capture BMPs proposed).

Table 23. Model Parameters: Capture and Infiltration BMP (Infiltration Gallery)

Model Parameter	Value Used	Notes
Description	n/a	This infiltration gallery BMP design included capture of storm water runoff in storage chambers so that water would infiltrate into the substrata. Given design considerations listed in this table (see below), typical design would include installing inlets to convey storm water from the curb and gutter to underground storage chambers. A filtration device would be installed between inlet and the chambers to pretreat the water (remove trash and coarse grain materials).
BMP Drainage Area	Various	Based on bottom-up approach of BMP selection. In general, a layer of clayey materials exists down to depths of 9 to 12 feet below the surface. Additional design consideration is that groundwater occurs in the watershed at depths of less than 10 feet below the surface (near the harbor) and at greater depths away from the harbor (up to the 20 to 30 feet range). The bottoms of the capture chambers should be designed with a 10-foot separation from groundwater. (Note: if the bottoms of the chambers are located with the clayey layer, then the clayey materials would need to be removed and replaced would suitable materials.) In general, selection of these BMPs were limited to Subwatershed 3 and 4 where estimated groundwater depths were greater than 16 feet below ground surface, and in those areas used to capture runoff from the remaining drainage areas not served by sidewalk swale capture BMPs.
Runoff "C"	Calculated	Same as described in Table 21.
Maximum Capture Capacity	1.1 inches of rainfall	Total BMP capacity calculated in cubic feet based on the provided rainfall capture capacity, BMP drainage area, and BMP drainage area Runoff "C".
Recharge Capacity	3 days	Conservative estimate based on the system at full capacity discharging through perforated or slotted underdrain piping. Well maintained BMP should be able to fully drain in 1 to 6 hours.
Temporary Storage	Calculated	Each time step: Similar to a standard basin routing calculations the CSM performed a series of calculation to account for runoff entering the system, runoff being bypassed, treated runoff being discharged, and the net storage up to the BMP maximum capture capacity (when system at capacity runoff reaching the BMP would be bypassed and not captured).
BMP Pollutant Removal Effectiveness	100%	Capture type BMP. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Same as described in Table 22.

Table 24. Model Parameters: Capture and Reuse BMP (Downspout Disconnect/Cistern)

Model Parameter	Value Used	Notes
Description	n/a	This capture type BMP includes installing rainfall collection tanks (or cisterns) to collect runoff from roofs. The captured rainfall would then be used to irrigate nearby landscaping. Due to the clayey nature of the materials throughout the watershed, the soils within irrigated landscaped areas served by the cistern would be amended so that delivered water would penetrate the soils and the area would have better evapotranspiration rates. The landscaped area would also be slightly depressed, where feasible, to improve temporary storage and prevent rainfall landing directly on the landscaped areas from being surface runoff.
BMP Drainage Area	Various	Based on bottom-up approach of BMP selection. Within private and leased properties implementation of these BMPs would be voluntary; however, incentive programs and/or community outreach programs may be developed in the future to improve participation. Limited opportunities were incorporated into the models (45% of single-family residential) with a focus of locating these BMPs primarily in areas where groundwater depths were estimated to be less than 16 feet below ground surface (45% of single-family residential area for these areas of shallow groundwater depths).
Runoff “C”	Calculated	Same as described in Table 21.
Maximum Capture Capacity	1.6 inches of rainfall	Value is based on providing capture capacity of 1,000 gallons per 1,000 ft^2 of tributary rooftop area. Landscaped area that is part of the BMP is assumed to also capture this amount of runoff during the storm (no surface runoff).
Recharge Capacity	9 days	For the BMP drainage area capacity assumed 2 to 1 ratio of landscaped area to rooftop. A review of rainwater harvesting performance graphs indicated that with assumed capture capacity and landscaping ratio the BMP would capture approximately 70% of the annual rainfall (see Figure 20). Simulating the system with the stated assumptions for the critical period (2009 rainfall year) and varying the recharge duration resulted in the value of 9 days providing approximately 70% capture of annual runoff. This value seems reasonable when considering the typical rainfall distribution and average evapotranspiration rates for the region.
Temporary Storage	Calculated	Each time step: Calculations were similar to the standard basin routing calculations. The CSM performed a series of calculations to account for runoff entering the system, runoff being bypassed, and the net storage up to the BMP maximum capture capacity (when system at capacity runoff reaching the BMP would be bypassed and not captured).
BMP Pollutant Removal Effectiveness	100%	Capture type BMP. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Same as described in Table 22.

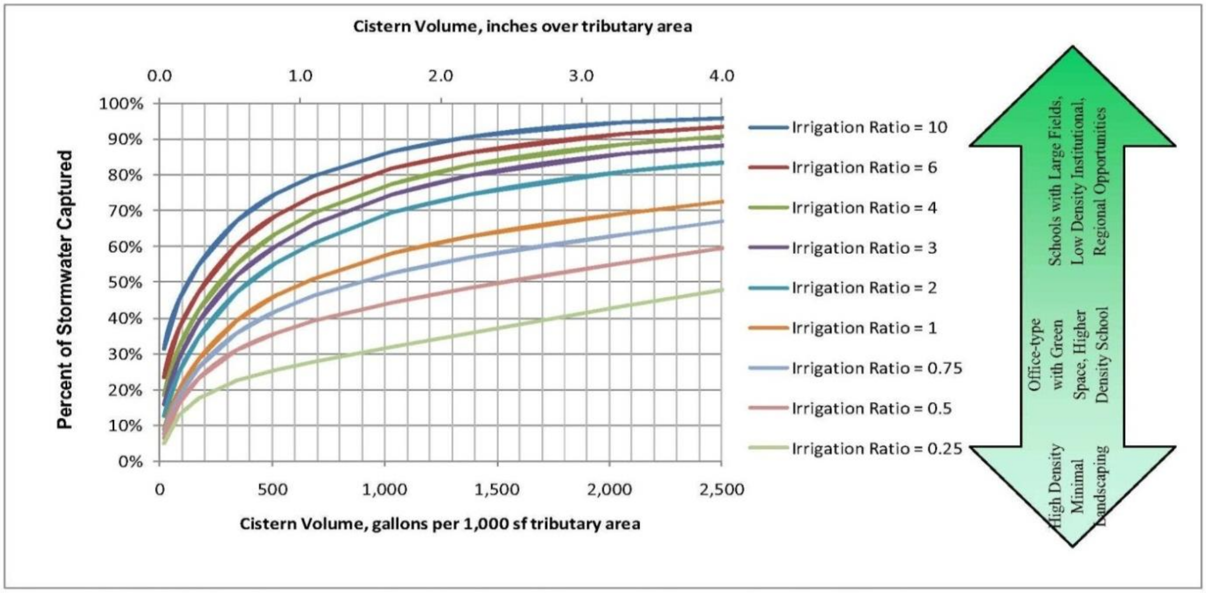

Figure 20. Rainwater Harvesting Systems Performance (Geosyntec, 2009)

Table 25. Model Parameters: Sanitary Sewer Diversion (Boone Olive Pump Station)

Model Parameter	Value Used	Notes
Description	n/a	The Boone Olive Pump / Low Diversion could be modified to function during wet weather. Current operating practice is not to divert flow to the sanitary sewer when measured rainfall exceeds 0.1 inches. This BMP includes modifying the operation of the system to continuously divert storm water during wet weather. The operation of the lift station pumps (that discharge to Basin E) would also be modified so that pumping of storm water to the harbor only occurs when the system nears capacity. This in turn would facilitate the capture and subsequent diversion of additional storm water runoff.
BMP Drainage Area	70.5	Pump station is located at the discharge point of Subwatershed 3.
Maximum Capture Capacity	13,000 gal (1,740 ft^3)	System has 14,000 gallon sump. Value selected assumed approximately 1,000 for water remaining in the sump below pump intake and allowed for freeboard within the system.
Recharge Capacity	0.216 ft^3 per second	Current rate at which water is diverted to the sanitary sewer system.
Temporary Storage	Calculated	Each time step: Similar to standard basin routing calculations, the CSM performed a series of calculation to account for runoff entering the system, runoff being bypassed, and the net storage up to the BMP maximum capture capacity (when system at capacity runoff reaching the BMP would be bypassed and not captured). The CSM estimated the pollutant concentrations of the storm water runoff reaching the system based on the runoff source (e.g., discharge from filtration BMP or untreated). The CSM also estimated the concentration of the water within holding tank, the concentrations and load runoff bypassing the BMP (being pumped to the harbor), and the concentrations of loads of diverted runoff .
BMP Pollutant Removal Effectiveness	100%	Capture type BMP. Per design captured runoff is not discharged to MS4.
Load Reductions	Calculated	Load removal based on concentration of water in the holding tank at the time step when diverted (i.e., comingled concentrations).

8. TOP-DOWN APPROACH IMPLEMENTATION STRATEGY AND RESULTS

The RAA Guidance Document requires 85th percentile design storm sizing be used for capture and infiltration or reuse type BMPs. If capture and infiltration or reuse is not feasible, then analysis shall be performed to demonstrate that proposed BMPs will meet the requirements of applicable WQBELs and/or RWLs for each TMDL. The MdR EWMP implementation strategy is to select locations where large BMPs can be sited to capture and infiltrate the 85th percentile storm. If infiltration is not feasible because of land availability, soil conditions, and/or shallow groundwater, BMPs that use evapo-transpiration will be selected to capture and reuse runoff from the 85th percentile storm event.

If capture and infiltration or reuse is not possible, other BMPs, such as filtration, will be considered. The approach to analyze these “other” types of BMPs is documented in this report. Filtration by a BMP with a design effectiveness less than that of the load reduction percentage required is less than optimal for BMP selection; however, implementing a BMP at a given location that achieves a fraction of the load reduction percentage required is better than not implementing a BMP at the location. To offset the implementation of BMPs with relatively low effectiveness, BMPs with high effectiveness must also be implemented, and these higher effectiveness BMPs, such as capture and infiltration or reuse BMPs, may be required to capture runoff for storm events exceeding the 85th percentile storm size. A CSM was prepared for each subwatershed that incorporates the WMMS output data along with adjustable parameters for various BMPs (e.g., treatment rate/capture volume, effectiveness, and recharge rate) in order to determine the appropriate combination of high and low effectiveness BMPs that may be implemented to achieve the required load reductions.

8.1 Subwatershed 1A Simulation Results

The Subwatershed 1A CSM was prepared to analyze annual load reduction from different combinations of BMPs. For the area of the subwatershed that drains to 85th percentile storm event capture and infiltration or reuse type BMPs, the CSM applies load reductions for that area equal to the load reduction required for the subwatershed area (e.g., if 90% load reduction is required and half the area drains to 85th percentile storm event capture and infiltration or reuse type BMPs, then half the area would be considered to have a 90% load reduction by the CSM). For the areas that do not drain to 85th percentile storm event capture and infiltration or reuse BMPs, the CSM performs time step calculations to estimate the load reductions accomplished by BMPs that differ from those that capture and infiltrate or reuse the runoff from the 85th percentile storm event.

The CSM includes four types of BMPs consisting of three filtration type (treatment) and one infiltration or bioretention type (capture BMPs with storm event capture size selected by the user). The CSM predicts that as more filtration type BMPs, with effectiveness values lower than the load reduction percentage required by the TMDL, are proposed for implementation, the capacity of the capture type BMPs must be increased in order to offset the pollutant loads in the discharge of treated runoff through the filtration BMPs. The CSM also predicts that there are maximum drainage areas that can be treated by filtration type BMPs. If those maximum areas are exceeded, then the annual required load reductions for the area would not be achieved.

CSM results for three hypothetical scenarios analyzed are provided in Table 26. These hypothetical scenarios assumed that no area drains to BMPs designed to capture and infiltrate or reuse the 85th percentile storm event and that three different quantities of filtration type BMPs are implemented (none, medium, and maximum quantity of treatment BMPs). The purpose of preparing the three hypothetical scenarios was not to identify the scenario that may be implemented as the final combination of BMPs, but to provide an indication of the proportional quantities of different types of BMPs that may be implemented to achieve the load reductions. This information helped in developing the final combination of BMPs, but other factors were also considered (e.g., soil types, groundwater level, etc.). The final combination of BMPs, which includes 85th percentile storm event capture and infiltration type BMPs, is described in Section 6.3 of the EWMP.

Table 26: Subwatershed 1A – (Back Basins) – Model Results Zero 85th Percentile Type BMPs

Scenario: Entire subwatershed area analyzed (no area excluded to account for BMPs designed to capture and infiltration or reuse runoff from the 85th percentile storm event)					
Load Reduction Required = 96.4%					
BMP Type	**Drainage Area (acres)**	**Treatment Capacity (in/hr)**	**Storage/ Capacity (in of rain)**	**TSS Removal Efficiency***	**Load Reduction Achieved**
85th Percentile Capture	0				-
Distribution of Other BMP Types: No Filtration BMPs					
Tree Box (Filtration)	0.0	0.2		63%	0.0%
Modular Wetland (Filtration)	0.0	0.2		63%	0.0%
Green St. (Filtration)	0.0		1.10**	63%	0.0%
Capture & Infiltration or Reuse	96.0		1.45	100%	96.4%
Total	**96.0**				**96.4%**
Distribution of Other BMP Types: Medium Amount of Filtration BMPs					
Tree Box (Filtration)	1.5	0.2		63%	0.9%
Modular Wetland (Filtration)	1.5	0.2		63%	0.9%
Green St. (Filtration Treatment Train)	1.5		1.10**	63%	1.0%
Capture & Infiltration or Reuse	91.5		1.60	100%	93.6%
Total	**96.0**				**96.4%**
Distribution of Other BMP Types: Maximum Amount of Filtration BMPs					
Tree Box (Filtration)	1.9	0.2		63%	1.2%
Modular Wetland (Filtration)	1.9	0.2		63%	1.2%
Green St. (Filtration Treatment Train)	1.9		1.10**	63%	1.2%
Capture & Infiltration or Reuse	90.3		1.80	100%	92.8%
Total	**96.0**				**96.6%**

*Source: International Stormwater BMP Data Base (Geosyntec, 2008).
** Treatment capacity for Filtration BMPs

For the scenario of medium distributions of filtration BMPs and zero BMPs designed strictly for the 85th percentile storm event, Figure 21 includes graphs of the total modeled runoff, runoff that bypasses the proposed BMPs, total modeled zinc load, zinc load removed, and zinc load discharged.

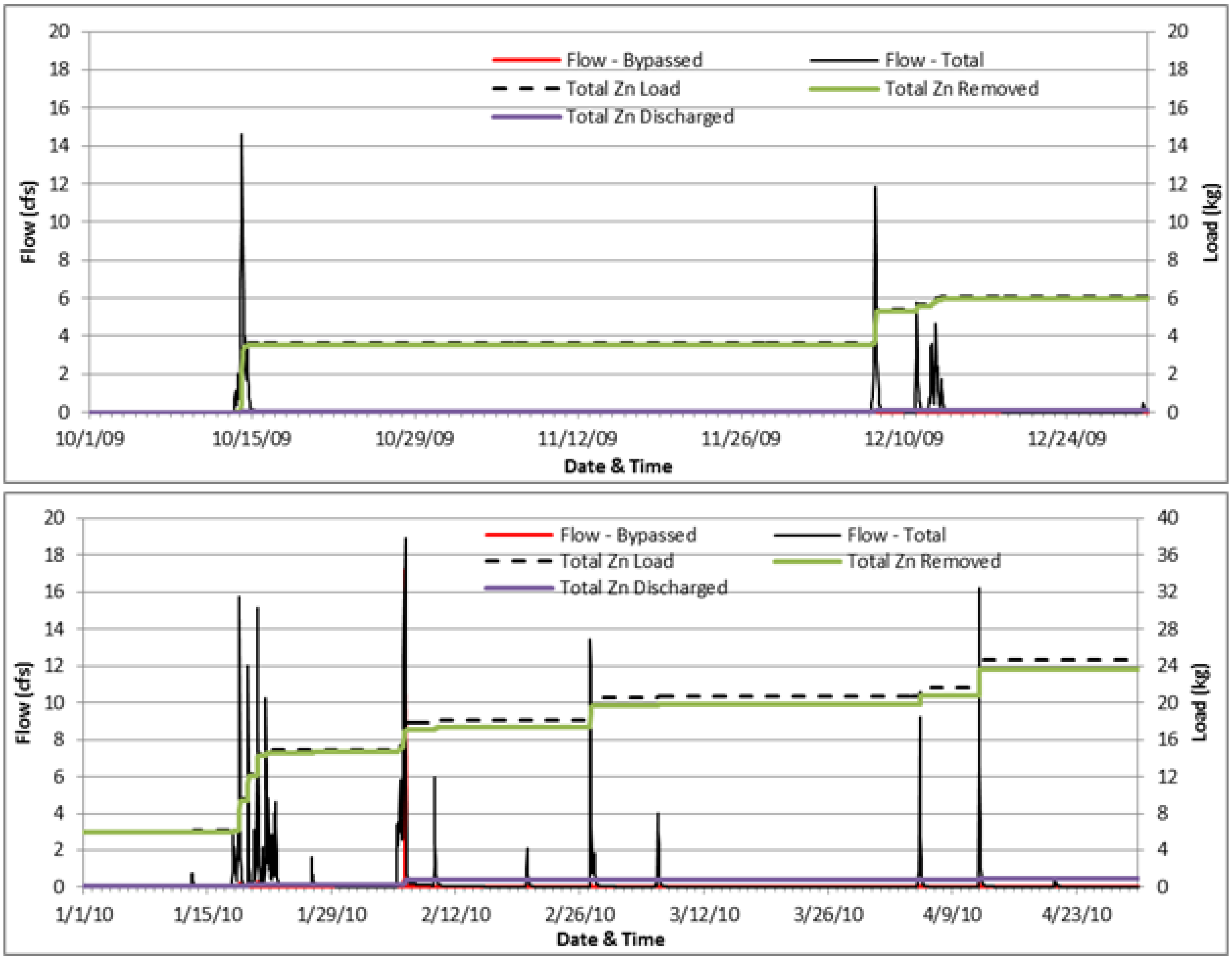

Figure 21: Subwatershed 1A Flow and Zinc Load Graphs

8.2 Subwatershed 1B (Front Basins) Simulation Results

Similar to the Subwatershed 1A CSM, the Subwatershed 1B CSM was prepared to analyze various types of BMPs that differ from those that capture and infiltrate or reuse the runoff from the 85th percentile storm event. The CSM includes four types of BMPs consisting of three filtration type (treatment) and one infiltration or bioretention type (capture). The CSM shows that as more filtration type BMPs, with effectiveness values lower than the load reduction percentage required by the TMDL, are proposed for implementation, the capacity of the capture type BMPs must be increased in order to make up for, or offset, the pollutant loads in the discharge of treated runoff through the filtration BMPs. The CSM also shows that there are maximum drainage areas that can be treated by filtration type BMPs, and if those maximum areas are exceeded then the annual required load reductions for the area would not be achieved.

The CSM results for three hypothetical scenarios analyzed are provided in Table 27. These hypothetical scenarios assumed that no area drains to BMPs designed to capture and infiltrate or reuse the 85th percentile storm event and that three different quantities of filtration type BMPs are implemented (none, medium, and maximum quantity of treatment BMPs). The purpose of preparing the three hypothetical scenarios was not to identify the scenario that may be implemented as the final combination of BMPs, but instead the purpose was to provide an indication on the proportional quantities of different types of BMPs that may be implemented to achieve load reductions. This information helped in developing the final combination of BMPs, but other factors were also considered (e.g., soil types, groundwater level). The final combination of BMPs, includes 85th percentile storm event capture and infiltration type BMPs, is described in Section 6.3 of the EWMP.

Table 27: Subwatershed 1B – Model Results Zero 85th Percentile Type BMPs

Scenario: Entire subwatershed area analyzed (no area excluded to account for BMPs designed to capture and infiltration or reuse runoff from the 85th percentile storm event)					
Load Reduction Required = 95.3%					
BMP Type	**Drainage Area (acres)**	**Treatment Capacity (in/hr)**	**Storage Capacity (in of rain)**	**TSS Removal Efficiency***	**Load Reduction Achieved**
85th Percentile Capture	0				-
Distribution of Other BMP Types: No Filtration BMPs					
Tree Box (Filtration)	0	0.2		63%	0.0%
Modular Wetland (Filtration)	0	0.2		63%	0.0%
Green St. (Filtration)	0		1.10**	63%	0.0%
Capture & Infiltration or Reuse	249.9		1.52	100%	95.4%
Total	**249.9**				**95.4%**
Distribution of Other BMP Types: Medium Amount of Filtration BMPs					
Tree Box (Filtration)	3.0	0.2		63%	0.7%
Modular Wetland (Filtration)	3.0	0.2		63%	0.7%
Green St. (Filtration Treatment Train)	3.0		1.10**	63%	0.7%
Capture & Infiltration or Reuse	241		1.60	100%	93.2%
Total	**249.9**				**95.3%**
Distribution of Other BMP Types: Maximum Amount of Filtration MBMPs					
Tree Box (Filtration)	5.8	0.2		63%	1.3%
Modular Wetland (Filtration)	5.8	0.2		63%	1.3%
Green St. (Filtration Treatment Train)	5.8		1.10**	63%	1.5%
Capture & Infiltration or Reuse	232.5		1.80	100%	91.2%
Total	**249.9**				**95.3%**

* Source: International Stormwater BMP Data Base (Geosyntec, 2008).
** Treatment capacity for Filtration BMPs

For the scenario of medium distributions of filtration BMP and zero BMPs designed strictly for the 85th percentile storm event Figure 22 includes graphs of the total modeled runoff, runoff that bypasses the proposed BMPs, total modeled zinc load, zinc load removed, and zinc load discharged.

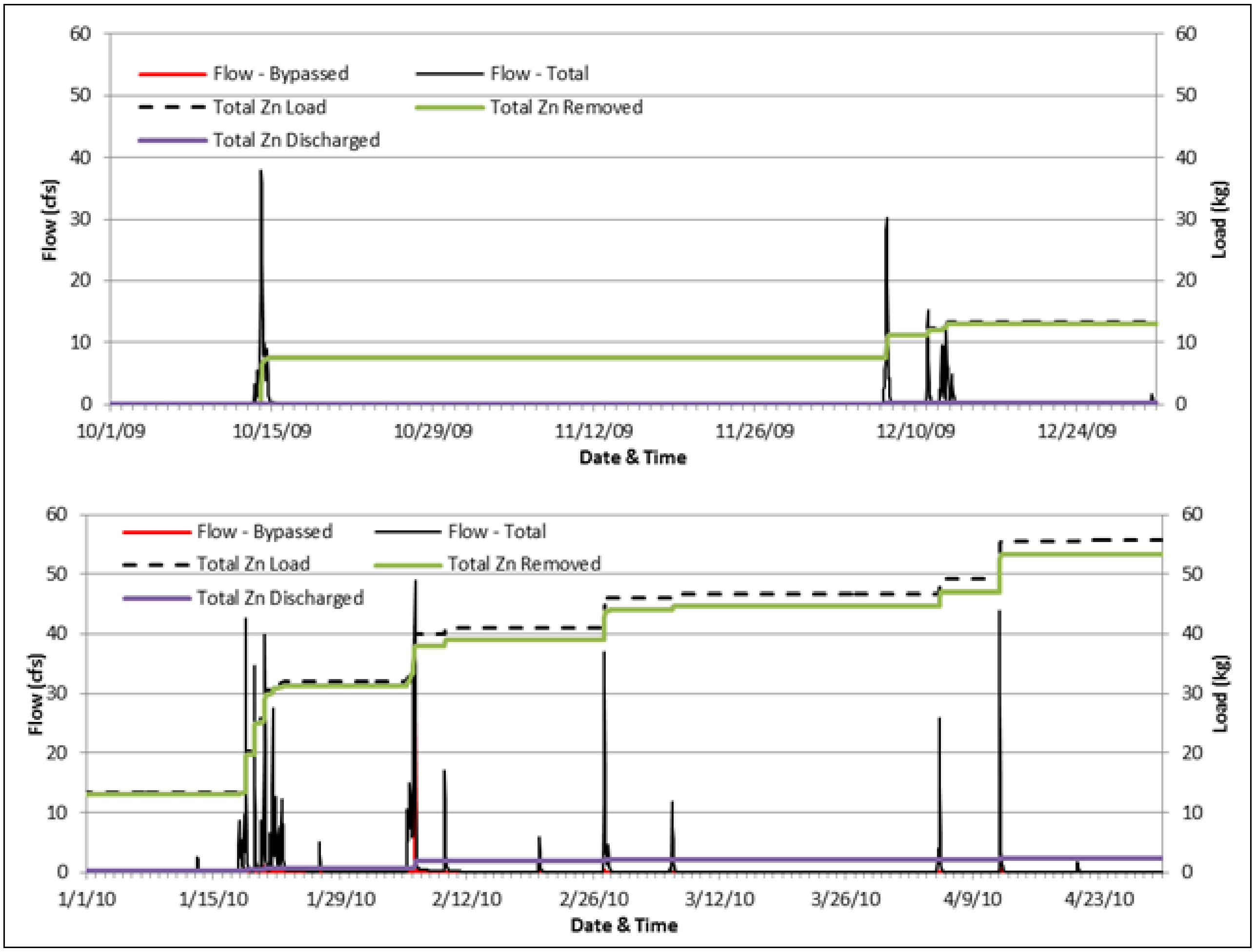

Figure 22: Subwatershed 1B Flow and Zinc Load Graphs

8.3 Subwatershed 2 Simulation Results (Non-TMDL Subwatershed)

The Subwatershed 2 CSM was prepared to analyze various types of BMPs that may be implemented to achieve load reductions. Similar to the other subwatersheds, the CSM was prepared to include four types of BMPs consisting of three filtration type (treatment) and one infiltration or bioretention type (capture). Summaries of the CSM results for the scenarios analyzed are provided in Table 28.

Table 28: Subwatershed 2 – Model Results Zero 85th Percentile Type BMPs

Scenario: Entire subwatershed area analyzed (no area excluded to account for BMPs designed to capture and infiltration or reuse runoff from the 85th percentile storm event)					
Load Reduction Required = 21.5%					
BMP Type	**Drainage Area (acres)**	**Treatment Capacity (in/hr)**	**Storage Capacity (in of rain)**	**TSS Removal Efficiency***	**Load Reduction Achieved**
85th Percentile Capture	0				-
Distribution of Other BMP Types: No Filtration BMPs					
Tree Box (Filtration)	0	0.2		63%	0.0%
Modular Wetland (Filtration)	0	0.2		63%	0.0%
Green St. (Filtration)	0		1.10**	63%	0.0%
Capture & Infiltration or Reuse	83.5		1.00	100%	21.5%
No BMPs	244.2				-
Total	**83.5**				**21.5%**
Distribution of Other BMP Types: Medium Amount of Filtration BMPs					
Tree Box (Filtration)	21.1	0.2		63%	3.6%
Modular Wetland (Filtration)	21.1	0.2		63%	3.6%
Green St. (Filtration Treatment Train)	21.1		1.10**	63%	4.1%
Capture & Infiltration or Reuse	40.0		1.00	100%	10.3%
No BMPs	200.3				-
Total	**94.0**				**21.5%**
Distribution of Other BMP Types: Maximum Amount of Filtration BMPs					
Tree Box (Filtration)	40.5	0.2		63%	6.9%
Modular Wetland (Filtration)	40.5	0.2		63%	6.9%
Green St. (Filtration Treatment Train)	40.5		1.10**	63%	7.8%
Capture & Infiltration or Reuse	0.0		1.00	100%	0.0%
No BMPs	181.2				-
Total	**113.1**				**21.5%**

* Source: International Stormwater BMP Data Base (Geosyntec, 2008).
** Treatment capacity for Filtration BMPs

For the scenario of medium distributions of filtration BMPs and zero BMPs designed strictly for the 85th percentile storm event, Figure 23 shows graphs of the total modeled runoff, runoff that bypasses the proposed BMPs, total modeled zinc load, zinc load removed, and zinc load discharged.

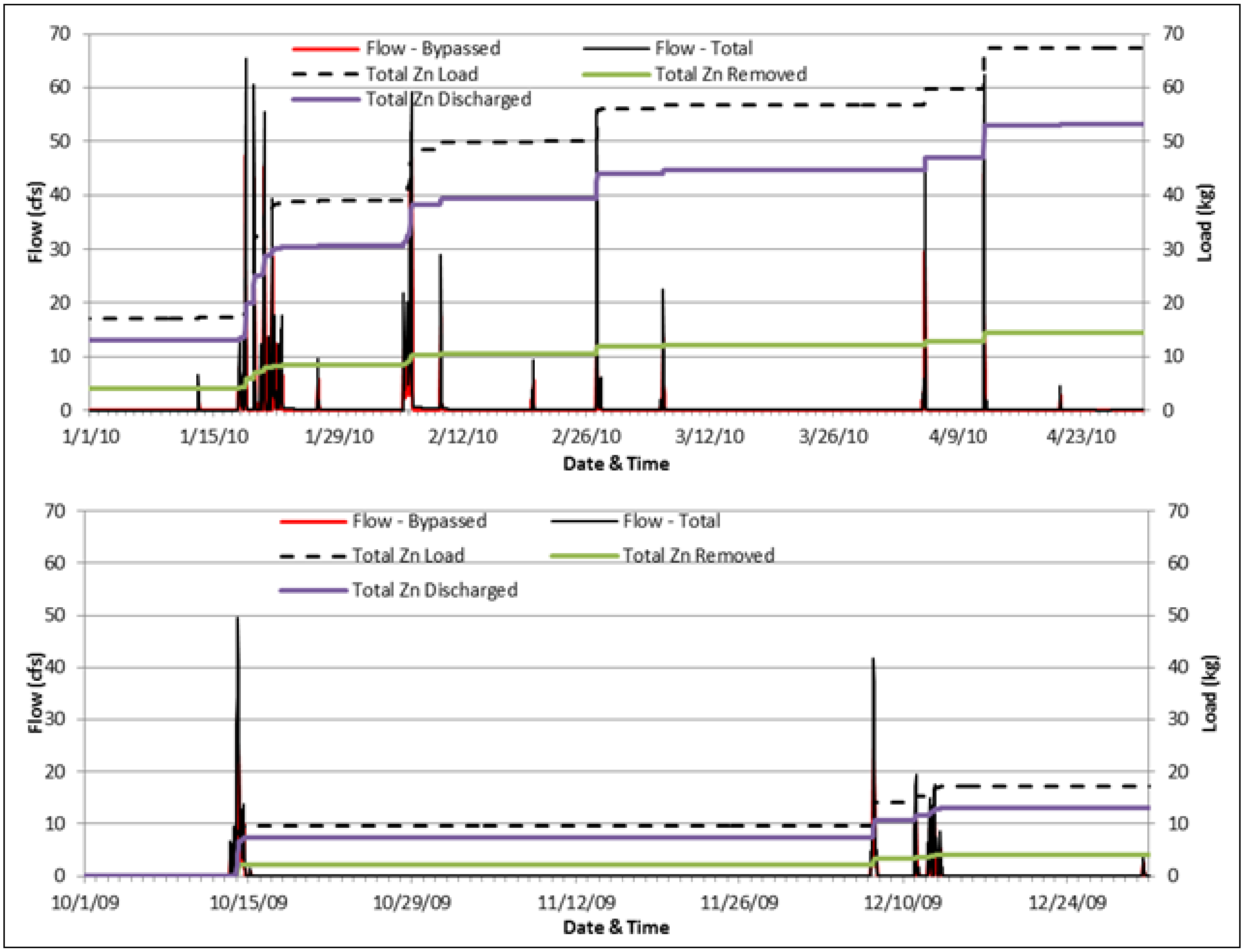

Figure 23: Subwatershed 2 Flow and Zinc Load Graphs

8.4 Subwatershed 3 Simulation Results

The Subwatershed 3 CSM was prepared to analyze various types of BMPs that differ from those that capture and infiltrate or reuse the runoff from the 85th percentile storm event. The CSM includes five types of BMPs consisting of three filtration type (treatment), one infiltration or bioretention type (capture), and the existing Boone Olive Pump Station low-flow diversion system (capture).
The CSM shows that as more filtration type BMPs, with effectiveness values lower than the load reduction percentage required by the TMDL, are proposed for implementation, the capacity of the capture type BMPs must be increased in order to make up for, or offset, the pollutant loads in the discharge of treated runoff through the filtration BMPs. The CSM also shows that there are maximum drainage areas that can be treated by filtration type BMPs. If those maximum areas are exceeded then the annual required load reductions for the area would not be achieved.

CSM results for the three hypothetical scenarios analyzed are provided in Table 29. These hypothetical scenarios assumed that no area drains to BMPs designed to capture and infiltrate or reuse the 85th percentile storm event and that three different quantities of filtration type BMPs are implemented (none, medium, and maximum quantity of treatment BMPs). The purpose of preparing the three hypothetical scenarios was not to identify the scenario that may be implemented as the final combination of BMPs, but instead to provide an indication on the proportional quantities of different types of BMPs that may be implemented to achieve load reductions. This information helped in developing the final combination of BMPs, but other factors were also considered (e.g., soil types, groundwater level). The final combination of BMPs, which includes 85th percentile storm event capture and infiltration type BMPs, is described in Section 6.3 of the EWMP.

Table 29: Subwatershed 3 – Model Results Zero 85th Percentile Type BMPs

Scenario: Entire subwatershed area analyzed (no area excluded to account for BMPs designed to capture and infiltration or reuse runoff from the 85th percentile storm event)					
Load Reduction Required = 87.8%					
BMP Type	**Drainage Area (acres)**	**Treatment Capacity (in/hr)**	**Storage Capacity (in of rain)**	**TSS Removal Efficiency***	**Load Reduction Achieved**
85th Percentile Capture	0				-
Distribution of Other BMP Types: No Filtration BMPs					
Tree Box (Filtration)	0	0.2		63%	0.0%
Modular Wetland (Filtration)	0	0.2		63%	0.0%
Green St. (Filtration)	0		1.10**	63%	0.0%
Capture & Infiltration or Reuse	70.5		1.13	100%	85.6%
Boone Olive Low Flow Diversion	70.5			100%	2.3%
Total	**70.5**				**87.9%**
Distribution of Other BMP Types: Medium Amount of Filtration BMPs					
Tree Box (Filtration)	7.3	0.2		63%	5.4%
Modular Wetland (Filtration)	7.3	0.2		63%	5.4%
Green St. (Filtration Treatment Train)	7.3		1.10**	63%	5.4%
Capture & Infiltration or Reuse	48.6		1.35	100%	63.9%
Boone Olive Low Flow Diversion	70.5			100%	6.6%
Total	**70.5**				**87.9%**
Distribution of Other BMP Types: Maximum Amount of Filtration BMPs					
Tree Box (Filtration)	8.7	0.2		63%	6.5%
Modular Wetland (Filtration)	8.7	0.2		63%	6.5%
Green St. (Filtration Treatment Train)	8.8		1.10**	63%	7.8%
Capture & Infiltration or Reuse	44.3		1.60	100%	60.9%
Boone Olive Low Flow Diversion	70.5			100%	6.2%
Total	**70.5**				**87.8%**

* Source: International Stormwater BMP Data Base (Geosyntec, 2008).
** Treatment BMPs do not have storage capacity, treatment capacity is shown in the table

The inclusion of the Boone Olive Pump Station low-flow diversion system resulted in the ability to implement a greater percentage of treatment type BMPs in Subwatershed 3. The green street capture, temporary storage, and then discharge type of BMP in this scenario discharged, captured, and treated flows that were in turn captured and treated by the low-flow diversion system. Similarly, for low intensity rainfall periods, the tree box and modular wetland filtration type BMPs discharged flows that were completely or partially captured by the diversion system thereby providing additional load reductions.

For the scenario of medium distributions of filtration BMPs and zero BMPs designed strictly for the 85th percentile storm event, Figure 24 includes graphs of the total modeled runoff, runoff that bypasses the proposed BMPs, total modeled zinc load, zinc load removed, and zinc load discharged.

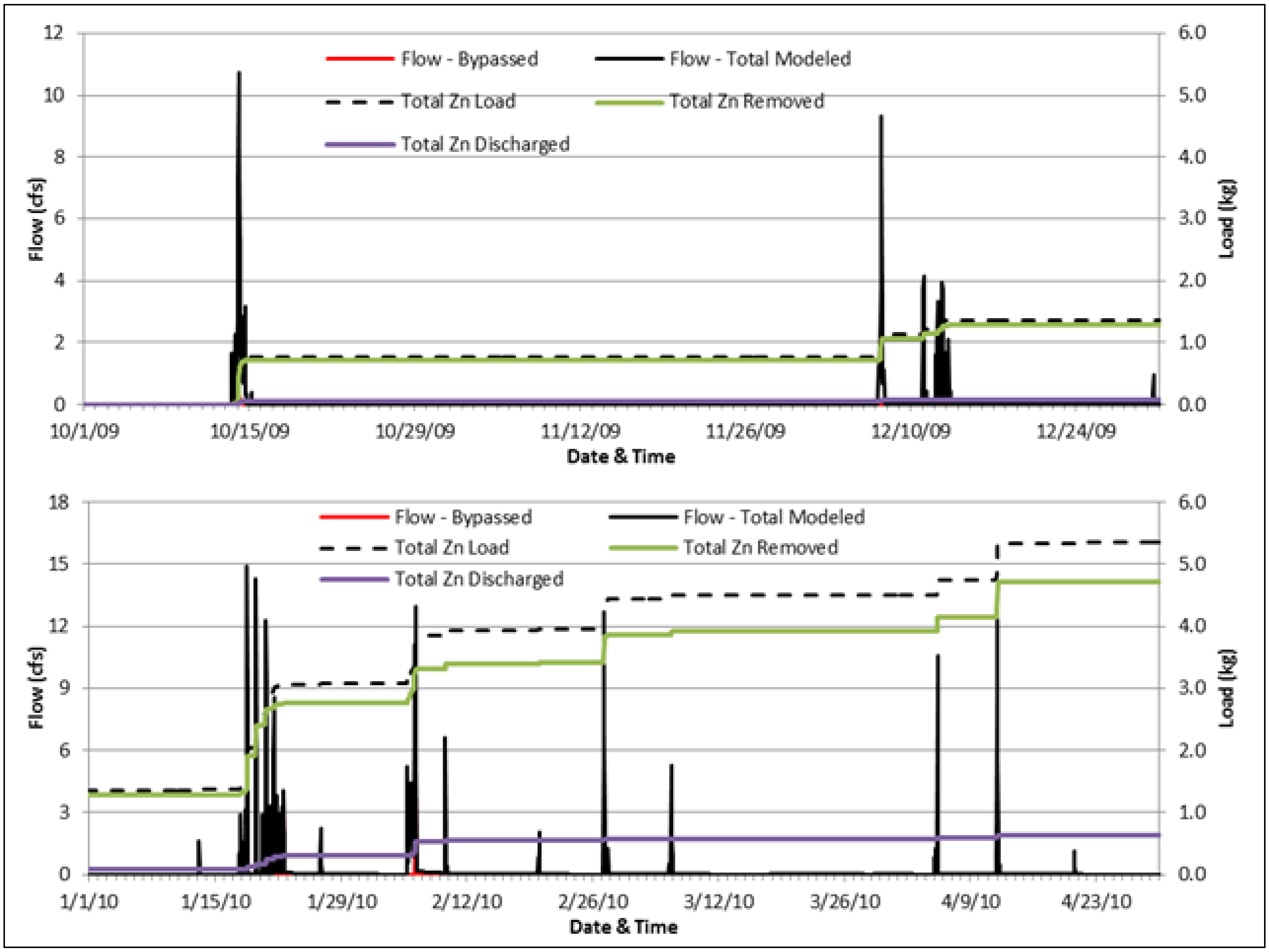

Figure 24: Subwatershed 3 Flow and Zinc Load Graphs

8.5 Subwatershed 4 Simulation Results

The Subwatershed 4 CSM was prepared to analyze various types of BMPs that differ from those that capture and infiltrate or reuse the runoff from the 85th percentile storm event. The CSM includes four types of BMPs consisting of three filtration type (treatment) and one infiltration or bioretention type (capture). The CSM shows that as more filtration type BMPs, with effectiveness values lower than the load reduction percentage required by the TMDL, are proposed for implementation, the capacity of the capture type BMPs must be increased in order to make up for, or offset, the pollutant loads in the discharge of treated runoff through the filtration BMPs. The CSM also shows that there are maximum drainage areas that can be treated by filtration type BMPs. If those maximum areas are exceeded, then the annual required load reductions for the area would not be achieved.

CSM results for the three hypothetical scenarios analyzed are provided in Table 30. These hypothetical scenarios assumed that no area drains to BMPs designed to capture and infiltrate or reuse the 8th percentile storm event and that three different quantities of filtration type BMPs are implemented (none, medium, and maximum quantity of treatment BMPs). The purpose of preparing the three hypothetical scenarios was not to identify the scenario that may be implemented as the final combination of BMPs, but instead the purpose was to provide an indication on the proportional quantities of different types of BMPs that may be implemented to achieve load reductions. This information helped in developing the final combination of BMPs, but other factors were also considered (e.g., soil types, groundwater level). The final combination of BMPs, which includes 85th percentile storm event capture and infiltration type BMPs, is described in Section 6.0 of the EWMP.

Table 30: Subwatershed 4 – Model Results Zero 85th Percentile Type BMPs

Scenario: Entire subwatershed area analyzed (no area excluded to account for BMPs designed to capture and infiltration or reuse runoff from the 85th percentile storm event)					
Load Reduction Required = 95.5%					
BMP Type	**Drainage Area (acres)**	**Treatment Capacity (in/hr)**	**Storage Capacity (in of rain)**	**TSS Removal Efficiency***	**Load Reduction Achieved**
85th Percentile Capture	0				-
Distribution of Other BMP Types: No Filtration BMPs					
Tree Box (Filtration)	0	0.2		63%	0.0%
Modular Wetland (Filtration)	0	0.2		63%	0.0%
Green St. (Filtration)	0		1.10**	63%	0.0%
Capture & Infiltration or Reuse	638.6		1.38	100%	95.5%
Total	**638.6**				**95.5%**
Distribution of Other BMP Types: Medium Amount of Filtration BMPs					
Tree Box (Filtration)	13.7	0.2		63%	1.1%
Modular Wetland (Filtration)	13.7	0.2		63%	1.1%
Green St. (Filtration Treatment Train)	13.7		1.10**	63%	1.3%
Capture & Infiltration or Reuse	597.5		1.60	100%	92.0%
Total	**638.6**				**95.5%**
Distribution of Other BMP Types: Maximum Amount of Filtration BMPs					
Tree Box (Filtration)	17.7	0.2		63%	1.4%
Modular Wetland (Filtration)	17.7	0.2		63%	1.4%
Green St. (Filtration Treatment Train)	17.7		1.10**	63%	1.7%
Capture & Infiltration or Reuse	585.5		1.80	100%	90.8%
Total	**638.6**				**95.5%**

* Source: International Stormwater BMP Data Base (Geosyntec, 2008).
** Treatment capacity for Filtration BMPs

For the scenario of medium distributions of filtration BMPs and zero BMPs designed strictly for the 85th percentile storm event, Figure 25 includes graphs of the total modeled runoff, runoff that bypasses the proposed BMPs, total modeled zinc load, zinc load removed, and zinc load discharged.

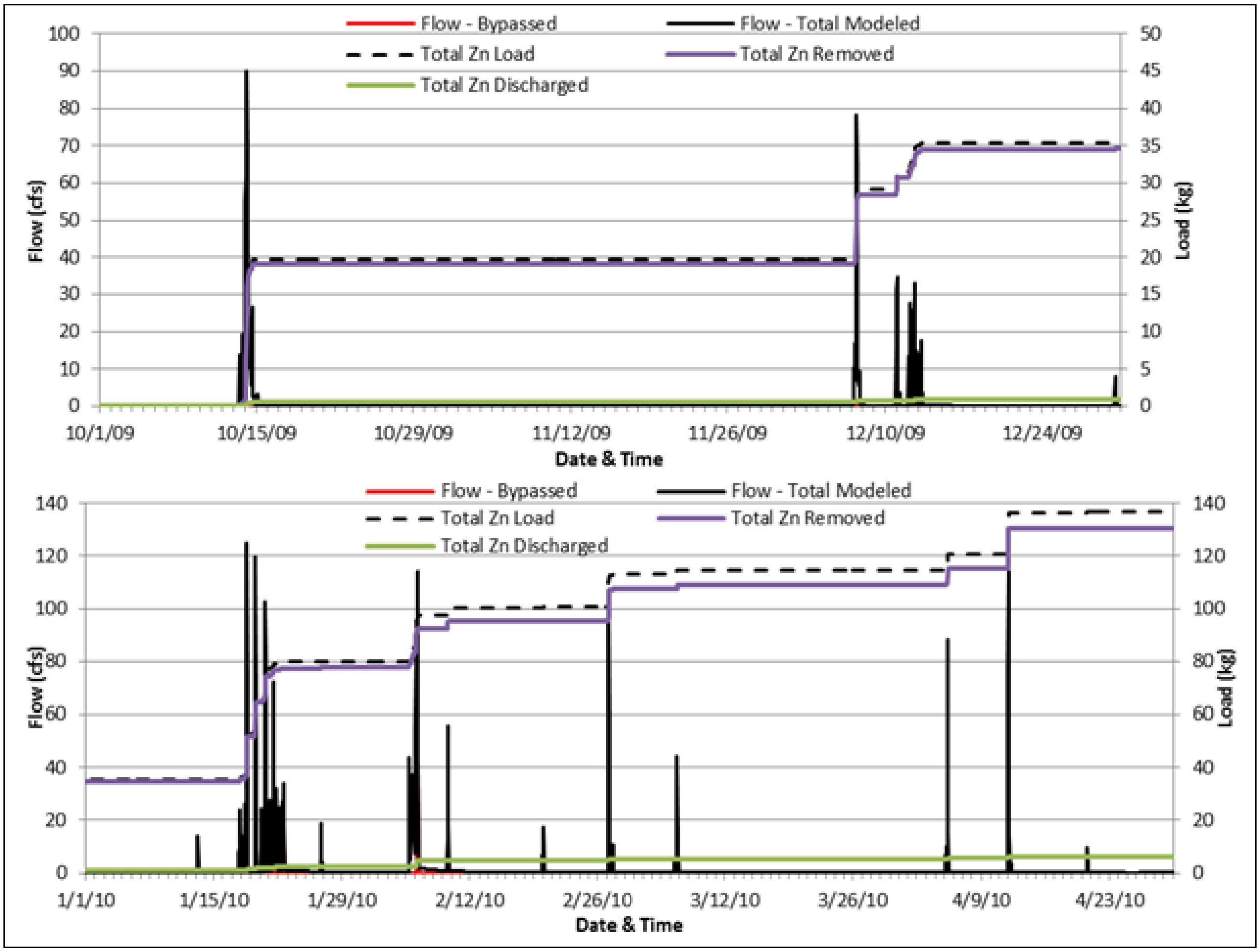

Figure 25: Subwatershed 4 Flow and Zinc Load Graphs

9. BACTERIA WATER QUALITY ANALYSIS

The existing understanding of the science that describes bacteria loading in wet weather runoff is complex and continues to evolve as new studies are performed and data are collected. Bacteria wet weather monitoring has shown that bacteria loadings are generally unpredictable. The science is additionally complicated in areas where runoff is discharged into open water, such as the MdRH, where many processes occur (e.g., die off, regrowth, other input sources, etc.).

In accordance with the Bacteria TMDL, the compliance stations for bacteria monitoring are located at various points within the Back Basins. The RAA bacterial water quality analysis was performed using available bacteria monitoring data to evaluate how the water quality of the MdRH responded to the wet weather runoff during wet weather monitored events. The numbers of recorded exceedance days compared to the numbers of allowable exceedance days were used to determine the required reduction in the number of exceedance days. Additional calculations and modeling were performed to convert the required reduction into percentages, loads, and BMP capacity.

9.1 Bacteria Monitoring Data

Monitoring under the Bacteria TMDL within the Back Basins was performed from 2007 through the present. The available monitoring results (2007-2013) are summarized in Table 31. Station MdRH-1 requires daily sampling; therefore, 17 wet weather exceedance days are allowed per rainfall year. MdRH-2 is sampled twice a week; therefore, five exceedance days are allowed per rainfall year. Weekly sampling is required at the other stations, and the compliance level is three wet weather exceedance days per rainfall year for each station.

Table 31: Historical Bacteria Data Summary (wet days)

	Exceedance Days / Total Days Sampled Each Year						
Station	**2007-2008**	**2008-2009**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**Total**
MdRH-1	23/48	16/46	28/45	33/89	16/43	27/62	143/333
MdRH-2	13/17	6/13	7/15	10/26	6/14	9/17	59/102
MdRH-3	3/9	3/6	3/7	5/15	4/7	5/9	23/53
MdRH-4 Depth	5/9	2/6	1/6	4/15	2/7	1/9	15/52
MdRH-4 Surface	4/9	2/6	2/6	6/15	2/7	4/9	20/52
MdRH-5	4/9	4/6	6/7	11/15	6/7	4/9	25/53
MdRH-6 Depth	4/9	3/6	1/6	6/15	3/7	4/9	21/52
MdRH-6 Surface	6/9	5/6	3/6	10/15	4/7	6/9	25/52
MdRH-7	6/9	5/6	4/6	10/15	4/7	4/9	24/52
MdRH-8 Depth	4/9	2/6	1/6	4/15	1/7	1/9	13/52
MdRH-8 Surface	4/9	2/6	2/6	7/15	1/7	2/9	18/52
MdRH-9 Depth	3/9	2/6	1/6	4/15	1/7	1/9	12/52
MdRH-9 Surface	4/9	3/6	3/6	7/15	2/7	3/9	22/52

9.2 Bacteria Required Load Reduction (Percentage)

The Bacteria TMDL requires that bacteria compliance be demonstrated for rainfall years up to the 90th percentile wet day year, which is considered by the TMDL to be 75 wet days. Monitoring at station MdRH-1 indicates that during the monitoring period used in this analysis, there were 333 wet days (days in which a wet weather sample was collected). This equates to an average 55.5 days per year and is below the 90th percentile value of 75 wet days. To adjust the measured values into data representative of the 90th percentile wet day year, the total number of sampled days at each station was increased by a factor of 1.35 (75 / 55.5 = 1.35), and the number of exceedance days was increased based on the measured percentage of exceedances, but the number of allowable exceedance days remained unchanged. This resulted in a reduction in the percentage of allowable exceedance days (e.g., percentage of allowable exceedance days = (3 per year/(1.35 * total sampled days)) and thus an increase in the required reduction percentage. The results of these data adjustments are shown in Table 32.

The adjusted data results (adjusted to represent the 90th percentile year in terms of wet days) indicate that of the stations sampled weekly, station MdRH-6 Surface requires the greatest reduction in the number of exceedance days in order to meet Bacteria TMDL compliance (22.9 percentage reduction required). Therefore, this station was selected to be the controlling station in the analysis. The adjusted sampling data show that this station may historically be in exceedance approximately 49% of the time for wet weather sample days. In other words, this station may be historically below the exceedance criteria 51% of time, but the TMDL requires this station to be below the exceedance criteria during approximately 74% of wet weather sampling days. To be in compliance, an improvement of approximately 23% of sampling days is needed.

Table 32: Required Bacteria Reduction Summary, Historical Data Adjusted to 90th Percentile Wet Days

Station	Allowable Exceedance Days*	Unadjusted Exceedances/ Sample Days	Adjusted** Exceedance Days	Adjusted** Sampled Days	Allowable Exceedance Days	Adjusted Historical Exceedance Days	Adjusted Reduction Required
MdRH-1	102	143/333	193	450	22.7%	42.9%	20.2%
MdRH-2	30	59/102	80	138	21.8%	59.0%	36.2%
MdRH-3	18	23/53	31	72	25.2%	43.1%	17.9%
MdRH-4 Depth	18	15/52	20	70	25.6%	28.6%	2.9%
MdRH-4 Surface	18	20/52	27	70	25.6%	38.6%	12.9%
MdRH-5	18	25/53	34	72	25.2%	47.2%	22.1%
MdRH-6 Depth	18	21/52	28	70	25.6%	40.0%	14.4%
MdRH-6 Surface	18	25/52	34	70	25.6%	48.6%	22.9%
MdRH-7	18	24/52	32	70	25.6%	45.7%	20.1%
MdRH-8 Depth	18	13/52	18	70	25.6%	25.7%	0.1%
MdRH-8 Surface	18	18/52	24	70	25.6%	34.3%	8.6%
MdRH-9 Depth	18	12/52	16	70	25.6%	22.9%	-2.8%
MdRH-9 Surface	18	22/52	30	70	25.6%	42.9%	17.2%

*Total of all years from 2007/2008 monitoring year through 2012/2013
**Adjusted values based on unadjusted values multiplied by 1.35 (1.35 is based on 75 wet days during 90th percentile year divided by 55.5 wet day per rainfall [average wet days per year during the monitored period of the assessed data])

9.3 Bacteria Required Load Reduction (Runoff Volume)

An analysis of historic rainfall data paired with bacteria monitoring results was performed based on the premise that a correlation between storm size and bacterial exceedances existed, and therefore a distinction between storms that exceeded TMDL criteria and storms that did not exceed TMDL criteria could be established. The analysis focused on determining the "cutoff" value between smaller and larger rainfall events for (1) the historical number of exceedances and (2) the allowable number of exceedances. The difference between these two cutoff values was determined to be the amount of rainfall that currently needs to be captured in order to meet bacteria compliance (i.e., the difference is the amount of rainfall that if captured would result in the cutoff rainfall value for the future historical exceedances being in alignment with the allowable exceedance cutoff rainfall value).

The controlling station and associated available sampling data determined if wet days (considered to be days with 0.1 inch or greater per day and the following 72 hours) or rainfall days (considered to be days with 0.1 inch or greater) would be used in the analysis. Sampling at the controlling station occurred weekly. It is assumed that the historic exceedance days correlate to the rainfall days; therefore rainfall days (0.1 inch or greater) data were used instead of wet days. If Station MdRH-1 had been determined to be the controlling station, wet days would have been presented because Station MdRH-1 sampling frequency is daily. To ensure the most conservative path was taken, an analysis of wet days was performed using MdRH-1 data (not presented), and the analysis results were less controlling than the rainfall day analysis (i.e., required less capture).

To determine the daily rainfall values associated with allowable exceedance days, historical exceedance days, and the difference between the two values, WMMS rain gauge data were first compiled into daily rainfall values, and then the daily rainfall values were rounded to the nearest tenth of an inch and plotted. During the monitoring period, there were a total of 123 rainfall days. By applying the percentage of historical exceedances associated with Station MdRH-6 Surface (controlling station) to the total rainfall days, 59 of 123 rainfall days have bacteria above the TMDL criteria (or 64 rainfall days that were below the criteria). The rainfall cutoff value associated with the 64 rainfall days is 0.29 inch. By applying the adjusted percentage of allowable exceedance days to the total rainfall days, 30 of 123 rainfall days are allowed to be elevated above the bacteria TMDL criteria (or 93 days are required to be below the criteria). The rainfall cutoff value associated with 93 rainfall days was 0.59 inch. Thus, the results indicate that a reduction in volume equivalent to capturing the runoff from 0.3-inch storm event is required to meet compliance at the controlling station. The storm event size distribution and the results of this analysis are presented in graphical form in Figure 26.

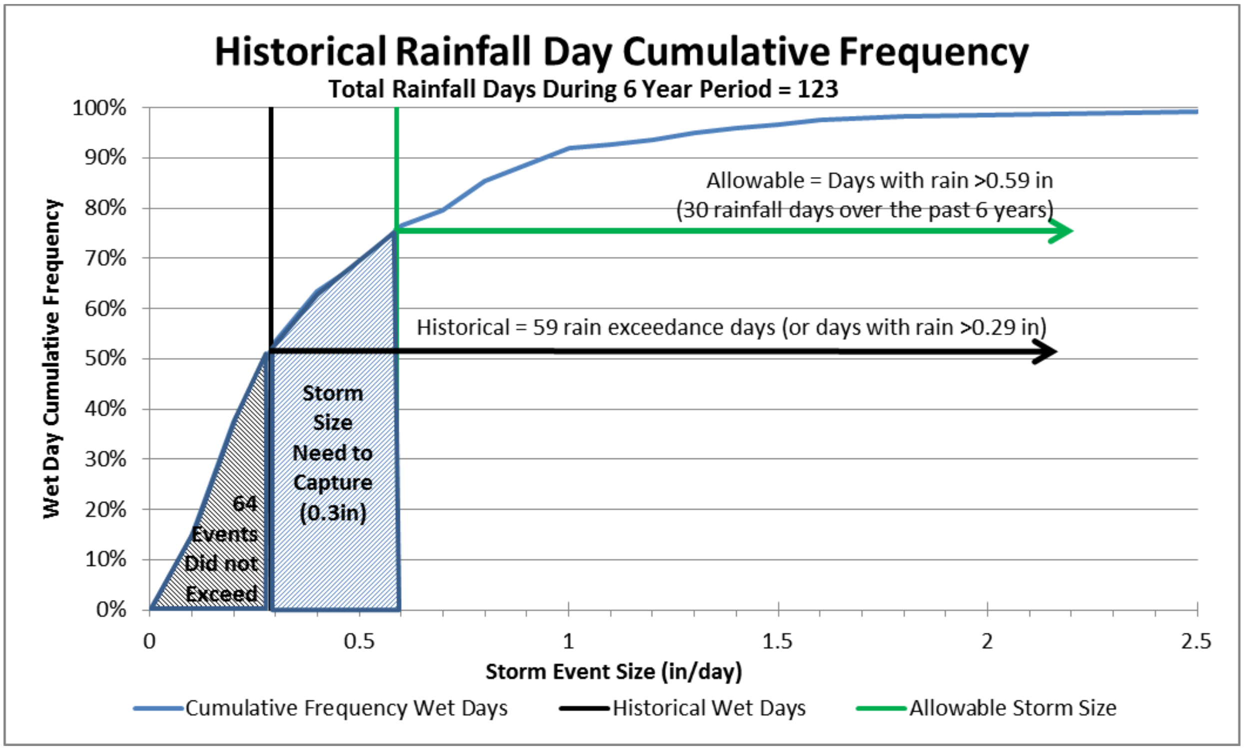

Figure 26: Summary of Rainfall Days and Rainfall Cutoff Value Analysis Results

9.4 Bacteria Required Load Reduction (Bacteria Counts)

The total bacteria load and reduction in bacteria load for BMPs designed to capture the runoff associated with a 0.3-inch storm event were estimated using the prepared CSM. The Back Basin drainage area was modeled using WMMS for the critical year of 1993 (the critical year identified in the TMDL). The WMMS tool output was used as the foundation to prepare the bacteria CSM. The CSM was used to estimate the flow reduction that would be achieved through the implementation of BMPs designed to capture and infiltrate or reuse the storm water runoff associated with 0.3 inch of rainfall. To calculate the load, the applicable volume was used along with the estimated fecal coliform EMC value for this watershed. The results of these calculations are provided in Table 32. The CSM assumed capture-type BMPs with 100% reduction of the loads for the captured volume. However, the treatment BMPs that achieve the same load reductions could be implemented to meet the TMDL compliance (e.g., treatment BMPs with twice the capacity and a 50% effectiveness would theoretically accomplish the load reduction target).

Table 33 Bacteria Loading and Required Reduction

Parameter	Total Modeled	Required Reduction	Percent Reduction
Volume	55,536,480 cf	13,494,920 cf	24%
Fecal Coliform Load	6.26E+14 MPN	1.52E+14 MPN	24%

9.5 Bacteria Required Load Reduction Conclusions

The results of the analysis of the rainfall data paired with monitoring data indicate that the Bacteria TMDL is less of a driver for the implementation of the structural BMPs than the Toxics TMDL. The load reduction associated with meeting the WLA for zinc requires capture and/or treatment of much greater volumes of runoff than that generated by 0.3 inch of rainfall. Therefore, based on the results of this bacteria load reduction analysis, it is assumed that the implementation of controls to meet the requirements of the Toxics TMDL will result in bacteria load reductions sufficient to meet the wet weather requirements of the Bacteria TMDL. This conclusion will be reassessed as part of the overall watershed adaptive management process, which may include evaluation of collective BMP effectiveness data and bacteria monitoring results.

10. WMMS TOOL OUTPUT

The WMMS tool output data for the 85th percentile storm, 24-hour storm event are provided in Table 34 through Table 38 for each of the MdR subwatersheds for the key parameters related to the Toxics TMDL. For the simulation of the critical rainfall year the raw output from the WMMS tool includes 26 parameters and 8,760 time step lines. Therefore, output is only provided for the 85th percentile, 24-hour storm event.

Table 34. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 1A

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.015	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.015	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.015	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	0.531	0.000	11.894	10.670	89.181
10/25/2014 4:00	0.03	0.833	23.032	9.679	8.684	72.579
10/25/2014 5:00	0.03	1.318	18.557	10.819	9.706	81.124
10/25/2014 6:00	0.03	1.635	26.477	10.664	9.567	79.961
10/25/2014 7:00	0.03	1.813	29.179	10.068	9.032	75.492
10/25/2014 8:00	0.03	1.911	11.825	9.573	8.588	71.782
10/25/2014 9:00	0.03	1.965	11.416	9.237	8.287	69.264
10/25/2014 10:00	0.04	1.994	11.142	9.027	8.099	67.690
10/25/2014 11:00	0.04	2.324	9.498	11.619	10.424	87.123
10/25/2014 12:00	0.04	2.510	13.448	12.183	10.930	91.350
10/25/2014 13:00	0.04	2.606	14.824	12.130	10.883	90.957
10/25/2014 14:00	0.05	2.655	15.135	11.976	10.744	89.796
10/25/2014 15:00	0.05	3.010	13.483	14.815	13.291	111.089
10/25/2014 16:00	0.06	3.192	18.034	15.224	13.658	114.157
10/25/2014 17:00	0.08	3.635	17.330	18.304	16.421	137.248
10/25/2014 18:00	0.12	4.553	20.804	25.320	22.715	189.855
10/25/2014 19:00	0.17	6.487	33.082	40.058	35.937	300.364
10/25/2014 20:00	0.04	9.330	67.713	57.260	51.370	429.350
10/25/2014 21:00	0.04	5.601	179.291	25.248	22.651	189.316
10/25/2014 22:00	0.02	4.070	45.432	14.221	12.758	106.634
10/25/2014 23:00	0.03	2.711	26.980	7.623	6.839	57.163
10/26/2014 0:00	0.00	2.389	11.242	7.531	6.756	56.470
10/26/2014 1:00	0.00	1.314	17.488	4.452	3.994	33.379
10/26/2014 2:00	0.00	0.795	9.399	3.190	2.862	23.917
10/26/2014 3:00	0.00	0.523	6.194	2.522	2.262	18.909
10/26/2014 4:00	0.00	0.361	4.667	2.087	1.872	15.648
10/26/2014 5:00	0.00	0.253	3.799	1.766	1.584	13.242
10/26/2014 6:00	0.00	0.196	2.918	1.553	1.393	11.642
10/26/2014 7:00	0.00	0.165	2.348	1.393	1.250	10.445
10/26/2014 8:00	0.00	0.141	2.093	1.242	1.114	9.309
10/26/2014 9:00	0.00	0.120	1.851	1.098	0.985	8.235
10/26/2014 10:00	0.00	0.104	1.624	0.963	0.864	7.224
10/26/2014 11:00	0.00	0.091	1.411	0.837	0.751	6.275
10/26/2014 12:00	0.00	0.080	1.213	0.719	0.645	5.395

Table 35. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 1B

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.043	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.044	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.046	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	1.700	0.000	9.974	9.141	75.907
10/25/2014 4:00	0.03	2.388	23.805	7.242	6.637	55.118
10/25/2014 5:00	0.03	3.566	6.798	8.337	7.641	63.453
10/25/2014 6:00	0.03	4.185	10.500	7.811	7.158	59.444
10/25/2014 7:00	0.03	4.487	11.347	7.270	6.663	55.328
10/25/2014 8:00	0.03	4.639	11.226	6.956	6.375	52.942
10/25/2014 9:00	0.03	4.710	11.093	6.785	6.219	51.641
10/25/2014 10:00	0.04	4.745	10.990	6.699	6.139	50.980
10/25/2014 11:00	0.04	5.610	10.664	9.152	8.387	69.649
10/25/2014 12:00	0.04	6.018	15.613	9.290	8.514	70.703
10/25/2014 13:00	0.04	6.208	16.666	9.122	8.360	69.427
10/25/2014 14:00	0.05	6.294	16.871	8.983	8.233	68.369
10/25/2014 15:00	0.05	7.212	17.180	11.366	10.416	86.500
10/25/2014 16:00	0.06	7.629	23.301	11.476	10.518	87.343
10/25/2014 17:00	0.08	8.716	25.288	13.776	12.625	104.845
10/25/2014 18:00	0.12	11.041	35.512	18.968	17.383	144.355
10/25/2014 19:00	0.17	15.873	61.450	29.630	27.155	225.505
10/25/2014 20:00	0.04	22.825	98.777	42.078	38.563	320.241
10/25/2014 21:00	0.04	12.607	165.077	17.280	15.836	131.509
10/25/2014 22:00	0.02	8.947	65.141	9.806	8.987	74.633
10/25/2014 23:00	0.03	5.741	33.227	5.160	4.729	39.269
10/26/2014 0:00	0.00	5.257	10.261	5.758	5.277	43.820
10/26/2014 1:00	0.00	2.605	15.714	2.767	2.536	21.056
10/26/2014 2:00	0.00	1.447	7.121	1.547	1.418	11.775
10/26/2014 3:00	0.00	0.897	3.567	1.059	0.971	8.063
10/26/2014 4:00	0.00	0.599	2.268	0.791	0.725	6.019
10/26/2014 5:00	0.00	0.438	1.548	0.624	0.572	4.750
10/26/2014 6:00	0.00	0.330	1.183	0.498	0.457	3.792
10/26/2014 7:00	0.00	0.258	0.910	0.402	0.368	3.059
10/26/2014 8:00	0.00	0.212	0.700	0.329	0.301	2.501
10/26/2014 9:00	0.00	0.192	0.518	0.274	0.251	2.088
10/26/2014 10:00	0.00	0.176	0.428	0.227	0.208	1.728
10/26/2014 11:00	0.00	0.163	0.351	0.186	0.171	1.416
10/26/2014 12:00	0.00	0.152	0.285	0.151	0.139	1.151

Table 36. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 2

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.043	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.044	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	0.045	0.000	0.000	0.000	0.000
10/25/2014 3:00	0.02	4.660	10.048	13.373	12.848	125.400
10/25/2014 4:00	0.03	3.892	13.519	4.629	4.448	43.408
10/25/2014 5:00	0.03	5.406	12.655	6.178	5.935	57.930
10/25/2014 6:00	0.03	5.610	13.920	6.039	5.803	56.633
10/25/2014 7:00	0.03	5.638	13.905	6.004	5.768	56.298
10/25/2014 8:00	0.03	5.644	13.888	5.996	5.761	56.225
10/25/2014 9:00	0.03	5.647	13.880	5.993	5.758	56.194
10/25/2014 10:00	0.04	5.649	13.874	5.990	5.755	56.169
10/25/2014 11:00	0.04	7.289	17.731	8.138	7.819	76.309
10/25/2014 12:00	0.04	7.494	18.570	8.033	7.718	75.328
10/25/2014 13:00	0.04	7.521	18.531	8.001	7.687	75.024
10/25/2014 14:00	0.05	7.527	18.512	7.993	7.679	74.949
10/25/2014 15:00	0.05	9.181	22.396	10.123	9.726	94.921
10/25/2014 16:00	0.06	9.383	23.181	10.023	9.630	93.990
10/25/2014 17:00	0.08	11.079	27.049	12.110	11.635	113.556
10/25/2014 18:00	0.12	14.620	35.798	16.259	15.621	152.464
10/25/2014 19:00	0.17	21.687	53.564	24.561	23.597	230.309
10/25/2014 20:00	0.04	30.799	76.463	34.710	33.349	325.480
10/25/2014 21:00	0.04	10.083	43.590	9.976	9.585	93.547
10/25/2014 22:00	0.02	7.879	19.459	7.819	7.512	73.320
10/25/2014 23:00	0.03	4.353	12.094	3.943	3.788	36.973
10/26/2014 0:00	0.00	5.540	12.507	5.989	5.754	56.160
10/26/2014 1:00	0.00	0.930	15.290	2.003	1.925	18.787
10/26/2014 2:00	0.00	0.303	4.499	0.584	0.562	5.480
10/26/2014 3:00	0.00	0.172	1.068	0.143	0.138	1.342
10/26/2014 4:00	0.00	0.138	0.224	0.032	0.030	0.296
10/26/2014 5:00	0.00	0.126	0.046	0.007	0.006	0.062
10/26/2014 6:00	0.00	0.122	0.009	0.001	0.001	0.013
10/26/2014 7:00	0.00	0.119	0.002	0.000	0.000	0.003
10/26/2014 8:00	0.00	0.118	0.000	0.000	0.000	0.001
10/26/2014 9:00	0.00	0.116	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.115	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.114	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.113	0.000	0.000	0.000	0.000

Table 37. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 3

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.012	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.012	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	1.236	14.119	6.027	5.870	23.845
10/25/2014 3:00	0.02	0.828	9.368	3.999	3.895	15.821
10/25/2014 4:00	0.03	1.236	14.120	6.028	5.870	23.845
10/25/2014 5:00	0.03	1.236	14.112	6.024	5.867	23.832
10/25/2014 6:00	0.03	1.237	14.104	6.021	5.864	23.819
10/25/2014 7:00	0.03	1.238	14.096	6.018	5.861	23.806
10/25/2014 8:00	0.03	1.239	14.088	6.014	5.858	23.793
10/25/2014 9:00	0.03	1.239	14.081	6.011	5.854	23.780
10/25/2014 10:00	0.04	1.648	18.825	8.036	7.827	31.791
10/25/2014 11:00	0.04	1.649	18.814	8.031	7.822	31.773
10/25/2014 12:00	0.04	1.650	18.803	8.027	7.818	31.755
10/25/2014 13:00	0.04	1.651	18.792	8.022	7.813	31.737
10/25/2014 14:00	0.05	2.060	23.533	10.046	9.784	39.742
10/25/2014 15:00	0.05	2.061	23.519	10.040	9.779	39.720
10/25/2014 16:00	0.06	2.470	28.256	12.062	11.748	47.719
10/25/2014 17:00	0.08	3.288	37.740	16.111	15.691	63.736
10/25/2014 18:00	0.12	4.922	56.716	24.212	23.581	95.783
10/25/2014 19:00	0.17	6.964	80.461	34.349	33.453	135.885
10/25/2014 20:00	0.04	1.664	18.643	7.959	7.751	31.484
10/25/2014 21:00	0.04	1.665	18.631	7.954	7.746	31.465
10/25/2014 22:00	0.02	0.850	9.127	3.896	3.795	15.414
10/25/2014 23:00	0.03	1.258	13.868	5.920	5.766	23.421
10/26/2014 0:00	0.00	0.035	0.000	0.000	0.000	0.000
10/26/2014 1:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 2:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 3:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 4:00	0.00	0.034	0.000	0.000	0.000	0.000
10/26/2014 5:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 6:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 7:00	0.00	0.033	0.000	0.000	0.000	0.000
10/26/2014 8:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 9:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.032	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.031	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.031	0.000	0.000	0.000	0.000

Table 38. WMMS Key Parameters Output for the 85th Percentile Storm Event – Subwatershed 4

Date Time	Rainfall (in)	Flow (cfs)	TSS (mg/L)	Total Cu (ug/L)	Total Pb (ug/L)	Total Zn (ug/L)
10/25/2014 0:00	0.02	0.130	0.000	0.000	0.000	0.000
10/25/2014 1:00	0.03	0.130	0.000	0.000	0.000	0.000
10/25/2014 2:00	0.03	10.131	20.407	6.712	6.035	73.608
10/25/2014 3:00	0.02	6.796	13.519	4.446	3.998	48.765
10/25/2014 4:00	0.03	10.130	20.408	6.712	6.035	73.611
10/25/2014 5:00	0.03	10.138	20.393	6.707	6.030	73.557
10/25/2014 6:00	0.03	10.145	20.378	6.702	6.026	73.503
10/25/2014 7:00	0.03	10.152	20.363	6.697	6.022	73.451
10/25/2014 8:00	0.03	10.160	20.349	6.693	6.017	73.398
10/25/2014 9:00	0.03	10.167	20.334	6.688	6.013	73.346
10/25/2014 10:00	0.04	13.508	27.208	8.948	8.046	98.139
10/25/2014 11:00	0.04	13.518	27.187	8.942	8.040	98.065
10/25/2014 12:00	0.04	13.529	27.167	8.935	8.034	97.990
10/25/2014 13:00	0.04	13.539	27.146	8.928	8.028	97.917
10/25/2014 14:00	0.05	16.883	34.014	11.187	10.058	122.687
10/25/2014 15:00	0.05	16.896	33.989	11.178	10.051	122.597
10/25/2014 16:00	0.06	20.244	40.849	13.435	12.079	147.341
10/25/2014 17:00	0.08	26.930	54.590	17.954	16.143	196.905
10/25/2014 18:00	0.12	40.296	82.087	26.998	24.274	296.089
10/25/2014 19:00	0.17	56.979	116.508	38.318	34.453	420.245
10/25/2014 20:00	0.04	13.681	26.864	8.835	7.944	96.899
10/25/2014 21:00	0.04	13.692	26.843	8.828	7.938	96.822
10/25/2014 22:00	0.02	7.032	13.067	4.298	3.864	47.132
10/25/2014 23:00	0.03	10.371	19.933	6.556	5.895	71.900
10/26/2014 0:00	0.00	0.374	0.000	0.000	0.000	0.000
10/26/2014 1:00	0.00	0.372	0.000	0.000	0.000	0.000
10/26/2014 2:00	0.00	0.368	0.000	0.000	0.000	0.000
10/26/2014 3:00	0.00	0.365	0.000	0.000	0.000	0.000
10/26/2014 4:00	0.00	0.362	0.000	0.000	0.000	0.000
10/26/2014 5:00	0.00	0.358	0.000	0.000	0.000	0.000
10/26/2014 6:00	0.00	0.355	0.000	0.000	0.000	0.000
10/26/2014 7:00	0.00	0.352	0.000	0.000	0.000	0.000
10/26/2014 8:00	0.00	0.348	0.000	0.000	0.000	0.000
10/26/2014 9:00	0.00	0.345	0.000	0.000	0.000	0.000
10/26/2014 10:00	0.00	0.342	0.000	0.000	0.000	0.000
10/26/2014 11:00	0.00	0.339	0.000	0.000	0.000	0.000
10/26/2014 12:00	0.00	0.336	0.000	0.000	0.000	0.000

11. REFERENCES

Geosyntec and WWE (Geosyntec Consultants, Inc. and Wright Water Engineers, Inc.). 2008. *Overview of Performance by BMP Category and Common Pollutant Type, International Stormwater BMP Database [1999-2008]*, June, 2008.

Geosyntec. 2009. *Large-Scale Cistern Standards, Santa Monica Bay Beaches Bacteria TMDL J1/4 Phase 1 Implementation*, Technical Memorandum. December 2, 2009.

LACDPW (Los Angeles County Department of Public Works). 2004. *Analysis of 85th Percentile 24-hour Rainfall Depth Analysis Within the County of Los Angeles*, February, 2004.

LACDPW. 2006. *Hydrology Manual*, January, 2006.

LARWQCB (Los Angeles Regional Water Quality Control Board). 2014. Guidelines for Conduction Reasonable Assurance Analysis in a Watershed Management Program, Including an Enhanced Watershed Management Program, March 25, 2014.

APPENDIX D

Legal Authority Certifications

COUNTY OF LOS ANGELES
OFFICE OF THE COUNTY COUNSEL
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December 16, 2013

Mr. Samuel Unger, P.E., Executive Officer
California Regional Water Quality Control Board – Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013-2343

Attention: Mr. Ivar Ridgeway

Re: Certification By Legal Counsel For County of Los Angeles' Annual Report

Dear Mr. Unger:

Pursuant to the requirements of Part VI(A)(2)(b) of Order No. R4-2012-0175 (the "Order"), the Office of the County Counsel of the County of Los Angeles makes the following certification in support of the Annual Report of the County of Los Angeles ("County"):

Certification Pursuant To Order Part VI(A)(2)(b)

"*Each Permittee must submit a statement certified by its chief legal counsel that the Permittee has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and this Order.*"

The County has the legal authority within its jurisdiction to implement and enforce each of the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and the Order.

Order Part VI(A)(2)(b)(i)

"*Citation of applicable municipal ordinances or other appropriate legal authorities and their relationship to the requirements of 40 CFR §122.26(d)(2)(i)(A-F) and this Order*"

Citations Of Applicable Ordinances Or Other Legal Authorities

Although many portions of State law, the Charter of the County of Los Angeles and the Los Angeles County Code are potentially applicable to the implementation and enforcement of these requirements, the primary applicable laws and ordinances are as follows:

Los Angeles County Code, Title 12, Chapter 12.80 STORMWATER AND RUNOFF POLLUTION CONTROL, including:

§12.80.010 - §12.80.360 Definitions

§12.80.370 Short title.

§12.80.380 Purpose and intent.

§12.80.390 Applicability of this chapter.

§12.80.400 Standards, guidelines and criteria.

§12.80.410 Illicit discharges prohibited.

§12.80.420 Installation or use of illicit connections prohibited.

§12.80.430 Removal of illicit connection from the storm drain system.

§12.80.440 Littering and other discharge of polluting or damaging substances prohibited.

§12.80.450 Stormwater and runoff pollution mitigation for construction activity.

§12.80.460 Prohibited discharges from industrial or commercial activity.

§12.80.470 Industrial/commercial facility sources required to obtain a NPDES permit.

§12.80.480 Public facility sources required to obtain a NPDES permit.

§12.80.490 Notification of uncontrolled discharges required.

§12.80.500 Good housekeeping provisions.

§12.80.510 Best management practices for construction activity.

§12.80.520 Best management practices for industrial and commercial facilities.

§12.80.530 Installation of structural BMPs.

§12.80.540 BMPs to be consistent with environmental goals.

§12.80.550 Enforcement—Director's powers and duties.

§12.80.560 Identification for inspectors and maintenance personnel.

§12.80.570 Obstructing access to facilities prohibited.

§12.80.580 Inspection to ascertain compliance—Access required.

§12.80.590 Interference with inspector prohibited.

§12.80.600 Notice to correct violations—Director may take action.

§12.80.610 Violation a public nuisance.

§12.80.620 Nuisance abatement—Director to perform work when—Costs.

§12.80.630 Violation—Penalty.

§12.80.635 Administrative fines.

§12.80.640 Penalties not exclusive.

§12.80.650 Conflicts with other code sections.

§12.80.660 Severability.

§12.80.700 Purpose.

§12.80.710 Applicability.

§12.80.720 Registration required.

§12.80.730 Exempt facilities.

§12.80.740 Certificate of inspection—Issuance by the director.

§12.80.750 Certificate of inspection—Suspension or revocation.

§12.80.760 Certificate of inspection—Termination.

§12.80.770 Service fees.

§12.80.780 Fee schedule.

§12.80.790 Credit for overlapping inspection programs.

§12.80.800 Annual review of fees.

Los Angeles County Code, Title 12, Chapter 12.84 LOW IMPACT DEVELOPMENT STANDARDS, including:

§12.84.410 Purpose.

§12.84.420 Definitions.

§12.84.430 Applicability.

§12.84.440 Low Impact Development Standards.

§12.84.445 Hydromodification Control.

§12.84.450 LID Plan Review.

§12.84.460 Additional Requirements.

Los Angeles County Code, Title 22 PLANNING AND ZONING, Part 6 ENFORCEMENT PROCEDURES, including:

§22.60.330 General prohibitions.

§22.60.340 Violations.

§22.60.350 Public nuisance.

§22.60.360 Infractions.

§22.60.370 Injunction.

§22.60.380 Enforcement.

§22.60.390 Zoning enforcement order and noncompliance fee.

Los Angeles County Code, Title 26 BUILDING CODE, including:

§26.103 Violations And Penalties

§26.104 Organization And Enforcement

§26.105 Appeals Boards

§26.106 Permits

§26.107 Fees

§26.108 Inspections

California Government Code §6502

California Government Code §23004

Relationship Of Applicable Ordinances Or Other Legal Authorities To The Requirements of 40 CFR §122.26(d)(2)(i)(A-F) And The Order

Although, depending upon the particular issue, there may be multiple ways in which particular sections of the County's ordinances and State law relate to the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and the Order, the table below indicates the basic relationship with Part VI(A)(2)(a) of the Order:

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
i. Control the contribution of pollutants to its MS4 from storm water discharges associated with industrial and construction activity and control the quality of storm water discharged from industrial and construction sites. This requirement applies both to industrial and construction sites with coverage under an NPDES permit, as well as to those sites that do not have coverage under an NPDES permit.	§12.80.410 [illicit discharge prohibited]; §12.80.450 [construction] §12.80.460 [industrial and commercial] §12.80.470 and .480 [industrial and commercial NPDES requirements] §12.84.440 [LID standards] §12.84.445 [hydromodification control] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§22.60.340 [violations] §22.60.350 [public nuisance] §22.60.360 [infractions] §22.60.370 [injunction] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.103 [violations and penalties] §26.104 [enforcement] §26.106 [permits] §26.108 [inspections]
ii. Prohibit all non-storm water discharges through the MS4 to receiving waters not otherwise authorized or conditionally exempt pursuant to Part III.A.	§12.80.410 [illicit discharge prohibited]
iii. Prohibit and eliminate illicit discharges and illicit connections to the MS4.	§12.80.410 [illicit discharge prohibited]; §12.80.420 [illicit connections prohibited]
iv. Control the discharge of spills, dumping, or disposal of materials other than storm water to its MS4.	§12.80.410 [illicit discharge prohibited]; §12.80.440 [littering and other polluting prohibited]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
v. Require compliance with conditions in Permittee ordinances, permits, contracts or orders (i.e., hold dischargers to its MS4 accountable for their contributions of pollutants and flows).	§12.80.490 [notification of uncontrolled discharge] §12.80.570 [obstructing access to facilities] §12.80.580 [compliance inspection] §12.80.610 [violation a nuisance] §12.620 [nuisance abatement] §12.80.635 [violation penalty] §12.80.640 [penalties not exclusive] §12.84.440 [LID standards] §12.84.445 [hydromodification control] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions] §22.60.340 [violations] §22.60.350 [public nuisance] §22.60.360 [infractions] §22.60.370 [injunction] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.103 [violations and penalties] §26.104 [enforcement] §26.106 [permits] §26.108 [inspections]
vi. Utilize enforcement mechanisms to require compliance with applicable ordinances, permits, contracts, or orders.	Same as item v., above

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
vii. Control the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements among Copermittees.	California Government Code §6502 and §23004
viii. Control of the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements with other owners of the MS4 such as the State of California Department of Transportation.	California Government Code §6502 and §23004
ix. Carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance and noncompliance with applicable municipal ordinances, permits, contracts and orders, and with the provisions of this Order, including the prohibition of non-storm water discharges into the MS4 and receiving waters. This means the Permittee must have authority to enter, monitor, inspect, take measurements, review and copy records, and require regular reports from entities discharging into its MS4.	§12.80.490 [notification of uncontrolled discharge] §12.80.570 [obstructing access to facilities] §12.80.580 [compliance inspection] §12.80.610 [violation a nuisance] §12.80.620 [nuisance abatement] §12.80.635 [violation penalty] §12.80.640 [penalties not exclusive] §22.60.380 [enforcement.] §26.106 [permits] §26.108 [inspections]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
x. Require the use of control measures to prevent or reduce the discharge of pollutants to achieve water quality standards/receiving water limitations.	§12.80.450 [construction mitigation] §12.80.500 [good housekeeping practices] §12.80.510 [construction BMPs] §12.80.520 [industrial/commercial BMPs] §12.84.440 [LID standards] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections]
xi. Require that structural BMPs are properly operated and maintained.	§12.80.530 [installation of structural BMPs] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections]
xii. Require documentation on the operation and maintenance of structural BMPs and their effectiveness in reducing the discharge of pollutants to the MS4.	§12.80.530 [installation of structural BMPs] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections]

Order Part VI(A)(2)(b)(ii)

"*Identification of the local administrative and legal procedures available to mandate compliance with applicable municipal ordinances identified in subsection (i) above and therefore with the conditions of this Order, and a statement as to whether enforcement actions can be completed administratively or whether they must be commenced and completed in the judicial system.*"

The local administrative and legal procedures available to mandate compliance with the above ordinances are specified in those ordinances, particularly in:

§12.80.550 Enforcement—Director's powers and duties.

§12.80.600 Notice to correct violations—Director may take action.

§12.80.610 Violation a public nuisance.

§12.80.620 Nuisance abatement—Director to perform work when—Costs.

§12.80.630 Violation—Penalty.

§12.80.635 Administrative fines.

§12.80.640 Penalties not exclusive.

§12.84.450 LID Plan Review.

§12.84.460 Additional Requirements.

Title 26, §103 Violations And Penalties

Title 26, §104 Organization And Enforcement

Title 26, §105 Appeals Boards

Title 26, §106 Permits

Title 22 PLANNING AND ZONING, Part 6 ENFORCEMENT PROCEDURES, including:

§22.60.330 General prohibitions.

§22.60.340 Violations.

§22.60.350 Public nuisance.

§22.60.360 Infractions.

§22.60.370 Injunction.

§22.60.380 Enforcement.

§22.60.390 Zoning enforcement order and noncompliance fee.

The County attempts to first resolve each enforcement action administratively. However, the above cited ordinances also provide the County with the authority to pursue such actions in the judicial system as necessary.

Very truly yours,

JOHN F. KRATTLI
County Counsel

By [signature]
JUDITH A. FRIES
Principal Deputy County Counsel
Public Works Division

JAF:jyj

COUNTY OF LOS ANGELES
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JOHN F. KRATTLI
County Counsel

December 16, 2013

Mr. Samuel Unger, P.E., Executive Officer
California Regional Water Quality Control Board – Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013-2343

Attention: Mr. Ivar Ridgeway

Re: Certification By Legal Counsel For Los Angeles County Flood Control District's Annual Report

Dear Mr. Unger:

Pursuant to the requirements of Part VI(A)(2)(b) of Order No. R4-2012-0175 (the "Order"), the Office of the County Counsel of the County of Los Angeles makes the following certification in support of the Annual Report of the Los Angeles County Flood Control District ("LACFCD"):

Certification Pursuant To Order Part VI(A)(2)(b)

"*Each Permittee must submit a statement certified by its chief legal counsel that the Permittee has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and this Order.*"

LACFCD has the legal authority within its jurisdiction to implement and enforce each of the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and the Order.

Order Part VI(A)(2)(b)(i)

"*Citation of applicable municipal ordinances or other appropriate legal authorities and their relationship to the requirements of 40 CFR §122.26(d)(2)(i)(A-F) and this Order*"

Citations Of Applicable Ordinances Or Other Legal Authorities

Although many portions of State law, the Charter of the County of Los Angeles, the Los Angeles County Code and LACFCD's Flood Control District Code ("Code") are potentially applicable to the implementation and enforcement of these requirements, the primary applicable laws and ordinances are as follows:

Los Angeles County Code, Title 12, Chapter 12.80 STORMWATER AND RUNOFF POLLUTION CONTROL, including:

§12.80.010 - §12.80.360 Definitions

§12.80.370 Short title.

§12.80.380 Purpose and intent.

§12.80.390 Applicability of this chapter.

§12.80.400 Standards, guidelines and criteria.

§12.80.410 Illicit discharges prohibited.

§12.80.420 Installation or use of illicit connections prohibited.

§12.80.430 Removal of illicit connection from the storm drain system.

§12.80.440 Littering and other discharge of polluting or damaging substances prohibited.

§12.80.450 Stormwater and runoff pollution mitigation for construction activity.

§12.80.460 Prohibited discharges from industrial or commercial activity.

§12.80.470 Industrial/commercial facility sources required to obtain a NPDES permit.

§12.80.480 Public facility sources required to obtain a NPDES permit.

§12.80.490 Notification of uncontrolled discharges required.

§12.80.500 Good housekeeping provisions.

§12.80.510 Best management practices for construction activity.

§12.80.520 Best management practices for industrial and commercial facilities.

§12.80.530 Installation of structural BMPs.

§12.80.540 BMPs to be consistent with environmental goals.

§12.80.550 Enforcement—Director's powers and duties.

§12.80.560 Identification for inspectors and maintenance personnel.

§12.80.570 Obstructing access to facilities prohibited.

§12.80.580 Inspection to ascertain compliance—Access required.

§12.80.590 Interference with inspector prohibited.

§12.80.600 Notice to correct violations—Director may take action.

§12.80.610 Violation a public nuisance.

§12.80.620 Nuisance abatement—Director to perform work when—Costs.

§12.80.630 Violation—Penalty.

§12.80.635 Administrative fines.

§12.80.640 Penalties not exclusive.

§12.80.650 Conflicts with other code sections.

§12.80.660 Severability.

§12.80.700 Purpose.

§12.80.710 Applicability.

§12.80.720 Registration required.

§12.80.730 Exempt facilities.

§12.80.740 Certificate of inspection—Issuance by the director.

§12.80.750 Certificate of inspection—Suspension or revocation.

§12.80.760 Certificate of inspection—Termination.

§12.80.770 Service fees.

§12.80.780 Fee schedule.

§12.80.790 Credit for overlapping inspection programs.

§12.80.800 Annual review of fees.

Los Angeles County Code, Title 12, Chapter 12.84 LOW IMPACT DEVELOPMENT STANDARDS, including:

§12.84.410 Purpose.

§12.84.420 Definitions.

§12.84.430 Applicability.

§12.84.440 Low Impact Development Standards.

§12.84.445 Hydromodification Control.

§12.84.450 LID Plan Review.

§12.84.460 Additional Requirements.

Los Angeles County Code, Title 22 PLANNING AND ZONING, Part 6 ENFORCEMENT PROCEDURES, including:

§22.60.330 General prohibitions.

§22.60.340 Violations.

§22.60.350 Public nuisance.

§22.60.360 Infractions.

§22.60.370 Injunction.

§22.60.380 Enforcement.

§22.60.390 Zoning enforcement order and noncompliance fee.

Los Angeles County Code, Title 26 BUILDING CODE, including:

§26.103 Violations And Penalties

§26.104 Organization And Enforcement

§26.105 Appeals Boards

§26.106 Permits

§26.107 Fees

§26.108 Inspections

LACFCD Code Chapter 21 - STORMWATER AND RUNOFF POLLUTION CONTROL including:

§21.01 Purpose and Intent

§21.03 Definitions

§21.05 Standards, Guidelines, and Criteria

§21.07 Prohibited Discharges

§21.09 Installation or Use of Illicit Connections Prohibited

§21.11 Littering Prohibited

§21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity

§21.15 Notification of Uncontrolled Discharges Required

§21.17 Requirement to Monitor and Analyze

§21.19 Conflicts With Other Code Sections

§21.21 Severability

§21.23 Violation a Public Nuisance

California Government Code §6502

California Government Code §23004

California Water Code §8100 *et. seq.*

Relationship Of Applicable Ordinances Or Other Legal Authorities To The Requirements of 40 CFR §122.26(d)(2)(i)(A-F) And The Order

Although, depending upon the particular issue, there may be multiple ways in which particular sections of the County of Los Angeles' ordinances, LACFCD's ordinances, and statutes relate to the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and the Order, the table below indicates the basic relationship with Part VI(A)(2)(a) of the Order:

Order Part VI(A)(2)(a) Items	**Primary Applicable Ordinance/Statute**
i. Control the contribution of pollutants to its MS4 from storm water discharges associated with industrial and construction activity and control the quality of storm water discharged from industrial and construction sites. This requirement applies both to industrial and construction sites with coverage under an NPDES permit, as well as to those sites that do not have coverage under an NPDES permit.	Los Angeles County Code: §12.80.410 [illicit discharge prohibited]; §12.80.450 [construction] §12.80.460 [industrial and commercial] §12.80.470 and .480 [industrial and commercial NPDES requirements] §12.84.440 [LID standards] §12.84.445 [hydromodification control] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions] §22.60.340 [violations] §22.60.350 [public nuisance] §22.60.360 [infractions] §22.60.370 [injunction] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.103 [violations and penalties]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§26.104 [enforcement] §26.106 [permits] §26.108 [inspections] LACFCD Code: §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze §21.23 Violation a Public Nuisance
ii. Prohibit all non-storm water discharges through the MS4 to receiving waters not otherwise authorized or conditionally exempt pursuant to Part III.A.	Los Angeles County Code: §12.80.410 [illicit discharge prohibited] LACFCD Code: §21.07 Prohibited Discharges
iii. Prohibit and eliminate illicit discharges and illicit connections to the MS4.	Los Angeles County Code: §12.80.410 [illicit discharge prohibited]; §12.80.420 [illicit connections prohibited] LACFCD Code: §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.23 Violation a Public Nuisance

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
iv. Control the discharge of spills, dumping, or disposal of materials other than storm water to its MS4.	Los Angeles County Code: §12.80.410 [illicit discharge prohibited]; §12.80.440 [littering and other polluting prohibited] LACFCD Code: §19.07 Interference With or Placing Obstructions, Refuse, Contaminating Substances, or Invasive Species in Facilities Prohibited §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze §21.23 Violation a Public Nuisance
v. Require compliance with conditions in Permittee ordinances, permits, contracts or orders (i.e., hold dischargers to its MS4 accountable for their contributions of pollutants and flows).	Los Angeles County Code: §12.80.490 [notification of uncontrolled discharge] §12.80.570 [obstructing access to facilities] §12.80.580 [compliance inspection] §12.80.610 [violation a nuisance] §12.620 [nuisance abatement] §12.80.635 [violation penalty]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§12.80.640 [penalties not exclusive] §12.84.440 [LID standards] §12.84.445 [hydromodification control] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions] §22.60.340 [violations] §22.60.350 [public nuisance] §22.60.360 [infractions] §22.60.370 [injunction] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.103 [violations and penalties] §26.104 [enforcement] §26.106 [permits] §26.108 [inspections] LACFCD Code: §19.11 Violation a Public Nuisance §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§21.19 Conflicts With Other Code Sections §21.23 Violation a Public Nuisance
vi. Utilize enforcement mechanisms to require compliance with applicable ordinances, permits, contracts, or orders.	Same as item v., above
vii. Control the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements among Copermittees.	California Government Code §6502 California Government Code §23004
viii. Control of the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements with other owners of the MS4 such as the State of California Department of Transportation.	California Government Code §6502 California Government Code §23004
ix. Carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance and noncompliance with applicable municipal ordinances, permits, contracts and orders, and with the provisions of this Order, including the prohibition of non-storm water discharges into the MS4 and receiving waters. This means the Permittee must have authority to enter, monitor, inspect, take measurements, review and copy records, and require regular reports from entities discharging into its MS4.	Los Angeles County Code: §12.80.490 [notification of uncontrolled discharge] §12.80.570 [obstructing access to facilities] §12.80.580 [compliance inspection] §12.80.610 [violation a nuisance] §12.80.620 [nuisance abatement] §12.80.635 [violation penalty] §12.80.640 [penalties not exclusive] §22.60.380 [enforcement.] §26.106 [permits] §26.108 [inspections]

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	LACFCD Code: §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze §21.23 Violation a Public Nuisance
x. Require the use of control measures to prevent or reduce the discharge of pollutants to achieve water quality standards/receiving water limitations.	Los Angeles County Code: §12.80.450 [construction mitigation] §12.80.500 [good housekeeping practices] §12.80.510 [construction BMPs] §12.80.520 [industrial/commercial BMPs] §12.84.440 [LID standards] §12.84.450 [LID Plan Review] §22.60.330 [general prohibitions] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections] LACFCD Code: §21.05 Standards, Guidelines, and Criteria

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze §21.23 Violation a Public Nuisance
xi. Require that structural BMPs are properly operated and maintained.	Los Angeles County Code: §12.80.530 [installation of structural BMPs] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections] LACFCD Code: §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze

Order Part VI(A)(2)(a) Items	Primary Applicable Ordinance/Statute
	§21.23 Violation a Public Nuisance
xii. Require documentation on the operation and maintenance of structural BMPs and their effectiveness in reducing the discharge of pollutants to the MS4.	Los Angeles County Code: §12.80.530 [installation of structural BMPs] §22.60.380 [enforcement.] §22.60.390 [zoning enforcement order] §26.106 [permits] §26.108 [inspections] LACFCD Code: §21.05 Standards, Guidelines, and Criteria §21.07 Prohibited Discharges §21.09 Installation or Use of Illicit Connections Prohibited §21.11 Littering Prohibited §21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity §21.15 Notification of Uncontrolled Discharges Required §21.17 Requirement to Monitor and Analyze §21.23 Violation a Public Nuisance

<u>Order Part VI(A)(2)(b)(ii)</u>

"*Identification of the local administrative and legal procedures available to mandate compliance with applicable municipal ordinances identified in subsection (i) above and therefore with the conditions of this Order, and a statement as to whether enforcement actions can be completed administratively or whether they must be commenced and completed in the judicial system.*"

The local administrative and legal procedures available to mandate compliance with the above ordinances are specified in those ordinances, particularly in:

Los Angeles County Code:

§12.80.550 Enforcement—Director's powers and duties.

§12.80.600 Notice to correct violations—Director may take action.

§12.80.610 Violation a public nuisance.

§12.80.620 Nuisance abatement—Director to perform work when—Costs.

§12.80.630 Violation—Penalty.

§12.80.635 Administrative fines.

§12.80.640 Penalties not exclusive.

§12.84.450 LID Plan Review.

§12.84.460 Additional Requirements.

Title 26, §103 Violations And Penalties

Title 26, §104 Organization And Enforcement

Title 26, §105 Appeals Boards

Title 26, §106 Permits

§22.60.330 General prohibitions.

§22.60.340 Violations.

§22.60.350 Public nuisance.

§22.60.360 Infractions.

§22.60.370 Injunction.

§22.60.380 Enforcement.

§22.60.390 Zoning enforcement order and noncompliance fee.

LACFCD Code:

§21.05 Standards, Guidelines, and Criteria

§21.07 Prohibited Discharges

§21.09 Installation or Use of Illicit Connections Prohibited

§21.11 Littering Prohibited

§21.13 Evidence of Compliance With Permit Requirements for Industrial or Commercial Activity

§21.15 Notification of Uncontrolled Discharges Required

§21.17 Requirement to Monitor and Analyze

§21.23 Violation a Public Nuisance

LACFCD attempts to first resolve each enforcement action administratively. However, the above cited ordinances also provide LACFCD with the authority to pursue such actions in the judicial system as necessary.

Very truly yours,

JOHN F. KRATTLI
County Counsel

By [signature]
JUDITH A. FRIES
Principal Deputy County Counsel
Public Works Division

JAF:jyj

CITY OF LOS ANGELES

CALIFORNIA

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January 22, 2015

Mr. Sam Unger, Executive Officer
Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Attention Mr. Ivar Ridgeway

Dear Mr. Unger:

CERTIFICATION BY LEGAL COUNSEL FOR THE CITY OF LOS ANGELES CONFIRMING LEGAL AUTHORITY TO IMPLEMENT THE PROVISIONS OF THE MUNICIPAL STORMWATER PERMIT

I write pursuant to Part VI(A)(2)(b) of Order No. R4-2012-0175,otherwise known as the Municipal Separate Stormwater Sewer System (MS4) Permit (the "Order"). Part VI(A)(2)(b) of the Permit provides:

> *"Each Permittee must submit a statement certified by its chief legal counsel that the Permittee has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d) (2) (i) (AF) and this Order."*

The Office of the City Attorney of the City of Los Angeles (City), serving as its legal counsel, certifies that the City has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and of the Order. This correspondence addresses all legal authority requirements as listed in the Order. Subsequently, annual certification by our office will be included in the Stormwater Annual Report as required by the Order.

Order Part VI(A)(2)(b)(i) - "Citation of applicable municipal ordinances or other appropriate legal authorities and their relationship to the requirements of 40 CFR §122.26(d) (2) (i) (A-F) and this Order"

Below is a list of applicable Los Angeles Municipal Code (LAMC) provisions that provide the requisite legal authorities:

LAMC 64.70 General Provisions.
LAMC 64.70.01 Definitions and Abbreviations.
LAMC 64.70.02 Pollutant Discharge Control.
LAMC 64.70.03 Elimination of Illicit Discharges and Illicit Connections.
LAMC 64.70.05 Authority to Inspect.
LAMC 64.70.06 Authority to Arrest and Issue Citations.
LAMC 64.70.07 Enforcement.
LAMC 64.70.08 Remedies Not Exclusive.
LAMC 64.70.09 Liability for Costs of Correction Arising from Unlawful Discharge.
LAMC 64.70.10 Disposition of Money Collected.
LAMC 64.70.11 Stormwater and Urban Runoff Pollution Education.
LAMC 64.70.12 Construction and Application.
LAMC 64.70.13 Severability.
LAMC 64.72 Stormwater Pollution Control Measures for Development Planning and Construction Activities.
LAMC 64.72.01 Authority of the Board of Public Works.
LAMC 64.72.02 Funds Collected from Waiver.
LAMC 64.72.03 Supplemental Provisions.
LAMC 64.72.04 Authority to Inspect and Enforce Stormwater Pollution Control Measures.
LAMC 64.72.05 LID Plan Check Fees.

In addition, statewide regulations provide further legal authorities with respect to intergovernmental authorities, specifically:

California Government Code §6502
California Government Code §23004

Relationship of Applicable Ordinances and Other Legal Authorities to the Requirements of 40CFR §122.26(d)(2)(i)(a-F) and the Order

The table below indicates the basic relationship between the "Legal Authority" requirements listed in Section VI(A)(2)(b) of the Order and the existing legal statutes that provide this legal authority.

Legal Authority Required by Permit	City/State Legal Provisions
VI.A.2.i. Control the contribution of pollutants to its MS4 from storm water discharges associated with industrial and construction activity and control the quality of storm water discharged from industrial and construction sites. This requirement applies both to industrial and construction sites with coverage under an NPDES permit, as well as to those sites that do not have coverage under an NPDES permit.	LAMC 64.70.02.B LAMC 64.70.02.C.1.a LAMC 64.70.02.D LAMC 64.70.03.A
ii. Prohibit all non-storm water discharges through the MS4 to receiving waters not otherwise authorized or conditionally exempt pursuant to Part III.A	LAMC 64.70.03.A
iii. Prohibit and eliminate illicit discharges and illicit connections to the MS4	LAMC 64.70.03.A LAMC 64.70.03.B
iv. Control the discharge of spills, dumping, or disposal of materials other than storm water to its MS4	LAMC 64.70.03.A
v. Require compliance with conditions in Permittee ordinances, permits, contracts or orders (i.e., hold dischargers to its MS4 accountable for their contributions of pollutants and flows)	LAMC 64.70.03.A LAMC 64.70.07
vi. Utilize enforcement mechanisms to require compliance with applicable ordinances, permits, contracts, or orders	LAMC 64.70.05.B.4 LAMC 64.70.05.B.6
vii. Control the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements among Co-permittees	California Government Code §6502 California Government Code §23004
viii. Control of the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements with other owners of the MS4 such as the State of California Department of Transportation	California Government Code §6502 California Government Code §23004

ix. Carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance and noncompliance with applicable municipal ordinances, permits, contracts and orders, and with the provisions of this Order, including the prohibition of non-storm water discharges into the MS4 and receiving waters. This means the Permittee must have authority to enter, monitor, inspect, take measurements, review and copy records, and require regular reports from entities discharging into its MS4	LAMC 64.70.05.A LAMC 64.70.05.B LAMC 64.72.04.B
x. Require the use of control measures to prevent or reduce the discharge of pollutants to achieve water quality standards/receiving water limitations	LAMC 64.70.02.D
xi. Require that structural BMPs are properly operated and maintained	LAMC 64.70.02.D
xii. Require documentation on the operation and maintenance of structural BMPs and their effectiveness in reducing the discharge of pollutants to the MS4	LAMC 64.70.05.B.3
VI.A.b.ii. Identification of the local administrative and legal procedures available to mandate compliance with applicable municipal ordinances identified in subsection (i) above and therefore with the conditions of this Order, and a statement as to whether enforcement actions can be completed administratively or whether they must be commenced and completed in the judicial system.	The local administrative and legal procedures available to mandate compliance with the above LAMC provisions are specified in the provisions themselves with key enforcement provisions being LAMC 64.70.06 and LAMC 64.70.07

The City is in the process of updating the LAMC with respect to its stormwater regulations. These changes will be reported with the 2014-2015 annual report.

Very truly yours,

JOHN CARVALHO, Deputy City Attorney
City's Attorney Office

WPDCR9163

OFFICE OF THE CITY ATTORNEY

CITY OF CULVER CITY

(310) 253-5660

FAX (310) 253-5664

9770 CULVER BOULEVARD, CULVER CITY, CALIFORNIA 90232-0507

CAROL A. SCHWAB

City Attorney

Mr. Sam Unger, Executive Officer
Los Angeles Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Attention Mr. Ivar Ridgeway

Dear Mr. Unger:

CERTIFICATION BY LEGAL COUNSEL FOR THE CITY OF CULVER CITY CONFIRMING LEGAL AUTHORITY TO IMPLEMENT THE PROVISIONS OF THE MUNICIPAL STORMWATER PERMIT

I write pursuant to Part VI(A)(2)(b) of Order No. R4-2012-0175, otherwise known as the Municipal Separate Stormwater Sewer System (MS4) Permit (the "Order"). Part VI(A)(2)(b) of the Permit provides:

> *"Each Permittee must submit a statement certified by its chief legal counsel that the Permittee has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and this Order."*

The Office of the City Attorney of the City of Culver City (City), serving as its legal counsel, certifies that the City has the legal authority within its jurisdiction to implement and enforce the requirements contained in 40 CFR §122.26(d)(2)(i)(A-F) and the Order. This correspondence addresses all legal authority requirements as listed in the Order. Subsequently, annual certification by our office will be included in the Stormwater Annual Report as required by the Order.

Order Part VI (A)(2)(b)(i) – "Citation of applicable municipal ordinances or other appropriate legal authorities and their relationship to the requirements of 40 CFR §122.26(d)(2)(i)(A-F) and this Order"

Below is a list of applicable Culver City Municipal Code (CCMC) provisions that provide the requisite legal authorities:

5.05.005 Title

5.05.010 Findings

5.05.015 Purpose and intent

5.05.020 Definitions

5.05.025 Prohibited activities

5.05.030 Requirements for existing properties; good housekeeping provisions

5.05.035 Requirements for industrial/commercial and construction activities

5.05.040 Standard Urban Stormwater Mitigation Plan (SUSMP) requirements for new development and redevelopment projects

5.05.045 Enforcement

5.05.050 Fees

In addition, statewide regulations provide further legal authority with respect to intergovernmental authorities, specifically:

California Government Code §6502
California Government Code §23004

Relationship of Applicable Ordinances and Other Legal Authorities to the Requirements of 40 CFR §122.26(d)(2)(i)(A-F) and the Order.

The table below indicates the basic relationship between the "Legal Authority" requirements listed in Section VI(A)(2)(b) of the Order and the existing ordinances and statutes that provide this legal authority.

Legal Authority Required by Permit	City/State Legal Provisions
Part VI(A)(2)(i) Control the contribution of pollutants to its MS4 from storm water discharges associated with industrial and construction activity and control the quality of storm water discharged from industrial and construction sites. This requirement applies both to industrial and construction sites with coverage under a NPDES permit, as well as to those sites that do not have coverage under a NPDES permit.	5.05.035 5.05.025(D) 5.05.040
Part VI(A)(2)(ii) Prohibit all non-storm water discharges through the MS4 to receiving waters not otherwise authorized or conditionally exempt pursuant to Part III.A.	5.05.025 (A)(1)
Part VI(A)(2)(iii)	5.05.025 (A)(1)

Prohibit and eliminate illicit discharges and illicit connections to the MS4.	
Part VI(A)(2)(iv) Control the discharge of spills, dumping, or disposal of materials other than storm water to its MS4.	5.05.025 (A)(1)
Part VI(A)(2)(v) Require compliance with conditions in Permittee ordinances, permits, contracts or orders (i.e., hold dischargers to its MS4 accountable for their contributions of pollutants and flows).	5.05.025 (F) 5.05.045
Part VI(A)(2)(vi) Utilize enforcement mechanisms to require compliance with applicable ordinances, permits, contracts, or orders.	5.05.045
Part VI(A)(2)(vii) Control the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements among Co-permittees.	CA Government Code §6502 CA Government Code §23004
Part VI(A)(2)(viii) Control of the contribution of pollutants from one portion of the MS4 through interagency agreements with other owners of the MS4 such as the State of California Department of Transportation.	CA Government Code §6502 CA Government Code §23004
Part VI(A)(2)(ix) Carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance and non-compliance with applicable municipal ordinances, permits, contracts and orders, and with the provisions of this Order, including the prohibition of non-storm water discharges into the MS4 and receiving waters. This means the Permittee must have authority to enter, monitor, inspect, take measurements, review and copy records, and require regular reports from entities discharging into its MS4.	5.05.045 (C)
Part VI(A)(2)(x) Require the use of control measures to prevent or reduce the discharge of pollutants to achieve water quality standards/receiving water limitations.	5.05.040
Part VI(A)(2)(xi) Require that structural BMPs are properly operated and maintained.	5.05.040 (G) & (H)

Part VI(A)(2)(xii) Require documentation on the operation and maintenance of structural BMPs and their effectiveness in reducing the discharge of pollutants to the MS4.	5.05.040 (G) & (H)
Part VI(A)(b)(ii) Identification of the local administrative and legal procedures available to mandate compliance with applicable municipal ordinances identified in subsection (i) above and therefore with the conditions of this Order, and a statement as to whether enforcement actions can be completed administratively or whether they must be commenced and completed in the judicial system.	5.05.045 (E) Enforcement actions can be completed administratively

If needed, please contact Kaden Young at (310) 253-6445 for further information.

Thank you,

Roland Miranda
Deputy City Attorney

APPENDIX E

Geotechnical Investigation Report

Geotechnical Investigation Report
Infiltration Study
Marina Del Rey Watershed BMP Design
Los Angeles, California

Weston Solutions, Inc.
5817 Dryden Place, Suite 101
Carlsbad, CA 92008

February 25, 2015
GDC Project No. LA-1225

Weston Solutions, Inc.
5817 Dryden Place, Suite 101
Carlsbad, CA 92008

February 25, 2015
Project No. LA-1225

Attention: Ms. Andrea Crumpacker
Southern California Resource Director

Subject: Geotechnical Investigation Report
Infiltration Study
Marina Del Rey Watershed BMP Design
Los Angeles, California

Dear Ms. Crumpacker,

Group Delta Consultants, Inc. (GDC) is pleased to submit our Geotechnical Investigation Report for the Infiltration Study conducted for the Marina Del Rey Watershed BMP Design.

We appreciate the opportunity to provide geotechnical services for this project. If you have any questions pertaining to this report, or if we can be of further service, please do not hesitate to contact us.

Sincerely,
Group Delta Consultants

Thomas D. Swantko, GE #813
Principal Geotechnical Engineer

Justin Spring, EIT
Staff Engineer

Distribution: (4) Addressee

370 Amapola Avenue, Suite 212, Torrance, CA 90501 TEL: (310) 320-5100
Anaheim – Irvine – Ontario – Sacramento – San Diego – Torrance – Victorville
www.GroupDelta.com

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Infiltration Study
Marina Del Rey Watershed BMP Design
Los Angeles, California

1.0 PROJECT DESCRIPTION

This report presents the results of a field infiltration testing program conducted at various sites within the Marina Del Rey Watershed to assist in evaluating the Best Management Practices (BMP) design for infiltration of rain runoff. The general location of the project is shown on the Vicinity Map, Figure 1. A site plan showing the street locations where borings/field testing was performed is presented on Figure 1A. The individual boring and test locations are also indicate in Figures 2 through 9.

2.0 SCOPE OF WORK

Our scope of work included:

- Drilling a total of 11 borings ranging in depth from 6 to 25 feet.
- Performing 8 infiltration tests in temporary wells installed to depths ranging in depth from 2.5 to 15 feet.
- Performing laboratory testing on representative samples of the soils encountered to assist in classification of the soils.
- A falling head permeability test was performed in each test well, after saturating the adjacent soils.
- Performing analysis of the field test data and calculation of soil infiltration rates.
- Preparation of this report.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Field Exploration Program

The field program included drilling a total of 11 borings, using hollow stem auger equipment. Falling head permeability tests were performed in 8 of the borings, established as temporary wells. The locations and depths for the borings/wells were provide to us by Weston Solutions. Locations are shown in Figure 1A and also in Figures 2 through 9.

The borings were advanced to depths ranging from 6 to 25 feet. Borings B-5 through B-7 are located in what is referred to as Green Streets Area 1, which includes locations in Penmar Avenue near Venice Boulevard, Walgrove Avenue and Carlton Way. Borings B-1 through B-4 are located in Green Streets Area 2, which includes locations in McKinley Avenue, Clement Avenue, Frey

Avenue and Boone Avenue. Borings B-8 through B-10 are located in the Costco parking lot. Two borings were drilled at location #6, to evaluate the infiltration rate at depths of 6 to 10 feet and also at 12 to 15 feet.

The borings were performed under the observation of our staff engineer, who maintained a detailed log of each boring and assisted in obtaining soil samples. Boring logs are provided in Appendix A. Details regarding installation of the wells and conducting the infiltration tests are provided in Sections 3.2 and 5.1, respectively.

3.2 Installation of Test Wells

Temporary test wells were installed at depth of 2.5 to 17 feet in Borings B-3, B-4, B-5, B-6A, B-6B, B-7, B-9 and B-10. The wells consisted of 2.25-inch outside diameter PVC pipe. The bottom 2 to 5 feet of the pipe was slotted in the zone to be tested. The bottom end of the pipe was capped and set on a 1.5-foot layer of bentonite chips. In the slotted portion of the pipe gravel was used as backfill outside of the pipe. The gravel backfill was sealed just above the slotted portion of the pipe with bentonite chips, followed by native soil backfill to surface.

Before performing the infiltration tests, each well was filled with water to saturate the surrounding soils within the test zone (Los Angeles County GS200.1). After completion of the field test, the test wells were abandoned. The entire length of the casing was removed, and the hole was backfilled with bentonite. The top 3 feet was backfilled with soil, and the hole capped with quickset concrete or asphalt cold patch.

3.3 Laboratory Testing

Representative samples of the soils encountered in the borings were obtained and returned to our laboratory for further visual examination and laboratory testing. Laboratory tests were performed to assist in classifying the soils and included the percent passing #200 sieve, to evaluate the fines content of the samples. Discussion of the laboratory test results is provided in Section 4.2. Test results are shown on the boring logs

4.0 SITE CONDITIONS

4.1 Surface Conditions

Borings B-1 through B-7 are located in city streets. The pavement in the streets typically consisted of 5 to 8 inches of concrete over 3 to 6 inches of aggregate base, or 4 to 5 inches of asphalt over 5 to 6 inches of base. Borings B-8 through B-10 are located in the parking lot of Costco, located on the northeast corner of W. Washington Boulevard and Walnut Avenue. At test locations, the parking lot was found to have a pavement consisting of 5 inches of asphalt over 4 inches of base.

4.2 Subsurface Conditions

Detailed logs of the borings are provided in Appendix A. The subsurface conditions encountered In Green Streets 1 Area (B-5, B-6A, B-6B and B-7), Green Streets Area 2 (B-1 through B-4) and in the Costco parking lot (B-8 through B-10) are summarized in the following table. Two distinct soil layers were encountered in most borings, as indicated in the table.

Location	Boring	Total Depth(ft)	Layer 1		Layer 2	
			Depth (ft)	Soil - % Fines	Depth (ft)	Soil - % Fines
Green Streets 2	B-1	6.5	1 – 6.5	Clayey Sand – 41%	--	--
	B-2	10	1 - 6	Clayey Sand	6 - 10	Sand – 12 to 44%
	B-3	7	1 - 4	Sand – 24%	4 - 7	Clay - 70%
	B-4	11	1 - 5	Sandy Clay - 61%	5 - 11	Clayey Sand
Green Streets 1	B-5	10	1 - 5	Clay – 79%	5 – 10	Sand – 18%
	B-6A	10	1 – 10	Clay – 95%	--	--
	B-6B	15	1 – 12	Clay – 87%	12 - 15	Sand
	B-7	22	1 – 8	Clay – 67 to 74%	8 – 22	Sand – 10%
Costco	B-8	25	1 – 9	Clayey Silt	9 - 25	Sand
	B-9	17	1 – 12	Clay	12 – 17	Sand – 22%
	B-10	17	1 – 12	Clay	12- 17	Sand – 44%

In Green Streets Area 1, the borings generally encountered clayey sand to sandy clay, which laboratory tests showed had 41 to 70 % fines (silt and clay content). B-3 found silty sand to a depth of about 4 feet, with 24% fines, and B-2 encountered silty to clayey sand at a depth of 6 to 10 feet, which had 12 to 44% fines.

In Green Streets Area 2 the borings found clay extending to a depth of 5 to 12 feet. The clay had 67 to 95% fines. Sand was encountered in B-5 at a depth of 5 to 10 feet, Boring B-6B between 12 and 15 feet, and B-7 between 8 and 22 feet. The sand had 10 to 44% fines.

At the Costco site, the borings found clay soils extending to a depth of 9 to a 12 that was underlain with sand to the maximum depts. Explored, which ranged from 17 to 25 feet. It is noted that similar conditions were also encountered in the extensive borings performed at the site by Kleinfelder (Kleinfelder, 1998) during their investigation for the Costco development.

4.3 Ground Water

Ground water was encountered in five of the borings at the time of drilling. The groundwater depths are summarized in the table below. In Area 1 and at Costco, the ground water was found at a depth of about 21 feet below the existing grade. In Area 2 the ground water was encountered at a depth of about 5.5 feet to 10 feet. It is noted that during the Kleinfelder investigation for Costco, ground water was found at depths generally ranging from about 15 to 20 feet. The highest historic ground water level within the general area of the project is at a depth of 5 to 10 feet reported (CDMG, 1998). However, there is a potential for perched water to occur anywhere in the project area, where the water "perches" on top of a clay layer.

Table 1: Summary of Groundwater Depth

Project Area	Boring	Location	Groundwater Depth (feet bgs)
Area 2	B-1	McKinley Ave. and Harbor St.	5.5
Area 2	B-2	Clement Ave. and Harbor St.	9
Area 2	B-4	Boone Ave. and Harbor St.	10
Area 1	B-7	Carlton Way and Penmar Ave.	21
Costco	B-8	Costco Parking Lot	21

5.0 DISCUSSION

5.1 Infiltration Test Results

Following saturation, falling head permeability tests were conducted in each test well in general accordance with ASTM 5912-96 and Los Angeles County GS200.1. The well casing was filled with water and then the level of water in the well was recorded at 20 to 30 second intervals.

For calculation of the permeability, the following formula derived by Jarvis (1953) as recommended in the Ground Water Manual (US Bureau of Reclamation) was used:

$$K = (r_1)^2 / (2A\,\Delta t) \{[(\sinh^{-1}(A/r_e))/2] \ln[(2H_1-A)/(2H_2-A)] - \ln[(2H_1 H_2-A H_2)/(2 H_1 H_2-A H_1)]\}$$

Where:

- K = average permeability of test section: m/sec, ft/sec
- A = length of the test section: m, ft (2 or 5 feet)
- r_1 = inside radius of drop pipe: m, ft (0.167 feet)
- r_e = effective radius of test section: m, ft (0.334 feet)
- Δt = time intervals t_1-t_0 , t_2-t_1, seconds
- $\sinh^{-1}$ = inverse hyperbolic sine
- ln = natural logarithm
- H = length of the water column from bottom of the test interval to water surface in the stand pipe, meters (feet) H_0, H_1, H_2 lengths at time of measurement t_0 , t_1, and t_2 etc.

The calculated results are summarized in Table 2, and are discussed in the following Section. Calculations are provided in Appendix B.

Table 2: Summary of Infiltration Tests

Boring	Project Area	Zone Evaluated (feet below grade)	Field Permeability (cm/sec)	Permeability Rate (in/hr)	Material
B-1	Area 2	--	--	--	Used for Ground Water
B-2		--	--	--	Used for Ground Water
B-3		4-6	4.4 E-05	0.06	Lean Clay
B-4		0.5-2.5	2.6 E-05	0.04	Sandy Lean Clay
B-5	Area 1	6-10	4.5 E-04	0.65	Silty Sand with Gravel
B-6A		6-10	3.2 E-06	0.005	Lean Clay with Sand
B-6B		12-15	7.1 E-04	1.0	Poorly Graded Sand with Silt
B-7		8-12	5.5 E-04	0.78	Poorly Graded Sand with Silt and Gravel
B-8	Costco	--	--	--	Used for Ground Water
B-9		12-17	4.6 E-03	6.5	Silty Sand
B-10		12-17	1.2 E-03	1.7	Silty Sand

5.2 Discussion of Results

The following summarizes the findings of the field testing and are provided for the purpose of assessing the feasibility of this project and performing design analysis:

1. The calculated infiltration rates are summarized in Table 1 and range from 0.005 to 0.06 inches per hour for clay layers and 0.65 to 6.5 inches per hour for sand layers. Calculated field permeability ranged from 3.2×10^{-6} to 1.2×10^{-3} cm/sec. The calculated permeability rates are consistent with the permeability of the clay, poorly graded sand, silty sand, and gravelly sand layers encountered in the borings (Holtz et al, 1981).

2. It should be cautioned that the soil permeability and infiltration rate can decrease with time, if fines are carried into the soil by the infiltrating water.

3. We recommend that infiltration structures should be kept at least 30 feet away from buildings.

6.0 LIMITATIONS

The conclusions and recommendations contained in this report are professional opinions intended for the use of Weston Solutions for the proposed infiltration project. The recommendations should not be extrapolated to areas not covered by this report, or used for other facilities without the review and approval of GDC. If this report, or portions of this report, is provided to contractors, or included in specifications, it should be understood that they are provided for information only.

Our investigation and evaluations were performed in accordance with generally accepted local and state standards using that degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

7.0 REFERENCES

California Department of Conservation, Division of Mines and Geology, Seismic Hazard Evaluation of The Venice 7.5 Minute Quadrangle, Los Angeles County, California, OFR 98-27, 1998.

California Department of Water Resources, Bulletin 104, Planned Utilization of the Groundwater Basins of the Coastal Plain of Los Angeles County, Appendix A, Groundwater Geology; June 1961.

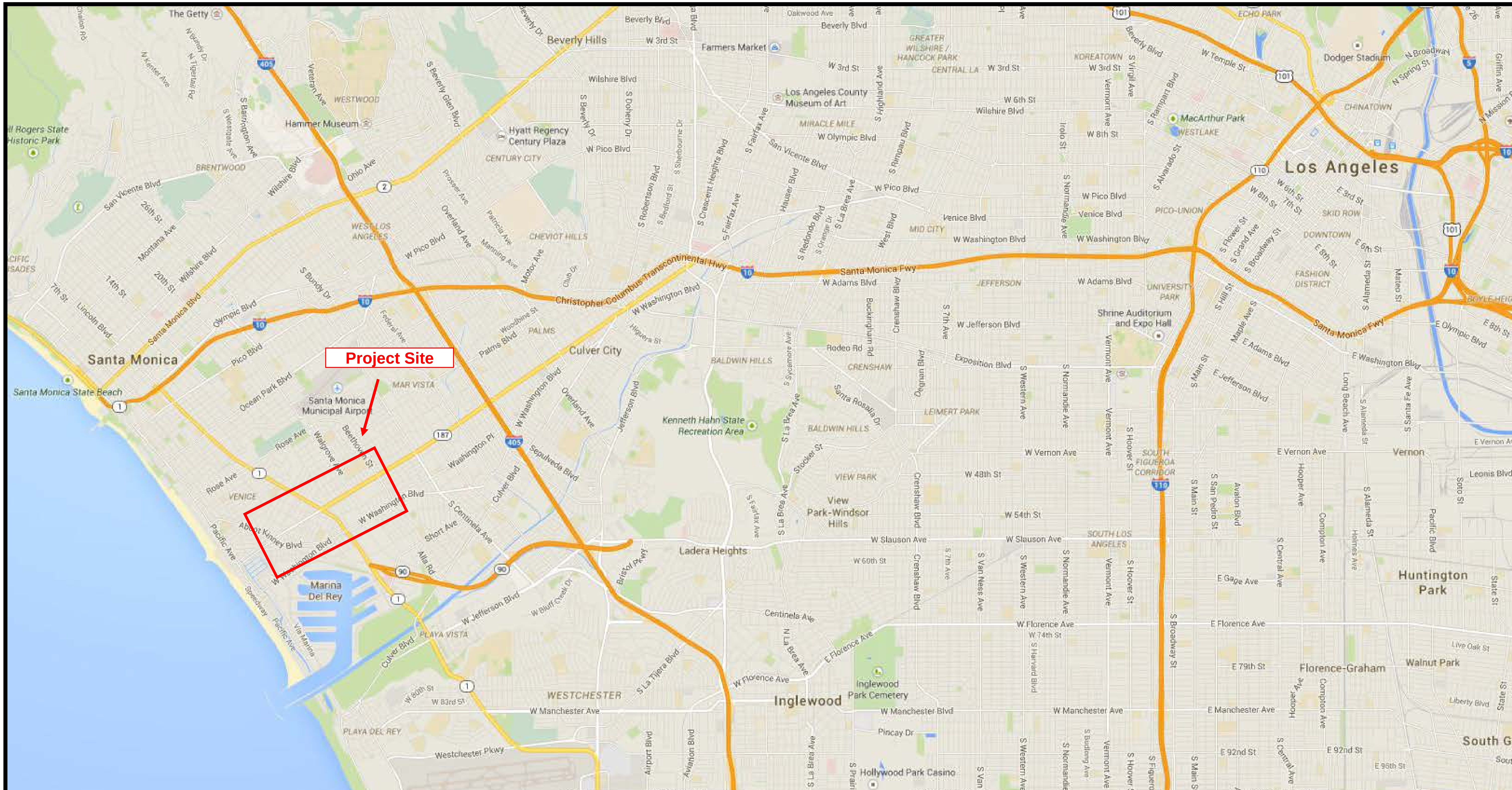
Holtz, Robert D., Kovacs, William D., An introduction to Geotechnical Engineering, Figure 7.6, pp. 210-211, 1983.

Kleinfelder, Supplemental Geotechnical Investigation, Proposed Costco Wholesale Plaza (Tract 52282), 13401-13499 Washington Boulevard, Culver City, California, dated November 17, 1998.

Los Angeles County, Administrative Manual, Department of Public Works, Geotechnical and Materials Engineering division, Guidelines for Design, Investigation and Reporting, Low Impact Development Stormwater Infiltration, GS200.1, dated June 30, 2014.

US Department of Army, Air Force and Navy, 1983, Dewatering and Groundwater Control.

FIGURES



Reference: Google Maps

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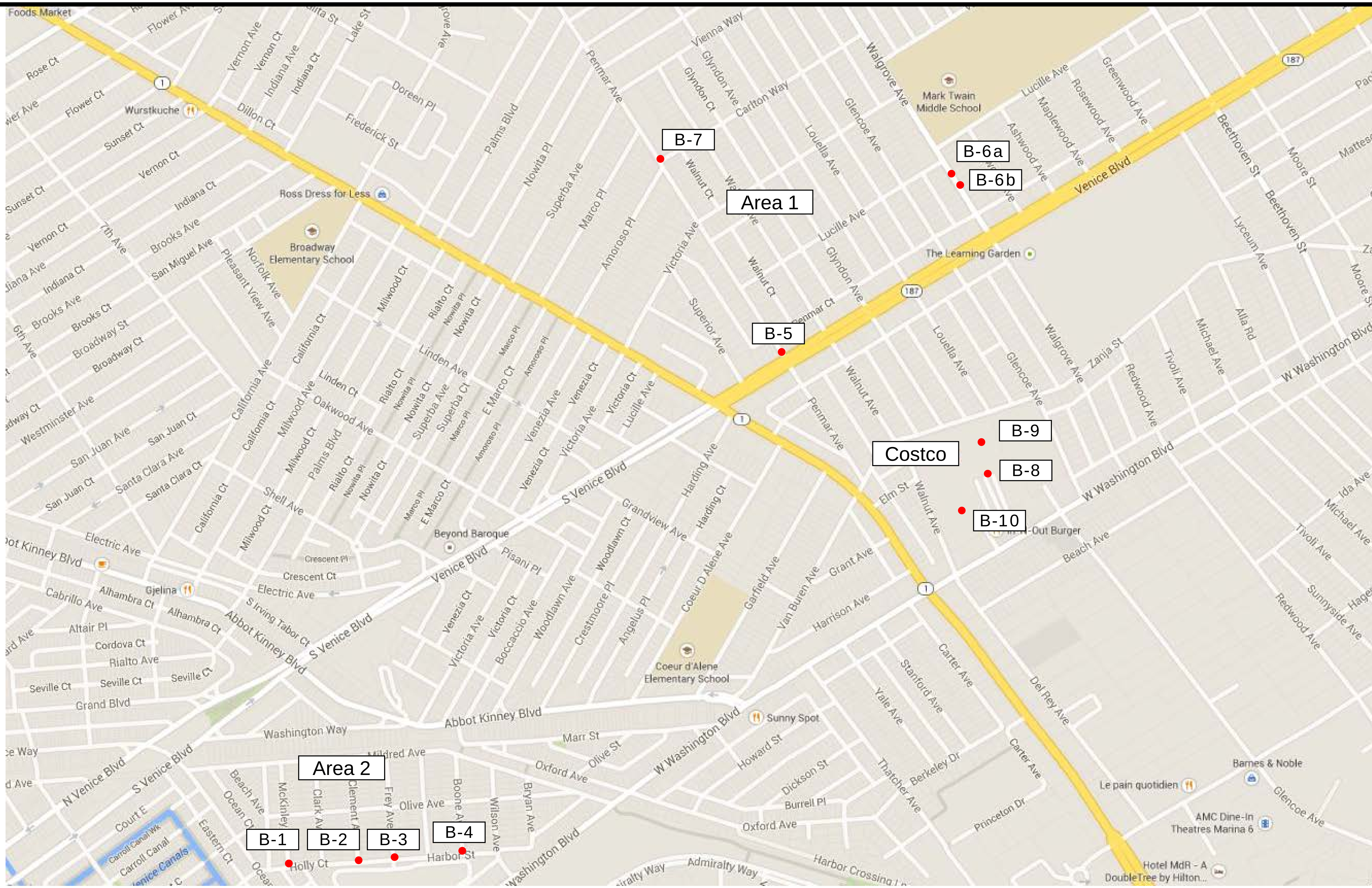
GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	**Vicinity Map**	PROJECT NUMBER: LA-1225
	Weston Solutions – BMP Infiltration	FIGURE NUMBER: 1



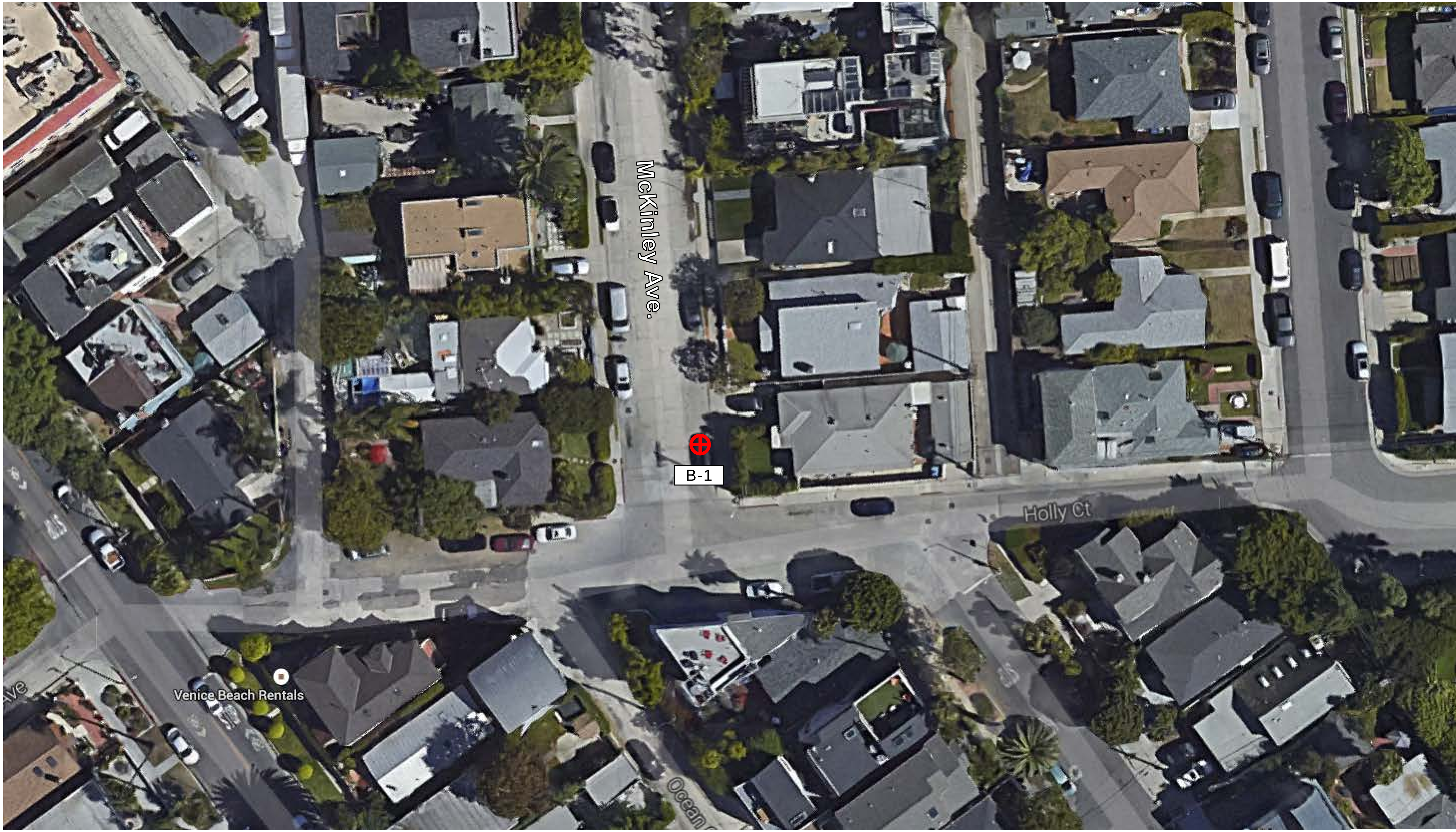
Reference: Google Maps

Legend

- Boring Location

N

GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Ampola Ave. Suite 212 Torrance, CA 90501	**Vicinity Map**	PROJECT NUMBER: **LA-1225**
		Weston Solutions – BMP Infiltration	FIGURE NUMBER: **1A**



Reference: Google Maps

Legend

⊕ Boring Location

N ↑

GROUP DELTA

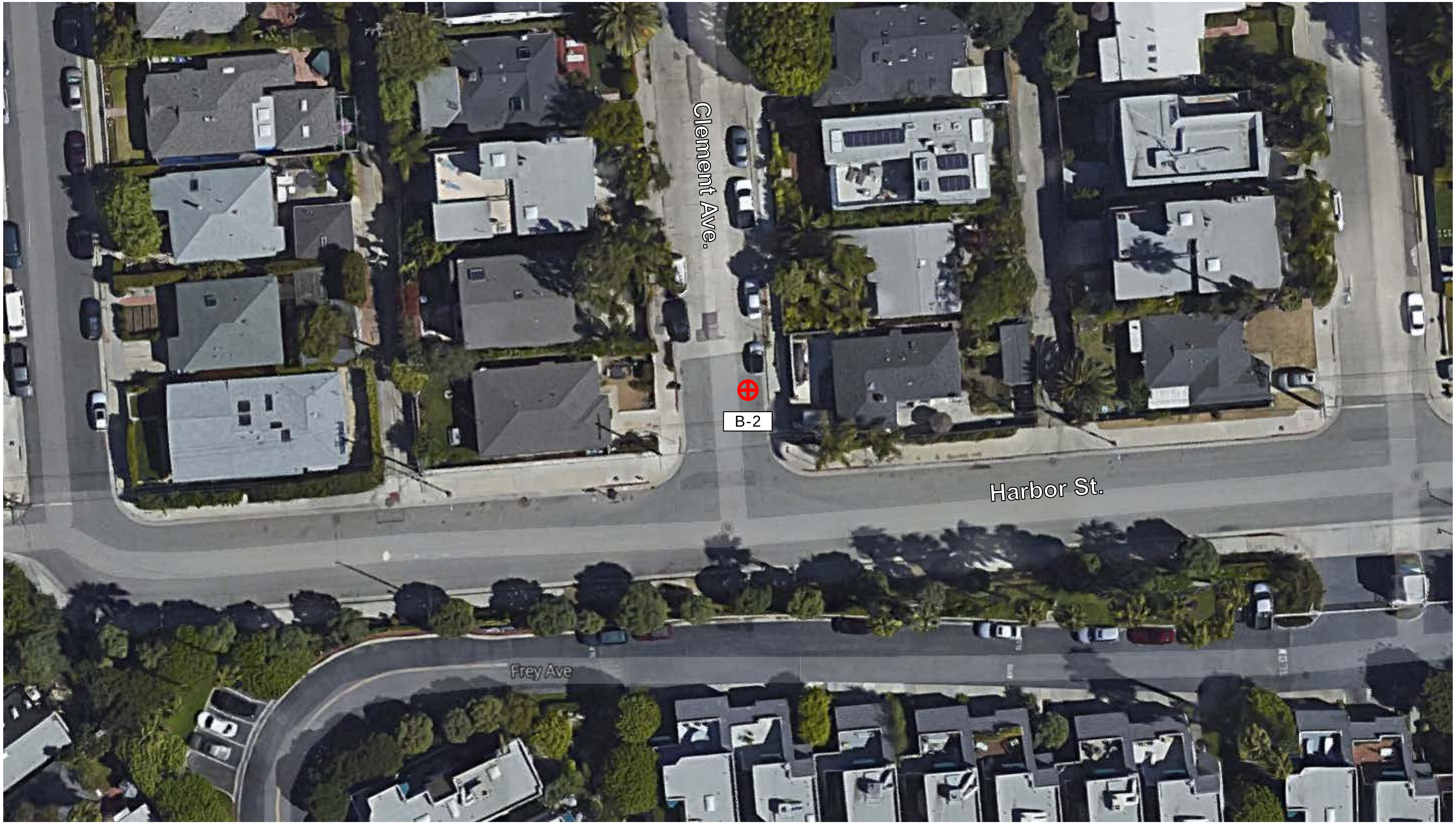
GROUP DELTA CONSULTANTS, INC
370 Amapola Ave.
Suite 212
Torrance, CA 90501

McKinley Ave. and Harbor St.

Weston Solutions – BMP Infiltration

PROJECT NUMBER: LA-1225

FIGURE NUMBER: 2



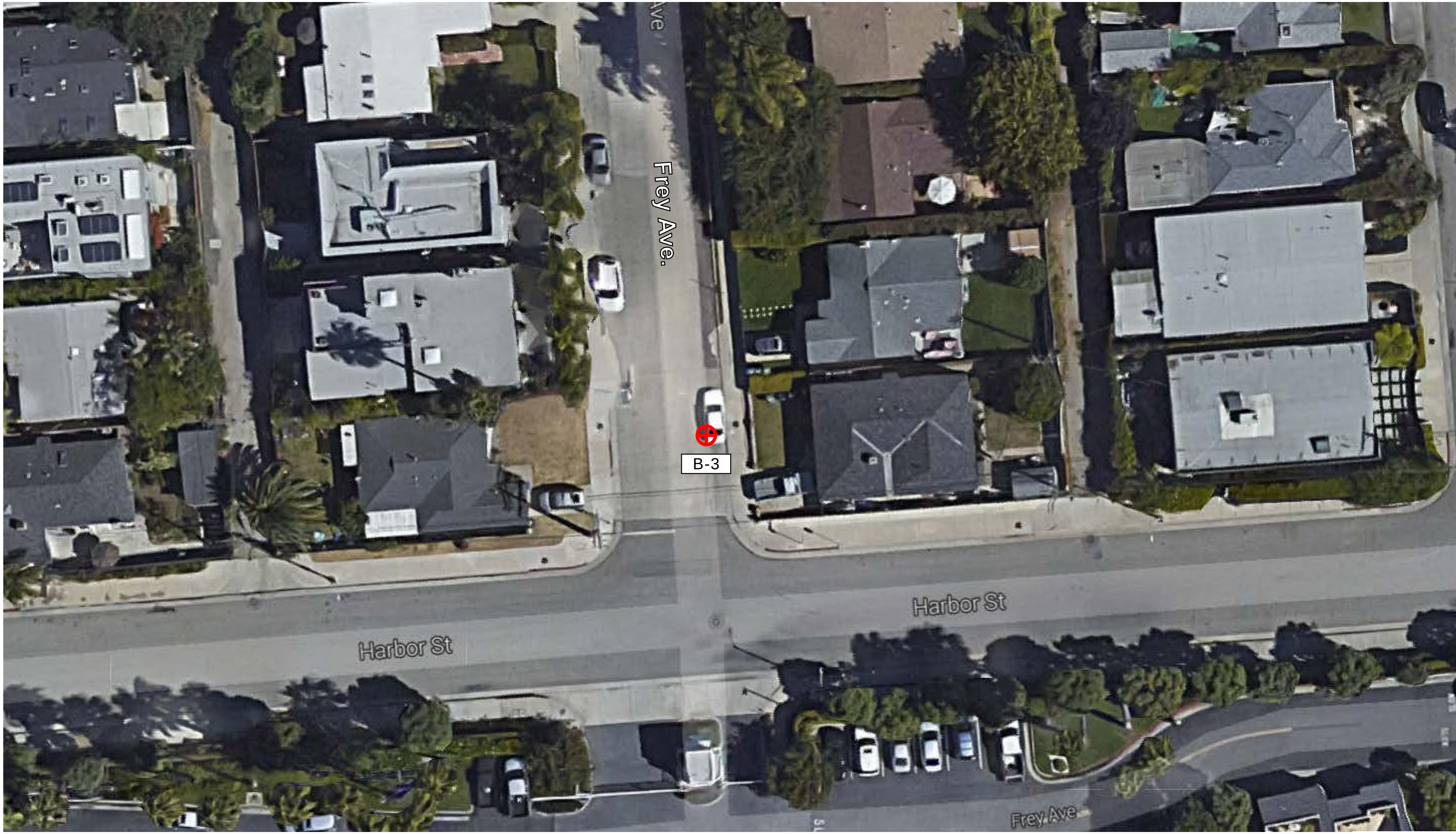
Reference: Google Maps

Legend

⊕ Boring Location

N

GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	**Clement Ave. and Harbor St.**	PROJECT NUMBER: LA-1225
		Weston Solutions – BMP Infiltration	FIGURE NUMBER: 3



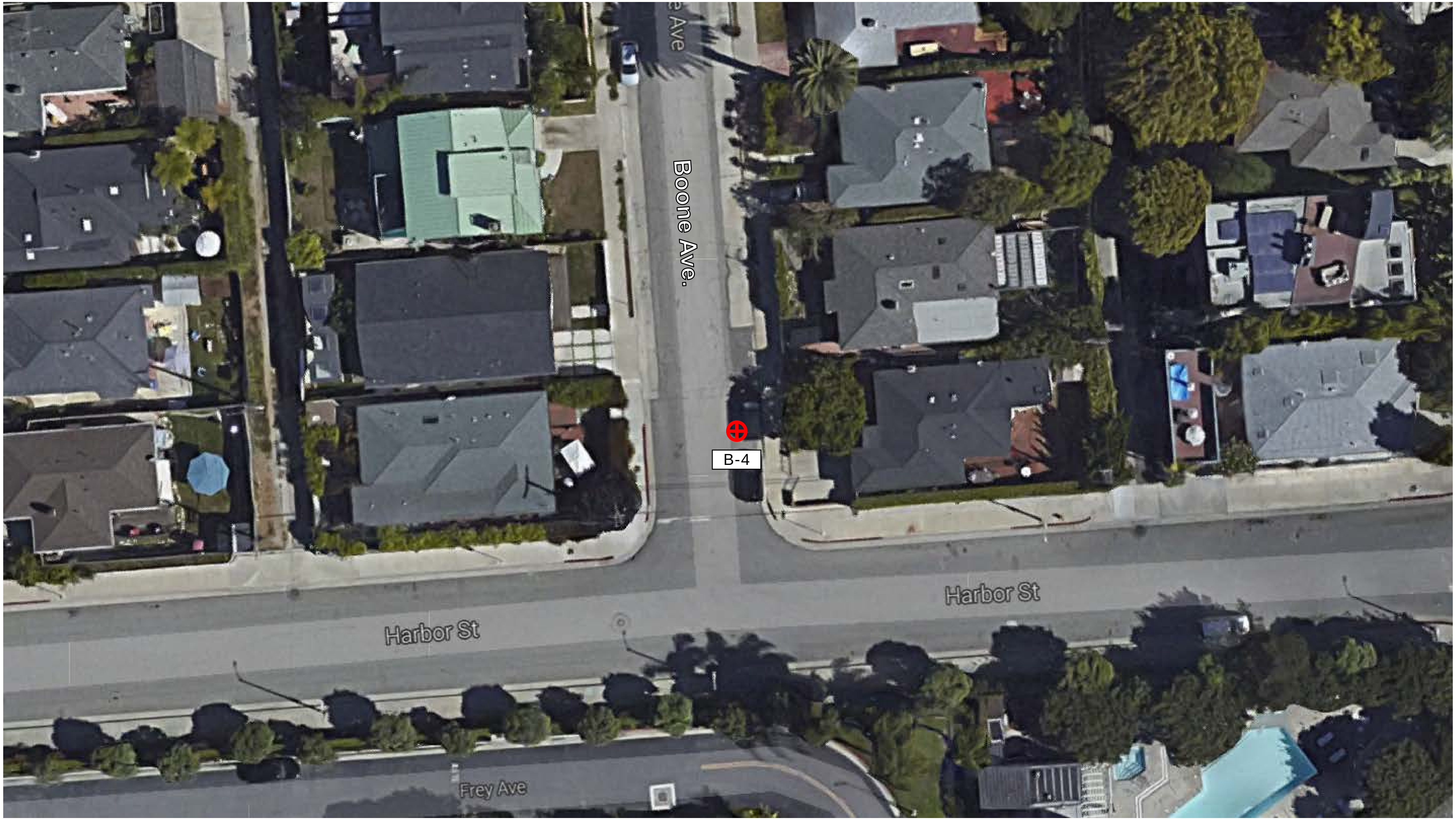
Reference: Google Maps

Legend

⊕ Boring Location

N

GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	**Frey Ave. and Harbor St.**	PROJECT NUMBER: LA-1225
	Weston Solutions – BMP Infiltration	FIGURE NUMBER: 4



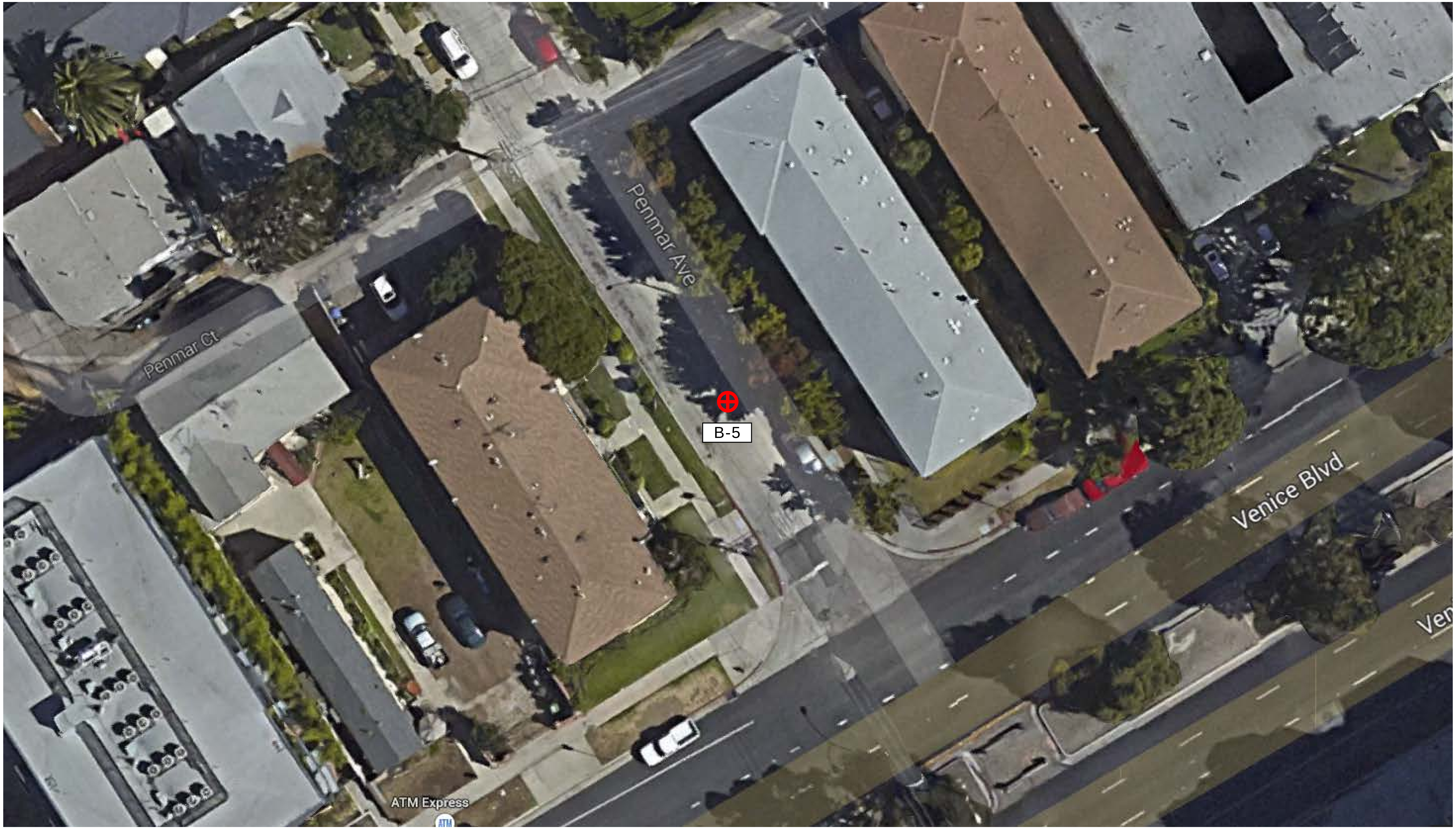
Reference: Google Maps

Legend

⊕ Boring Location

N ↑

GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	**Boone Ave. and Harbor St.**	PROJECT NUMBER: **LA-1225**
		Weston Solutions – BMP Infiltration	FIGURE NUMBER: **5**



Reference: Google Maps

Legend

⊕ Boring Location

N ↑

GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	**Penmar Ave. and Venice Blvd.**	PROJECT NUMBER: LA-1225
		Weston Solutions – BMP Infiltration	FIGURE NUMBER: 6

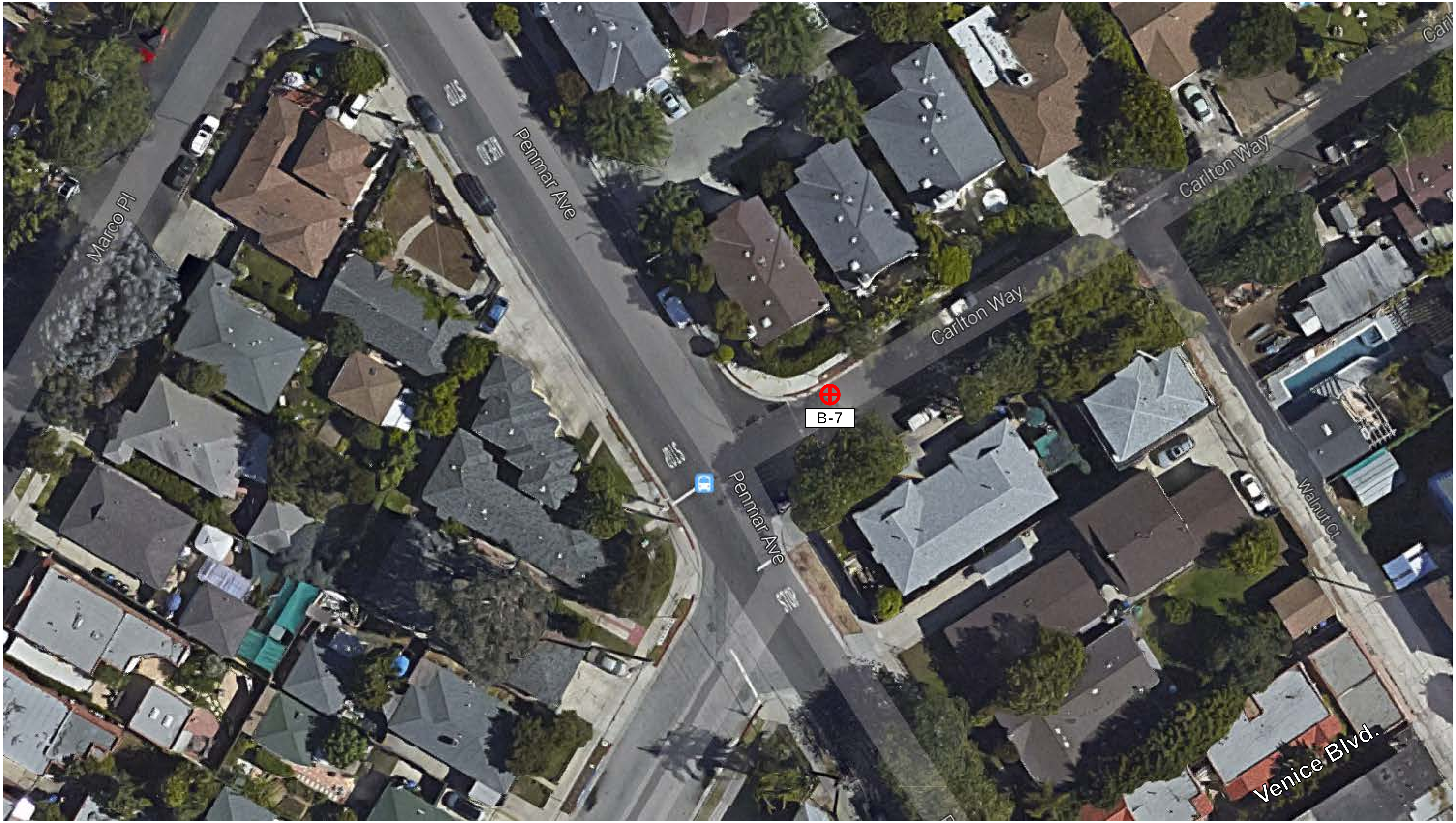
Reference: Google Maps

Legend

⊕ Boring Location

N

GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	Walgrove Ave. and Venice Blvd.	PROJECT NUMBER: LA-1225
	Weston Solutions – BMP Infiltration	FIGURE NUMBER: 7



Reference: Google Maps

Legend

⊕ Boring Location

N ↑

GROUP DELTA

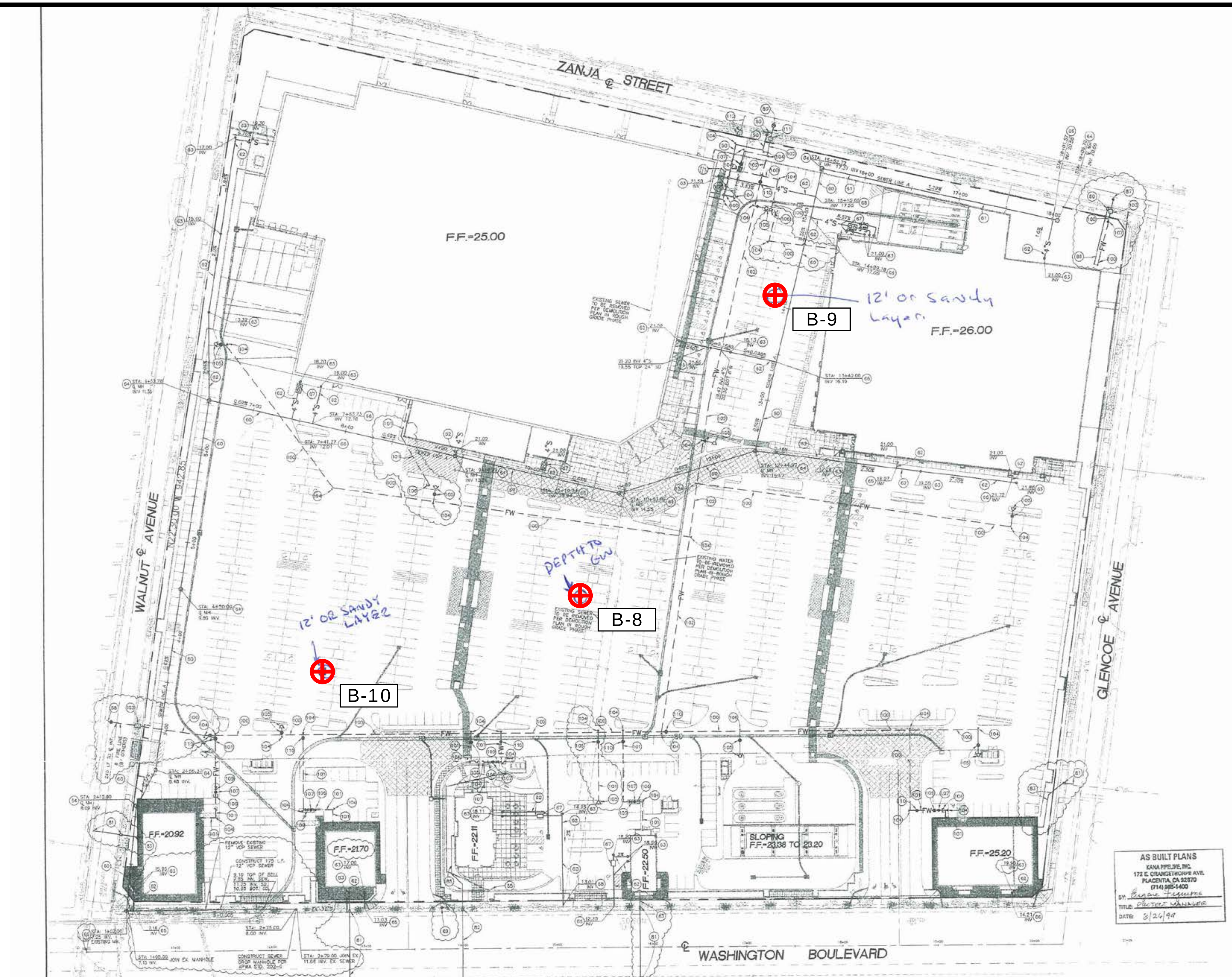
GROUP DELTA CONSULTANTS, INC
370 Amapola Ave.
Suite 212
Torrance, CA 90501

Carlton Wy. and Penmar Ave.

Weston Solutions – BMP Infiltration

PROJECT NUMBER: LA-1225

FIGURE NUMBER: 8



Reference: Grading , Paving and Drainage Plan

Legend

⊕ Boring Location

N

GROUP DELTA	GROUP DELTA CONSULTANTS, INC 370 Amapola Ave. Suite 212 Torrance, CA 90501	Costco, 13463 Washington Blvd. Marina Del Rey, CA 9092	PROJECT NUMBER: LA-1225
		Weston Solutions – BMP Infiltration	FIGURE NUMBER: 9

APPENDIX A

FIELD INVESTIGATION

BORING RECORD

PROJECT NAME	Weston Solutions - BMP Infiltration
PROJECT NUMBER	LA-1225
HOLE ID	B-1
SITE LOCATION	McKinley Ave. and Harbor St.
START	2/3/2015
FINISH	2/3/2015
SHEET NO.	1 of 1
DRILLING COMPANY	2R Drilling
DRILL RIG	CME 75
DRILLING METHOD	Hollow Stem Auger
LOGGED BY	CL
CHECKED BY	TS
HAMMER TYPE (WEIGHT/DROP)	None
HAMMER EFFICIENCY (ERi)	
BORING DIA. (in)	8"
TOTAL DEPTH (ft)	6.5
GROUND ELEV (ft)	5
DEPTH/*ELEV.* GW (ft)	∇ 5.5 / *-0.5* DURING DRILLING; ▼ / *na* AFTER DRILLING
DRIVE SAMPLER TYPE(S) & SIZE (ID)	None
NOTES	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0–0.5														6" of Concrete with 6" of base.
0.5–6.5			B-1					41						**Clayey SAND (SC)**; brown, moist, mostly fine sand.
5	0												∇ (5.5)	
6.5														End of Boring at 6.5 feet bgs. Groundwater measured at 5.5 feet bgs. No percolation test was performed. Backfilled with soil cuttings and hydrated bentonite chips.
10	-5													
15	-10													
20	-15													

GROUP DELTA CONSULTANTS, INC.
370 Amaploa Ave., Suite 212
Torrance, CA 90501

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE A-1

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	B-2

SITE LOCATION	START	FINISH	SHEET NO.
Clement Ave. and Harbor St.	2/3/2015	2/3/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
2R Drilling	CME 75	Hollow Stem Auger	CL	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	9	4	∇ 9.0 / *-5.0* DURING DRILLING; ▼ / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	4													5" of Concrete with 5" of base.
														Clayey SAND (SC); olive grey, moist, mostly fine SAND, few GRAVEL.
5	0													
6														**Poorly Graded SAND with SILT and GRAVEL (SP-SM)** yellowish brown, moist to wet, mostly fine SAND, some GRAVEL.
8			B-1					44						
9	-5		B-2					12					∇	
10														End of Boring at 10 feet bgs. Groundwater measured at 9 feet bgs. No percolation test was performed. Backfilled with soil cuttings and hydrated bentonite chips.
15	-10													
20	-15													
	-20													

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	**B-3**

SITE LOCATION	START	FINISH	SHEET NO.
Frey Ave. and Harbor St.	2/2/2015	2/2/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
2R Drilling	CME 75	Hollow Stem Auger	CL	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	7	3	∇ NM / *na* DURING DRILLING; ▼ / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
														6.5" of Concrete with 3.5" of base.
														SILTY SAND with GRAVEL(SM) olive brown, moist, mostly fine SAND, few GRAVEL.
	0		B-1					24						
														Lean CLAY with SAND (CL); grey, moist, little fine SAND, trace GRAVEL.
5			B-2					70						
	-5													End of Boring at 7 feet bgs. Groundwater not encountered. Percolation test was performed 4'-6'. Backfilled with soil cuttings and hydrated bentonite chips.
10														
	-10													
15														
	-15													
20														
	-20													

GROUP DELTA CONSULTANTS, INC.
370 Amaploa Ave., Suite 212
Torrance, CA 90501

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE A-3

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	B-4

SITE LOCATION	START	FINISH	SHEET NO.
Boone Ave. and Harbor St.	2/3/2015	2/3/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
2R Drilling	CME 75	Hollow Stem Auger	CL	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	11	2	∇ 10.0 / *-8.0* DURING DRILLING; ▼ / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	2												Asphalt	5" of Asphalt with 5" of base.
													CL	**SANDY Lean CLAY (CL)**; olive grey, moist, some fine SAND.
2	0	Bulk	B-1					61						
5													SC	**CLAYEY SAND (SC)** ; brown, moist, mostly fine SAND.
7	-5	Bulk	B-2					40						
10													∇	
11														End of Boring at 11 feet bgs. Groundwater measured at 10 feet bgs. Percolation test was performed .5'-2.5'. Backfilled with soil cuttings and hydrated bentonite chips.

Depth scale: 5, 10, 15, 20. Elevation scale: 0, -5, -10, -15, -20.

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FIGURE

A-4

BORING RECORD

PROJECT NAME Weston Solutions - BMP Infiltration	**PROJECT NUMBER** LA-1225	**HOLE ID** **B-5**	
SITE LOCATION Penmar Ave. and Venice St.	**START** 2/4/2015	**FINISH** 2/4/2015	**SHEET NO.** 1 of 1
DRILLING COMPANY 2R Drilling	**DRILL RIG** CME 75	**DRILLING METHOD** Hollow Stem Auger	**LOGGED BY** CL / **CHECKED BY** TS
HAMMER TYPE (WEIGHT/DROP) None	**HAMMER EFFICIENCY (ERi)**	**BORING DIA. (in)** 8"	**TOTAL DEPTH (ft)** 10
GROUND ELEV (ft) 25	**DEPTH/*ELEV.* GW (ft)** ∇ NM / *na* DURING DRILLING; ▼ / *na* AFTER DRILLING		
DRIVE SAMPLER TYPE(S) & SIZE (ID) None	**NOTES**		

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	25													6" of Concrete with 6" of base.
0.5														**Lean CLAY with SAND (CL)**; brown, moist, little fine SAND, trace GRAVEL.
			B-1					79						
5	20													
5.5														**SILTY SAND with GRAVEL (SM)**; yellowish brown, moist, mostly fine SAND, little GRAVEL.
			B-2					18						
10	15													End of Boring at 10 feet bgs. Groundwater not measured. Percolation test was performed 6'-10'. Backfilled with soil cuttings and hydrated bentonite chips.
15	10													
20	5													

GDC_LOG_BORING_2011 LA1225 - B-5.GPJ GDCLOG.GDT 2/27/15

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FIGURE
A-5

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	B-6A

SITE LOCATION	START	FINISH	SHEET NO.
Walgrove Ave. and Venice St.	2/2/2015	2/2/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
2R Drilling	CME 75	Hollow Stem Auger	CL	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	10	26	⊻ NM / *na* DURING DRILLING; ▼ / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	26													4" of Asphalt with 6" of base.
	25													**Lean CLAY with SAND (CL)**; olive brown, moist, trace fine SAND.
5	20													
9.5			B-1					95						
10	15													End of Boring at 10 feet bgs. Groundwater not measured. Percolation test was performed 6'-10'. Backfilled with soil cuttings and hydrated bentonite chips.
15	10													
20	5													

GDC_LOG_BORING_2011 LA1225 - B-6AB.GPJ GDCLOG.GDT 2/27/15

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FIGURE A-6

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	**B-6B**

SITE LOCATION	START	FINISH	SHEET NO.
Walgrove Ave. and Venice St.	2/2/2015	2/2/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
2R Drilling	CME 75	Hollow Stem Auger	CL	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	15	26	⊻ NM / *na* DURING DRILLING ▼ / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	26													4" of Asphalt with 6" of base.
1	25													**Lean CLAY with SAND (CL)**; olive brown, moist, trace fine SAND.
5	21		B-1					87						
10	16													
12	14													**Poorly-graded SAND with SILT and GRAVEL (SP-SM)** yellowish brown, moist, mostly fine SAND, some GRAVEL.
13	13		B-2					13						
15	11													End of Boring at 15 feet bgs. Groundwater not measured. Percolation test was performed 12'-15'. Backfilled with soil cuttings and hydrated bentonite chips.
20	6													

GDC_LOG_BORING_2011 LA1225 - B-6AB.GPJ GDCLOG.GDT 2/27/15

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FIGURE

A-7

BORING RECORD

PROJECT NAME Weston Solutions - BMP Infiltration	**PROJECT NUMBER** LA-1225		**HOLE ID** B-7
SITE LOCATION Carlton Way and Penmar Ave.	**START** 2/4/2015	**FINISH** 2/4/2015	**SHEET NO.** 1 of 1
DRILLING COMPANY 2R Drilling	**DRILL RIG** CME 75	**DRILLING METHOD** Hollow Stem Auger	**LOGGED BY** CL / **CHECKED BY** TS
HAMMER TYPE (WEIGHT/DROP) None	**HAMMER EFFICIENCY (ERi)**	**BORING DIA. (in)** 8"	**TOTAL DEPTH (ft)** 22
GROUND ELEV (ft) 27	**DEPTH/ELEV. GW (ft)** ∇ 21.0 / *6.0* DURING DRILLING; ▼ / *na* AFTER DRILLING		
DRIVE SAMPLER TYPE(S) & SIZE (ID) None	**NOTES**		

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	27													8" of Concrete with 3" of base.
	25													**Lean CLAY with SAND (CL)**; brown, moist, little fine SAND, trace GRAVEL.
			B-1					74						
5														
	20		B-2					67						
														Poorl-graded SAND with SILT and GRAVEL (SP-SM) yellowish brown, moist, mostly fine SAND, little GRAVEL.
10			B-3					10						
	15													
15														
	10													
20														
	5													End of Boring at 22 feet bgs. Groundwater measured at 21 feet bgs. Percolation test was performed 8'-12'. Backfilled with soil cuttings and hydrated bentonite chips.

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FIGURE A-8

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	**B-8**

SITE LOCATION	START	FINISH	SHEET NO.
13463 W. Washington Blvd	2/17/2015	2/17/2015	1 of 2

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
Gregg Drilling and Testing	CME 95	Hollow Stem Auger	JS	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	25	25	∇ 21.0 / *4.0* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	AFTER DRILLING
None		▼ / *na*

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
														5" of Asphalt 4" of base.
														CLAYEY SILT (ML); brown, slightly moist, very stiff, some fine sand.
5	20													
10	15													**SILTY SAND (SM)**; brown, moist, medium dense, mostly fine sand.
15	10													**SAND with SILT**; brown, moist, fine to medium sand, some coarse sand, trace gravel
20	5												∇	

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	**B-8**

SITE LOCATION	START	FINISH	SHEET NO.
13463 W. Washington Blvd	2/17/2015	2/17/2015	2 of 2

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
Gregg Drilling and Testing	CME 95	Hollow Stem Auger	JS	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	25	25	∇ 21.0 / *4.0* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	
None		▼ / *na* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
														End of Boring at 25 feet bgs. Groundwater measured at 21 feet bgs. Backfilled with grout, 3 feet of soil, and hydrated bentonite chips.
30	-5													
35	-10													
40	-15													
45	-20													

GDC_LOG_BORING_2011 LA1225 - COSTCO.GPJ GDCLOG.GDT 2/27/15

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	B-9

SITE LOCATION	START	FINISH	SHEET NO.
13463 W. Washington Blvd	2/17/2015	2/18/2015	1 of 1

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
Gregg Drilling and Testing	CME 95	Hollow Stem Auger	JS	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	17	26	▽ NM / *na* DURING DRILLING; ▼ NM / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0														5" of Asphalt 4" of base.
	25													**SILTY CLAY (CL)**; brown, slightly moist, few fine sand.
5														
	20													
10														
	15													
														SILTY SAND (SM); brown, moist, mostly fine sand, few gravel.
			B-1					22						
15														
	10													
														End of Boring at 17 feet bgs. Groundwater not encountered. Backfilled with grout, 3 feet of soil, and hydrated bentonite chips.
20														
	5													

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FIGURE A-10

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Weston Solutions - BMP Infiltration	LA-1225	**B-10**

SITE LOCATION	START	FINISH	SHEET NO.
13463 W. Washington Blvd	2/17/2015	2/18/2015	1 of 2

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
Gregg Drilling and Testing	CME 95	Hollow Stem Auger	JS	TS

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
None		8"	17	25	∇ NM / *na* DURING DRILLING; ▼ NM / *na* AFTER DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES
None	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	25													5" of Asphalt 4" of base.
														SILTY CLAY (CL); brown, slightly moist, few fine sand.
5	20													
10	15													
12														**SILTY SAND (SM)**; brown, moist, mostly fine sand.
13.5			B-1					44						
15	10													
20	5													

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FIGURE A-11 a

BORING RECORD

PROJECT NAME	Weston Solutions - BMP Infiltration
PROJECT NUMBER	LA-1225
HOLE ID	**B-10**
SITE LOCATION	13463 W. Washington Blvd
START	2/17/2015
FINISH	2/18/2015
SHEET NO.	2 of 2
DRILLING COMPANY	Gregg Drilling and Testing
DRILL RIG	CME 95
DRILLING METHOD	Hollow Stem Auger
LOGGED BY	JS
CHECKED BY	TS
HAMMER TYPE (WEIGHT/DROP)	None
HAMMER EFFICIENCY (ERi)	
BORING DIA. (in)	8"
TOTAL DEPTH (ft)	17
GROUND ELEV (ft)	25
DEPTH/*ELEV.* GW (ft)	∇ NM / *na* DURING DRILLING; ▼ NM / *na* AFTER DRILLING
DRIVE SAMPLER TYPE(S) & SIZE (ID)	None
NOTES	

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	MOISTURE (%)	DRY DENSITY (PCF)	PASSING #200 (%)	ATTERBERG LIMITS (LL:PL:PI)	POCKET PEN (TSF)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
														End of Boring at 17 feet bgs. Groundwater not encountered. Backfilled with grout, 3 feet of soil, and hydrated bentonite chips.
30	-5													
35	-10													
40	-15													
45	-20													

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FIGURE

A-11 b

APPENDIX B
INFILTRATION TESTING CALCULATIONS

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-3
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		2
Top of casing above bottom of test section		6
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/02/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/02/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	300
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		1

Calculation

Time Change - seconds	300.0
First Height - above bottom of Test Section	6
Second Height - above bottom of Test Section	5

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000060800532		
B=ASINH(A/re)/2	1.246383377		
C=2H1-A	10		
D=2H2-A	8		
E=2H1H2-Ah2	50		
F=2H1H2-Ah1	48		
K=A(B*ln(C/D)-ln(E/F))		**1.44E-06**	**feet/sec**
		4.40E-05	**cm/sec**
		0.062	inch/hour
		4.4E-05	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	2402.4		
Y = h1/h2	1.2		
t = t1-t2	300.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**2.2E-06**	**feet/ sec**
		6.58E-05	**cm/sec**
		0.093	inch/hour
		6.6E-05	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-4
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		2
Top of casing above bottom of test section		2.5
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/03/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/03/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	250
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		0.16

Calculation

Time Change - seconds	250.0
First Height - above bottom of Test Section	2.5
Second Height - above bottom of Test Section	2.34

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000072960639		
B=ASINH(A/re)/2	1.246383377		
C=2H1-A	3		
D=2H2-A	2.68		
E=2H1H2-Ah2	7.02		
F=2H1H2-Ah1	6.7		
K=A(B*ln(C/D)-ln(E/F))		**6.85E-07**	**feet/sec**
		2.09E-05	**cm/sec**
		0.030	inch/hour
		2.1E-05	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	2402.4		
Y = h1/h2	1.1		
t = t1-t2	250.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**9.4E-07**	**feet/ sec**
		2.86E-05	**cm/sec**
		0.041	inch/hour
		2.9E-05	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-5
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		4
Top of casing above bottom of test section		10
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/04/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/04/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	106
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		6

Calculation

Time Change - seconds	106.0
First Height - above bottom of Test Section	10
Second Height - above bottom of Test Section	4

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000086038489		
B=ASINH(A/re)/2	1.590391243		
C=2H1-A	16		
D=2H2-A	4		
E=2H1H2-Ah2	64		
F=2H1H2-Ah1	40		
K=A(B*ln(C/D)-ln(E/F))		**1.49E-05**	**feet/sec**
		4.55E-04	**cm/sec**
		0.645	inch/hour
		4.5E-04	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	4804.8		
Y = h1/h2	2.5		
t = t1-t2	106.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**1.7E-05**	**feet/ sec**
		5.09E-04	**cm/sec**
		0.722	inch/hour
		5.1E-04	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-6a
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		4
Top of casing above bottom of test section		10
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/02/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/02/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	380
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		0.25

Calculation

Time Change - seconds	380.0
First Height - above bottom of Test Section	10
Second Height - above bottom of Test Section	9.75

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000024000210
B=ASINH(A/re)/2	1.590391243
C=2H1-A	16
D=2H2-A	15.5
E=2H1H2-Ah2	156
F=2H1H2-Ah1	155

K=A(B*ln(C/D)-ln(E/F))	**1.06E-07**	**feet/sec**
	3.22E-06	**cm/sec**
	0.005	inch/hour
	3.2E-06	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000	
m = (kh/kv)0.5	100	
x = 4Lm/D	4804.8	
Y = h1/h2	1.0	
t = t1-t2	380.0	
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))	**1.3E-07**	**feet/ sec**
	3.93E-06	**cm/sec**
	0.006	inch/hour
	3.9E-06	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-6b
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		3
Top of casing above bottom of test section		15
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/02/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/02/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	135
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		12

Calculation

Time Change - seconds	135.0
First Height - above bottom of Test Section	15
Second Height - above bottom of Test Section	3

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000090074863
B=ASINH(A/re)/2	1.447219186
C=2H1-A	27
D=2H2-A	3
E=2H1H2-Ah2	81
F=2H1H2-Ah1	45

K=A(B*ln(C/D)-ln(E/F))	**2.33E-05**	**feet/sec**
	7.12E-04	**cm/sec**
	1.009	inch/hour
	7.1E-04	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	3603.6		
Y = h1/h2	5.0		
t = t1-t2	135.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**3.0E-05**	**feet/ sec**
		9.05E-04	**cm/sec**
		1.282	inch/hour
		9.0E-04	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-7
Date	05-Feb-15

INPUT DATA

Length of Test Section - feet		4
Top of casing above bottom of test section		12
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/04/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/04/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	104
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		8

Calculation

Time Change - seconds	104.0
First Height - above bottom of Test Section	12
Second Height - above bottom of Test Section	4

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000087693076
B=ASINH(A/re)/2	1.590391243
C=2H1-A	20
D=2H2-A	4
E=2H1H2-Ah2	80
F=2H1H2-Ah1	48

K=A(B*ln(C/D)-ln(E/F))	**1.80E-05**	**feet/sec**
	5.48E-04	**cm/sec**
	0.776	inch/hour
	5.5E-04	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	4804.8		
Y = h1/h2	3.0		
t = t1-t2	104.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**2.0E-05**	**feet/ sec**
		6.22E-04	**cm/sec**
		0.882	inch/hour
		6.2E-04	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-9
Date	18-Feb-15

INPUT DATA

Length of Test Section - feet		5
Top of casing above bottom of test section		17
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/18/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/18/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	7
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		9

Calculation

Time Change - seconds	7.0
First Height - above bottom of Test Section	17
Second Height - above bottom of Test Section	8

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0001042294878		
B=ASINH(A/re)/2	1.701652466		
C=2H1-A	29		
D=2H2-A	11		
E=2H1H2-Ah2	232		
F=2H1H2-Ah1	187		
K=A(B*ln(C/D)-ln(E/F))		**1.49E-04**	**feet/sec**
		4.56E-03	**cm/sec**
		6.457	inch/hour
		4.6E-03	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	6006.0		
Y = h1/h2	2.1		
t = t1-t2	7.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**1.7E-04**	**feet/ sec**
		5.21E-03	**cm/sec**
		7.382	inch/hour
		5.2E-03	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

Calculation of Borehole Permeability

Project Name	Weston Solutions-BMP Infiltration
Project Number	LA-1225
Location	Marina Del Rey
Boring	B-10
Date	18-Feb-15

INPUT DATA

Length of Test Section - feet		5
Top of casing above bottom of test section		17
Inside Radius Test Section		0.085417
Effective Radius of Test Section		0.333
Date of First Reading		02/18/15
Time of First Reading	Hours	0
	Minutes	0
	Seconds	0
Date of Second Reading		02/18/15
Time of Second Reading	Hours	0
	Minutes	0
	Seconds	26
First Reading - below top of casing (feet)		0
Second Reading - below top of casing (feet)		9

Calculation

Time Change - seconds	26.0
First Height - above bottom of Test Section	17
Second Height - above bottom of Test Section	8

Equation 4 by Jarvis in Groundwater Manual page 284

A=r^2/2At	0.0000280617844		
B=ASINH(A/re)/2	1.701652466		
C=2H1-A	29		
D=2H2-A	11		
E=2H1H2-Ah2	232		
F=2H1H2-Ah1	187		
K=A(B*ln(C/D)-ln(E/F))		**4.02E-05**	**feet/sec**
		1.23E-03	**cm/sec**
		1.738	inch/hour
		1.2E-03	cm/sec

Equation by Hvorslev, Case D, Figure 2.20 page 63 Cedergren

kh/kv (1)	10000		
m = (kh/kv)0.5	100		
x = 4Lm/D	6006.0		
Y = h1/h2	2.1		
t = t1-t2	26.0		
K = d2*ln(x)*ln(Y)/(8*L*(t2-t1))		**4.6E-05**	**feet/ sec**
		1.40E-03	**cm/sec**
		1.988	inch/hour
		1.4E-03	cm/sec

(1) For a bottom seal at the well, used kh/kv = 10000

References: Cedergren, H. R/, " Seepage, Drainage and Flow Nets," 3rd Edition, John Wiley & Sons, N.Y.

U.S. Department of the Interior, Bureau of Reclamation, " Groundwater Manual, A water Resources Technical Publication, " Reprint 1985.

APPENDIX F

Marina del Rey
Enhanced Watershed Management Program
Work Plan

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"To Enrich Lives Through Effective and Caring Service"

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (626) 458-5100
http://dpw.lacounty.gov

GAIL FARBER, Director

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

IN REPLY PLEASE
REFER TO FILE: WM-7

June 26, 2014

Mr. Samuel Unger, P.E.
Executive Officer
California Regional Water Quality
Control Board – Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, California 90013

Attention Ms. Renee Purdy

Dear Mr. Unger:

SUBMITTAL OF ENHANCED WATERSHED MANAGEMENT PROGRAM WORK PLAN AND COORDINATED INTEGRATED MONITORING PROGRAM PLAN FOR THE MARINA DEL REY ENHANCED WATERSHED MANAGEMENT PROGRAM GROUP

The County of Los Angeles, Los Angeles County Flood Control District, Cities of Los Angeles and Culver City, collectively the Marina del Rey Enhanced Watershed Management Program (EWMP) Group, are submitting the enclosed EWMP Work Plan and Coordinated Integrated Monitoring Program (CIMP) Plan. The Marina del Rey EWMP Group is submitting these documents to fulfill the requirements of Order No. R4-2012-0175 Municipal Separate Storm Sewer System (MS4) Permit.

The enclosed EWMP Work Plan fulfills the requirements identified in Section VI.C.4.c.iv of the MS4 Permit and the enclosed CIMP Plan fulfills the requirements identified in Attachment E Sections IV.C.4 of the MS4 Permit.

If you have any questions, please contact me at (626) 458-4300 or ghildeb@dpw.lacounty.gov or your staff may contact Mr. Bruce Hamamoto at (626) 458-5918 or bhamamo@dpw.lacounty.gov.

Very truly yours,

GAIL FARBER
Director of Public Works

GARY HILDEBRAND
Assistant Deputy Director
Watershed Management Division

MR:ba
P:\wmpub\Secretarial\2014 Documents\Letter\EWMPWP_CIMP Submittal Ltr-MdR.doc\C14163

Enc.

cc: City of Los Angeles
City of Culver City

Marina del Rey
Enhanced Watershed Management Program
Work Plan

Prepared For:

Marina del Rey Enhanced Watershed Management Agencies

County of Los Angeles
Los Angeles County Flood Control District
City of Los Angeles
City of Culver City

June 28, 2014

Marina del Rey Enhanced Watershed Management Program

Work Plan

Prepared For:

Marina del Rey Enhanced Watershed Management Agencies

County of Los Angeles
Los Angeles County Flood Control District
City of Los Angeles
City of Culver City

Prepared By:

Weston Solutions, Inc.
5817 Dryden Place, Suite 101
Carlsbad, California 92008

June 28, 2014

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LIST OF ACRONYMS

AVS	acid volatile sulfide
BMP	best management practice
BSS	City of Los Angeles Bureau of Street Services
Caltrans	California Department of Transportation
CCC	criterion continuous concentration
CEM	cost effectiveness metric
CEQA	California Environmental Quality Act
CIMP	Coordinated Integrated Monitoring Program
CM	control measure
CMP	Coordinated Monitoring Plan
CMC	criterion maximum concentration
CNG	compressed natural gas
County	County of Los Angeles
CTR	California Toxics Rule
CWA	Clean Water Act
CWP	Center of Watershed Protection
DDT	dichlorodiphenyltrichloroethane
EF	Effectiveness Factor
EMC	event mean concentration
ER	efficiency ratio
ER-L	effects range low
EWMP	Enhanced Watershed Management Program
FCG	fish contaminant goal
GIS	Geographic Information System
GPM	gallons per minute
HRU	Hydrologic Response Unit
IC/ID	illegal connection/illicit discharge
IP	Implementation Plan
LACDBH	Los Angeles County Department of Beaches and Harbors
LACFCD	Los Angeles County Flood Control District
LADPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LCC	life cycle cost
LFD	low flow diversion
LID	Low Impact Development
LPG	liquefied petroleum gas
LSPC	Loading Simulation Program in C++
MCM	Minimum Control Measure
MDL	method detection limit
MdR	Marina del Rey
MdRH	Marina del Rey Harbor
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPRP	National Pollutant Removal Performance
NPSS	non-point source study
NPV	net present value
O&M	operations and maintenance

OEHHA	Office of Environmental Healy Hazard Assessment
p,p'-DDE	p,p'-dichlorodiphenyldichloroethylene
PCB	polychlorinated biphenyl
PIPP	Public Information and Participation Programs
PVS	Palos Verdes Shelf
RAA	Reasonable Assurance Analysis
RMD	Los Angeles County Road Maintenance Division
RV	recreational vehicle
RWL	Receiving Water Limitation
SEM	simultaneously extracted metals
SMBRC	Santa Monica Bay Restoration Commission
SOL	Summation of Loads
SPS	Site Priority Score
SUSMP	Standard Urban Stormwater Mitigation Plan
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TSO	Time Schedule Order
TSS	total suspended solids
UV	ultraviolet
Weston	Weston Solutions, Inc.
WLA	waste load allocation
WMA	Watershed Management Area
WMMS	Watershed Management Modeling System
WQBEL	water quality based effluent limitations

1.0 INTRODUCTION

The Marina del Rey (MdR) watershed is a small sub-watershed located in the larger, Santa Monica Bay watershed. The Marina del Rey Harbor (MdRH) was officially opened in 1965 and is the world's largest man-made small craft harbor. The tributary area served by an MS4 that drains to MdRH is approximately 1,409 acres and consists of portions of the cities of Culver City, Los Angeles, as well as portions of the unincorporated County of Los Angeles (County). The MdR Watershed Management Area (WMA) is one of the smallest WMAs in the County of Los Angeles, but it is also one of the most important and active watersheds.

The MdR watershed has the one of the most aggressive Total Maximum Daily Load (TMDL) schedules for both Toxics and Bacteria and often leads the way in TMDL implementation for the rest of the County.

The extensive ongoing efforts of the County, Los Angeles County Flood Control District (LACFCD), and the cities of Culver City and Los Angeles to improve water quality in the MdR watershed include conducting activities and implementing best management practices (BMPs) to help reduce pollutants from stormwater runoff from the watershed to the harbor. Over the past 10 years, the responsible agencies in the MdR watershed have spent tens of millions of dollars in special studies, low-flow diversions, non-structural BMPs, structural BMPs, and monitoring efforts.

The water quality in the harbor has significantly improved due to the cooperative efforts of the the County, the LACFCD, and the cities of Culver City and Los Angeles (collectively known as the MdR Enhanced Watershed Management Program [EWMP] agencies). The MdR EWMP agencies look forward to working with interested stakeholders and the Regional Board to further improve water quality in the watershed.

1.1 Enhanced Watershed Management Plan Overview

On December 28, 2012, the Los Angeles Regional Water Quality Control Board (LARWQCB) adopted the National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Permit (MS4 Permit). This new MS4 Permit establishes the waste discharge requirement for stormwater and non-stormwater discharges within the watersheds of Los Angeles County. The MS4 Permit includes provisions that allow Permittees to voluntarily choose to implement an Enhanced Watershed Management Program (EWMP).

The EWMP for the Marina del Rey (MdR) watershed is a collaborative effort of the EWMP agencies, comprised of the County of Los Angeles (County), Los Angeles County Flood Control District (LACFCD), and the cities of Los Angeles and Culver City. Development of the MdR EWMP in accordance with the MS4 Permit includes incorporating the following steps into the work plan:

1. Identification of water quality priorities, including evaluation of existing water quality conditions, classification of pollutants, assessment of known and suspected pollutant sources in the watershed and prioritization of water quality issues in the watershed.
2. Characterization of existing and potential control measures within the watershed

3. Addressing the approach to incorporate reasonable assurance analysis (RAA) in the optimization of MdR watershed control measures.

For the purposes of the MdR EWMP, the MdR watershed management area (WMA) is approximately 1,409 acres and consists of portions of the cities of Culver City and Los Angeles, as well as unincorporated County areas. The MdR EWMP will cover the areas owned by the MS4 Permittees within the watershed (Figure 1). The WMA does not include the area adjacent to the Ballona Wetlands because the area is owned by the State of California (State) and does not include the California Department of Transportation (Caltrans) right-of-way areas because these agencies are not members of the MdR EWMP Agencies. The WMA also does not include the water areas within the MdR watershed because they are considered non-point sources and are not covered by the MS4 Permit.

Figure 1. Marina del Rey Watershed Jurisdictional Boundaries

1.2 MdR Watershed Land Use and Drainage Characteristics

The MdR watershed is bordered by the Santa Monica Bay Watershed to the west and the Ballona Creek Watershed to the north and east. The MdR harbor is open to the Santa Monica Bay through the main channel and shares a common breakwater with Ballona Creek. The MdR watershed consists of four subwatersheds, referred to as Subwatersheds 1 to 4 (Figure 1). Table 2 summarizes the MdR watershed acreage by subwatershed.

The MdRH is an active harbor for pleasure craft, consisting of the main channel and eight basins (A to H). Basins A, B, C, G, and H are known as the Front Basins. Basins D, E, and F are known as the Back Basins and are located in Subwatershed 1. The MdR watershed also includes the Venice Canals and the tributary area to the Ballona Lagoons, which discharge to the MdRH, near the exit to the Santa Monica Bay (Subwatershed 2). The Caltrans right of way areas which are located mainly within the City of Los Angeles in Subwatersheds 1 and 4, and the portions of the Ballona Wetland (49.3 acres) located on State land in Subwatershed 1 are outside the boundaries of the MdR EWMP MS4 Permit area.

Figure 2. MdR Land Use and Subwatersheds

Table 1. Summary of Marina del Rey Subwatershed Acreage

Agency	EWMP MS4 Permittee	Sub-watershed 1 (Acres)	Sub-watershed 2 (Acres)	Sub-watershed 3 (Acres)	Sub-watershed 4 (Acres)	EWMP Watershed (Acres)	% EWMP Watershed Area
City of Los Angeles	Yes	32.9	278.1	70.5	589.8	971.3	69%
County of Los Angeles	Yes	336.2	46.8	0.0	12.7	395.7	28%
City of Culver City	Yes	0.0	0.0	0.0	42.2	42.2	3%
Los Angeles County Flood Control District	Yes	N/A	N/A	N/A	N/A	N/A	N/A
Area of EWMP Agencies		**369.1**	**324.9**	**70.5**	**644.7**	**1409**	**100%**
Caltrans	No	5.4	0.0	0.0	26.4	31.8	NA
State of California (Ballona Wetland)	No	49.3	0.0	0.0	0.0	49.3	NA
MdRH Watershed Area		**423.8**	**324.9**	**70.5**	**671.1**	**1490**	-

The following land uses are found in the MdR watershed:

- The MdRH land area in Subwatershed 1 (369.1 acres) is almost entirely composed of unincorporated County land and has many small drains that discharge into all the basins. The MdR Small Drain Survey, completed for the Los Angeles County Department of Beaches and Harbors (LACDBH, 2004), identified approximately 724 small outfalls that discharge directly into MdRH, the majority of which serve the individual parcels and small roads among the basins. The remaining drains are located in the streets surrounding the basins. The City of Los Angeles, Caltrans, and the City of Culver City are not responsible for any outlets that drain directly to the harbor. The LACFCD owns 20 storm drain outlets and two storm drain inlets that flow into the Oxford Basin. No MS4 Permittee was assigned responsibility for four storm drain outlets. LACDBH is responsible for approximately 700 storm drain outlets associated with leased parcel sites.
- Subwatershed 2 (approximately 324.9 acres) does not drain into the MdRH Front or Back Basins but drains into the Venice Canal and the Ballona Lagoon, which discharge into the MdRH main channel mouth.
- Boone Olive Pump Plant serves Subwatershed 3, a tributary area of 70.5 acres that lies entirely within the boundaries of the City of Los Angeles. The pump station discharges into Basin E.
- Subwatershed 4 lies mainly within the jurisdiction of the City of Los Angeles and the City of Culver City and totals approximately 644.7 acres (excluding Caltrans areas). Its corresponding runoff discharges into the Oxford Basin, a stormwater retention basin occupying approximately 10 acres within the County. Situated north of the Back Basins, Oxford Basin is operated by the LACFCD. It drains into Basin E through two tide gates and storm drain piping.

Table 2 presents the land use acreages by subwatershed and
Table 3 shows the land use acreages by jurisdiction.

Table 2. Land Use Acreages by Subwatershed (Acres)

Land Use Class	Subwatershed Acreage*				Total
	1	2	3	4	
Single Family Residential	1.8	45.8	22.9	167.2	237.7
Multi-Family Residential	137.1	131.8	21.1	96.3	386.3
Institutional/Public Facilities	8.0	10.1	2.6	67.2	87.9
Commercial and Services	120.0	22.8	1.6	124.2	268.6
Industrial/Mixed with Industrial	0.2	0.2	0.3	27	27.7
Transportation/Road ROW	38.2	83.3	22.0	153.8	297.3
Developed Recreation/Marina Parking	41.6	0.7	0	1.9	44.2
Beach	8.2	0	0	0	8.2
Water**	6.4	30.3	0	7.1	43.8
Vacant	7.6	0	0	0	7.6
Total	369.1	325	70.5	644.7	1409

*Acreage excludes Caltrans and State owned land (Ballona Wetland) not in EWMP Area

**Marina Boat Area and MdRH Water not included in "Water" class acreage provided here. Water class includes Ballona Lagoon (14.4 ac), Venice Canals (15.9), Oxford Basin (7.1 ac), and Ballona Shoreline and other water (6.4 ac)

Table 3. Land Use Acreages by EWMP Agency Jurisdiction

Land Use Class	EWMP Agencies Jurisdictional Areas (Acres)*			
	City of Culver City	City of Los Angeles	County of Los Angeles	Total
Single Family Residential	6.8	230.6	0.3	237.7
Multi-Family Residential	0	229.4	156.9	386.3
Institutional/Public Facilities	0	83.7	4.2	87.9
Commercial and Services	24.3	122.3	122.0	268.6
Industrial/Mixed with Industrial	0	27.7		27.7
Transportation/Road ROW	11.1	246.4	39.8	297.3
Developed Recreation/Marina Parking	0	0.9	43.3	44.2
Beach	0	0	8.2	8.2
Water**	0	30.3	13.5	43.8
Vacant	0	0	7.6	7.6
Total	42.2	971.3	395.7	1409

*Acreage excludes Caltrans and State-owned land (Ballona Wetland) not in EWMP Area.

**Marina Boat Area and MdRH Water not included in "Water" class acreage provided here. Water class includes Ballona Lagoon (14.4 ac), Venice Canals (15.9), Oxford Basin (7.1 ac), and Ballona Shoreline and other water (6.4 ac)

2.0 REGULATORY BACKGROUND

2.1 Section 303(d) List 2010

The federal Clean Water Act (CWA), Section §303(d), requires states to identify waters that do not meet applicable water quality standards despite the treatment of point sources by the minimum required levels of pollution control technology. States are required not only to identify these "water quality limited segments" but also to prioritize such waters for the purpose of developing Total Maximum Daily Loads (TMDLs). A TMDL is defined as the "sum of the individual waste load allocations (WLAs) for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2), such that the capacity of the waterbody to assimilate constituent loads (the loading capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (USEPA, 2000).

The §303(d) list was last updated in 2010 and identified a number of constituents for the MdRH Back Basins and harbor Beach (Table 4).

Table 4. Summary of Section 303(d) Listings

Water Body	Constituent	Final Listing Decision
Marina del Rey Harbor - Back Basins	Chlordane (tissue and sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Copper (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	DDT* (tissue)	Do Not Delist from §303(d) list (TMDL required list)
	Dieldrin* (tissue)	Do Not Delist from §303(d) list (TMDL required list)
	Fish Consumption Advisory	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Indicator Bacteria	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Lead (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	PCBs (tissue and sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
	Sediment toxicity	Do Not Delist from §303(d) list (being addressed with USEPA-approved TMDL)
	Zinc (sediment)	List on §303(d) list (being addressed by USEPA-approved TMDL)
Marina del Rey Harbor Mother's Beach	Indicator Bacteria	List on §303(d) list (being addressed by USEPA-approved TMDL)

*USEPA-approved TMDL has made a finding of non-impairment for this constituent.

2.2 Existing TMDLs Summary

The Marina del Rey watershed is subject to three TMDLs; the Santa Monica Bay Nearshore Debris TMDL (Debris TMDL), the Marina del Rey Harbor Mother's Beach and Back Basin Bacteria TMDL (Bacteria TMDL), and the Toxic Pollutants in Marina del Rey Harbor (MdRH) TMDL (Toxics TMDL). Each of these TMDLs is briefly summarized below. The Toxics TMDL supersedes the EPA established Santa Monica Bay DDTs and PCBs TMDL. The compliance schedules for the applicable TMDLs are represented in Table 5. The Ballona Creek Wetlands TMDL for Sediment and Invasive Exotic Vegetation has been established for the neighboring Ballona Creek Wetlands, which is not included in the MdR WMA.

Table 5. TMDL Compliance Schedules

TMDL	Matrix	Parameters	Goal	Date
Marina del Rey Harbor Toxic Pollutants TMDL	Harbor Water	Dissolved Copper (from boats)	Meet LAs	3/22/2024
	Harbor sediments (Back Basins)	Copper, lead, zinc, chlordane, PCBs, DDTs, p'p-DDE	Interim Sediment Allocations	3/22/2016
			Final Compliance	3/22/2018
	Harbor sediments (Front Basins)		Interim Sediment Allocations	3/22/2019
			Final Compliance	3/22/2021
Marina del Rey Mother's Beach and Back Basins Bacteria TMDL	Harbor Water	Total coliform, Fecal coliform, *Enterococcus*	Compliance with allowable exceedance days for summer and winter dry weather	3/18/2007
	Harbor Water		Compliance with allowable exceedance days for wet weather and geometric mean targets	7/15/2021
Santa Monica Bay Nearshore and Offshore Debris TMDL	Trash		20% reduction	3/20/2016
			40% reduction	3/20/2017
			60% reduction	3/20/2018
			80% reduction	3/20/2019
			100% reduction	3/20/2020

2.2.1 Santa Monica Bay Nearshore Debris TMDL

The Debris TMDL was adopted by the LARWQCB on November 4, 2010 (Resolution No. R10-010 and became effective upon adoption by the U.S. Environmental Protection Agency (USEPA) on March 20, 2012. Responsible agencies identified for the Debris TMDL include, among others, the County, the City of Culver City, and the City of Los Angeles. The Debris TMDL established numeric targets and waste load allocations of zero discharge of trash and plastic pellets to waterbodies within the Santa Monica Bay WMA, which includes MdRH. The trash WLA applicable to the MS4 permittees shall be complied with through the Ballona Creek Trash TMDL (Resolution No. R08-007).

2.2.2 Bacteria TMDL

The Bacteria TMDL was originally adopted by the LARWCQB on August 7, 2003 (Resolution No. 2003-012) and became effective on March 18, 2004 upon approval by the USEPA. The Bacteria TMDL was revised by the LARWQCB on June 7, 2012 (Resolution No. R12-007). The responsible agencies identified for the Bacteria TMDL include the County, LACFCD, City of Los Angeles, the City of Culver City, and CalTrans.

The Bacteria TMDL established numeric bacterial compliance targets based on the acceptable health risk for marine recreational waters as defined by the USEPA. The numeric targets are expressed as both single sample limits and rolling 30-day geometric means (Table 6).

Table 6. Bacteria TMDL Numeric Targets

Indicator	Rolling 30-Day Geometric Mean Limit	Single Sample Limit
Total coliform	1,000 MPN/100 mL	1,000 MPN/100 ml if fecal > 10% of total, or 10,000 MPN/100 mL**
Fecal coliform	200 MPN/100 mL	400 MPN/100 mL
Enterococcus	35 MPN/100 mL	104 MPN/100 mL

*The geometric mean is calculated weekly as a rolling geometric mean using 5 or more samples, for 6 week periods starting all calculation weeks on Sunday.
** Total coliform single sample limit of 10,000 most probable number (MPN) decreases to 1,000 when the fecal coliform value is greater than 10% of total coliform value.

The TMDL WLAs are expressed as allowable exceedance days, or the number of days on which sampling results can surpass the numeric targets and WLAs. The geometric mean targets may not be exceeded at any time. For the single sample targets, allowable exceedance days are specified by three defined seasons (summer dry, winter dry, and wet weather) and vary by monitoring site. Each season has its own compliance dates, requirements, and limits, as presented on Table 7.

Table 7. Bacteria TMDL Seasons

Compliance Season	Compliance Season Dates	Allowable Exceedance Days/Year	Compliance Deadline
Geometric Mean	Year-round	0 days/year	July 15, 2021
Summer dry	April 1–October 31	0 days/year (daily and weekly sampling)	March 18, 2007
Winter dry	November 1–March 31	9 days/year (daily sampling)	March 18, 2007
		2 days/year (weekly sampling)	
Wet weather	Rain event ≥ 0.1 inches at LAX rain gauge, and 3 days following the end of the rain event	17 days/year (daily sampling)*	July 15, 2021
		3 days/year (weekly sampling)*	

*Wet weather allowable exceedance days for MDRH-9 are 8 days/year for daily sampling and 1 day/year for week sampling.

2.2.3 Toxics TMDL Summary

The Regional Board adopted the Toxics TMDL on October 6, 2005 (Resolution No. 2005-012). The Toxics TMDL was approved by USEPA and became effective on March 22, 2006. The Toxics TMDL originally addressed certain metals and organics in the Back Basins of MdRH (Basins D, E, and F). The Toxics TMDL was amended in 2014 to include the Front Basins of MdRH (Basins A, B, C, G and H). The metals addressed by the TMDL are copper, lead, and zinc, while Chlordane, total polychlorinated biphenyls (PCBs), p,p'-dichlorodiphenyldichloroethylene (p,p'-DDE) and total dichlorodiphenyltrichloroethanes (DDTs) are the targeted organic constituents. The responsible agencies identified for the Toxics TMDL include the County, LACFCD, City of Los Angeles, City of Culver City, and Caltrans. The Toxics TMDL compliance schedule is included in Table 5.

2.2.3.1 Sediment Numeric Targets

The Toxics TMDL established sediment numeric targets using the effects range low (ER-L) (Long et al., 1995) guidelines for copper, lead, zinc, chlordane, total DDTs, and p,p'-DDE. The sediment numeric target for total PCBs in sediments was selected to protect human health from consumption of contaminated fish (Table 8).

Table 8. Toxics TMDL Sediment Numeric Targets

Constituent	Numeric Target for Sediment
Chlordane	0.5 µg/kg
Total PCBs	3.2 µg/kg
Total DDTs	1.58 µg/kg
p-p'-DDE	2.2 µg/kg
Copper	34 mg/kg
Lead	46.7 mg/kg
Zinc	150 mg/kg

2.2.3.2 Water Column Numeric Targets

The Toxics TMDL established a final numeric target for PCBs in the water column using the California Toxics Rule (CTR) criterion for the protection of human health from the consumption of aquatic organisms. A numeric target for dissolved copper in the water column was also established based on the CTR Criterion Maximum Concentration (CMC) and Criterion Continuous Concentration (CCC) (Table 9).

Table 9. Toxics TMDL Water Column Numeric Targets

TMDL Phase	Numeric Target (µg/L)
Total PCBs	0.00017*
Dissolved copper	Acute – 4.8/Chronic – 3.1

*Receiving water quality samples shall be collected monthly and analyzed for total PCBs at detection limits that are at or below the minimum levels. The minimum levels are those published by the State Water Resources Control Board in Appendix 4 of the Policy for the Implementation of Toxic Standards for Inland Surface Water, Enclosed Bays, and Estuaries of California, March 2, 2000. Special emphasis should be placed on achieving detection limits that will allow evaluation relative to the CTR standards.

2.2.3.3 Fish Tissue Numeric Targets

The Toxics TMDL fish tissue numeric target of 3.6 µg/kg for total PCBs is the Office of Environmental Health Hazard Assessment (OEHHA) Fish Contaminant Goal (FCG).

2.2.3.4 Sediment Waste Load Allocations

Loading capacity was estimated based on annual average total suspended solids (TSS) loads into MdRH under the assumption that the finer sediments transport the majority of constituents. The Toxics TMDL for sediment was calculated based on the estimated loading capacity and the numeric sediments targets (Table 10). The sediment load allocation is the same as the numeric target.

Table 10. Toxics TMDL Numeric Targets and Loading Capacity

Metals	Numeric Target (Load Allocation) ERL(mg/kg)	TMDL Loading Capacity(kg/year)
Copper	34	2.88
Lead	46.7	3.95
Zinc	150	12.69
Organics	**ERL (µg/kg)**	**Proposed TMDL (g/year)**
Chlordane	0.5	0.04
PCBs	22.7	1.92
Total DDTs	1.58	0.13
p-p'-DDE	2.2	0.19

2.2.3.5 Water Column Load Allocations

The load allocation for dissolved copper from boats is a reduction of 85% from the baseline copper load from boats of 3,609 kg/year.

2.2.3.6 Stormwater Waste Load Allocations

WLAs for stormwater are also included in the Toxics TMDL for each of the Permittees (Table 11).

Table 11. Toxics TMDL Stormwater Waste Load Allocations

Permittees	Copper (kg/year)	Lead (kg/year)	Zinc (kg/year)	Chlordane (g/year)	Total PCBs (g/year)	Total DDT (g/year)	p'p-DDE (g/year)
MS4	2.26	3.10	9.96	0.0332	1.51	0.10	0.15
Caltrans	0.036	0.05	0.16	0.0005	0.024	0.0017	0.0024
General construction	0.23	0.32	1.02	0.0034	0.16	0.011	0.015
General industrial	0.012	0.016	0.053	0.0002	0.008	0.0006	0.0008
Total	**2.54**	**3.49**	**11.2**	**0.04**	**1.70**	**0.12**	**0.16**

3.0 DATA EVALUATION AND WATER QUALITY PRIORITIZATION

3.1 Approach to Data Compilation and Analysis

In accordance with the MS4 Permit, existing water quality conditions were characterized using data from relevant studies and monitoring completed within the past 10 years. Table 12 provides a summary of the data and studies used in the evaluation.

Table 12. Summary of Data and Studies Used in the Evaluation

Report	Parameters	Stormwater / MS4	Harbor Water	Sediment	Sediment Cores	Fish Tissue
Toxics TMDL Monitoring (2010-2013)	Organics	x	-	x	-	x
	Metals	x	x	x	-	-
	Conventional	x	-	x	-	-
	Toxicity	-	-	x	-	-
Storm Borne Sediment Monitoring (2011)	Organics	x	-	-	-	-
	Metals	x	-	-	-	-
	Conventional	x	-	-	-	-
Special Study – Low Detection Limits (2011)	Organics	x	-	x	-	-
Special Study - Partitioning Coefficient (2011)	Organics	x	-	x	-	-
	Metals	x	x	x	-	-
	Conventional	x	x	x	-	-
MdRH Annual Reports (2002-2007)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	x	-	-	-
	Bacteria	-	x	-	-	-
MdRH Sediment Characterization Study (2008)	Organics	-	-	x	x	-
	Metals	-	-	x	x	-
	Conventional	-	x	x	-	-
	Toxicity	-	-	x	-	-
Oxford Basin Study (2010)	Organics	-	x	x	x	-
	Metals	-	x	x	x	-
	Conventional	-	x	x	x	-
	Bacteria	-	x	x	-	-
Bight '03 (2003)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	-	x	-	-
	Toxicity	-	-	x	-	-
Bight '08 (2008)	Organics	-	-	x	-	-
	Metals	-	-	x	-	-
	Conventional	-	-	x	-	-
	Toxicity	-	-	x	-	-
Section 2.2.9– Bacteria TMDL Monitoring (2007-2013)	Bacteria	-	x	-	-	-
Nonpoint Source Bacteria Study (2006)	Bacteria	x	x	x	-	-

3.2 Summary of Findings by Matrix

3.2.1 Stormwater

Stormwater monitoring was conducted as part of the Toxics TMDL coordinated monitoring plan at five stations (Figure 3).

A total of 23 storms were monitored in accordance with the Toxics TMDL Coordinated Monitoring Plan (CMP) during the 3-year period (2010 to 2013). Two special studies and one pilot study were also conducted: the Partitioning Coefficient Special Study, the Low Detection Limit (LDL) Special Study, and the storm borne sediment pilot study. Because the Toxics TMDL targets for stormwater are sediment based, it is not feasible to make an assessment of water quality exceedances based on water column data. For this report, the data were compared to the CTR water column criteria to provide a general sense of the water quality conditions in the stormwater to help guide the prioritization of water quality issues. Key findings include:

- Dissolved copper and dissolved zinc frequently exceeded the CTR CMC in Toxics TMDL monitoring, whereas dissolved lead rarely exceeded the CTR CMC (one sample exceeded at CTR CMC at MdR-C-2 on 3/8/2013).
- Partitioning Coefficient Study results for copper in stormwater showed that concentrations were above background levels and may be contributing to copper in the MdRH.
- Chlordane was not detected in any of the Toxics TMDL monitoring samples above the Method Detection Limit (MDL). The MDLs were below the CTR CMC for acute toxicity for freshwater (2.4 µg/L). Low Detection Limit Special Study results for chlordane in stormwater achieved lower MDLs. The low MDL results confirmed that chlordane levels were below the applicable criterion.
- Total PCBs were not detected above the MDL for the first two monitoring years of Toxics TMDL monitoring, and at only two events at all stations during the third year. The field trip blank also had total PCB results above the MDL for each of those events.
- Low Detection Limit Special Study results for total PCBs achieved lower MDLs. The results showed that all samples exceeded the harbor water numeric target of 0.00017 µg/L by a factor of at least 12.

Figure 3. TMDL Monitoring Locations

3.2.2 Harbor Water

Water quality samples have been collected in MdRH for more than 25 years as part of the Annual Report Monitoring for MdRH (ABC 2001 to 2008). Samples were analyzed for indicator bacteria and physical parameters (e.g., temperature, salinity, dissolved oxygen). Monitoring under the Bacteria TMDL began in 2007, with more frequent sampling and observational data collection. In addition, a bacteria non-point source special study was conducted in 2006. In 2010, copper, lead, zinc, total PCBs, and chlordane were added to the list of constituents and monitored monthly as part of the Toxics TMDL CMP.

Dissolved copper concentrations in the water column exceeded the Toxics TMDL numeric target (4.8 µg/L) at all stations during all years, with the exception of MdRH-F-4 and MdRH-F-5 in 2011. Concentrations were comparable within the Front and Back Basins, particularly between stations MdRH-B-1, MdRH-B-2, MdRH-F-1, and MdRH-F-2 (Basin D, Basin E, Basin A, and Basin B, respectively). The Partitioning Coefficient Special Study collected samples at the same stations as the Toxics TMDL monitoring at surface, mid-depth, and at-depth. The results showed that copper concentrations were higher near the surface and lowest at the deepest sample depths.

There were no exceedances of the Toxics TMDL water column PCB numeric target for the Toxics TMDL monitoring. However, as part of the LDL Special Study, lower MDLs were achieved and it was determined that all samples collected as part of the LDL study exceeded the final Toxics TMDL numeric target of 0.00017 µg/L by at least a factor of 12. The highest concentrations were observed in Basin F.

Chlordane results exceeded the saltwater CTR CMC for one sample, MdRH-B-1 in October 2011. Chlordane was also analyzed as part of the LDL Special Study, and lower MDLs were achieved (0.028 ng/L). Only one result was above the CTR for Human Health; however, the trip blank associated with the sample also had a detection greater than the CTR for Human Health. These results are therefore qualified due to the results of the field blank analysis.

Bacteria TMDL monitoring began in 2007 with monitoring of nine compliance stations and five ambient stations. In 2009 monitoring at the ambient stations was discontinued. The Bacteria TMDL requires daily or weekly monitoring at the nine compliance stations within the MdRH, along with samples collected at depth at four stations. Historical bacteria data are also available from monitoring conducted prior to 2007 as part of the MdRH Annual Monitoring conducted by the LACDBH. A Non-Point Source Study was conducted in 2006 to assess potential sources of bacteria from within the MdRH. The findings of the study showed that birds were a likely source of bacteria to the MdRH.

The Bacteria TMDL is split into three seasons: summer dry, winter dry, and wet weather. Data were analyzed and presented for each season. The highest proportion of exceedance days from the Bacteria TMDL monitoring during dry weather occurred at stations MdRH-5 and MdRH-7. Historically, the greatest proportion of exceedance days during summer dry was at MdRH-5 and MdRH-6 (MdRH-7 was not monitored prior to 2007). Of interest to note is that during winter dry weather, the highest proportion of exceedance days occurs at stations MdRH-1, MdRH-2, and MdRH-3, which are different from those most often exceeding during summer dry. Monitoring is no longer conducted at MdRH-10, MdRH-11, MdRH-12, MdRH-13, or MdRH-14.

Observational data are collected as part of the Bacteria TMDL monitoring, and those data were assessed for patterns relating to the observed indicator bacteria concentrations. A slight correlation was observed between the animal and/or bird observation data and indicator bacteria results, with slightly higher concentrations of indicator bacteria occurring when the number of birds and/or animals observed was higher.

3.2.3 Sediment

Annual chemistry sediment monitoring has been conducted by the LACDBH for more than 25 years at 20 monitoring stations within the MdRH. In addition to the annual monitoring program, which ended in 2007, Bight ‘03, Bight ‘08, the Oxford Basin Special Study (2010), the MdRH Sediment Characterization Study (2008), the Toxics TMDL Monitoring (2010-present) and two special studies have been conducted.

In addition to the chemistry monitoring that has been conducted, toxicity and benthic infauna monitoring have also been conducted as part of Bight ‘03, Bight ‘08, the MdRH Sediment Characterization Study (2008), and Toxics TMDL Monitoring (2010 to present). It is important to assess the chemistry along with the toxicity and biological data to gain a broader understanding of the impacts of chemistry results in the environment. During Bight ’08, acid-volatile sulfide (AVS) and simultaneously extracted metals (SEM) analyses was conducted, as well as analysis of total organic carbon. These additional chemistry parameters allowed an assessment of the bioavailability of metals in the samples.

The Bight ’08 monitoring results included AVS:SEM analyses. The bioavailability analysis of the results showed that although these divalent metals occur at high concentrations within the MdRH, they are not likely bioavailable due to the high levels of sulfides and carbon also present in the sediments.

Toxicity results for the Bight ’08 support the AVS:SEM analyses, which indicated non-toxic levels at three of the five stations, low toxicity at one of the five stations, and moderate toxicity at one station. The Toxics TMDL monitoring toxicity results were also low for *E. estuarius* and *M. galloprovincialis;* however, *L. plumulosus* chronic testing showed toxicity to the sediments. The causes of the toxicity are not clear, although they do not appear to be due to metals.

Metals concentrations within the MdRH are higher in the basins and main channel adjacent to the basins. The spatial pattern of these analytes is presented in Figure 4 through Figure 6. All available data are presented in the figures. The maps are intended to provide a visual presentation of the results, and should not be used for predictive purposes.

Copper concentrations in MdRH are highest in the Back Basins (Basin D, E, and F) along the back of Basin G and in the middle portion of Basin B (Figure 4).

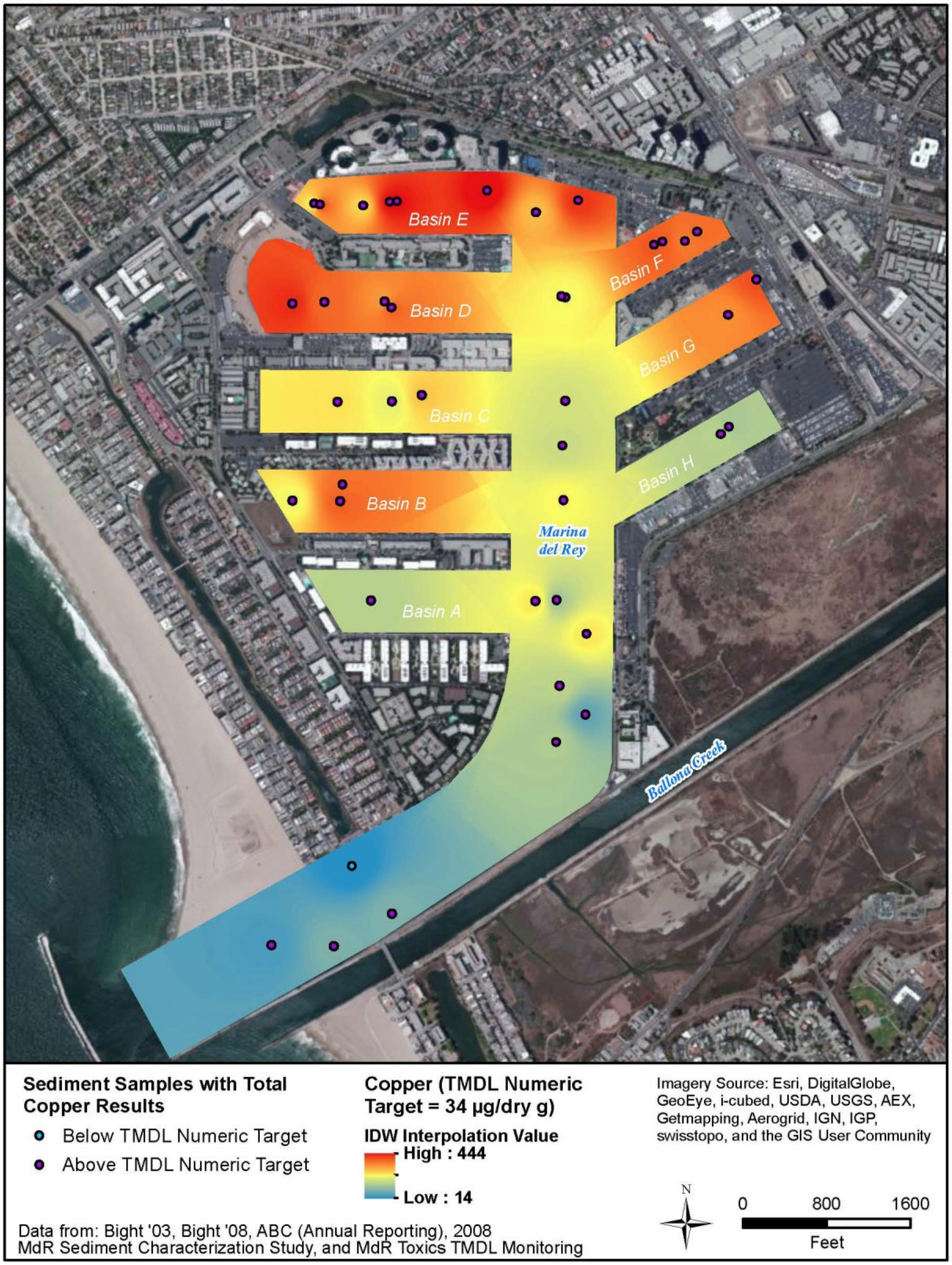


Figure 4. Marina del Rey Harbor Sediment Copper Concentrations, 2002 to 2013

Lead concentrations are highest in Basin B, the main channel toward the harbor entrance, and in some samples collected near the entrance to the MdRH (Figure 5).

Figure 5. Marina del Rey Harbor Sediment Lead Concentrations, 2002 to 2013

Zinc concentrations followed a similar spatial pattern when compared to the copper concentrations, with the highest concentrations in Basin E, the back of Basin D, and Basin B (Figure 6).

Figure 6. Marina del Rey Harbor Sediment Zinc Concentrations, 2002 to 2013

Total PCBs (Aroclors and congeners separately), DDTs, and p,p'-DDE were also assessed for spatial patterns within the MdRH. Figure 7 and Figure 8 illustrate the concentrations. Bight monitoring data, along with the 2008 Sediment Characterization data, used a sum of PCB congeners to calculate total PCBs. The Toxics TMDL monitoring uses a sum of Aroclors to calculate total PCBs. These two methods are not directly comparable; in fact, the total PCB results can be quite different. Therefore, the results are presented on two separate maps (Figure 7 and Figure 8). The concentrations of Aroclor total PCBs were highest in Basin C and Basin E; however, samples exceeded the TMDL numeric target throughout the MdRH.

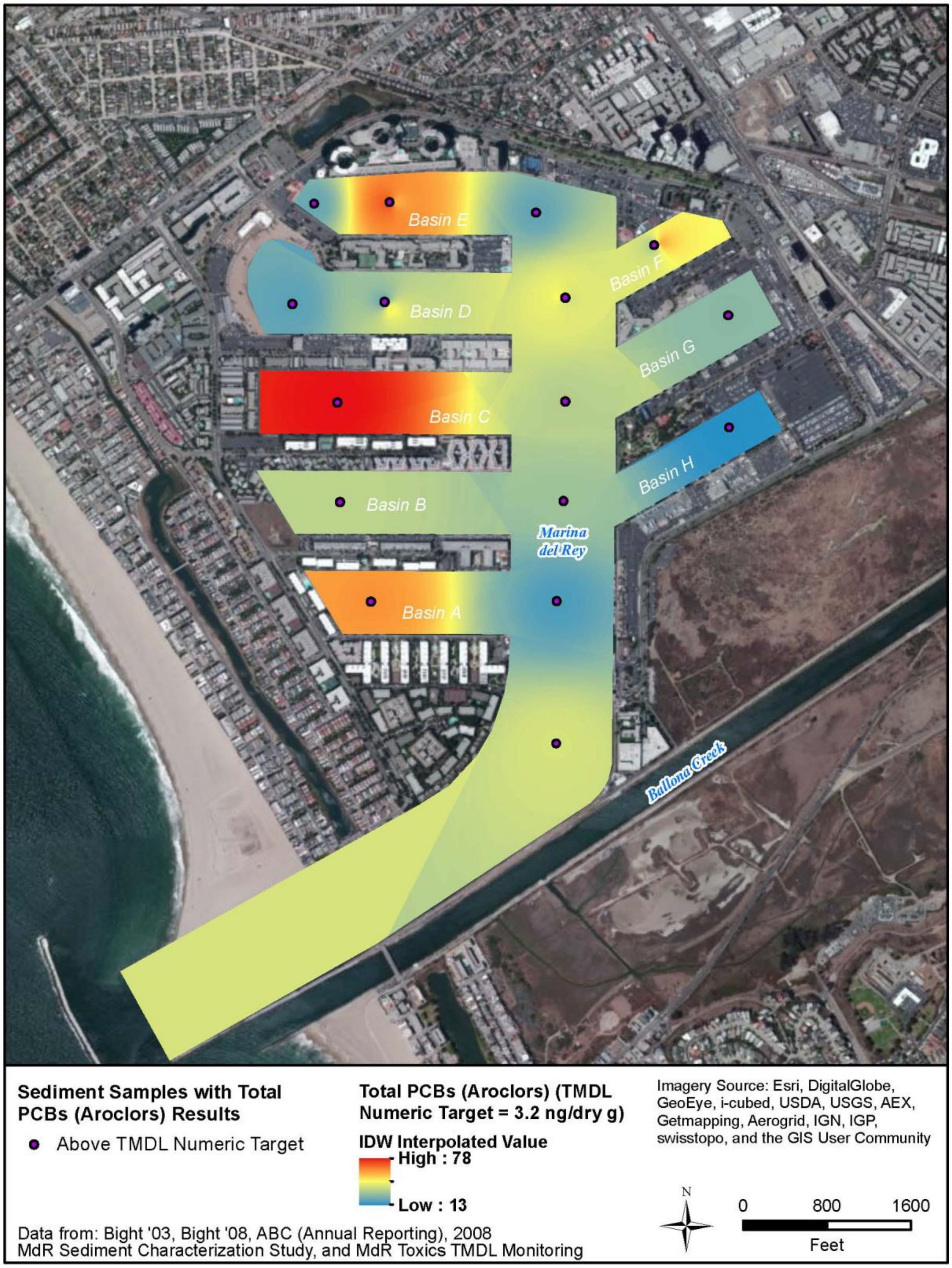


Figure 7. Marina del Rey Harbor Sediment Total PCB (Aroclor) Concentrations, 2002 to 2013

Congener total PCB concentrations were highest in the main channel between Basins D and F, in Basin E, and at the back of Basin C. Some higher concentrations were also detected near the mouth of the harbor in the main channel; however, several samples near the mouth of the MdRH were below the TMDL numeric target, so the sediments are likely heterogeneous.

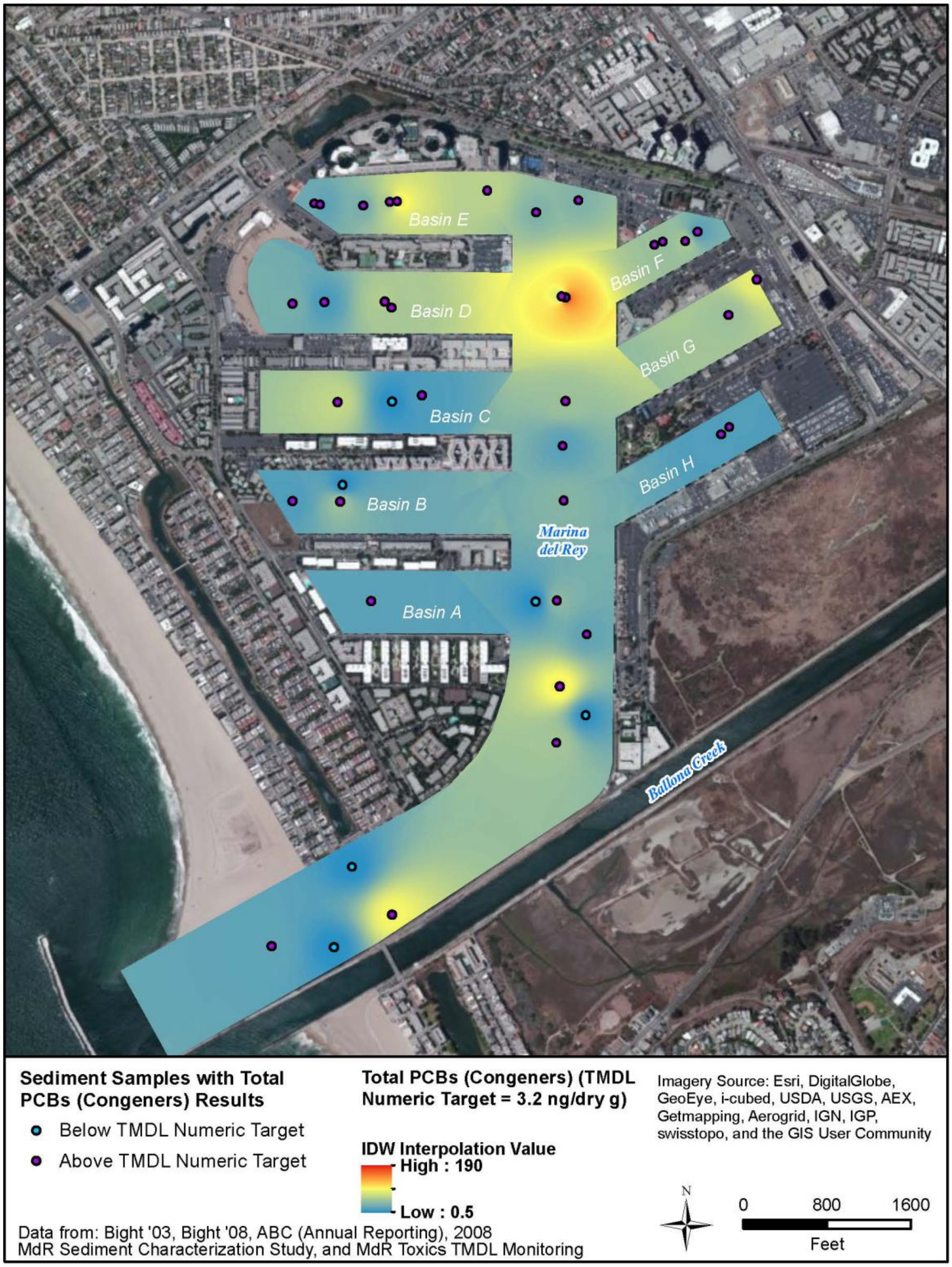


Figure 8. Marina del Rey Harbor Sediment Total PCB (Congener) Concentrations, 2002 to 2013

Total DDTs are presented in Figure 9. The highest single results were from the main channel near the mouth of the harbor and Basin E. Results were also high throughout the main channel and into Basins F and G.

Figure 9. Marina del Rey Harbor Sediment Total DDT Concentrations, 2002 to 2013

Finally, p,p'-DDE results are presented in Figure 10 and follow a pattern similar to that observed for total DDTs. The highest concentrations were in Basin E, Basin G, and near the mouth of MdRH.

Figure 10. Marina del Rey Harbor Sediment p,p'DDE Concentrations, 2002 to 2013

3.3 Summary of Findings by Constituent

Copper – Sediment and harbor water copper concentrations are highest in Basin D, Basin E, and to some extent in Basins B and C; and do not meet Toxics TMDL numeric targets. Stormwater is likely contributing to the harbor water concentrations in these locations, as well as paint with copper additives leaching from boat hulls in the MdRH water. However, preliminary AVS:SEM analyses indicate that copper may not be causing toxicity in the sediments. The MS4 waste load allocations for copper are not currently met.

Lead – Sediment concentrations of lead are highest near the mouth of the MdRH, in Basins A, and B, and to some extent, in Basin G. Sediments do not currently meet Toxics TMDL numeric targets. Stormwater runoff concentrations of dissolved lead are low, although storm borne sediment analysis of stormwater runoff shows that high levels of lead can be found associated with suspended sediments in stormwater runoff. However, the storm borne sediment analysis was only based on one event in 2011 and may not be representative of the annual load.

Zinc – The sediment concentrations of zinc follow a pattern similar to that of copper (highest concentrations in Basins D and E, and to a lesser extent in Basins B and C) and can also be found at high levels in stormwater runoff and storm borne sediment samples. However, the storm borne sediment analysis was only based on one event in 2011 and may not be representative of the annual load. Currently, the zinc concentrations in sediment do not meet Toxics TMDL numeric targets. Preliminary AVS:SEM analyses indicate that zinc is not likely causing toxicity in the sediments. The MS4 waste load allocations for zinc are not currently met.

Total PCBs – Sediment PCB concentrations are highest in the back basins, particularly Basin E and do not currently meet Toxics TMDL numeric targets. Fish tissue concentrations for total PCBs do not currently meet Toxics TMDL numeric targets. Both stormwater and harbor water samples collected as part of the Toxics TMDL CMP monitoring are below MDLs for all samples collected, but the MDLs are above the Toxics TMDL numeric target. The Low Detection Limit (LDL) study results, which achieved MDLs below the TMDL numeric targets, show that neither stormwater nor harbor water meet the Toxics TMDL numeric target. During the storm borne sediment monitoring, PCBs were also at high levels at MdR-5 (which drains into Basin E). However, the storm borne sediment analysis was only based on one event in 2011 and may not be representative of the annual load.

Total DDTs – DDTs were recently added to the TMDL; therefore monitoring as part of the Toxics TMDL has not been conducted. However, assessment of historical sediment data in the MdRH show that DDTs have been found in levels higher than the Toxics TMDL numeric target. Historic samples of DDT in Oxford Basin have also been above the Toxics TMDL numeric target.

p,p’-DDE – p,p’-DDE was recently added to the TMDL, and follows the same spatial patterns as total DDTs. The Toxics TMDL numeric targets are not currently met for p-p’DDE.

Chlordane – Sediment monitoring conducted as part of the Toxics TMDL CMP resulted in non-detected results for chlordane for all samples. However, the MDL used in the analysis is above the Toxics TMDL numeric target. Historical sediment samples collected in the MdRH such as those collected for the 2008 Sediment Study, Bight ’03, and Bight ’08, have found chlordane at levels above the Toxics TMDL numeric target. The highest concentrations occurred near the mouth of the MdRH. Stormwater, harbor water, and the initial special studies analyses also resulted in non-detected results for chlordane for all samples. Re-analysis of stormwater and harbor water as part of the Low Detection Limit Study resulted in low detections of chlordane. Methods for estimating total chlordane may vary between studies, and cause discrepancies in the estimation of total chlordane. Findings regarding the sources and amounts of chlordane present in the MdRH remain inconclusive.

Bacteria – Bacteria TMDL monitoring has been conducted in the MdRH since 2007 at nine locations. The TMDL has three compliance seasons, summer dry, winter dry, and wet weather. Currently, the MdRH is not consistently meeting the single sample or geometric mean sample Bacteria TMDL allowable exceedance day targets. The highest proportion of exceedance days occurs at MdRH-5 and MdRH-7 (Basin E). However, during winter dry weather the highest proportion of exceedance days occurs at MdRH-1, MdRH-2, and MdRH-3 (Basin D at Marina Beach). Historical source identification studies have pointed toward birds as the greatest contributor to bacteria concentrations in the MdRH.

4.0 WATER BODY- POLLUTANT CLASSIFICATION

In accordance with the MS4 Permit, Section VI.C.5.a, water-body pollutant combinations were classified into one of the following three categories (Table 13):

1. Category 1 (Highest Priority) – Pollutants with receiving water limitation or water-quality-based effluent limits (WQBEL) as established in Part V1.E and Attachments L through R of the MS4 Permit.

2. Category 2 (High Priority) – Pollutants in the receiving water that are listed as §303(d) and for which MS4 discharges may be causing or contributing to the impairment.

3. Category 3 (Medium Priority) – Pollutants with insufficient data to list as §303(d) but which exceed receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance.

4.1 MdR WMA Pollutant Classification

Category 1 (highest priority) pollutants are defined by the MS4 Permit as those constituents that have been addressed with receiving water limitations or WQBELS established through a TMDL. The Toxics TMDL, as described in Section 2.2.3, establishes waste load allocations for chlordane, total PCBs, total DDTs, p-p'-DDE, copper, lead and zinc. In addition, the TMDL establishes numeric targets for dissolved copper and total PCBs in the water column in MdRH. As a result of the establishment of the TMDL for these constituents, they are classified in accordance with the MS4 Permit as Category 1 pollutants for MdRH (Table 13).

The Bacteria TMDL as described in Section 2.2.2 established numeric bacterial compliance targets for fecal coliform, *Enterococcus*, and total coliform in MdRH. As a result of the TMDL, these constituents are classified in accordance with the MS4 Permit as Category 1 pollutants for MdR (Table 13).

Table 13. Waterbody – Pollutant Classification

Waterbody	Pollutant	Classification
Marina del Rey Harbor	Dissolved Copper	Category 1
	Copper	Category 1
	Lead	Category 1
	Zinc	Category 1
	Total PCBs	Category 1
	Total DDTs	Category 1
	p,p'-DDE	Category 1
	Chlordane	Category 1
	Fecal coliform	Category 1
	Enterococcus	Category 1
	Total coliform	Category 1
Ballona Lagoon/ Venice Canal	None known	None

Ballona Lagoon is the only waterbody other than MdRH that falls within the MdR WMA. However, there are no available data concerning the receiving water or discharges to the receiving water. Category 2 constituents are defined in the MS4 Permit as pollutants in the receiving water that are listed as §303(d) and for which MS4 discharges may be causing or contributing to the impairment. Dieldrin is a §303(d) listed constituent for MdRH (Table 4), however the EPA made a finding of non-impairment for this constituent so it will not be considered a Category 2 pollutant.

Category 3 constituents are those pollutants with insufficient data to list as §303(d) but which exceed receiving water limitations contained in the MS4 Permit and for which MS4 discharges may be causing or contributing to the exceedance. The data evaluation did not result in any constituents being classified as a Category 3 constituent.

5.0 POLLUTANT SOURCE ASSESSMENT

A pollutant source assessment was carried out to identify potential sources of Category 1 to 3 pollutants.

5.1 Harbor-Based Sources

Likely sources of bacteria, copper, lead, zinc, total PCBs, total DDTs, p,p'-DDE, and total chlordane that have been identified within the MdRH include the following:

- **Boats**: Several studies attributed the higher metal concentrations found in the main channel and in the mouths of each Back Basin as being sourced from maritime activities. Anti-fouling, copper-based hull paint was specifically identified as a source of higher copper in the MdRH. This source is being addressed through the revised Toxics TMDL.
- **Legacy Sediments**: Several studies have characterized the unconsolidated and consolidated sediments of the harbor and found higher concentrations of metals, PCBs, chlordane, and DDT. Disturbance of these sediments could cause re-suspension in the water column and transport to other areas of the MdRH.
- **Boone Olive Pump Station**: During wet weather, this site was identified as a source of fecal indicator bacteria contributing to higher bacterial loads to Basin E.
- **Oxford Basin**: This water body was identified as a potential source of metals and bacteria in a number of studies conducted prior to the installation of dry weather diversions. Assessment within Oxford Basin in 2010 during dry and wet weather suggested that Oxford Basin was not a significant contributor of pollutants (particularly metals). Dry-weather bacteria contributions from Oxford Basin appear to have decreased with the construction of the dry-weather diversions. The Oxford Basin Low Flow Diversion (LFD) came online in January 2009 and the Washington and Thatcher LFD in December 2006. Further Best Management Practices (BMP) evaluation may be required to assess the effectiveness of the diversions. During wet weather, Oxford Basin has been found to contribute to bacteria concentrations in Basin E. Oxford Basin is currently undergoing a restoration, which will potentially improve water quality in Oxford Basin.
- **Natural Sources**: Birds have been found to be a significant source of fecal indicator bacteria to MdRH. Within the unincorporated areas of the county the impact of this natural source can be limited through structural BMPs such as bird controls, nonstructural BMPs, and bird waste management programs.

5.2 Watershed-Based Sources

Likely sources of bacteria, copper, lead, zinc, total PCBs, total DDTs, p,p'-DDE, and total chlordane from the watershed to the MdRH include the following:

- **Stormwater Runoff**: Stormwater monitoring conducted under the Toxics TMDL has shown that copper, lead, and zinc are being transported into the MdRH during storm events. Storm borne sediment monitoring has shown that chlordane and PCBs are transported by suspended sediment in stormwater. However, the storm borne sediment analysis was only based on one event in 2011 and may not be representative of the annual load.
- **Residential Contributions**: Use of certain building materials can contribute loads of copper and zinc (from structures such as roofing materials, gutters, and fencing) through urban runoff. Non-stormwater discharges such as over-irrigation and wash water can provide a transport mechanism for pollutants and provide a reservoir for bacteria growth and/or regrowth in soils and the MS4. Control of these sources may include structural solutions, such as aggressive street and parking

lot sweeping, covering and containing trash, proper recycling of yard waste, controlled/reduced pesticide and fertilizer applications, and additional nonstructural solutions, such as targeted educational and enforcement programs for irrigation and washing activities and/or facilities.

- **Commercial Contributions**: Certain commercial practices, including poorly managed restaurant wash-down and trash storage, can impact water quality. These facilities may also attract birds, and their waste may contribute to bacterial concentrations in MdRH. Management actions could include targeted trash inspection programs to correct pollutant loading activities, education to improve housekeeping and trash containment and cover activities, and bird exclusion devices.
- **Atmospheric Deposition**: Atmospheric deposition of metals has been found to be a significant source of copper (brake pads) and zinc (brake pads and tires). Improvements to loads from these sources can be achieved through true source control activities, such as the Brake Pad Partnership and product substitution and structural solutions, such as targeted aggressive street and parking lot sweeping.
- **Anthropogenic Fecal Sources**: Fecal sources can include poorly contained pet waste, bird attractants (e.g., open trash receptacles), and public restrooms. Another key anthropogenic source may be the illegal dumping of boat waste into the harbor. Solutions may include outreach regarding pet waste, RV waste and boat waste disposal, enforcement programs, trash inspection programs, targeted restaurant inspections, and containment of wash-down water used for restroom facility cleaning.

5.3 Summary of Sources per Contaminant

Multiple monitoring programs and special studies have sought to assess conditions in the MdRH. This section presents the interrelationship of the findings of these multiple studies in terms of constituents, potential sources, and potential data gaps.

A summary of the identified constituent sources from key studies is presented on Table 14.

Table 14. Key Study Findings – Attributed Sources

Study	Bacteria	Metals	Chlordane, PCBs, and DDTs
Bacteria TMDL Non-Point Source Study	Oxford Basin, birds, and some anthropogenic sources	Not tested	Not tested
MdRH Mother's Beach and Back Basins Bacteria Indicator TMDL Compliance Study	Birds and some anthropogenic sources	Not tested	Not tested
MdRH Annual Reports	Oxford Basin	Copper based boat hull paint, legacy sediments, and stormwater runoff	Boat hull paint, legacy sediments, and stormwater runoff
MdRH Sediment Characterization Study	Not tested	Boats, legacy sediments, and stormwater runoff	Boat hull paint, legacy sediments, and stormwater runoff
Oxford Basin Sediment and Water Quality	Natural levels observed	Low concentrations observed	Low concentrations observed
Bight '03	Not tested	Boats, legacy sediments	Boats, legacy sediments
Bight '08	Not tested	Boats, legacy sediments	Boats, legacy sediments
Toxics TMDL Monitoring	Not tested	Boats, legacy sediments, residential contributions, commercial contributions, and stormwater runoff	Boats, legacy sediments, and stormwater runoff
Toxics TMDL Special Studies	Not tested	Boats, legacy sediments, residential contributions, commercial contributions, and stormwater runoff	Boats, legacy sediments, and stormwater runoff

5.3.1.1 Chlordane, PCBs, and DDTs

The pesticide chlordane was widely used for food crops and lawn care until 1978 when use was limited to termite control. In 1988 chlordane use was banned in the United States. Assessment of sediment in MdRH found concentrations of chlordane to be highest in the main channel, near the mouth of the harbor.

Before DDT was banned in 1972, large DDT releases occurred during agriculture or vector control applications. Emissions could also have resulted during production, transport, and disposal. DDT was released to surface waters for vector control or as a result of dry and wet deposition from the atmosphere or direct gas transfer. DDTs can be released to the soil during spraying operations from direct or indirect releases during manufacturing, formulation, storage, or disposal. Another potential source of DDT contamination in sediment is the Palos Verdes Shelf (PVS), because contaminated sediment near an outfall can act as a source of contamination to a distant part of a water body. Fish exposed to the PVS sediments may bioaccumulate PCBs and DDTs, and when captured in the MdRH, have high levels of these pollutants although there is a potential that this exposure may not have occurred in the MdRH. DDT and its metabolites may be transported from one medium to another by the processes of solubilization, adsorption, remobilization, bioaccumulation, and volatilization. It can also be transported by currents, winds, and diffusion.

From 1947 to 1983, Montrose Chemical Corporation manufactured DDT at its plant near Torrance, CA. The plant discharged wastewater containing the now-banned pesticide into Los Angeles sewers that emptied into the Pacific Ocean off White Point on the PVS. The DDT manufacturing process also resulted in groundwater and surface soil contamination on and near the Montrose plant property. It is estimated that more than 800 to 1,000 tons of DDT were discharged between the late 1950s and the early 1970s. Several other industries also discharged PCBs into the Los Angeles sewer system that ended up on the PVS by way of outfall pipes. The PVS site is defined by the large area of DDT- and PCB-contaminated sediment on the ocean floor. The contaminated sediment deposit is thin, 2 inches to 2 feet thick, and covers several square miles. The most contaminated sediment is buried under a layer of cleaner sediment whose surface concentrations of DDT and PCB have dropped over time.

Prior to the use of copper and tributyltin as anti-fouling paints, PCBs were used in boat hull paint. It is possible that historical contamination from boat hulls may be contributing to high levels of PCBs in the Back Basins.

5.3.1.2 Metals

The results of most sediment studies conducted in the MdRH found copper and zinc concentrations to be highest in the Back Basins. Lead concentrations were highest in the main channel. The sources of these metal were generally identified as maritime activities (e.g., hull leachate), discharge from storm drains into the receiving water, and atmospheric deposition.

The Oxford Basin Sediment and Water Quality Characterization (Weston, 2010a) provided insights into the potential for the Oxford Basin to act as a reservoir and potential source for contaminated sediments entering Basin E. The results of the study indicated low concentrations of metals, except chromium and lead, suggesting that resuspension of sediments in Oxford Basin is not likely to be a source of metals in Basin E.

5.3.1.3 Fecal Indicator Bacteria

Water quality has been comprehensively assessed throughout the MdRH as special studies and as part of continuous monitoring programs. As a result of these studies, a number of constituent sources have been identified.

Assessments of bacterial contributions to Basin E were consistent among the majority of projects, with the Oxford Basin and Boone Olive Pump Station identified as a source of bacterial loads during wet weather. The most recent study did not indicate that Oxford Basin was a predominant contributor to bacteria concentrations in Basin E during dry-weather flows (the Oxford Basin Sediment and Water Quality Characterization [Weston, 2010a]). This study was undertaken after the installation of a dry-weather diversion into the Oxford Basin.

In the bacterial source identification study (Weston, 2007), birds were identified as a key contributor throughout MdRH and management actions targeting this source were recommended (Figure 11). Anthropogenic sources and transport mechanisms included boat-related maintenance activities, trash and food waste, washing activities (restaurants, restrooms, parking areas, and buildings), landscaping, and the MS4. Another key factor in the presence of bacteria within MDRH is the limited flow through the marina waters. This lack of circulation increases the potential for bacterial reservoirs to inhabit locations such as pier supports and boat hulls. These locations are also prone to limited ultraviolet (UV) penetration and subsequently allow increased microbial longevity.

Bacterial concentrations in sediments were found to be very low in all studies, suggesting that marina sediments do not act as a significant reservoir of fecal indicator bacteria.

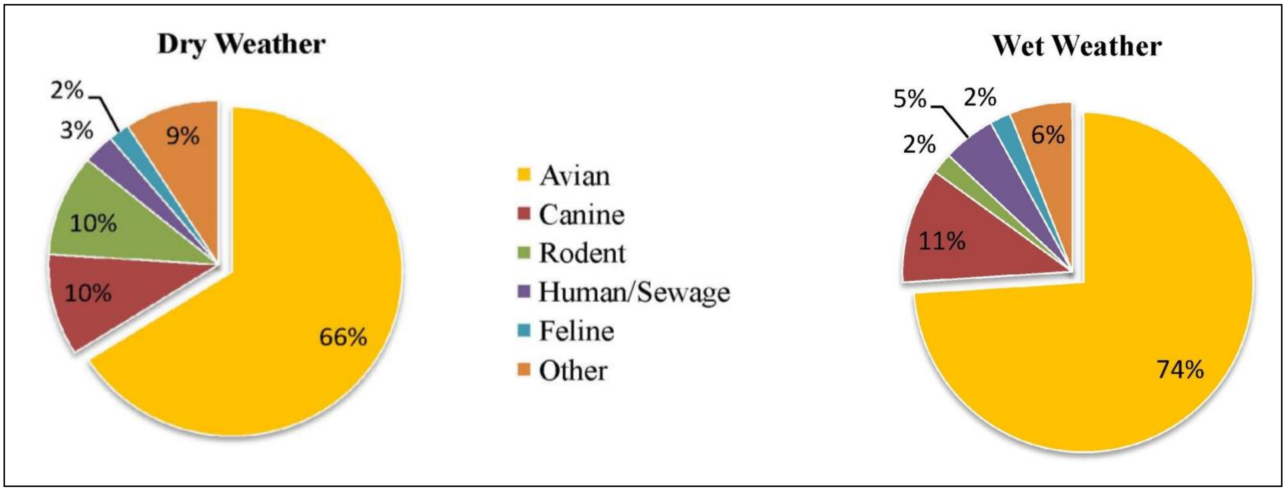


Figure 11. Ribotyping Results for Wet Weather and Dry Weather (Weston, 2007)

5.4 Prioritized Sources

Based on the source assessment, the issues within the MdR watershed were prioritized and sequenced in accordance with section VI.C.5.a.iv of the MS4 Permit (Table 15). As specified in the MS4 Permit, the highest priority is assigned to those pollutants with TMDLs according to the following criteria:

a. Controlling pollutants for which there are established WQBELS, or receiving water limitation with interim or final compliance deadlines within the current MS4 Permit term, or whose TMDL deadlines have passed without achieving the limitations,
b. Controlling pollutants for which there are established WQBELs or receiving water limitations with compliance deadlines (interim or final) between September 6, 2012 and October 25, 2017.

The second highest priorities are established for pollutants for which receiving water limitations are exceeded, or impairment is implicated as a result of discharges from the MS4. For purposes of the prioritization, third priority will be attributed to controlling pollutants with TMDL compliance dates beyond the term of the MS4 Permit.

Table 15. Prioritized Sources

Priority	Waterbody	Pollutant	Priority Sources*	Compliance Deadlines
1a	MdRH Back Basins	Bacteria (dry weather)	Birds, anthropogenic sources	March 18, 2007 final Summer and Winter dry.
1b	MdRH Back Basins	Copper	Boats, residential, stormwater runoff	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		Lead	Legacy sediment, stormwater runoff (suspended sediment)	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		Zinc	Commercial contributions, stormwater runoff	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		PCBs	Legacy sediment, boats, stormwater runoff (suspended sediment)	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		DDTs	Legacy sediment, stormwater runoff	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		p,p'-DDE	Legacy sediment, stormwater runoff	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.
		Chlordane	Legacy sediment, stormwater runoff (suspended sediment)	March 22, 2016 interim sediment allocations met. Final compliance March 22, 2018.

Table 15. Prioritized Sources

Priority	Waterbody	Pollutant	Priority Sources*	Compliance Deadlines
3	MdRH Back Basins	Bacteria (wet weather)	Birds, stormwater runoff, anthropogenic sources	July 15, 2021 final wet weather and geometric mean.
	MdRH Front Basins	Copper	Boats, residential, stormwater runoff	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		Lead	Legacy sediment, stormwater runoff (suspended sediment)	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		Zinc	Commercial contributions, stormwater runoff	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		PCBs	Legacy sediment, boats, stormwater runoff (suspended sediment)	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		DDTs	Legacy sediment, stormwater runoff	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		p,p'-DDE	Legacy sediment, stormwater runoff	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.
		Chlordane	Legacy sediment, stormwater runoff (suspended sediment)	March 22, 2019 interim sediment allocations met. Final compliance March 22, 2021.

*Although stormwater is not a primary source of pollutants it is a conveyance mechanism and is treated as a point source for purposes of the Toxicity TMDL.

6.0 STRUCTURAL AND NON-STRUCTURAL CONTROL MEASURES

The development of the MdR EWMP requires the identification of optimal combination of control measures necessary and sufficient to meet WQBELs and Receiving Water Limitations (RWLs) set in the MdR Bacteria TMDL, Toxics TMDL (modified in 2014), and 2012 MS4 Permit, thus, reducing the impact of stormwater and non-stormwater runoff on receiving water quality.

BMPs are generally classified as structural and non-structural or institutional BMPs. Structural BMPs can be further categorized into distributed and centralized. Minimum Control Measures (MCMs) are a subset of non-structural BMPs. These are classified as planning, enforcement and inspection, monitoring, source control, and Public Information and Participation Programs (PIPP) (i.e. education, outreach, and incentives).

The purpose of this section is to summarize structural and non-structural BMPs already in effect, planned BMPs that are not yet online, customization measures to improve existing BMPs, as well as potential new structural and non-structural BMP opportunities within the MdR area under the jurisdiction of the MdR EWMP agencies. The information presented in this section was compiled from the various Notice of Intents (NOIs), Time Schedule Orders (TSOs), MdR Bacteria and Toxics Implementation Plans , and information submitted directly by the MdR EWMP agencies for the purpose of this EWMP development.

The BMPs are listed in Table 16, Structural BMPs, and Table 17 Non-Structural BMPs. The tables list the control measures with their general types, date implemented, status, responsible agency, and a descriptive summary, followed by proposed potential customization to improve the existing BMPs, which will be further developed in the EWMP process. The locations of the existing structural control measures, when applicable, are shown in Figure 12.

Participating agencies are continuing to implement the MCMs required under the 2001 MS4 Permit. Applicable new MCMs will be implemented by the time the EWMP is approved by the Regional Board.

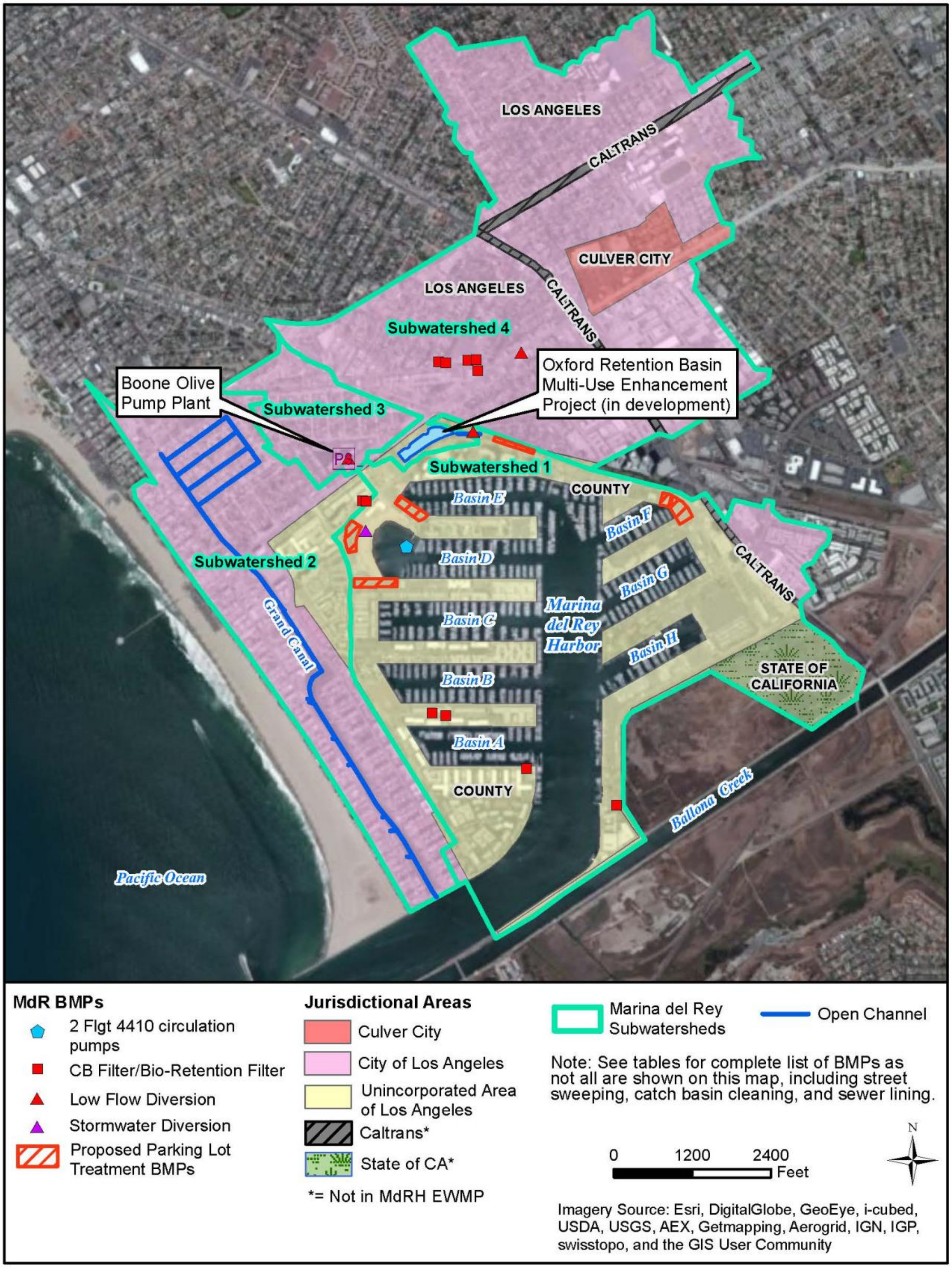


Figure 12. Existing Structural Control Measures within MdRH Boundaries

Table 16. List of Existing and Proposed Structural BMPs in the EWMP Agencies Jurisdictions Areas

Project "Title" // Descriptive Title	BMP Type	Status	Date	Agency	Location	Description	Potential Customization
Marina Beach Water Quality Improvement Project – Phase I	Mechanical Circulation Device	Complete	10/2006	County, LACDBH	Basin D / Mother's Beach	Two subsurface water circulators (2 Flygt 4410 circulation pumps) with 55-inch-diameter banana propellers were installed in Basin D just offshore from Marina Beach, attached under a special dock at Parcel No. 91. The circulators pump water toward the beach face at a rate of 60,000 gallons per minute (GPM) (30,000 GPM each).	
Marina Beach Water Quality Improvement Project – Phase II	Stormwater Diversion	Complete	8/2007	County, LACDBH	Basin D / Mother's Beach	A stormwater collection system was constructed to redirect all stormwater sheet flows from impervious areas currently draining into Marina Mothers' Beach and Back Basin D into Basin C.	Water Quality BMP can be added to downstream end of diversion pipe to improve Basin C
Tree Wells (5)	Bio-Retention Filter (Filterra)	Complete	1/2007	LACFCD	West and East side of Garfield Ave West and East side of Coeur D'Alene Abbot Kinney	Five bioretention filters were installed upstream of Project No. 5243 as an additional measure to prevent pollutants from entering Back Basin E. Each has a footprint of 6.5 ft by 4 ft to collect and treat dry weather runoff and stormwater serving three subdrainage areas of 0.3, 14.1, and 16.5 acres, a total of 30.9 acres.	
Project 3874, 5243, 3872	Low Flow Diversion	Complete	3/2007	LACFCD	539 Washington St. 3874 Boone-Olive Pump Station 3872 Oxford Pump Station	Three low flow diversions (92,000, 20,000 and 288,000 gal/day) were installed at three locations to divert dry-weather non-stormwater urban runoff to a sanitary sewer flowing into Hyperion Treatment Plant, to comply with the MdRH Dry Weather Bacteria TMDL. The diversions serve 61, 310, and 148 acres, respectively.	Form a low-flow diversion task force to recommend management actions that optimize operations for the MdRH. Implement a pilot project to test new technologies for low-flow diversion monitoring to better operate the system and characterize the sources of dry weather flows.
Sewer and Manhole Lining		Complete	1993	County, City of Los Angeles	Surrounding Basins D, E, and F	Existing sewers in MdRH have been lined since 1993 to reduce Stormwater Sewer Overflows. Since 2007, the County has lined and rehabilitated 11 miles of sewer lines and 208 manholes in the MdRH watershed.	
Catch Basin Retrofit		Complete / In Development	2011	County, City of Los Angeles, City of Culver City	Across MdRH	In the City of Los Angeles area, 293 catch basins have been retrofitted with trash screens (103 City-owned and 190 LACFCD-owned catch basins with trash screens). Catch basin cleaning has been conducted at a typical frequency of at least 3 to 4 times/year. The City of Culver City has retrofitted four catch basins with full capture devices. The County plans to retrofit 40 catch basins in the MdR with full-capture devices.	
Parking Lot Retrofits		In Development	Yearly until 2017	County	Parking Lots 5, 7, 9, and Library	The retrofitting of three parking lots and the library facility in MdR is underway based on the multi-pollutant implementation plan developed in 2011 for MdR. The retrofitting will incorporate various BMPs such as bioretention planters, biofiltration systems, porous pavement, and rain barrels. The goal of these parking lot projects is to treat runoff coming from the County facilities before it enters the harbor.	Implement a pilot study to assess the effectiveness of the retrofitted parking lots in reducing contaminants loads from their respective drainage areas and propose potential customizations to improve performance if deemed necessary.
Oxford Retention Basin Multi-Use Enhancement Project		In Development	Fall 2015	County, LACFCD	Oxford Retention Basin	This project, scheduled to begin construction in 2014, is designed to enhance flood protection, reduce runoff pollution, and significantly improve the quality of plant and wildlife habitat within the facility, as well as its aesthetic appeal. Diseased trees and non-native plants will be replaced with native, more drought-tolerant species. The project will also provide new recreational and safety amenities, including a walking path, observation areas, wildlife-friendly lighting, and more attractive tubular fencing. The project will improve water quality by increasing circulation and dissolved oxygen levels of the water in the basin by constructing a circulation berm.	Implement a monitoring program to assess the impact of the project on the receiving water quality.
Tree Wells		Proposed / In Development	Within 60 months of TSO adoption	City of Los Angeles, LACFCD	To Be Decided	Tree wells were proposed in the Time Schedule Order (TSO) Request for MdRH Bacteria TMDL. LACFCD is constructing seven bioretention areas on Admiralty as part of Oxford Basin Project.	
Green Streets		To Be Assessed				MdR is highly urbanized with the potential for implementation of green streets practices across its four subwatersheds.	Green streets will be assessed as a regional BMP through the assessment of the execution of a series of distributed BMPs across the various jurisdictions and subwatersheds in the MdR watershed to capture the 85th percentile, 24-hour storm event.
Ballona Lagoon and Venice Canals		To Be Assessed				The canals service Subwatershed 2, South of Washington Blvd and Venice Beach, from Ballona Grand Canal (East) to the West Canal then discharging at the MdRH mouth as shown in Figure 12. They are generally surrounded by residential areas with habitat protection buffer strips on both banks.	
Boone Olive Pump Station		To Be Assessed				The pump station is located at 581 Washington Street, Venice, CA 90291. It services the flows from Subwatershed 3.	

Table 17. List of Existing and Proposed Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies Jurisdictions Areas

Project "Title" // Descriptive Title	BMP Type 1	BMP Type 2	Status	Regulatory Driver	Date	Agency	Description	Potential Customizations
PLANNING								
Marina del Rey Bacteria TMDL Implementation Plan (MDRWRA, 2007)	Planning	Compliance	Complete	Bacteria TMDL	01/2007	County, Multiple	The plan includes procedures, plans, programs, and actions to be carried out through the MdR watershed in order to reduce bacteria concentrations at this impaired water body to comply with the Bacteria TMDL requirements.	The 2012 MS4 Permit allows Permittees to voluntarily choose to implement an Enhanced Watershed Management Program (EWMP), which includes prioritization of water-quality issues; identification of implementation strategies, CMs, and BMP to meet pertinent standards; integrated water-quality monitoring; and opportunity for stakeholder input, using integrated planning, to comprehensively evaluate opportunities to implement multi-benefit regional projects to improve water quality. These projects may also achieve other benefits such as flood protection, water supply enhancement, recreational opportunities, and wildlife habitat enhancement.
Marina del Rey Multi-Pollutants Implementation Plan (LADPW, 2012)	Planning	Compliance	Complete	Toxics TMDL, Trash TMDL	03/2011	County	The plan includes procedures, plans, programs, and actions to be carried out through the unincorporated area of MdR watershed in order to reduce toxics and bacteria concentrations at this impaired water body to comply with the Toxics and Bacteria TMDL requirements.	
Marina del Rey Toxics Implementation Plan (City of Los Angeles, 2011)	Planning	Compliance	Complete	Toxics TMDL	03/2011	City of Los Angeles, Multiple	The plan includes procedures, plans, programs, and actions to be carried out through the MdR watershed within the City of Los Angeles, Caltrans and City of Culver City boundaries in order to reduce bacteria concentrations at this impaired water body to comply with the Toxics TMDL requirements.	
ENFORCEMENT								
Illegal Connection/ Illicit Discharge (IC/ID) Program	Enforcement	IC/ID	Existing/ Ongoing	MS4 Permit	2001 - present	LACFCD County, City of Los Angeles, City of Culver City	This program involves coordination of multiple departments to cease and eliminate pollution by IC/IDs to the stormwater system. The County has an active education, response, and enforcement program. The data are tracked for the County region and for the County's Road Maintenance Division (RMD), as part of its annual pre-storm season drainage inspection program. The cities of Los Angeles and Culver City have citywide programs that have also been implemented in MdR watershed.	
Construction Inspections Industrial/Commercial Facility Inspections	Enforcement	Inspections (w/ Education)	Ongoing	MS4 Permit		County, City of Los Angeles, City of Culver City	Los Angeles County MS4 Permit Program has been implemented in MdR watershed as part of a citywide and county wide program. The City of Culver City has a citywide program that has also been implemented in the MdR watershed.	
Restaurant Inspections	Enforcement	Inspections (w/ Education)	Ongoing	MS4 Permit	2004	County, City of Los Angeles	Annual inspections target restaurants as a potential source of food waste. This program identifies facilities lacking minimum stormwater BMPs and housekeeping practices - for waste disposal, grease containers, mop sinks, and other housekeeping activities.	
Low Impact Development (LID) ordinance	Enforcement	Ordinance	Existing	MS4 Permit	Jan 2009 May 2012 In Development	County, City of Los Angeles, City of Culver City	The City of Los Angeles is currently amending sections of the LID Ordinance, as well as its Stormwater and Urban Runoff Pollution Control Ordinance (L.A.M.C. Chapter VI, Article 4.4) to meet all the MS4 Permit requirements. The County adopted a revised LID ordinance on November 12, 2013 to meet all MS4 Permit requirements. Based on a communication with the City of Culver City staff, an ordinance is being developed based on the existing ones for the County and the City of Los Angeles; it is expected to be in effect by December 2014.	

Table 17. List of Existing and Proposed Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies Jurisdictions Areas

Project "Title" // Descriptive Title	BMP Type 1	BMP Type 2	Status	Regulatory Driver	Date	Agency	Description	Potential Customizations
Green Street Policy	Enforcement	Ordinance	Existing	MS4 Permit	Jul 2011 In Development	County, City of Los Angeles, City of Culver City	The City of Los Angeles and the County have adopted a Green Street Policy that is in compliance with the requirements of the MS4 Permit for its portion in the watershed. Based on a communication with the City of Culver City staff, an ordinance is being developed based on the existing ones for the County and the City of Los Angeles; it is expected to be in effect by December 2014.	
Standard Urban Stormwater Mitigation Plan (SUSMP)	Enforcement	Ordinance	Existing	MS4 Permit	Ongoing	City of Los Angeles	The City of Los Angeles has several projects in MdR Watershed as part of its implementation of the Citywide SUSMP program	
SOURCE CONTROL								
Brake Pad Partnership	Source Control	Alternative Product	Complete	MS4 Permit, Toxics TMDL	2010	Multiple	MdRH Agencies have supported the Brake Pad Partnership and the adoption process of SB 346 (adopted in 2010) through monetary contributions, in-kind technical services, and committee memberships. Caltrans, in conjunction with the State Board, contributed close to $1,000,000 to research on impacts of brake pads to surface waters. The Brake Pad Partnership is an example of true source control that will remove copper brake pads from the market, and therefore, a source of loading to the environment. SB346 requires that brake pads contain no more than 5% copper by weight by 2021 and no more than 0.5% copper by weight by 2025.	
Trash Removal and Control	Source Control		Proposed	Trash TMDL		City of Los Angeles, County, City of Culver City	The Santa Monica Bay Debris TMDL requires responsible parties to reduce their trash contribution to the Santa Monica Bay by 10% each year for a period of 10 years with the goal of zero trash to waterbodies. The County and City of Los Angeles have achieved every yearly milestone, solely through the implementation of structural measures without having to take credit for implemented institutional measures that are also resulting in a reduction of trash. Other programs are implemented by other entities for trash control. For example, the City of Los Angeles Bureau of Street Services (BSS) offers a reward for information resulting in the identification of persons committing an act of illegal dumping.	

Table 17. List of Existing and Proposed Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies Jurisdictions Areas

Project "Title" // Descriptive Title	BMP Type 1	BMP Type 2	Status	Regulatory Driver	Date	Agency	Description	Potential Customizations
MAINTENANCE								
Street Sweeping	Maintenance	Maintenance	Ongoing	Toxics TMDL, Trash TMDL, Bacteria TMDL	2008	County, Multiple	County: Streets are swept 2x/week Mondays and Thursday. Parking lots are swept at least 2 times/week and up to 6 times/week. Ten sweepers are used in MdRH, 4 vacuum and 6 mechanical stationed with the RMD-3 fleet. One of each is compressed natural gas (CNG) powered versus liquefied petroleum gas (LPG) powered. Lot 15: 6x/week (winter); daily (summer), Lots 11, 13 and 16: 4x/week. City of Los Angeles / Caltrans: Bureau of Street Services (BSS) conducts sweeping: 130 mechanical broom sweepers, 100 operators, weekly sweeping for posted streets and monthly sweeping for arterial streets. Has a delegated maintenance agreement with Caltrans to sweep Venice and Lincoln/Pacific Coast Highway. The City of Culver City has a street sweeping program that includes weekly sweeping of street in its portion of MdRH. Current schedule is side Streets – Monday and Tuesday 8:00 AM to 12:00 PM, Washington Boulevard – Monday through Friday 4:00 AM to 6:00 AM. The City of Los Angeles BSS currently sweeps approximately 63 curb miles (some swept weekly and some swept monthly) located within the City of Los Angeles' portion of MdRH. Maintenance responsibility of Lincoln Boulevard (State Route 1) and Venice Boulevard (State Route 187) has been delegated to the City of Los Angeles by a Delegated Maintenance Agreement. Caltrans will be working closely with the City of Los Angeles to achieve optimal maintenance performance that includes sweeping, trash pickup, and drainage cleanup.	
Catch Basin Cleaning	Maintenance	Maintenance	Ongoing	Toxics TMDL, Trash TMDL, Bacteria TMDL	2011	City of Los Angeles, County, City of Culver City	The City of Los Angeles catch basin cleaning occurs at a typical frequency of 3 to 4 times per year, targeting trash. Within the County area, catch basins are be cleaned quarterly, semi-annually or every year depending on the prioritization of each catch basin. The City of Culver City cleaning occurs three times per year.	
County Beaches - Sanitation Program	Maintenance	Maintenance	Ongoing	MS4 Permit, Bacteria TMDL		County	County staff "sanitizes" the beach 7 days a week, provided the sand is not wet. A tractor with rake and screen system is used to collect trash and turn off the beach sand. This process removes solids and debris and allows the sun to "sanitize" the sand during the day. Operations are between 5 am and 1:30 pm daily.	
PUBLIC INFORMATION AND PARTICIPATION PROGRAM								
Billboard Educational Campaign	PIPP	Outreach, Education	Complete	MS4 Permit, Toxics TMDL	Feb 2012		This program was a countywide, 8-week billboard campaign designed to promote protective waste management practices. A used motor oil educational advertisement was displayed on 20 billboards throughout the County.	

Table 17. List of Existing and Proposed Non-Structural BMPs in the Marina del Rey Harbor EWMP Agencies Jurisdictions Areas

Project "Title" // Descriptive Title	BMP Type 1	BMP Type 2	Status	Regulatory Driver	Date	Agency	Description	Potential Customizations
Boating Clean and Green Campaign	PIPP	Outreach, Incentive	Ongoing	Toxics TMDL, Bacteria TMDL	Apr 1997	County	This statewide educational and outreach program is designed to educate boaters about environmentally sound boating practices. The County held a focus group session to bring boaters together to openly share observations on boater behavior and motivations as they relate to water pollution. The boaters shared their observations on what is needed to better enforce current boater regulations as well as what visual messages would be most effective in influencing boater behavior. Based on the results of the Boater Focus Group, the County started the "Boaters Help Keep Marina del Rey and Santa Monica Bay Clean" campaign. A series of posters were created and posted at strategic sites in the harbor.	
Dock Walker Training	PIPP	Education, Outreach	Ongoing	Bacteria TMDL		LACDBH	This program consists of volunteers who inspire and educate boaters and other recreators to be safe and environmentally sound while boating in California. Through this program, general boater educational materials were developed.	
Clean LA	PIPP	Education, Outreach	Ongoing	Bacteria and Toxics TMDLs	2002	County	County of Los Angeles portal to a number of award-winning programs that help residents, businesses, and government keep the County clean and sustainable.	
School Outreach	PIPP	Education, Outreach	Ongoing	MS4 Permit, Bacteria TMDL, Toxics TMDL, Trash TMDL		City of Los Angeles, LACFCD	Los Angeles County MS4 Permit and MdRH Bacteria TMDL Implementation Plan Programs: This program includes making targeted phone calls to all public and private K-12 schools within the MdRH to notify them of the availability of environmental education programs offered by the LACFCD and City of Los Angeles, emphasizing to school administrators that these programs comply with State curriculum standards and provide opportunities to fulfill service-learning requirements.	
Clean Marinas Program	PIPP	Outreach, Incentive	Ongoing	Bacteria TMDL, Trash TMDL	Apr 2006	County	This program is a partnership among private marina owners, government marina operators, and yacht clubs that was developed to provide clean facilities to the boating community.	
Smart Gardening	PIPP	Education, Outreach, Incentive	Ongoing	Toxics TMDL, Bacteria TMDL		County	This program targets businesses, schools, and homeowners through outreach and education materials for water-wise gardening. Topics covered include drought-tolerant plants and native plants, irrigation methods and associated water use/savings, irrigation management, and structural BMPs (i.e., rain barrels, cisterns, green roofs). The program includes educational workshops, training events, and the design/build of demonstration gardens targeting local residences and businesses. The County operates 12 Learning Centers throughout the County. They are equipped with educational and demonstration materials designed for program workshops. Each is landscaped with various backyard and drought-tolerant plants. Some of the centers also include grass recycling demonstrations. The County is partnering with the University of California Cooperative Extension "Master Gardeners" volunteers from the community. The volunteers are trained to promote environmentally responsible and sustainable horticultural practices in the home, community, and school landscapes by conducting workshops and demonstrations; speaking to community groups; educating teachers and parents at school gardens; and answering gardening questions at fairs and farmers markets as well as staffing email and phone helplines.	

7.0 CONTROL MEASURE PERFORMANCE ANALYSIS

Although the performance of any given BMP is difficult to predict without a detailed evaluation of design and site characteristics, monitoring program, and analysis methodology, there are many studies that may provide some useful generalizations for BMP efficiencies. Numerous studies, national resources, and methodologies that focus on the assessment of BMP performance and selection process were reviewed in the development of this, and the following, sections. These resources include the International BMP Database studies and guidelines, the National Pollutant Removal Performance Database, as well as studies and guidance documents performed across the nation.

The first subsection (7.1) provides a summary of the considerations associated with the process of BMP performance assessment and affecting the comparisons between BMP-type application and among different BMP types. The next subsection (7.2) presents the efficiency calculation methods used in the comparison with their limitations, followed by (7.3) the compilation of available BMP performance analysis studies and databases results and the generation of BMP performance efficiencies using readily available reported data for Southern California and (4) comparison of the BMP performance data from the compiled and calculated information. This information will be used in the generation of a non-quantitative effectiveness and performance comparison matrix for the various BMP strategies, in accordance with the following sections.

7.1 Terms Definition

To describe the level of treatment achieved and how well a device, system, or practice meets its goals, three terms are usually employed: (a) performance, (b) effectiveness, and (c) efficiency. These terms are defined, respectively, as a measure of how well a BMP system (a) meets its goals for stormwater that the BMP is designed to treat, (b) meets its goals in relation to all stormwater flows, (c) removes pollutants.

The focus of this control measure performance analysis is to determine the efficiency of various BMP types, through a quantitative percent removal metric, noting that efficiency does not capture all the aspects relating to performance and effectiveness, but allows evaluation of the ability of a BMP to meet any regulatory goals based on percent removal.

Performance and effectiveness metrics can be generated by developing a ranking matrix comparing non-quantitative measures such as volume reduction benefit, operations and maintenance (O&M) needs, failure potential, sensitivity to site conditions, applicability for a certain land use, potential for thermal increases, and groundwater contamination.

7.2 Factors Affecting Performance Comparison

The performance, efficiency, and effectiveness of a structural BMP, where, generally, inflow and outflow of a treatment type BMP can be monitored, varies by design differences, operational and maintenance approaches, pollutant, different input concentrations, storm characteristics (such as rainfall amount, rainfall density, antecedent weather), and age.

Structural BMP performance is dependent on many design and site-specific details. Specific characteristics of regional climate, soil type, BMP-specific engineering details, or maintenance programs, even if reported, cannot be accurately incorporated in the quantitative assessment and comparison of a single BMP type or across the different BMP types.

It is equally important to consider the size and land use of the contributing drainage area; which is directly related to the pollutant loading and initial concentrations generated by a storm event. With most BMPs, efficiency decreases with smaller influent concentration. If the inflow pollutant concentration is very low, a low or negative removal percentage can be recorded because limited performance potential can be achieved by the BMP. In addition, stormwater quality varies during a storm event, from event to event at the same site, and between sites of the same land use. In addition, as the concentration approaches its analytical detection limit, the effect of the variability of laboratory techniques becomes more significant. For high influent concentrations, a negative efficiency may be due to resuspension of pollutants, a change in pH that dissolved precipitated or sorbed pollutants, or erosion of the basin side.

Another important factor affecting the reported or actual performance of a BMP lies in the associated monitored storm event characteristics. For example, studies with few or no major storm events may report low removal efficiencies because both influent and effluent concentrations were low. In addition, a large number of storms must be monitored to statistically discern a difference in performance among BMPs.

In addition, note that different programs collect different analytes at different frequencies. Even when studies are similar, inconsistencies in sampling and assessment methods can yield widely different efficiencies. For example, several categories of BMPs can be effective at reducing the overall runoff volume, hence the associated pollutants loads, which would not be accounted for if only concentrations are being monitored.

The statistical analysis results comparing performance efficiencies of different BMP types should be examined with an understanding of the caveats associated with the data limitations. Whereas the use of BMPs is continuously increasing in Southern California and across the nation, and the monitoring and reporting requirements are increasing, the number of monitoring studies is still limited. In many cases, reported monitoring information is just used for compliance purposes and not further analyzed for BMP efficiency information. Across the various BMP categories, the range of data regarding concentrations, loads, or percent removal for a particular pollutant is generally high, resulting in a large difference between the lowest and highest removal efficiencies. The greater the range, the less confidence there is in the median and average removal efficiency.

Finally, the effect of infiltration and the resulting volume reduction cannot be ignored when comparing BMPs. A higher concentration in the effluent of a BMP with high infiltration compared to another similar BMP with limited or no infiltration is not indicative of a lower performance because the former is associated with lower loads from lower flows, thus yielding higher efficiency.

7.3 Analysis and Results

The efficiency of stormwater structural BMPs can be evaluated in a number of ways (the listing and description of these methods are beyond the scope of this document). The two most common computation methods are event mean concentration (EMC) efficiency ratio (ER) and mass balance or loads summation, where pollutant removal efficiency, usually represented as a percentage, specifically refers to the pollutant reduction from the inflow to the outflow of a system. As a general rule, the concentration-based technique often results in slightly lower performance efficiencies than the load-based technique.

7.3.1 EMC Efficiency Ratio

The ER is defined as the percent reduction of the average inflow and outflow EMC of pollutants over a period of time.

$$ER = \frac{Average\ EMC_{inflow} - Average\ EMC_{outflow}}{Average\ EMC_{inflow}}$$

This method weights EMCs from all storms regardless of their magnitude such that a high concentration, high volume event (higher loads) has weight equal to a low concentration, low volume (lower loads) event. Thus, “cleaner” watersheds record lower performances (the logarithmic data transformation generally minimizes the difference between EMC and mass balance calculations). It also does not account for storage capacity. Also, using this method, efficiency can vary depending on whether efficiency was based on average EMCs or an average of efficiency of each storm event.

7.3.2 Summation of Loads

The Summation of Loads (SOL) approach defines efficiency as the ratio of the summation of all incoming loads to the summation of all outflow loads, where loads are calculated as the product of the EMC by the corresponding volume.

$$SOL = \frac{Sum\ \ Loads_{inflow} - Sum\ Loads_{outflow}}{Sum\ Loads_{inflow}}$$

This method assumes that the removal of a constituent of concern is most relevant over an entire period of analysis, such as yearly. Generally, a small number of large storms dominate efficiency. In this method, some data points without a corresponding inflow or outflow flow volume cannot be used. This is not the case for the ER method because it is volume independent.

7.3.3 International BMP Database

The International BMP Database (WERF et al., 2013) was used to calculate BMP performance percentages for the toxic metals copper, lead, and zinc, in addition to fecal coliform and total suspended solids (TSS). For each BMP type, every BMP site concentration and/or volume was averaged and/or summed for every storm event, for each reported pollutant inflow and outflow concentration/inflow and outflow volume. The ER and SOL were then calculated using these averages as percentage change values. The process was performed on data filtered on the national level (USA), California State level (CA), and Southern California (SOCAL) using San Diego, Orange, Los Angeles, Ventura, and Riverside counties. The number of events used, resulting mean, median, minimum, maximum, first quartile, and third quartiles, for each BMP category, for the USA, CA, and SOCAL are compared in Table 18. This analysis is based on pollutant reduction and does not consider volume reduction. The BMP database publications reported that normally-dry vegetated BMPs (filter strips, vegetated swales, bioretention, and grass lined detention basins) appear to have substantial potential for volume reduction on a long-term basis, on the order of 30 percent (%) for filter strips and grass-lined detention basins, 40% for grass swales, and greater than 50% for bioretention with underdrains. Bioretention facilities without underdrains would be expected to provide greater volume reduction.

Table 18. Structural BMP Efficiency Potential Comparison for TSS

BMP CATEGORY	Region	N	Efficiency Ratio - ER - Percent Concentration Reduction						Sum of Loads - SOL - Percent Load Reduction					
			Avg	Min	Q1 25%	Med	Q3 75%	Max	Avg	Min	Q1 25%	Med	Q3 75%	Max
BIORETENTION														
Biofilter - Grass Strip	CAL	235	66	-281	55	91	100	100	80	-38	78	96	100	100
	SOCAL	104	60	-281	53	100	100	100	82	-38	76	98	100	100
	USA	392	46	-2,683	52	85	100	100	84	-38	83	98	100	100
Biofilter - Grass Swale	CAL	59	21	-1,700	46	74	100	100	74	-162	78	89	100	100
	SOCAL	59	21	-1,700	46	74	100	100	74	-162	78	89	100	100
	USA	222	-34	-2,125	-29	39	80	100	48	-295	51	82	95	100
Biofilter - Wetland Vegetation Swale	USA	43	-15	-440	-86	50	100	100	.	.	.	.	.	.
Bioretention	USA	330	-1063	-350,777	61	91	99	100	57	-1200	84	97	100	100
NPRP* - Grass and Dry Swale	USA	15		18	69	81	87	99		18	69	81	87	99
NPRP* Bioretention Filter	USA	10		-100	15	59	74	98		-100	15	59	74	98
FILTRATION														
Filter - Other Media	CAL	18	36	-62	10	40	56	100	36	-62	10	40	56	100
	SOCAL	18	36	-62	10	40	56	100	36	-62	10	40	56	100
	USA	92	22	-4,700	57	89	100	100	56	-1853	59	96	100	100
Filter - Peat Mixed With Sand	CAL	19	82	13	71	98	100	100	82	13	71	98	100	100
	SOCAL	19	82	13	71	98	100	100	82	13	71	98	100	100
	USA	19	82	13	71	98	100	100	82	13	71	98	100	100
Filter - Sand	CAL	140	67	-1,590	81	92	97	100	80	-122	81	92	97	100
	SOCAL	87	81	-122	81	92	97	100	80	-122	81	92	97	100
	USA	376	65	-1,590	70	88	98	100	78	-125	80	91	96	100
NPRP* - Organic and Sand	USA	18								8	80	86	92	98

Table 18. Structural BMP Efficiency Potential Comparison for TSS (Continued)

BMP CATEGORY	Region	N	Efficiency Ratio - ER - Percent Concentration Reduction						Sum of Loads - SOL - Percent Load Reduction					
			Avg	Min	Q1 25%	Med	Q3 75%	Max	Avg	Min	Q1 25%	Med	Q3 75%	Max
INFILTRATION														
Infiltration (Percolation) Trench	USA	36	100	100	100	100	100	100	.	.	.	.	.	.
Infiltration Basin	CAL	13	80	17	64	91	97	100	.	.	.	.	.	.
	SOCAL	13	92	55	92	96	99	100	95	88	94	96	98	100
	USA	53	-391	-12,763	55	87	99	100	.	.	.	.	.	.
Porous Pavement - Porous Asphalt	USA	12	80	-19	78	93	98	100	.	.	.	.	.	.
NPRP* - No underdrain	USA	4								0	62	89	96	97
DETENTION AND SETTLING														
Detention - Underground Vault, Tank or Pipe(s)	USA	21	26	-128	-31	18	100	100	21	0	0	19	46	46
Detention Basin (Dry) - Concrete or Lined Tank and/or Basin With Open Surface	CAL	13	5	-279	-27	45	75	90	5	-279	-27	45	75	90
	SOCAL	13	5	-279	-27	45	75	90	5	-279	-27	45	75	90
	USA	46	65	-279	67	92	100	100	11	-279	-27	56	76	90
Detention Basin (Dry) - Surface Grass-Lined Basin That Empties Out After A Storm	CAL	63	63	-282	63	76	83	100	69	-266	75	84	91	100
	SOCAL	63	63	-282	63	76	83	100	69	-266	75	84	91	100
	USA	332	32	-2,220	39	72	100	100	-5	-4,583	45	74	90	100
NPRP* - Dry Pond	USA	10								-1	18	49	71	90
Retention Pond (Wet) - Surface Pond With a Permanent Pool	CAL	54	-361	-5,056	-281	0	95	100	95	85	94	97	98	100
	SOCAL	13	64	0	33	75	88	98	93	85	91	95	95	98
	USA	911	15	-8,600	66	93	100	100	-4	-8,600	67	90	99	100
NPRP* - Wet Pond	USA	46								-33	60	80	88	99
Wetland - Basin With Open Water Surfaces	CAL	8	.	.	.	.	.	.	.	.	.	.	.	.
	SOCAL	8	79	17	70	91	96	98	.	.	.	.	.	.
	USA	331	44	-1,000	45	77	94	100	40	-351	24	66	90	100

Table 18. Structural BMP Efficiency Potential Comparison for TSS (Continued)

BMP CATEGORY	Region	N	Efficiency Ratio - ER - Percent Concentration Reduction						Sum of Loads - SOL - Percent Load Reduction					
			Avg	Min	Q1 25%	Med	Q3 75%	Max	Avg	Min	Q1 25%	Med	Q3 75%	Max
Wetland - Basin Without Open Water (Wetland Meadow Type)	USA	3	57	50	50	59	62	62	.	.	.	.	.	.
Wetland - Channel With Wetland Bottom	USA	213	-7,440	-1,533,923	0	64	100	100	-30006	-1,591,712	50	80	96	100
NPRP* - Wetland	USA	40								-100	46	72	86	100
MANUFACTURED DEVICE														
Manufactured Device	CAL	90	4	-1298	-2	43	75	100	2	-1298	1	65	94	100
	SOCAL	65	-17	-1298	-25	33	67	100	-56	-1298	-16	15	81	99
	USA	1044	43	-1506	19	62	92	100	34	-1298	8	55	87	100
COMPOSITE														
Composite	USA	268	-38	-17963	63	92	100	100	-205	-11394	81	94	100	100

*NPRP Database Percent TSS Removal: Whenever possible SOL were used; when more than one method was used to calculate pollutant removal in a specific BMP study, SOL were entered into the database rather than ER. Averages were not reported.
National level = USA, California State level = CAL, and Southern California = SOCAL.

7.3.4 National Pollutant Removal Performance Database

The National Pollutant Removal Performance (NPRP) Database was developed by the Center for Watershed Protection (CWP, 2007). It includes a total of 166 studies published through 2006. The data were statistically analyzed to derive the mean and quartile removal values for the major groups of stormwater BMPs for copper, zinc, bacteria, and TSS among others. The data did not include lead. Whenever possible, SOL were used. When more than one method was used to calculate pollutant removal in a specific BMP study, SOL were entered into the database rather than ER. Averages were not reported. The NPRP efficiencies for TSS are summarized in Table 18.

In selecting a BMP performance efficiency assumption, the 75-percentile removal efficiency should be used, rather than the median. Use of the median may lead to design standards that aim to the middle range of performance, and thus to BMPs showing a mediocre performance. The number of storm events, and the average, median, minimum, maximum, first quartile, and third quartile results for each BMP category are listed in Table 18 for the data obtained from the BMP Database for Southern California, California, and the USA, as well as the NPRP database. Figure 13 was generated as an example to demonstrate the wide range of variability in TSS removal efficiencies in the following areas: (1) among the methods used to calculate efficiencies, (2) among the different BMP categories, and (3) and among the different storm events, even with the exclusion of outliers. The figure presents a comparison of the efficiencies calculated for Southern California BMP applications, using both ER and SOL.

As expected, manufactured devices display the highest level of variability due to the variety of devices used. The variability is also relatively high for detention ponds, and bioretention strips and swales. Minimum values often include negative efficiencies, which may be the result of a natural process, or a design or operational flaw. In general, filters and infiltration basins showed the best efficiencies, in addition to biofiltration (grass strips and grass swales), followed by grass lined detention ponds and retention ponds.

An assessment of the statistical analysis performed and comparisons of efficiencies developed for different regions and using different methods, presented in Table 18, will be conducted in order to select “best-suited” efficiency values. The values thus may be used in the BMP evaluation and selection process with minimum or controlled risk. A stochastic two-stage modeling approach might be developed, if found necessary, to manage risk of non-compliance, with a specified confidence level.

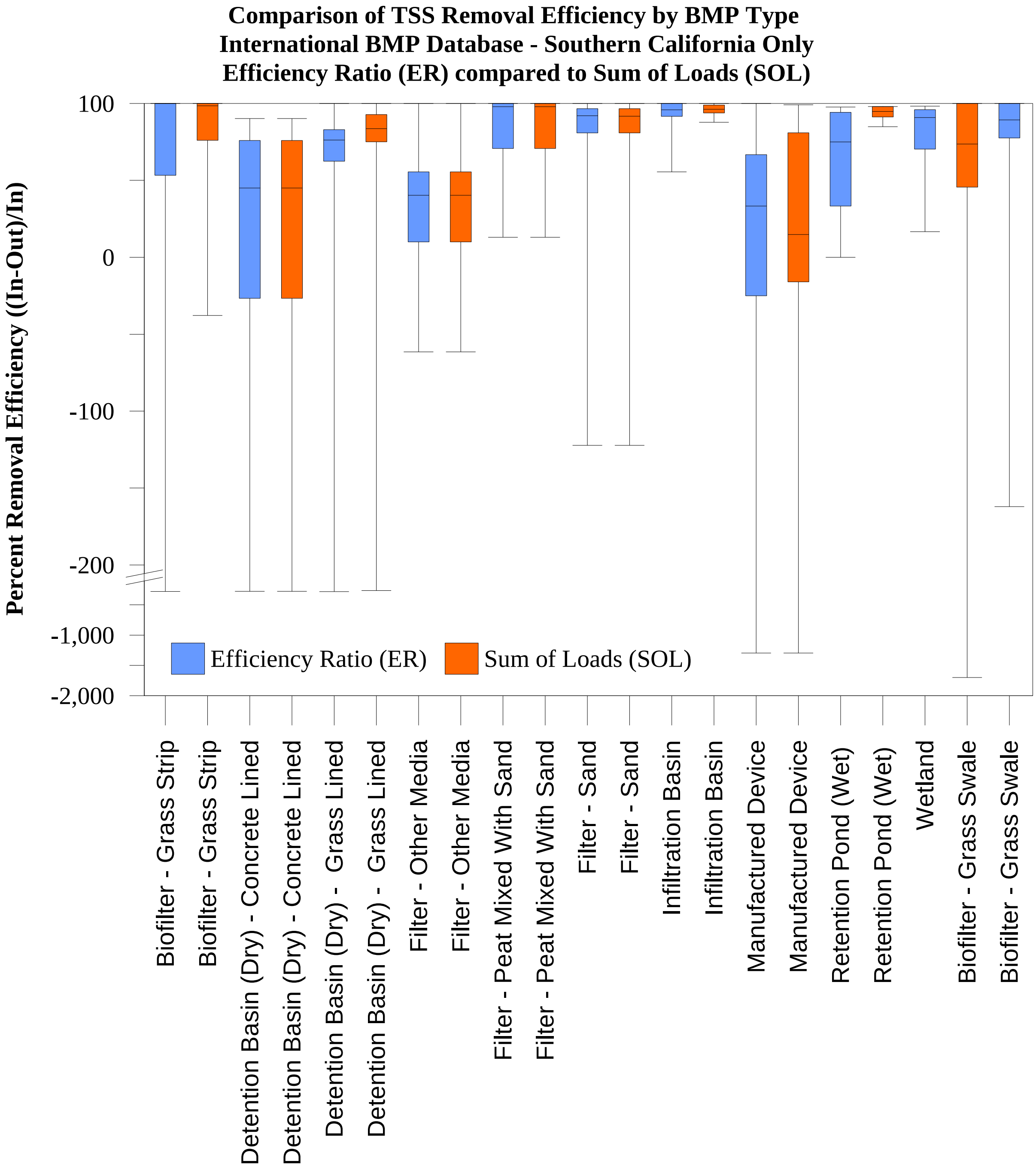


Figure 13. Comparison of BMP Efficiencies for Southern California (BMP Database)

7.3.5 BMP Performance and Effectiveness Matrix

A composite average rating score, Effectiveness Factor (EF), will be developed to rank different BMPs based on a multitude of factors affecting the performance and effectiveness of a BMP, as previously discussed. The scores will be assigned quantitative values, such as -10 through 10, with 10 being the score for the highest positive aspect and -10 the score of the highest negative aspect of a certain BMP. The scores will be based on the qualitative evaluation of the effectiveness of BMPs in the context of MdR. Such qualitative analysis will include factors such as volume reduction, beautification potential, land needs, associated cost and risk. The BMP specific efficiency estimates, ER or SOL, will be weighted by the site-specific composite scores, resulting in the EF. The EF will be used to rank the BMP types with the highest EF associated with the relatively best performance and effectiveness.

A Cost Effectiveness Metric (CEM) ($/mass reduction/year and/or $/volume reduction/year) will be developed using the following factors: (1) estimated load removal potential of a certain strategy, efficiency measure, in terms of volume reduction/year and mass reduction/year; (2) Capital Cost ($); (3) Life Cycle Cost, ($/Year); and/or (4) Cost associated with drainage areas ($/Acre). LID designs, such as rain barrels and roof gardens, will be used in the comparison of various control measure strategy scenarios.

7.3.6 Evaluation of Nonstructural BMPs

The direct impact of Non-structural non-treatment type BMPs such as aggressive street sweeping, true source control, enhanced inspections, bird exclusion devices, runoff reduction programs cannot be easily quantified with efficiency metrics and require innovative methods to measure effectiveness that are not determined through a comparison of inflow and outflow. However, some studies have attempted to quantify the benefits of nonstructural control measures. Supporting evidence and studies do exist, however, justifying the load reduction apportionment for various nonstructural programs that may be implemented within the MdR watershed. Recent pilot studies conducted in Southern California provide a basis for estimated load reductions. In this section, a conservative approach was adopted to quantifying the efficiency of nonstructural control measures. It is expected that the estimates of potential reductions presented in this section will be increased based on current and future studies for toxics.

When targeted at the actual pollutant source, studies have shown nonstructural solutions, such as operational source controls, to be very effective at removing the source and therefore reducing concentrations and/or loads to below regulatory requirements, with the added benefit of being highly cost effective. The recently approved legislation reducing the concentration of copper in brake pads in California was achieved through the Brake Pad Partnership that provided scientific data on the impact of copper from brake pads on water quality in urban areas. This true source control approach will significantly reduce copper concentrations in most urbanized watersheds, including MdR.

The City of San Diego performed a street sweeping pilot study (Weston, 2010b) to assess the effectiveness of various street and parking lot sweeping strategies. The study demonstrated that aggressive street sweeping was effective in reducing metals and pesticide loading and, to a lesser extent, bacteria. The Multi-Pollutant Implementation Plan for the Unincorporated Area of MdRH (LADPW, 2012) used this study to develop a potential mass-based load reduction efficiency, presented in Table 19.

Table 19. Summary of Nonstructural Control Measures Effectiveness

Nonstructural Program (targeted source)	Range of Potential Load Reductions			
	Metals – Minimum	Metals – Maximum	Bacteria – Minimum	Bacteria – Maximum
Sweeping (Streets/Parking Lots)	13%	15%	8.5%	9.5%
Birds	–	–	7%	10%
Parking garage structures	3%	6%	3%	6%
Restaurants	1%	4%	1%	4%
MS4 catchment/sewage	1%	3%	1%	3%
Runoff reduction	1%	2%	1%	2%
Buildings and construction	1%	2%	–	1%
Pet waste	–	–	1%	2%
Boating community	–	1%	–	1%
Total	**20%**	**33%**	**22.5%**	**38.5%**

The estimated effectiveness of nonstructural BMPs for bacteria is based on the Bacteria Non-point Source Study (NPSS) conducted for MdRH (Weston, 2007). The study showed that avian sources represented 74% of the wet-weather bacterial sources and 66% of the dry-weather bacterial sources. If the current bird waste management program was expanded to more aggressively target the recreational areas along the waterfront through a combination of pollutant removal (street sweeping) and long-term bird deterrence, it is conservatively estimated that 10% to 15% of this source may be reduced. This type of program could potentially result in a 7% to 10% reduction in bacterial load. The study also found that canines represent 11% of the wet-weather source and 10% of the dry-weather source of bacterial loading. If an aggressive dog waste management program was implemented across MdRH, it is conservatively estimated that 10% to 20% of this source could be removed. This type of program is estimated to achieve an approximate reduction of 2% to 3% of the bacterial load reduction. In addition to birds and canines, the study found that parking lot wash down activities were the cause for highest bacterial concentrations measured during the study; thus targeting parking garages would likely result in comparable reduction in bacterial and metals loading. Operational source control measures that reduce urban runoff from sources, such as over-irrigation and washing activities, will therefore address both toxic constituents and bacteria by addressing the transport mechanism for these pollutants. This type of program could potentially result in a 3% to 6% pollutant load reduction.

The NPSS collected spot samples from five instances of irrigation runoff, two of which were collected at the entry point to the MS4. Given the freshwater source, runoff from over-irrigation is not a pollutant unto itself, but rather a transport mechanism for other pollutants. A runoff reduction program was given a greater potential for load reduction than buildings and construction sources, pet waste, and the boating community because of the higher potential frequency of occurrence and the opportunity to leverage programs to encourage implementation of BMPs (e.g., cisterns, rain barrels, and green roofs). This type of program could potentially result in a 1% to 2% pollutant load reduction.

The MdR Toxics TMDL assumed that nonstructural BMPs would be able to reduce loads by 30% (LARWQCB, 2005). Based on the estimates presented in the Multi-Pollutant Implementation Plan for the Unincorporated Area (LADPW, 2012), as summarized above and presented in Table 19, the estimated total reductions that could be achieved from nonstructural BMPs is approximately 33%; however, the plan used a conservative load reduction of 25%. For the purposes of the MdR EWMP, a more conservative percent reduction (such as 10% or 15%) may be assumed and modified based on the adaptive management process of BMPs observed performance, evaluation and customization.

8.0 APPROACH FOR CUSTOMIZING EXISTING CONTROL MEASURES AND IDENTIFYING ADDITIONAL CONTROL MEASURES

This section presents an approach for identifying and evaluating new, regional, or decentralized control measures or potential customization and/or retrofits of existing control measures to manage wet weather runoff caused by existing and new development and/or redevelopment.

In accordance with this approach, the MdR EWMP will assess the feasibility of implementing Regional BMPs across the MdR watershed. The EWMP will build on the previous TMDL implementation plans; reevaluate the proposed watershed control measures; identify additional regional projects to maximize capture of all non-stormwater runoff and stormwater from the 85^{th} percentile, 24-hour storm event; and identify additional watershed control measures for those areas in the watershed that cannot be addressed by a regional project while considering opportunities to maximize multi-benefit solutions regarding flood control, water quality, and aesthetics, where possible including public and private facilities.

The primary step in the identification of additional runoff control measures is a needs assessment. The purpose of the needs assessment is to quantify the type, quantity, and quality of runoff that may require control.

The first step in the analysis involves the estimation of runoff volume generated in the watershed. This may be performed by a multitude of methods such as Modified Rational Method calculations, trend analysis based on existing monitoring data, or watershed modeling using the Watershed Management Modeling System (WMMS). One or several of these techniques may be used to estimate the volume of runoff that will be generated by an 85^{th} percentile, 24-hour storm event for the whole watershed, the subwatersheds, and/or at parcel level.

The second step in the needs assessment is the water quality analysis. This component consists of estimating the TSS and associated pollutants loads, bioavailable or otherwise, that are generated in the watershed by the corresponding runoff volumes. The loads may be extrapolated from existing monitoring information in the watershed or using the WMMS-estimated volume results.

Based on the estimated volumes and corresponding pollutants loads characterization, the runoff volume and/or contaminant loads reductions will be quantified. Comparison of these numbers with the TMDLs, taking into account the existing control measures, will allow assessment of the need for additional control measures.

After it has been established that additional runoff control measures are necessary to address compliance, alternatives, structural, non-structural, and combinations of both types of control measures can be generated as customization and/or retrofits of existing measures or as new ones, based on site-specific considerations. Existing control measures that do not address or partially address the water quality priorities and have proven to present challenges will be evaluated for elimination or customization in order to modify their function and/or increase their effectiveness. This process will include the qualitative evaluation of non-structural minimum control measures (MCMs), such as public outreach material and industrial inspection frequency, using tools such as surveys of the knowledge base of agency stormwater staff. Factors such as cost, poor performance, difficult maintenance, resources intensiveness, and redundancy will be taken into consideration.

A comprehensive evaluation will be conducted to evaluate a variety of treatment strategies for their ability to meet reductions in WLAs; minimize bacteria exceedances for drainage areas in the MdR watershed; and provide multiuse benefits, which include flood control protection, recreational enhancements, and stormwater reuse, when possible.

In addition to structural measures, reductions in runoff using source control BMPs will be evaluated (e.g., smart irrigation systems, drip irrigations systems, drought tolerant landscaping, ordinance enforcement, and public education and/or outreach programs). This collective approach will provide a long-term solution for TMDL compliance in the MdR watershed. The nonstructural programs may consist of expansions of existing programs or may be based on applicable data available or TMDL compliance recommendations proposed in other reports and special studies.

The analysis will consider a multitude of factors involved in the assessment of structural BMPs, including geology, hydrology, land use, watershed characteristics, drainage area, runoff characteristics, BMP types and combinations, BMP performance, and associated costs.

Geographic Information System (GIS) analysis will be used to assist as a site selection tool, with focus on the availability of public parcels. Only sites within a public ROW or on publicly owned land will be considered during the identification process.

A BMP optimization matrix will be developed as a comparison tool of different individual BMP type functionality, with the greatest focus put on their multi-pollutants and multi-benefits potential. A similar assessment matrix will be generated for calculated and compiled performance efficiencies for different BMP types. A Life Cycle Cost estimation will be prepared for each BMP type and a corresponding dollar value will be estimated per unit pollutant load reduction and unit volume reduction as an additional means to compare the different BMPs. Using these optimization matrices, similar measures will be calculated for a combination of systems of BMPs in series, on-site and/or regional, and online and/or offline alternatives.

8.1 Example Regional BMPs

Opportunities for Regional BMPs will be evaluated within and across subwatersheds, with focus on the multi-benefits potential for capture and reuse of wet weather flows corresponding to the 85th percentile, 24-hour storm events, for variable drainage areas.

Availability of public land will be the first criteria directing the location identification and BMP type selection process. GIS analysis will be used to assist as a site selection tool to identify potential public parcels.

Where large public areas are available (and applicable), including parks, feasibility of using these spaces as capture and reuse Regional BMPs will be evaluated with the corresponding drainage area identified.

Soil investigations performed as part of the County's Parking Lot 5 Project in MdR shows a groundwater depth around 5 feet near MdRH. However, soil investigations from the County's Parking Lot 7 Project East of Oxford Basin demonstrate a groundwater depth close to 20 feet, which provides infiltration BMP opportunities in the upstream area of the MdR watershed.

In the highly urbanized areas, as is the case for a majority of watersheds in the Los Angeles Region, where public land is not available, the potential for the capture and reuse of wet weather runoff may be evaluated for underground storage facilities and green streets application. This might be applicable for areas in Subwatershed 4, under the jurisdiction of the City of Los Angeles. The network of storm drain and catch basin in these residential and commercial areas would be evaluated for locations where underground capture is maximized. Green streets should be designed in conjunction with the evaluations and captured water would be used to maintain the green streets.

In addition, existing infrastructure will be assessed for potential modifications to maximize their benefits as potential Regional BMPs. Examples of these include Boone Olive Pump Plant in Subwatershed 3, under the jurisdiction of the City of Los Angeles, and Venice Canals and Ballona Lagoon in Subwatershed 2, under the jurisdiction of the City of Los Angeles and the County.

8.2 Regional BMP Selection Tool

The MdR EWMP will propose measures aimed at targeting multi-pollutants on a regional scale. A composite ranking matrix will be generated to prioritize areas of concern based on their contributions to the total watershed contaminant loads. Individual projects will be assigned a relative priority, based on priority sources, number of priority pollutants, opportunity to transport to marina waters, and/or opportunities for bacterial regrowth, as determined from past special studies and reports. Generally, pollutant sources that contributed both bacterial and toxic pollutants will be given priority over sources that contributed to a single type of pollutant. Also, a higher priority will be given to projects building upon existing programs. Each structural solution will identify the BMP type, goal, description, targeted pollutant and audience, assessment, and potential methods of measure for effectiveness assessment. Source identification studies, code modification evaluations, and other baseline projects will also be given higher priority.

This section provides guidance on factors that should be considered when selecting BMPs for existing, new development, or redevelopment projects. BMP selection involves many factors such as physical site characteristics, water quality objectives, multi-benefits potential, aesthetics, safety, maintenance requirements, and cost that provide opportunities for BMPs or constrain BMP selection. Typically, there is not a single answer but rather multiple solutions ranging from stand-alone BMPs to treatment trains that combine multiple BMPs to achieve water quality objectives as well as other benefits such as flood control and recreation. A BMP selection decision tree is presented in Figure 14.

It is important to start the following discussion by noting that in the highly urbanized setting of MdR, the availability of public land will be a determining factor in the feasibility of implementation of a structural BMP. Another very important factor is the fact that the MdR watershed is characterized by a high groundwater table and strong tidal influence which decrease in the North Eastern direction in the watershed. Regional BMPs however are not limited to infiltration BMPs. A collection of distributed BMPs, such as green streets, to capture the 85^{th} percentile, 24-hour storm event would qualify as a Regional BMP.

Five geological and hydrological characteristics were identified as important in determining the feasibility of BMP scenarios in terms of BMP type and site selection evaluation. These characteristics are depth to bedrock, type of bedrock, soil characteristics, depth to water table, and land use. In addition, other factors affecting the implementation of a control measure include compatibility with the surrounding area, health and safety, maintenance considerations, cost feasibility, and performance and risk analysis. The factors are further discussed below. Existing maps of these five characteristics, when applicable, will be used whenever possible, along with GIS modeling and aerial photography and/or remote sensing to assist in BMP site and type selection. The integration of surface and subsurface information to map such parameters will provide more data that are directly relevant in the decision-making process of urban and county planners, engineers and developers, and geotechnical investigators.

1. Type of and Depth to Bedrock—Bedrock that is commonly fractured, such as shallow dolomite or limestone, is highly susceptible to contamination. The fractures provide direct and rapid pathways for contaminants to reach the water table. Groundwater within sandstone formations is less susceptible because sandstone contains fewer well-connected fractures. Soil and sediment overlying bedrock slows seepage to the water table. A greater depth to bedrock increases groundwater protection. The depth-to-bedrock value limits capabilities and activities on the surface.

2. Soil Type—Soils are classified by the Natural Resource Conservation Service into the four Hydrologic Soils Groups, A, B, C and D, where As, are generally the deepest, have the smallest runoff potential, and highest infiltration rate and Ds generally have the greatest runoff potential and lowest infiltration rate and include soils with a permanent high water table, soils with high swelling potential, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious material. Soils A and B are well-suited for infiltration-based BMPs such as rain gardens, permeable pavement systems, sand filter, grass swales, and buffers, often without the need for an underdrain system.

3. Depth to the water table—Shallow groundwater may limit the ability to infiltrate runoff. In addition, groundwater quality protection is an issue that should be considered for infiltration-based BMPs. For example, infiltration BMPs should be avoided for land uses that involve storage or use of materials that have the potential to contaminate groundwater underlying a site, such as runoff from fueling stations or materials storage areas. In addition, the deeper the groundwater table, the better the opportunity for contaminants to be filtered or to degrade before arriving at the water table.

4. Land Use—The land use cover identifies potential areas where regional and decentralized BMP implementation might be feasible. In addition, it allows the quantification of the degree of urbanization and imperviousness, both important factors affecting BMP type and location selection. Space constraints are frequently cited as feasibility issues for BMPs, especially for high-density, lot-line-to-lot-line development and redevelopment sites, where there is a limited amount of publicly operated land available to implement the larger scale projects that would be necessary to capture and/or reuse runoff. The primary focus will be to identify opportunities to retrofit existing conveyance systems, parks, and other recreational areas with water quality protection measures.

5. Existing Utilities—Utilities are frequently located below ground, which coincides with the feasible locations for stormwater BMPs. Typically, water and sewer piping, natural gas lines, and telephone and electrical conduits are located in the public ROW and on individual parcels. BMPs will require modification to fit into the limited available space without disrupting existing utilities, or utilities will require relocation for BMP installation.

6. Compatibility with Surroundings—Stormwater quality areas can add interest and diversity to a site, serving multiple purposes. Gardens, plazas, rooftops, and parking lots can become amenities and provide visual interest while performing stormwater quality functions and reinforcing urban design goals for the neighborhood and community. The integration of BMPs and associated landforms, walls, landscape, and materials can reflect the standards and patterns of a neighborhood and help to create lively, safe, and pedestrian-oriented districts. The quality and appearance of stormwater quality facilities should reflect the surrounding land use type, the immediate context, and the proximity of the site to important civic spaces. The standard of design and construction should maintain and enhance property values without compromising function. In addition, construction staging should be sited in a way to minimize the effect of construction mobilization and noise to adjacent tenants

7. Health and Safety—Stormwater quality facilities must be designed and maintained in a manner that does not pose health or safety hazards to the public. The potential for nuisances, odors, and prolonged soggy conditions should be evaluated for BMPs, especially in areas with high pedestrian traffic or visibility. Urban areas are heavily populated, which adds to safety concerns when considering potential BMPs such as ponds, wetlands, and surface sand filters. Open surface systems may require additional measures such as fencing to ensure public safety and reduce vandalism. Often the only feasible location for BMPs in developed areas is underground, which presents more complex maintenance issues that trigger worker safety requirements. The installation of subsurface BMPs may require maintenance activities to be performed in confined spaces. Confined spaces have specific entry requirements to ensure safety that would need to be followed each time BMPs are inspected or maintained.

8. Maintenance—BMPs can be more effectively maintained when they are designed to allow easy access for inspection and maintenance and to take into consideration property ownership, easements, visibility from easily accessible points, slope, vehicle access, and other factors. Clear, legally-binding written agreements assigning maintenance responsibilities and committing adequate funds for maintenance are also critical. Maintenance requirements must be carefully planned and implemented when access to subsurface BMPs is limited to manhole openings or requires the removal of grates and panels. Subsurface BMPs may be considered confined spaces and require additional measures to ensure safe access for inspection or maintenance. As a result of these potential restrictions and/or additional measures, BMP technologies that require maintenance on an annual or semiannual basis are often preferred to those requiring more frequent maintenance. Difficulty in performing the maintenance (increased level of effort) can increase the cost of the required maintenance.

9. Watershed Characteristics—The contributing drainage area is an important consideration both on the site level and at the regional level. On the site level, there must be a practical minimum size for certain BMPs related to the ability to drain and treat the associated runoff over the required drain time. On the regional level, there must be a limit on the maximum drainage area for a regional facility to assure adequate treatment of rainfall events. In addition, in a highly urbanized setting, small drainage areas and undefined outfalls limit the number of treatment strategies that can be used to treat stormwater runoff.

10. BMP Categories—BMPs can be categorized based on their functionality (storage versus conveyance) and design strategy (stand-alone versus in series; online versus offline). Storage-based BMPs provide volume reduction benefits and include bioretention and/or rain gardens, extended detention or dry basins, sand and/or media filters, constructed wetland ponds, retention or wet ponds, and permeable pavement systems. Conveyance-based BMPs include grass swales, grass buffers, constructed wetlands channels,

and other BMPs that improve quality and reduce volume but only provide incidental storage. Ideally, a combination of conveyance-based and storage-based BMPs can be used to allow the implementation of multiple benefits BMPs. Given the natural variability of the volume, rate and quality of stormwater runoff, and the variability in BMP performance, using multiple practices in a treatment train that links together complementary processes can expand the range of pollutants that can be treated and increase the overall efficiency of the system for pollutant removal and provide system redundancy; also, the land requirements for a combined facility are lower than for two separate facilities. In addition, BMPs may be designed to be online such that all of the off-site runoff from the upstream watershed and site runoff is intercepted and treated by the BMP. Locating BMPs offline requires that all on-site catchment areas flow though a BMP prior to combining with flows from the upstream off-site watershed.

11. BMP Performance—BMP performance evaluation is not required for Regional BMPs, except to the extent that they capture the 24-hour 85th percentile storm. Performance of various BMPs depends on numerous factors, such as BMP type, design, site, storm characteristics, monitoring methodology, performance measures, and pollutant loadings. A comparison of available performance data is presented in Section 7.3.5 above. It is important to note that a wide range of reported effectiveness data exist that varies widely between and among different BMPs.

12. Cost Estimates—Cost effectiveness is an essential component in BMP planning and selection, especially with the stricter regulations and leaner budgets imposed on stormwater management programs. Life cycle cost (LCC), which refers to all costs that occur during the economic life of a project, should be optimized. Generally, the components of the LCC for a constructed facility include construction, engineering and permitting, contingency, land acquisition, routine operation and maintenance, and major rehabilitation costs minus salvage value. It is also recommended that the cost of administering a stormwater management program be included as a long-term cost for BMPs. One method to assess and compare the LCC of various BMPs is to use the net present value (NPV) of the whole life costs of the BMP(s) implemented, the average annual mass of pollutant removed, and the average annual volume of surface runoff reduced to compute a unit cost per pound of pollutant or cubic feet of runoff removed over the economic life of the BMP.

13. Risk Assessment—A risk assessment will be conducted for the selected BMP systems by evaluating estimated reduction efficiencies, treatment capacity, whether or not a BMP can be integrated with other BMPs, likelihood of failure, and ease of adaptive customization.

14. Other Factors—California Environmental Quality Act (CEQA) environmental consideration not listed above include cultural resources, greenhouse gas emissions, and air quality and traffic will be preliminarily assessed for potentially significant impact to identify permitting and potential mitigation requirements at this early assessment phase

The diagram presented in Figure 14 depicts the iterative multi-stage nature of the BMP selection process necessary to ensure the optimal BMP strategies combinations are selected while accounting for the complex relational dynamics between the different BMP selection considerations, such as cost, risk, and effectiveness.

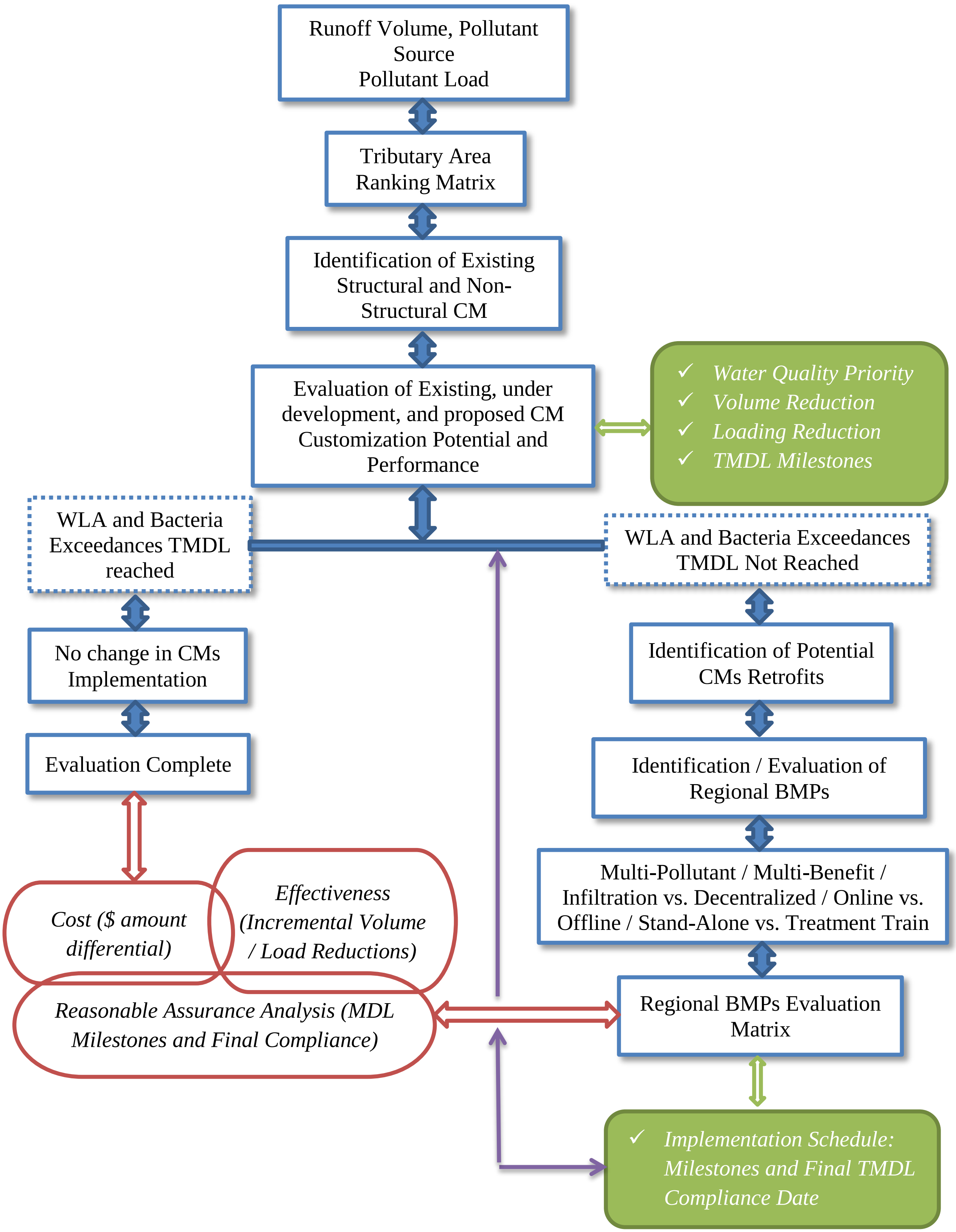


Figure 14. Conceptual Diagram of EWMP BMPs Selection Decision Tree

9.0 REASONABLE ASSURANCE ANALYSIS

A key element of the MdR EWMP will be the Reasonable Assurance Analysis (RAA). The purpose of the RAA is to quantitatively demonstrate that the proposed control measures designed in the EWMP will "achieve applicable WQBELs and/or RWLs with compliance deadlines during the Permit term" (Section C.5.b.iv.(5) of the 2012 MS4 Permit). The RAA requires the development of a modeling process to support the selection of BMPs as well as an adaptive customization and scheduling process to demonstrate and address compliance with the MS4 Permit. The RAA for the MdR watershed will comply with RAA guidelines provided by the LARWQCB to the extent practicable and applicable to the watershed.

The following sections describe the modeling tool selection justification and model configuration processes. They also describe the BMP adaptive selection methodology, including selection of BMP types and evaluation of their effectiveness, their pollutant removal potential, location optimization, and risk evaluation and cost minimization, as well as implementation scheduling to address conformity with compliance milestones.

9.1 Modeling Tool Selection

The MdR EWMP agencies have selected the Los Angeles County WMMS as the model to be used for the development of the MdR EWMP, as allowed by the corresponding MS4 Permit.

WMMS is a computer-based decision support system developed by LACFCD for all major watersheds within the County to simulate hydrologic and pollutant generation and transport processes. The model results help identify cost-effective pollution reduction measures to address urban runoff and stormwater quality issues and TMDL implementation planning. WMMS provides a tool for future planning of multi-benefit projects involving water quality, flood control, water conservation, and open space development.

The WMMS expands on the USEPA watershed and BMP selection optimization models, Loading Simulation Program in C++ (LSPC) and the System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) model.

WMMS will be used for the MdR watershed to support the estimated current loadings and the required load reductions that will be used to set targets and/or goals for selected BMPs and watershed management strategies, and to demonstrate that the activities and control measures identified and selected in the MdR EWMP will achieve applicable WQBELs and/or RWLs. The MdR watershed is a highly urbanized area with a typically uniform distribution of land use, soil types, and imperviousness. The groundwater table across the watershed is variable with deeper levels at the northeastern boundary. These characteristics make the MdR watershed different from other larger watersheds. The modeling tool will be used to the extent applicable for the watershed, in conjunction with other spreadsheet analysis.

WMMS conforms to the modeling system selection criteria set by the LARWQCB–led RAA committee to ensure that an RAA is performed in the process of developing the MdR EWMP. WMMS has the following capabilities: (1) provides a dynamic, continuous, long-term simulation for modeling pollutant loadings, flows, and concentrations in receiving water from lands in a watershed system; (2) accounts for rainfall and runoff for urban and natural watershed systems; (3) represents variability in pollutant loadings, based on land use, soil hydrologic group, and slope; (4) follows a BMP process based approach; and (5) can function as a decision support system to evaluate BMP performance, risk, and cost.

9.2 WMMS Model Configuration

The WMMS was calibrated for all major watersheds within the County to simulate hydrologic and pollutant generation and transport processes. Therefore, it incorporates watershed-specific initial default input values of the calibration parameters, which may need to be modified based on more recently available data to be consistent with the current watershed conditions.

The input information that will potentially be verified and updated in the WMMS input files includes land use, precipitation, imperviousness, drainage characteristics, and land use load allocations. The model will subsequently be recalibrated and validated using the most recent monitoring information, collected as part of the Coordinated Monitoring Plans for the MdR watershed.

WMMS was calibrated for a total of eight watersheds, one of which is the Ballona Creek watershed. For the MdR EWMP watershed area, WMMS was calibrated based on monitoring information for the Ballona Creek watershed, a total of 130 square miles, segmented into seven subwatersheds based on the drainage network. The Ballona Creek watershed is adjacent to the MdR watershed and possesses similar characteristics; therefore, the current calibrated model incorporates an accurate representation of the MdR watershed. This similarity will be verified in the current effort, and the relevant adjustments will be performed as deemed necessary.

The application of WMMS to simulate the MdR watershed runoff and pollutant transport will require the adaptation of the model to the MdR watershed. This adaptation involves multiple steps, including the segmentation of watershed, the configuration of key model components (i.e., soils, land use representation, meteorological data), the model calibration and validation (for hydrology, sediment, and pollutants), and multiple scenario model simulation. These steps are discussed below.

9.2.1 Segmentation

The segmentation of MdR watershed into smaller discrete subwatersheds in WMMS for modeling and analysis will be investigated. In WMMS, subwatershed segmentation is based primarily on drainage networks, such as engineered storm drain and stream networks, and secondly on the topography, the flow, and the location of water quality monitoring stations, as well as the consistency of hydrologic factors, land use consistency, and existing hydrologic boundaries. Based on the specific objective of the simulation runs to be performed, the sensitivity of the model to segmentation in the MdR watershed will be shown. Objectives include model calibration, jurisdictional loading assessment, and storm runoff volumes evaluation. For example, the potential of modifying the MdR subwatershed boundaries assigned in WMMS will be evaluated to allow the model to generate runoff volumes and pollutant loadings representing the various MdR Subwatershed 1, 2, 3, and 4, as well as jurisdictional boundaries of the MdR EWMP agencies within each subwatershed modeled. Where monitoring information is not available, such as in the case of Subwatershed 2, the most representative subwatershed calibration or an average of the various subwatersheds will be used.

9.2.2 Drainage Characteristics

WMMS incorporates a GIS layer containing flow directions for all subwatersheds. Subwatershed routing will be scrutinized to ensure that flow routing is accurately represented within and between subwatersheds of the MdR watershed. The highest resolution will be used, depending on the data availability and the feasibility of implementation. Using the highest resolution might be of significance for the assessment of the runoff in the Front Basins, which were included in the revised TMDL. In addition, the drainage network for the MdR watershed will be updated for the analysis to ensure that the most current infrastructure is represented in the model and accounted for during the BMP selection process. Point sources and hydromodifications will also be identified and incorporated in the simulation process.

9.2.3 Landuse/Imperviousness

WMMS assigns imperviousness based on land use categories. Imperviousness is then used as a basis to distribute hydrologic and water quality parameters. Land use will be updated based on information provided by the EWMP agencies. In addition, it will be updated based on GIS and aerial imagery to account for redevelopment, new developments, and public structures, such as previously marked vacant land use areas. The combination of land use, soils, and slope influence, used by WMMS to assign Hydrologic Response Units (HRUs) provides a sound physical basis for refining and differentiating the representation of vacant land. For that reason, this land use category might need to be refined to better represent the physical variability and variations in an area’s hydrologic response to weather. The highest spatial resolution will be used based on the most recent available information from a variety of spatial data sources to create composite land use and imperviousness maps.

9.2.4 Land Use Based Loadings

To capture the pollutant loading of sources, WMMS is set up to include a suite of land uses that represent a variety of pollutant sources, forming the basis for the representation of pollutant generation and accumulation and the resulting pollutant runoff and delivery to receiving waterbodies. Pollutant loading in WMMS is correlated with the HRUs defined within the model.

9.2.5 Meteorological Data

Rainfall-runoff processes for each subwatershed are driven by precipitation data. The most recent rainfall time-series data with the highest applicable time resolution from the most representative station for the MdR watershed will be updated into WMMS, as provided by the EWMP agencies. Original rainfall data included in the formal model calibration extend from 1987 to 2006. Evapotranspiration and other meteorological factors (such as wind speed and air temperature), which were processed and evaluated during the formal development of WMMS, are not anticipated to be modified in this effort.

9.2.6 Watershed Boundaries

The potential for modifying the MdR subwatershed boundaries assigned in WMMS will be evaluated to allow the model to generate runoff volumes and pollutant loadings within the respective set boundaries. These boundaries will be defined and assessed based on different objectives, including BMP site selection. As an example, multiple runs representing the various jurisdictional boundaries of the EWMP agencies entities within each subwatershed modeled will be evaluated for runoff volumes and pollutant loadings, through the use of the corresponding land use types and areas.

9.2.7 Recalibration and Validation

Model calibration and validation is a critical step that will be performed prior to model application to ensure as accurate as possible a representation of the physical system, with allowed confidence level criteria, summarized in Table 20.

Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations on the basis of field monitoring data. The simulation and calibration of the hydrologic and water quality components of the watershed model will be performed to obtain physically realistic model predictions by selecting parameter values that reflect the unique characteristics of the watersheds represented, in this case, MdR. Spatial and temporal aspects will be evaluated through the calibration process using the representative monitoring stations and associated drainage areas and events. Where monitoring information is not available, weighted area averaged calibration parameters will be used.

The calibration of WMMS for the MdR watershed and subwatersheds will be an iterative process of parameter evaluation and refinement as a result of comparing simulated and observed values of interest. It is required for parameters that cannot be deterministically and uniquely evaluated from topographic, climatic, physical, and chemical characteristics of the watershed and compounds of interest. The hydrologic calibration will be based on the available years of simulation to evaluate parameters under a variety of climatic conditions and produce the best overall agreement between simulated and observed values throughout the calibration period. Calibration might include, as applicable and feasible, a time series comparison of daily, monthly, seasonal, and annual values, and individual storm events. Composite comparisons (e.g., average monthly stream flow values over the period of record) might also be made for a proper calibration of hydrologic parameters.

The second step following hydrologic calibration will be sediment calibration. Considering that several of the pollutants of concern in the MdR watershed are assumed to be transported as sorbed to sediment (TSS), accurate sediment simulation is an important step in water quality modeling. TSS calibration will be performed using the most recent monitoring information for TSS within the MdR watershed. The water quality calibration for the pollutants of concern will follow the TSS calibration. The objective of the water quality calibration is to select water quality parameters that adequately represent the loading generation capabilities for the different modeled HRUs for a wide range of storm intensities specific to the MdR watershed.

The third step following hydrologic and sediment parameter calibration is pollutant modeling calibration. The removal of sediment-associated water quality constituents is simulated by multiplying the mass of sediment (tons/acre/time interval) washed off in runoff by a washoff potency factor (POTFW) (pollutant quantity/ton), the amount of a pollutant that is associated with a ton of sediment for a land segment. Different POTFW parameter values exist for copper, lead, zinc, DDT, and PCB by land use. For this calibration, a potency factor analysis will be performed using available storm sampling data. To estimate the potency factors, mass- and flow-weighted concentrations will be used to calculate the ratio between the metals and the sediment by land use. The derived values will then be compared to previously estimated potency factors during the initial WMMS calibration, and these factors will be updated if needed.

9.2.8 Model Simulation Calibration Criteria

As noted previously, the application of WMMS for the MdR watershed was based on its calibration using the Ballona Creek hydrology and quality monitoring data. Because new monitoring data exist for the MdR watershed, the model will be recalibrated using the MdR-specific information, in conjunction with the other updated information discussed in the previous subsections. The acceptable model calibration criteria are listed in Table 20, as provided by the RAA Technical Advisory Committee (TAC) sub-committee to ensure the calibrated model properly assesses all the model parameters and modeling conditions that can affect model results.

Table 20. Model Calibration Criteria

Model Parameters	% Difference Between Simulated and Observed Values		
	Very Good	Good	Fair
Hydrology/Flow	<10	10-15	15-25
Sediment	<20	20-30	30-45
Water Temperature	<7	8-12	13-18
Water Quality/Nutrients	<15	15-25	25-35
Pesticides/Toxics	<20	20-30	30-40

9.3 BMP Selection Methodology

The MdR watershed is very different from the other Los Angeles watersheds because it is small and highly urbanized, with a large portion of the lower watershed within a high groundwater and tidally influenced former estuary. A combination of regional, decentralized, and institutional BMPs, including LID filtration, street sweeping, and storm water reuse, will be required to address attainment of the stormwater volume and pollutant loading reductions necessary for compliance.

A hierarchical, iterative, risk-based optimization process will be used for the identification, evaluation, and selection of a suite of control measures and corresponding implementation plans. The identification and evaluation of potential control measures will be based on multiple factors in two categories, functional performance goals and drainage area location and pollutant reduction prioritization. This section discusses these factors.

9.3.1 Control Measures Effectiveness Potential

Using a statistical quantification of a concentration or load-based percent efficiency metric to represent the performance of a BMP system does not reflect the variability of its effectiveness in real-world conditions. A composite average rating score, Effectiveness Potential (EP), will be developed to account for the compounded nature of the many factors affecting the performance and effectiveness of a BMP strategy.

A weighted value of the compounded BMP system efficiency estimates, which will be selected using the empirical databases analyzed and presented in Section 7, will be calculated. In addition, the efficiency associated with a BMP system will be weighted by a score generated using a quantitative ranking matrix. This matrix will account for non-quantifiable factors such as the potential for a management strategy to generate multiple benefits, including volume reduction, multiple pollutant removal, ability to be implemented on public land, and ease of operation and maintenance in the context of MdR. The MdR Multi-pollutant Implementation Plan provides a list of BMPs applicable to the MdR watershed along with qualitative descriptions of some of their requirements. A summary is presented in Table 21. This table will be verified and modified and a version of it will be used as the basis for further analysis of potential BMPs.

The BMP strategy-specific efficiency estimates, weighted by the site-specific composite scores, result in the EP. The EP will be used to rank the BMP types. The highest EP will be associated with the relatively best performance and effectiveness.

An additional third weighting process, involving a drainage area and pollutant prioritization mechanism, will be considered in the evaluation and selection process. This process is discussed in the following sections.

9.3.1.1 Pollutant Removal

Concentration and mass based pollutant removal efficiency values for various BMP types, are presented in Section 7.0 of this document. Removal of pollutants varies widely among and across different BMPs and is a factor of drainage area, land use, storm characteristics, design, and operational considerations. Therefore, the estimated efficiencies extend over a wide range of values, including negative estimates. Studies with negative efficiencies (the BMP acted as a source, not a sink for pollution) will be included in the EP development process because they reflect operational conditions, such as natural processes or construction and operational related issues, which can create a system that is not providing its expected pollutant removal. Alternatively, if negative efficiencies were not included, efficiencies could be discounted to account for failed systems that occur operationally. This inclusion may be achieved by decreasing the confidence level when selecting the efficiency measures to be used in the calculations.

Table 21. Example Review of Site Specific Best Management Practices as Presented in the Multi-Pollutants Implementation Plan (LADPW, 2012)

Best Management Practices	Scoping				Evaluation										Final Selection				
					Controlling Factors		Additional Factors												
	Bacteria Removal Efficiency (%)	Configuration	Effective Life[1,3] (yrs)	Water Quantity Reduction	Applicable in Areas with High Groundwater Table	Applicable in Areas with High Groundwater Table Using Modifications or Underdrains	Area Required for BMP[1,5]	Independent of Natural Underlying Soils	Maintenance Requirements	Subsurface	Surface	Training	Viability in Urbanized Areas	Additional Benefits[7]	Capital Costs	Construction Timeline	Public Acceptance	No Safety Concerns
THIS TABLE HAS BEEN IMPORTED AS AN EXAMPLE FROM THE MdR MULTI-POLLUTANT IMPLEMENTATION PLAN; THE NUMBERS AND SOURCES IN THIS TABLE WILL BE VERIFIED AND MODIFIED AS NEEDED FOR THE PURPOSE OF THE EWMP DEVELOPMENT.																		
Detention and Retention Practices																		
Detention Tanks and Vaults	NA[1]	Offline	50–100	✓		✓	0.5–1%	✓	Frequent Cleanout	✓		Mod.	✓		Mod. - High	Mod. - High	✓	
Dry/Wet Ponds	70–88[2]	Both	20–50	✓	✓		10–20%	✓	Annual Inspection		✓	Low		✓	Mod.	Mod.	✓	
Extended Detention Basins	78	Both	--	✓			--		Biannual Inspection		✓	Low			Mod. - High	Mod.		
Wetlands and Shallow Marsh Systems	78[2]	Both	20–50		✓		10%		Annual Inspection		✓	Low		✓	Mod. - High	Mod. - High	✓	
Filtration Practices																		
Green Roofs	70–90[3]	Offline	--	✓	✓		NA	✓	Biannual Inspection		✓	Low	✓	✓	Mod. - High	Mod.	✓	✓
Filtration and Disinfection Facilities	70–90[3]	Both	--		✓		NA	✓	Frequent Inspection		✓	High	✓		High	Mod. - High		✓
Organic Media Filters	90[1]	Offline	5–20		✓		2–3%	✓	Annual Media Removal	✓	✓	Low	✓		High	Mod.	✓	✓
Surface Sand Filters	70–90[3]	Offline	5–20		✓		2–3%	✓	Biannual Media Removal		✓	Low			Mod.	Mod.		
Underground Sand Filters	70–90[3]	Offline	5–20		✓	✓	2–3%	✓	Annual Media Removal	✓		Mod.	✓		High	Mod.	✓	✓
Infiltration Practices																		
Bioretention[8]	70–90[3]	Both	5–20	✓		✓	4–10%	✓[6]	Mowing / Plants	✓	✓	Low	✓	✓	Mod.	Low	✓	✓
Infiltration Basin	75–98[1]	Offline	5–10	✓			2–4%		Mowing / Sediment Removal		✓	Low		✓	Mod.	Mod. - High	✓	
Infiltration Trench	75–98[1]	Both	10–15	✓		✓	2–4%		Biannual Inspection		✓	Mod.	✓		Mod. - High	Mod.		✓
Porous Pavements																		
Porous Pavements	NA[1,3]	NA	15–20	✓		✓	NA	✓[6]	Biannual Vacuum	✓	✓	Low	✓		Mod. - High	Mod. - High	✓	✓
Proprietary Devices																		
Cartridge Filters	50–80[1]	Offline	--		✓		<1%	✓	Frequent Cleanout	✓		Mod.	✓		Mod.	Low	✓	✓
Catch Basin Inserts	40–70[4]	In-line	--		✓		None	✓	Frequent Cleanout	✓		Low	✓		Low	Low	✓	✓
Hydrodynamic Devices	40–70	Both	--		✓		None	✓	Periodic Cleanout	✓		Low	✓		Mod.	Low	✓	✓
Proprietary Biotreatment Devices	Up to 96	Offline	--		✓		--	✓	Periodic Cleanout	✓	✓	Mod.	✓	✓	Mod.	Low	✓	✓
Low Flow Diversions to Sanitary Sewers	100	In-line	--		✓		None	✓	Periodic Cleanout	✓		Mod.	✓		High	Mod. - High	✓	✓
Stormwater Storage																		
Cisterns	70–90[3]	Both	--	✓	✓		4%	✓	Biannual Inspection	✓	✓	Low	✓	✓	Low - Mod.	Low	✓	✓
Rain Barrels	70–90[3]	Both	--	✓	✓		4%	✓	Biannual Inspection		✓	Low	✓	✓	Low	Low	✓	✓
On-Site Storage and Reuse	70–90[3]	Offline	--	✓	✓	✓	--	✓	Biannual Inspection	✓	✓	High	✓	✓	High	Mod. - High	✓	✓
Vegetated Swales																		
Vegetated Swales	25–50	In-line	5–20	✓	✓	✓	10–20%		Mowing		✓	Low	✓	✓	Low	Low	✓	

Notes: **THIS TABLE HAS BEEN IMPORTED AS AN EXAMPLE FROM THE MdR MULTI-POLLUTANT IMPLEMENTATION PLAN (LADPW, 2012); THE NUMBERS IN THIS TABLE WILL BE VERIFIED AND MODIFIED AS NEEDED FOR THE PURPOSE OF THE EWMP DEVELOPMENT.**

1 U.S. Department of Transportation – Federal Highway Administration: Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring
2 Green Country Stormwater Alliance – National Pollutant Removal Performance Database, Version 3
3 Neponset River Watershed Association – Fact Sheet: The Wetlands Act & TMDLs
4 Assumes regular maintenance, occasional removal of accumulated materials, and removal of any clogged media.
5 Expressed as a percent of the total drainage area; can be modified to accommodate urban conditions.
6 When equipped with an underdrain system.
7 Recreational, wildlife habitat, aesthetics, etc.
8 Bioretention systems may include raised planters and flow-through planter boxes that act as LID filtration devices.

9.3.1.2 Minimum Control Measures/Institutional BMPs
Institutional BMPs will be evaluated. These include street sweeping (mechanism and frequency) and trash removal, as well as education and enforcement. Multiple scenarios of institutional control measure efficiencies will be incorporated into the analysis through the different associated EPs based on the relevant available studies, as discussed in Section 7.0. The scheduling scenarios will also be considered in the selection and implementation of the institutional BMPs. Participating agencies are continuing to implement the MCMs required under the 2001 MS4 Permit. Applicable new MCMs will be implemented by the time the EWMP is approved by the Regional Board

9.3.1.3 Volume Reduction
BMPs that promote infiltration and/or that incorporate evapotranspiration have the potential to reduce the volume of runoff generated. Volume reduction control measures have many benefits in terms of hydrology, sediment washoff, and pollutant mobilization. Groundwater elevation information throughout the MdR watershed will be necessary to evaluate the potential implementation of large infiltration BMPs. Based on a communication with the City of Los Angeles in December 2013, it is observed that inland areas of the watershed are characterized by a groundwater table deeper than 20 feet.

9.3.1.4 Operational Conditions
Efficiencies need to be adjusted based on operational conditions. Where possible, efficiencies will be adjusted for surface water and groundwater interactions, along with geology and soil types (e.g., slope, seeps, floodplain). Management conditions, including the operation and maintenance of the BMP, design and construction supervision, and/or upland land use change will also impact efficiencies. If maintenance is neglected, a BMP may become impaired, no longer providing its functions as designed. Proper maintenance of outlet structures, flow splitters, and clean-out gates is critical to achieving the designed efficiency of a stormwater BMP. As an example, in a scenario where a BMP whose performance depends on the underlying groundwater table is selected for a site with a high groundwater table, the BMP's efficiency will be reduced to represent the overall conditions that will govern the performance of the BMP.

The efficiency estimates summarized in Section 7.0 include negative numbers that represent situations of natural or man-caused impairment of a BMP. These negative numbers will not be excluded from the statistical analysis of efficiencies.

9.3.1.5 Public Land Availability
Individual BMPs require surface area footprints based on their expected design-based water volume and water quality load reduction. In highly urbanized areas where limited public land and ROW are available, BMPs with high acreage requirements are of limited applicability and may contribute a significant added cost to an otherwise optimal management strategy.

9.3.1.6 Existing and Proposed BMPs
The performance of existing BMPs will be evaluated depending on the availability of quantitative and/or qualitative information. The associated load reductions will be subtracted from the model load estimation to be included in the analysis of the additional required BMPs. Load reductions associated with proposed BMPs will be similarly incorporated. When possible, the type and location of these BMPs that are not yet in their planning phase will be reassessed.

9.3.2 Control Measures Location Prioritization

Currently, there are several water quality monitoring stations located throughout the MdR watershed. Section 3.0 of the MdR EWMP Work Plan provides a summary of water quality information from different efforts relevant to MdR, including the results from the monitoring stations in MdRH, pursuant to the MdR TMDL Monitoring Plan. For each monitoring site, a pollutant-specific weighting factor may be generated from the number of exceedances and/or the percent exceedances for each pollutant, using the available MdR monitoring data. A composite weighting factor may be obtained, for a specific site or drainage area as the product or summation of its corresponding pollutant weighting factors. The resulting monitoring site-specific factors are associated with the drainage area corresponding to that monitoring site. A high factor signifies a potential for high pollutant loadings. Adjusting the composite weighing factors by their corresponding drainage area acreage will assign a Site Priority Score (SPS) to that drainage area. This score will help identify what kind of treatment capacity is necessary and how it might be optimally distributed upstream of an assessment point. A large area with low factors might have a lower score than a smaller area with relatively high pollutant factors.

9.3.3 Cost and Risk Optimization

Various BMPs can be associated with specific cost and risk factors based on the strategy adopted in their implementation. These factors will be incorporated in the evaluation and selection process of the runoff management strategies. The estimation of a CEM in terms of $/mass reduction/year and/or $/volume reduction/year, and/or $/drainage acre might provide some insight in the BMP selection process. The optimal volume and/or pollutant loading reduction contribution of a certain BMP strategy, in conjunction with the best value, will be selected, taking into consideration the risk associated with the design storm selection. Nonstructural BMPs will also be included in the analysis.

WMMS includes cost-effectiveness curves derived for various management levels, as achieved pollutant percent load reductions with associated cost for representative BMPs. These curves are subwatershed-specific. They represent the highest pollutant reduction benefit at the minimum associated cost. The curves estimate a maximum cost beyond which there is no load reduction benefit. A curve represents an optimized set of BMP sizes and locations in a watershed or subwatershed. The curves are specific to the physiographic features of the watershed, which are classified as management categories in the model. A degree of practice, defined as risk tolerance, or allowable Exceedances, or TMDL attainment, may be set in the model to simulate uncertainty. In the BMP selection process, a set desired degree of practice is specified based on the existing pollutant loadings information. For this degree of practice, an optimal management level is determined for various management categories.

An analysis will be performed for the critical condition storm event to ensure an adequate representation of the potential runoff volumes and pollutant loadings. This storm will be used for the selection and design of the mitigation measures for the distributed BMPs with a to-be-selected conservative risk level to address compliance. Baseline flow rates/runoff volumes may be based on one of the 90th percentile of long term estimated/modeled flow rates or other established hydrologic critical condition in the applicable TMDL. Appendix B of the Toxics TMDL, defines the average deposition over 10 years as the critical conditions (not 90th percentile wet year). The 90th percentile wet day year will be used for compliance with the Bacteria TMDL for MdR.

Regional BMPs will be designed to capture the 85th percentile 24-hour storm event corresponding to the drainage area to the BMP. The uncertainty analysis will help demonstrate the model sensitivity of the system to the optimization objective, in terms of the stringency of the water quality attainment target.

Current/baseline pollutant loading will based on relevant subwatershed data and the best available representative land use and pollutant loading data collected within the last 10 years. These baseline pollutant loadings will be assessed and reported considering variability in pollutant loading at a spatial and temporal (including critical and average condition) scale consistent with that used in the MdR TMDLs and in the approved monitoring plan.

The SUSTAIN model will be used as part of the optimization framework for the BMP assessment and selection. SUSTAIN allows for the development, evaluation, and selection of optimal BMP combinations at various watershed scales on the basis of cost and effectiveness. It helps identify cost-effective BMP placement and selection strategies based on a pre-determined list of feasible sites and applicable BMP types and size ranges. This module uses evolutionary optimization techniques to search for cost-effective BMPs that meet user-defined decision criteria. Efficiency frontier curves assist in the selection of the optimal combination of BMPs and treatment thresholds to comply with the TMDL requirements using the most effective approach and associated cost.

The risk analysis in the framework of SUSTAIN lies in the identification of the optimal cost/risk solutions in achieving the required pollutant removal, while optimizing the BMP implementation schedule.

Cost estimates will be developed at the level of detail necessary for planning and strategy development for TMDL implementation of projects and programs in the MdR watershed. Project-specific cost estimates will be developed for individual nonstructural and structural projects. For example, the cost of a nonstructural program may consist of a 1-year initial pilot study cost, including project startup and assessment, and if applicable, ongoing O&M costs. Implementation costs for structural BMP conceptual design projects will include engineering design, permitting, construction, building materials, and O&M.

9.4 Implementation Schedule Methodology

The implementation schedule for the structural and institutional BMP strategies will be based on the corresponding MdR TMDL load reduction schedule. A phased approach will be used, in which compliance is to be achieved in an incremental percentage of the watershed through preset compliance milestones, and the minimum load reduction is to be achieved by the milestone date with the final date being 2021. New and/or modifications to the existing TMDL will be incorporated into the implementation schedule, if applicable. Interim milestones and dates to address adequate progress toward achieving interim and final water quality-based effluent limitations and/or receiving water limitations deadlines identified in TMDL provisions in Part VI.E and attachments L – R will be identified. BMPs must be implemented within time frame that is consistent with the most critical/closest deadline to address the gradual phasing of percent load reductions over the course of the implementation schedule. For areas to be addressed through retention of the runoff volume from the 85th percentile, 24-hour storm, volume reductions over time shall be related to the interim and final milestones.

For institutional BMPs, the programs expected to deliver the greatest value, highest pollutant reduction potential at minimum cost, will be considered first. All programs may be assumed to be stand-alone, with the understanding that they may include synergies providing for a more efficient implementation of similar programs. Considering each program as a stand-alone ensures a more conservative approach.

For structural BMPs, the programs corresponding to the highest SPS, described earlier, will be evaluated for implementation earliest in the implementation schedule timeline. In general, these programs will correspond to the relatively larger drainage area with the relatively higher associated multi-pollutant loading potential. BMP performance will be taken into account.

Considerations such as funding availability cannot be ignored during this prioritization process. The schedule will include establishing the time frame for BMP planning, design, construction, and assessment. The assessment of the implemented control measures will be performed at regular time intervals by evaluating the pollutant concentrations and loads measured and estimated at the various existing and proposed monitoring stations across the MdR watershed and in accordance with the Coordinated Integrated Monitoring Plan (CIMP) being generated for the MdR watershed. When load reductions at a monitoring station are not expected to be reached within the compliance timeframe, as projected by the modeling results, selection of BMPs, and set schedule, the proposed BMPs corresponding to the flows represented by the monitoring station will be reassessed in terms of expected performance and implementation schedule.

9.5 Results Presentation

The model output will include a series of summary tables and graphs for the different modeled scenarios performed for the risk analysis. These outputs are summarized in Table 22. For the various analyzed storm events and for the various defined land uses and drainage areas, the outputs include the following: (1) existing runoff and pollutant loadings and (2) load reduction required to meet TMDL requirements. The data can then be used to generate hydrographs and pollutographs for the different scenarios simulated as a requirement of the uncertainty analysis.

An example output presentation is provided in Figure 15. The figure presents a summary of the net cost and pollutant reduction as a function of the proposed implementation schedule from the MdR Multi-Pollutant Implementation Plan developed for the County (LADPW, 2012). These costs and pollutant reduction estimates are based on the proposed structural and institutional measures required to reach the load reduction TMDL milestone for the limiting pollutant, in this case zinc. Similar figures may be developed for a variety of storm scenarios to evaluate the effectiveness of the selected measures under the associated runoff volumes and pollutant loadings, as part of the RAA.

Table 22. Summary of WMMS Model Outputs

Model Output	Output Content
Current/Existing Pollutant Loadings	Current pollutant loadings at each subwatershed and each land use
Load Reduction Output	Pollutant load reduction at each subwatershed for each BMP scenario in dry and wet weather conditions Time series plot of pollutant load reduction for each BMP scenario at compliance points
Surface Runoff Output	Surface runoff at each subwatershed for each BMP scenario in dry and wet weather conditions Percent reduction at each subwatershed for each BMP scenario
Hydrographs and Pollutographs	Flow hydrographs at compliance points for each BMP scenario Pollutographs at compliance points for each BMP scenario
BMP Performance Summary	Load comparison with and without BMP and graphs for each BMP scenario BMP storage distribution for each BMP scenario

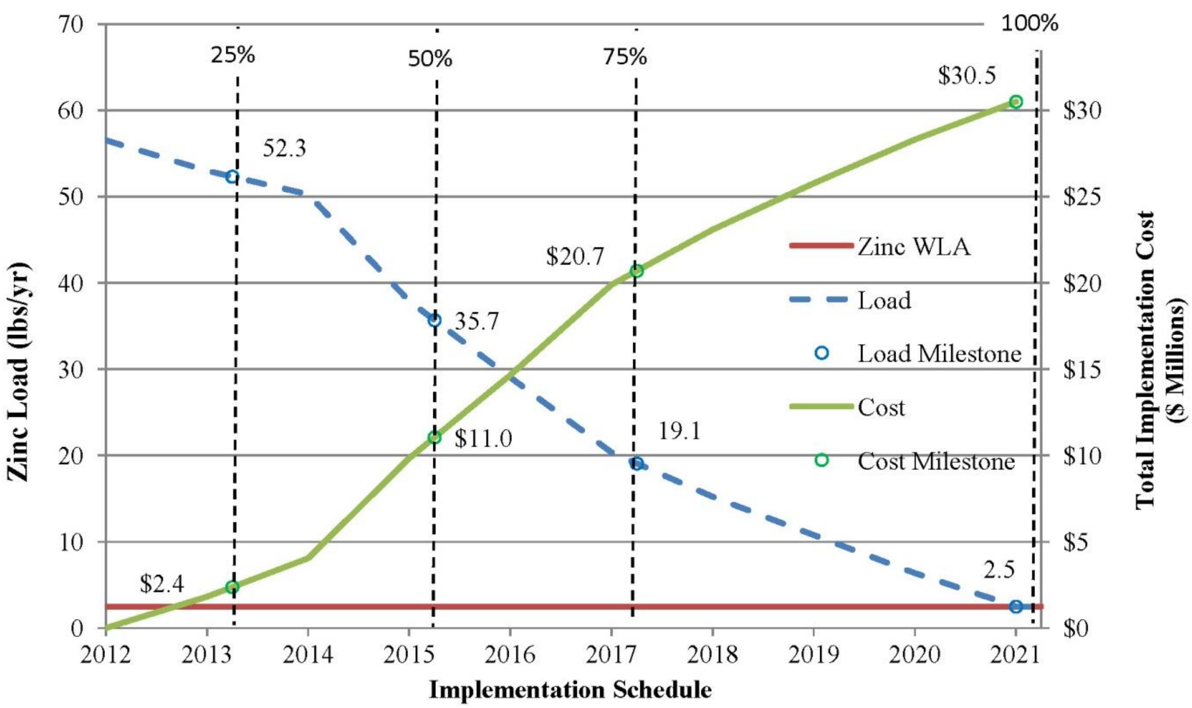


Figure 15. Example of Estimated Load Reductions and Annual Spending Projected to Achieve the Zinc Waste Load Allocation (LADPW, 2012)

10.0 MdR EWMP COMPLETION SCHEDULE

After the submittal of the EWMP Final Work Plan to the Regional Board, due June 28, and in consultation with the MdR EWMP agencies, the EWMP Plan development will proceed and will implement all aspects of the Final Work Plan, providing technical memorandums, a Draft EWMP Plan and a Final EWMP Plan that meet all requirements of Section VI.C. of the MS4 Permit. Multiple sub-tasks will be performed ending in completion of the Final Final EWMP Plan. These items are summarized below and in Figure 16 .

<u>Item 1. Finalize Approach to Addressing USEPA TMDLs, 303(d) Listings, and Other Exceedances of Receiving Water Limitations:</u>

A technical memorandum will be developed to address permit requirements related to USEPA TMDLs, §303(d) listings, and other exceedances of receiving water limitations. As part of this sub-task interim numeric milestones and compliance schedules for the Ballona Wetlands TMDLs for Sediments and Invasive Exotic Vegetation, for the Santa Monica Bay TMDLs for DDTs and PCBs will be developed, as well as for the §303(d) listed and non-§303(d) listed receiving water limitations exceedances not addressed in a TMDL in the watershed. The Draft Memorandum will be provided as electronic files by August 29, 2014.

<u>Item 2. – List of Regional Projects and Initial Screening</u>

Potential locations for regional projects to retain (i) all non-stormwater and (ii) all stormwater runoff of the volume equivalent to the 85th percentile, 24-hour storm event for the drainage area tributary to the project will be identified. A preliminary list of the regional projects for initial screening based on the Final EWMP Work Plan approach will be developed and presented in a draft memorandum for review by the EWMP agencies by September 30, 2014. Based upon feedback preliminary soils analysis and testing as well as an initial environmental study of up to three of the proposed regional project sites to support the feasibility analysis will be performed.

Regulatory issues, environmental permits and other requirements for implementing the proposed project sites will be reviewed and the feasibility of constructing the identified projects, including the rough cost estimates, will be assessed to develop a recommended final list. Analysis and results from this sub-task will be presented in the draft memorandum delivered under Sub-task 4.3 Watershed Control Measures and Reasonable Assurance Analysis.

Based upon feedback from EWMP agencies, preliminary soils analysis and testing as well as an initial environmental study of each proposed regional project site to support the feasibility analysis may be conducted.

<u>Item 3 – Watershed Control Measures Performance</u>

Following the process identified in the EWMP Work Plan, the modeling tool will be updated to represent hydrology, hydraulics, stormwater quality, non-stormwater quality, and receiving water quality before and after implementation of watershed control measures.

The performance of the implemented BMPs will be evaluated through quantitative analysis, qualitative assessment, or modeling to demonstrate that the identified control measures will achieve applicable WQBELs and/or RWLs.

Item 4 – Develop Project Schedules and Cost Estimates

Based on the selected watershed control measures, cost estimates for implementing the proposed watershed control measures will be developed. The cost analysis will include any necessary planning, design, permits, construction, operation and maintenance, energy, waste removal, post construction monitoring, and right of way acquisition. Schedules and sequencing for each of the proposed watershed control measures will also be prepared. The sequencing will be based on the approach outlined in the EWMP Work Plan. The schedules will account for:

- TMDL Compliance Schedules, Water Quality Priority categories, and proposed milestones
- The implementation period and milestones during the current Permit term will be differentiated from the future implementation period beyond the current Permit term. A higher level of detail regarding cost and schedule will be provided for watershed control measures scheduled for implementation during the current and next permit term. For control measures scheduled after the next permit term, a generic sequencing and schedule will be provided.
- The schedules will identify the responsibilities for each individual Permittee
- The project schedules will include planning, design, permits, right of way acquisition, construction, operation and maintenance, energy, waste removal, and post-construction monitoring. Realistic constructions durations will be proposed for each project including preconstruction activities such as bid, ware, notice to proceed, move in, construction sub activities depending on the Scope of Work, construction completion, and post construction monitoring, among other considerations that may be applicable during the completion of this sub-task.
- A reasonable time frame will be recommended to initiate projects, nonstructural solutions, and programs during the timeframes based on WESTON's best professional judgment of the requirements for each project.

The financial strategies to implement the EWMP will also be provided to the EWMP agencies and may include such measures as grant funding opportunities and stormwater taxes. Suggested strategies will be based on information gained from each of the EWMP agencies, as well as available known public funding options. The strategies will be presented as general recommendations and not include grant applications or other documentation necessary to fund the EWMP.

The Draft Memorandum will be delivered for review by February 13, 2015.

Item 5 – Draft EWMP Plan

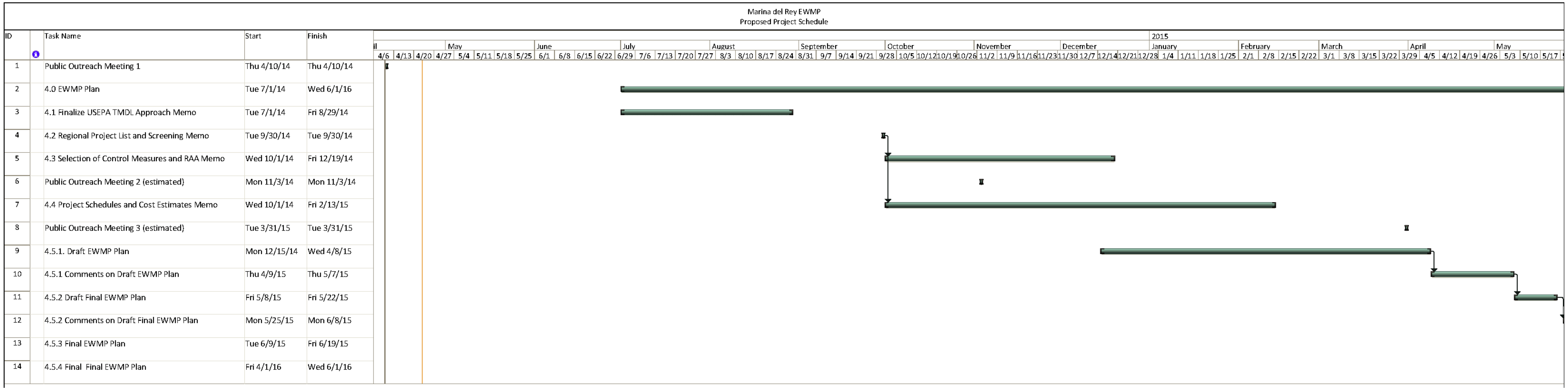
Finally, the deliverables from previously completed tasks will be incorporated to develop a draft and final EWMP plan. Weston will develop milestones and compliance schedules into the EWMP to measure progress toward addressing the highest water-quality priorities and achieving applicable WQBELs and/or RWLs in the shortest time as possible taking into account technological, operation, and economic factors.

The Draft EWMP Plan will be submitted to the MdR EWMP agencies by April 8, 2015. After the agency review, it is assumed that comments will be received by May 7, 2015, and incorporated into a Revised

Draft EWMP Plan by May 22, 2015. After one more revision iteration, a Draft Final EWMP Plan and a Final Final EWMP Plan will be submitted to the EWMP agencies by June 19, 2015 for submission to the Regional Board by June 28, 2015.

Public Outreach Meetings

Local stakeholders will be engaged in the EWMP development process through three workshops/meetings. The first meeting took place on April 10th, 2014 and included an overview of the EWMP process and milestones (Work Plan, CIMP, and EWMP). The second meeting will occur in the Fall of 2014 and the third meeting will likely occur in Winter 2014 or Spring 2015.



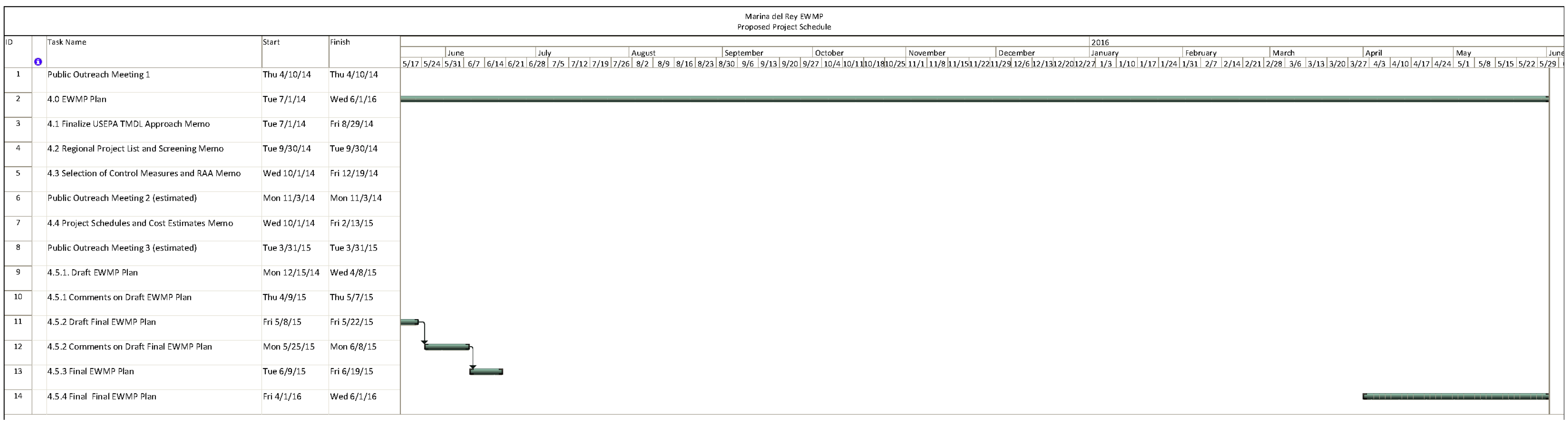


Figure 16. MdR EWMP Gant Chart Schedule

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Marina del Rey Enhanced Watershed Management Program

Work Plan

Appendix A

Los Angeles County Flood Control District Background Information

LACFCD Background Information

In 1915, the Los Angeles County Flood Control Act established the LACFCD and empowered it to manage flood risk and conserve stormwater for groundwater recharge. In coordination with the United States Army Corps of Engineers the LACFCD developed and constructed a comprehensive system that provides for the regulation and control of flood waters through the use of reservoirs and flood channels. The system also controls debris, collects surface storm water from streets, and replenishes groundwater with storm water and imported and recycled waters. The LACFCD covers the 2,753 square-mile portion of Los Angeles County south of the east-west projection of Avenue S, excluding Catalina Island. It is a special district governed by the County of Los Angeles Board of Supervisors, and its functions are carried out by the Los Angeles County Department of Public Works. The LACFCD service area is shown in Figure 17**.**

Unlike cities and counties, the LACFCD does not own or operate any municipal sanitary sewer systems, public streets, roads, or highways. The LACFCD operates and maintains storm drains and other appurtenant drainage infrastructure within its service area. The LACFCD has no planning, zoning, development permitting, or other land use authority within its service area. The permittees that have such land use authority are responsible under the Permit for inspecting and controlling pollutants from industrial and commercial facilities, development projects, and development construction sites. (Permit, Part II.E, p. 17.)

The MS4 Permit language clarifies the unique role of the LACFCD in storm water management programs: "[g]iven the LACFCD's limited land use authority, it is appropriate for the LACFCD to have a separate and uniquely-tailored storm water management program. Accordingly, the storm water management program minimum control measures imposed on the LACFCD in Part VI.D of this Order differ in some ways from the minimum control measures imposed on other Permittees. Namely, aside from its own properties and facilities, the LACFCD is not subject to the Industrial/Commercial Facilities Program, the Planning and Land Development Program, and the Development Construction Program. However, as a discharger of storm and non-storm water, the LACFCD remains subject to the Public Information and Participation Program and the Illicit Connections and Illicit Discharges Elimination Program. Further, as the owner and operator of certain properties, facilities and infrastructure, the LACFCD remains subject to requirements of a Public Agency Activities Program."
(Permit, Part II.F**,** p. 18.)

Consistent with the role and responsibilities of the LACFCD under the Permit, the [E]WMPs and CIMPs reflect the opportunities that are available for the LACFCD to collaborate with permittees having land use authority over the subject watershed area. In some instances, the opportunities are minimal, however the LACFCD remains responsible for compliance with certain aspects of the MS4 permit as discussed above.

In some instances, in recognition of the increased efficiency of implementing certain programs regionally, the LACFCD has committed to responsibilities above and beyond its obligations under the 2012 Permit. For example, although under the 2012 Permit the Public Information and Participation Program is a responsibility of each Permittee, the LACFCD is committed to implementing certain regional elements of the PIPP on behalf of all Permittees at no cost to the Permittees. These regional elements include:

- Maintaining a countywide hotline (888-CLEAN-LA) and website (www.888cleanla.com) for public reporting and general stormwater management information at an estimated annual cost of $250,000. Each Permittee can utilize this hotline and website for public reporting within its jurisdiction.
- Broadcasting public service announcements and conducting regional advertising campaigns at an estimated annual cost of $750000.
- Facilitating the dissemination of public education and activity specific stormwater pollution prevention materials at an estimated annual cost of $100,000.
- Maintaining a stormwater website at an estimated annual cost of $10,000.

The LACFCD will implement these elements on behalf of all Permittees starting July 2015 and through the Permit term. With the LACFCD handling these elements regionally, Permittees can better focus on implementing local or watershed-specific programs, including student education and community events, to fully satisfy the PIPP requirements of the 2012 Permit.

Similarly, although water quality monitoring is a responsibility of each Permittee under the 2012 Permit, the LACFCD is committed to implement certain regional elements of the monitoring program. Specifically, the LACFCD will continue to conduct monitoring at the seven existing mass emissions stations required under the previous Permit. The LACFCD will also participate in the Southern California Stormwater Monitoring Coalition's Regional Bioassessment Program on behalf of all Permittees. By taking on these additional responsibilities, the LACFCD wishes to increase the efficiency and effectiveness of these programs.

Figure 17 Los Angeles County Flood Control District Service Area

Marina del Rey Enhanced Watershed Management Program

Work Plan

Appendix G

Existing Water Quality Data Marina del Rey Watershed

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LIST OF ACRONYMS

AVS	acid volatile sulfide
BMP	best management practice
BOD	biochemical oxygen demand
Caltrans	California Department of Transportation
CMP	Coordinated Monitoring Plan
COP	California Ocean Plan
County	County of Los Angeles
CTR	California Toxics Rule
DDT	dichlorodiphenyltrichloroethane
EPA	United States Environmental Protection Agency
EqP	equilibrium partitioning
ER-L	effects range-low
ER-M	effects range-median
ESB	equilibrium partitioning sediment benchmark
LACDBH	Los Angeles County Department of Beaches and Harbors
LACFCD	Los Angeles County Flood Control District
LOE	line of evidence
MDL	method detection limit
MdR	Marina del Rey
MdRH	Marina del Rey Harbor
MLOE	multiple lines of evidence
MS4	Municipal Separate Storm Sewer System
O&M	operation and maintenance
p,p'-DDE	dichlorodiphenyldichloroethylene
PCB	polychlorinated biphenyl
PCR	Polymerase Chain Reaction
RL	reporting limit
SCCWRP	Southern California Coastal Water Research Project
SEM	simultaneously extracted metals
SQO	Sediment Quality Objective
SSC	suspended sediment concentration
TCLP	Toxicity Characteristic Leaching Procedure
TIE	toxicity identification evaluation
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TSS	total suspended solids
TTLC	Total Threshold Limit Concentration
Weston	Weston Solutions, Inc.
WLA	waste load allocation
WQO	water quality objective

1.0 Introduction

Appendix G summarizes existing data from monitoring in the MdR watershed that were used in development of the Marina del Rey Enhanced Watershed Management Program Work Plan Figure 1 represents an overview of the watershed and the jurisdictional boundaries.

Figure 1. Marina del Rey Watershed

2.0 Toxics TMDL Monitoring

The Toxics Total Maximum Daily Load (Toxics TMDL) established sediment numeric targets for metals, chlordane, and total polychlorinated biphenyls (PCBs). Water column and fish tissue targets were also established for PCBs. In 2014 the Toxics TMDL was revised to extend the coverage area to include the Front Basins of the Marina del Rey Harbor (MdRH), implement the final numeric target for PCBS in the water column, reduce the PCB numeric target for sediment and fish tissue, change the metals waste load allocations, and add dichlorodiphenyltrichloroethanes (DDT) and dichlorodiphenyldichloroethylene (p,p'-DDE) to the TMDL.

2.1 Stormwater Monitoring

Stormwater monitoring in the areas draining to the Back Basins was conducted during the first 3 monitoring years of the Coordinated Monitoring Program (CMP) (2010 to 2013). Stations monitored were MdRU-C-1, MdRU-C-2, MdR-3, MdR-4, and MdR-5 (Figure 2).

Figure 2. TMDL Monitoring Locations

A total of 23 storms were monitored during the 3-year period (2010 to 2013). Because the TMDL targets for stormwater are sediment based, it is not feasible to make an assessment of water quality exceedances based on water column data. For this report, the data were compared to the California Toxics Rule (CTR) water column criteria to provide a general sense of the water quality conditions in the stormwater to help guide the prioritization of water quality issues. Key findings include the following:

- Chlordane was not detected in any of the samples above the Method Detection Limit (MDL). The MDLs were below the CTR Criteria Maximum Concentration (CMC) for acute toxicity for freshwater (2.4 µg/L).
- PCBs were not detected above the MDL for the first 2 monitoring years. However, the MDLs were greater than the CTR human health target established for consumption of organisms (0.00017 µg/L), which is the numeric target established for the water column in the Back Basins of MdRH. During the third monitoring year, PCB-1254 (Aroclor 1254) was detected above the MDL during the third and fourth monitored storms (12/31/2012, 1/28/2013) at all five monitoring stations. However, this Aroclor was also detected in the equipment blank at an estimated concentration of 0.064 µg/L (detection above MDL but below the reporting limit [RL]) during the 12/31/2012 monitoring event. This Aroclor was also detected in the field blank (deionized water) during the 1/2/2013 monitoring event at an estimated concentration of 0.024 µg/L (detection above MDL but below RL). The presence of Aroclor 1254 in the quality assurance/quality control samples requires that the reported values be considered with caution.
- Dissolved copper exceeded the hardness-based CTR CMC during 21 of the 23 monitored events at MDR-3; including five of the six monitored events in the 2012 to 2013 monitoring season (see Appendix G2). At MdR-4, dissolved copper results exceeded the hardness-based CTR CMC during eight of the 23 monitored events, including two of the six monitored events in the 2012 to 2013 monitoring season. At MdR-5, only one sample exceeded the hardness-based CTR CMC for dissolved copper. At MdRU-C-1, 16 of 23 samples exceeded the CMC, including four of the six samples from the 2012 to 2013 monitoring year. At MdRU-C-2, 18 of 23 samples exceeded the CMC, including four of the six samples from the 2012 to 2013 monitoring year. Average dissolved copper concentrations were similar across all stations. The highest concentrations were observed at MdRU-C-2 (Figure 3).
- Dissolved lead exceeded the hardness-based CTR CMC only once at MdRU-C-2 during the 3/8/2013 event. Average dissolved lead results were similar across all the stations with the highest concentrations observed at MdRU-C-1 and MdRU-C-2 (Figure 3).
- Dissolved zinc exceeded the hardness-based CTR CMC at MdR-3 for 20 of the 23 samples collected, including five of the six samples collected during the 2012 to 2013 monitoring year. At MdR-4, dissolved zinc exceeded the CMC during nine of the 23 monitored events, including during two of the six events in the 2012 to 2013 monitoring year. There were no exceedances of dissolved zinc at station MdR-5. At MdRU-C-1, dissolved zinc exceeded the CMC during 13 of the 23 monitored events, including two of the six events monitored in 2012 to 2013. At MdR-CU-2, dissolved zinc exceeded the CMC during 15 of the 23 events, including four of the six events monitored in the 2012 to 2013 monitoring season. Average dissolved zinc concentrations were higher at MdR-3 and MdR-4 (Figure 3).

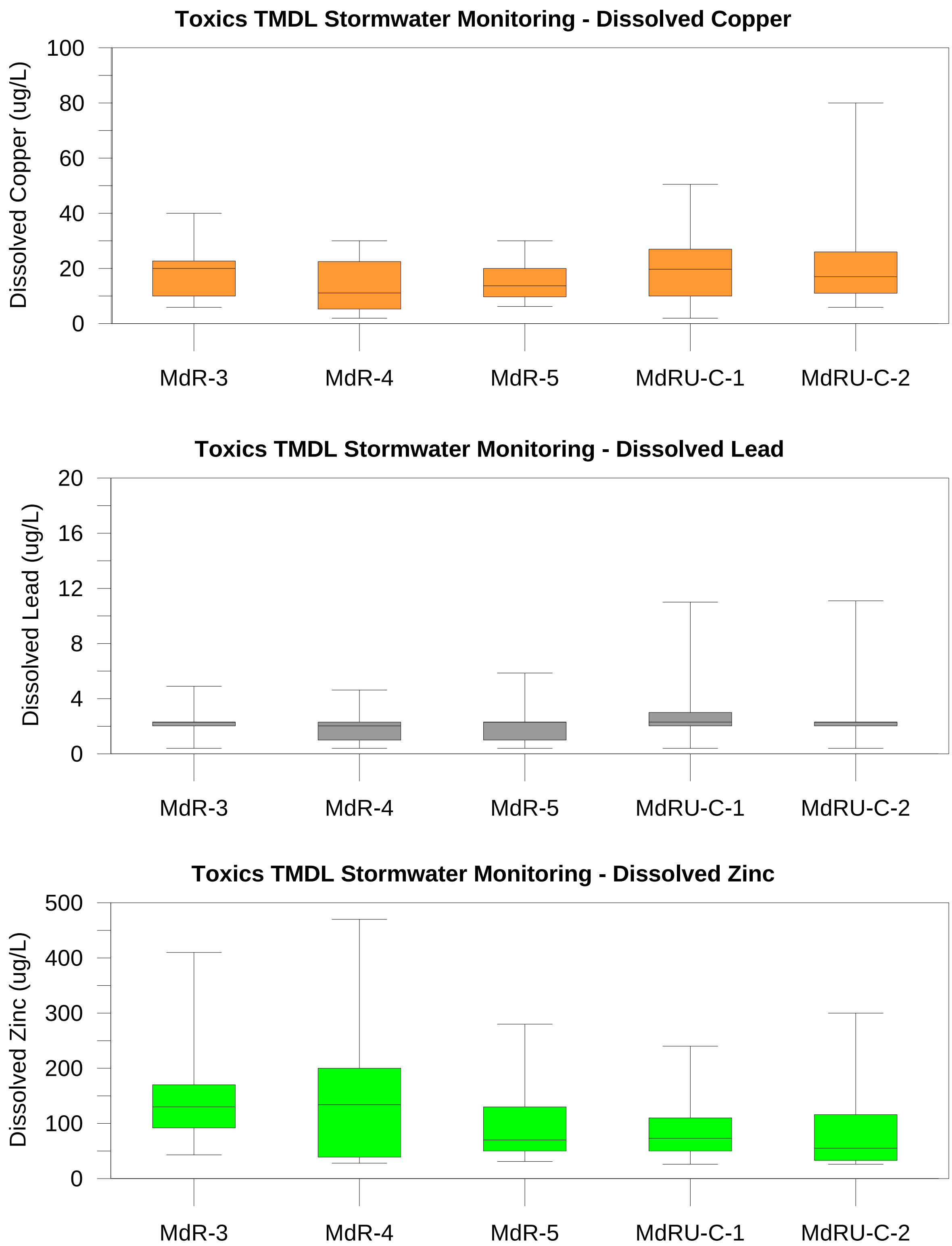


Figure 3. Toxics TMDL Stormwater Metals Concentrations

The Toxics TMDL includes stormwater waste load allocations (WLAs) for the Municipal Separate Storm Sewer System (MS4) Permittees, California Department of Transportation (Caltrans), and general construction and industrial stormwater permits (Table 1). These stormwater WLAs were developed by first determining the total loading capacity of MdRH and then subtracting loads allocated to other sources (i.e., atmospheric deposition). The loading capacity was determined in the TMDL by multiplying the annual average total suspended solids (TSS) discharged to MdRH (84,612 kg/year) by the numeric targets (see Table 8 in Work Plan).

Table 1. Toxics TMDL Stormwater Waste Load Allocations

Permittees	Copper (kg/year)	Lead (kg/year)	Zinc (kg/year)	Chlordane (g/year)	Total PCBs (g/year)	Total DDT (g/year)	p p'-DDE (g/year)
MS4	2.26	3.10	9.96	0.0332	1.51	0.10	0.15
Caltrans	0.036	0.05	0.16	0.0005	0.024	0.0017	0.0024
General construction	0.23	0.32	1.02	0.0034	0.16	0.011	0.015
General industrial	0.012	0.016	0.053	0.0002	0.008	0.0006	0.0008
Total	**2.54**	**3.49**	**11.2**	**0.04**	**1.70**	**0.12**	**0.16**

2.2 Storm Borne Sediment Monitoring

A pilot project was conducted in March 2013 to determine the feasibility and effectiveness of collecting storm borne sediment using passive sediment collection devices. These devices were installed at three of the stormwater monitoring sites, MdR-4, MdR-5 and MdRU-C-1 (Figure 2). Sediment collected was analyzed for metals, PCBs, chlordane, and total organic carbon (TOC) (Table 2, Figure 4). The TMDL did not establish numeric targets associated with storm borne sediment. For comparative purposes, the results on Table 2 were compared to the numeric targets identified in the TMDL for sediments in MdRH. Concentrations for chlordane and for all of the metals were well above the numeric targets. However, the concentration of chlordane observed in the storm borne sediment samples is not consistent with observations in harbor sediments. The lowest storm borne chlordane results (150 µg/kg) were 10 times greater than the highest sediment chlordane results found during the 2008 study (Weston, 2008) which ranged from non-detect to 10 µg/kg (Table 17). Bight '03 and Bight '08 sample results from the mouth of the harbor ranged from 5 µg/kg at B03-4149 to 62.8 µg/kg at B08-6513. Additionally, chlordane was not detected during the Toxics TMDL monitoring, which had MDLs below 150 µg/kg (Appendix G2). Therefore, the chlordane results should be interpreted with caution, because the total concentration observed is much higher than would be expected. Further research into the sampling results should be conducted to confirm these chlordane concentrations.

PCBs were the only constituent not consistently detected in the storm borne sediment. MdR-5 was the only station with PCBs detected above the MDL. The remaining stations did not have detections of PCBs; however, the MDL was greater than the numeric target so the comparison is inconclusive.

Table 2. Storm Borne Sediment Monitoring Results

Constituent	Units	TMDL Numeric Target [1]	MdR-4	MdR-5	MdRU-C-1
			3/8/2013	3/8/2013	3/8/2013
Metals					
Copper	mg/kg	34	502	340	202
Lead	mg/kg	46.7	121	182	112
Zinc	mg/kg	150	2,260	1,270	878
PCBs					
Aroclor 1016	µg/kg	NA	<42	<64	<29
Aroclor 1221	µg/kg	NA	<38	<58	<26
Aroclor 1232	µg/kg	NA	<31	<48	<22
Aroclor 1242	µg/kg	NA	<37	<56	<25
Aroclor 1248	µg/kg	NA	<42	<65	<29
Aroclor 1254	µg/kg	NA	<35	1,900	<24
Aroclor 1260	µg/kg	NA	<33	<51	<23
Aroclor 1262	µg/kg	NA	<36	<55	<25
Total PCBS (Aroclors)	µg/kg	3.2	<42	1,900	NA
Organics					
Chlordane	µg/kg	0.5	150	410	43
Conventionals					
Dry mass	g		12	14	26
Percent solids	%		34.1	22.2	49.5
Wet mass	g		36	63	53
Total organic carbon	mg/kg		150,000	150,000	170,000

[1] Numeric target is for in-harbor sediments.

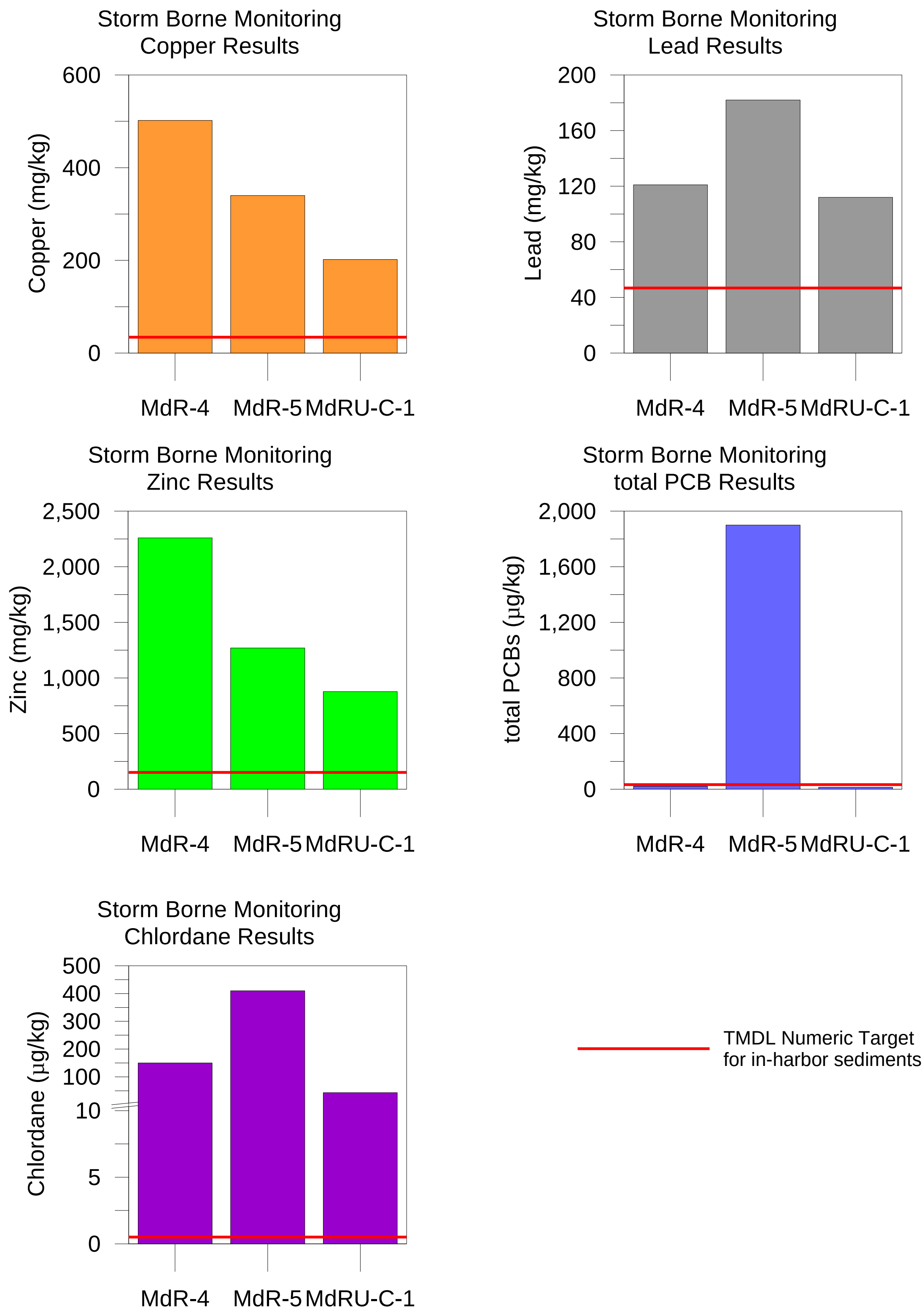


Figure 4. Storm Borne Sediment Monitoring Results

2.3 Load Calculations

TSS concentrations (mg/L) for the five stormwater monitoring stations (MdR-3, MdR-4, MdR-5, MdRU-C1, and MdRU-C2) were monitored during eight events for the 2011-2012 west season and six events for the 2012-2013 west season. Runoff volumes (Liters) for each of these events and stations were also monitored. For each of the storms at each monitoring station, a TSS load was calculated (Kg). These loads were summed by station resulting in a total TSS load associated with each of the stations and their corresponding drainage area. Using this data, volume-weighted average TSS concentrations were calculated for each of the monitoring stations, for each of the monitored wet seasons.

Table 3. Volume-Weighted TSS Concentrations from Stormwater Monitoring (mg/L)

Monitoring Year	Volume-Weighted TSS Concentration (mg/L)				
	MdR-3	MdR-4	MdR-5	MdRU-C1	MdRU-C2
2011-2012	83	36	61	108	38
2012-2013	72	29	38	56	23

For each of the wet seasons, 2011-2012 and 2012-2013, 6 storms and 7 storms were not monitored, respectively, for TSS. Runoff volumes for these storms for each monitoring station were estimated using the Rationale Method and the rainfall data available from the Annual Reports and were summed to obtain net runoff volumes over the unmonitored storms corresponding to each station's drainage area. These volumes were used, along with the volume-weighted average TSS concentrations to estimate the unmonitored loads associated with each station for the total unmonitored events and summed with the calculated monitored loads to establish a total TSS load at each station (Table 4).

Table 4. Estimated TSS Loads

Station	2011-2012 TSS Load (kg)			2011-2012 TSS Load (kg)		
	Monitored	Unmonitored	Total	Monitored	Unmonitored	Total
MdR-3	5,181	3,618	8,799	2,848	7,051	9,899
MdR-4	1,104	758	1,862	556	1,385	1,941
MdR-5	1,679	230	1,909	647	322	969
MdRU-C1	173	13	186	100	15	115
MdRU-C2	142	25	167	23	35	58

An area-weighted total watershed TSS load was calculated using each of the monitoring station's associated contribution to the total MdR watershed area (Table 5). The total TSS load was estimated to be 29,970 Kg and 30,109 Kg, for wet seasons 2011-2012 and 2012-2013, respectively. These TSS loads are considerably lower than the average annual TSS load used in the Toxics TMDL (84,612 kg/year).

Table 5. Monitoring Stations Drainage Areas

Monitoring Station	MdR-3	MdR-4	MdR-5	MdRU-C1	MdRU-C2
Drainage Area	376.4	153.4	70.5	0.7	6.5
Percent of MdR Watershed	26.7	10.9	5.0	0.1	0.5

Stormborne sediment was monitored during March, 2013, for three stations, MdR-4, MdR5, and MdRU-C1. An area-weighted average was calculated to account for the representation of each of these monitored stations in the whole watershed (Table 6). The area-weighted averages were then multiplied by the previously estimated area-weighted TSS loads (Table 4) to calculate the total estimated load for each of the monitored toxic constituents (Table 7). These loadings estimates were very similar for both monitored seasons, resulting in required percent reductions of 79%, 6%, 78%, 90%, and 99% for copper, lead, zinc, PCBs, and chlordane, respectively.

Table 6. Area-Weighted Average Concentration

Constituent	Units	TMDL Numeric Target	Watershed Weighted Average
Copper	mg/kg	34	**450**
Lead	mg/kg	46.7	**140**
Zinc	mg/kg	150	**1945**
PCBs	ug/kg	3.2	**616**
Chlordane	ug/kg	0.5	**231**

Table 7. Estimated Constituent Load

Constituent	Watershed Stormborne Sediment Loads (Kg)	TMDL Loading Capacity	Compliance Percent Reduction
2011-2012			
Copper (Kg)	13.49	2.88	0.79
Lead (Kg)	4.20	3.95	0.06
Zinc (Kg)	58.29	12.69	0.78
PCBs (g)	18.46	1.92	0.90
Chlordane (g)	6.93	0.04	0.99
2012-2013			
Copper (Kg)	13.56	2.88	0.79
Lead (Kg)	4.22	3.95	0.06
Zinc (Kg)	58.56	12.69	0.78
PCBs (g)	18.55	1.92	0.90
Chlordane (g)	6.96	0.04	0.99

2.4 Sediment

Sediment samples were collected quarterly from the Back Basins at monitoring locations MdRH-B-1, MdRH-B-2, MdRH-B-3, and MdRH-B-4 (Figure 2,Appendix G1). The Toxics TMDL implemented sediment numeric targets for PCBs, chlordane, and total metals (Table 8) and was updated in 2014 to include numeric targets for total DDTs and p,p’-DDE.

Table 8. Summary of Toxics TMDL Sediment Monitoring Exceedances

Station	Year	Total Copper	Total Lead	Total Zinc	Total PCB Aroclors (Calculated)
MdRH-B-1	2010	2/2	2/2	2/2	0/2**
	2011	4/4	4/4	4/4	4/4
	2012	4/4	4/4	4/4	4/4
	2013	2/2	2/2	2/2	2/2
MdRH-B-2	2010	2/2	2/2	2/2	0/2**
	2011	4/4	4/4	4/4	4/4
	2012	4/4	4/4	4/4	4/4
	2013	2/2	2/2	2/2	2/2
MdRH-B-3	2010	2/2	2/2	2/2	1/2*
	2011	4/4	4/4	4/4	4/4
	2012	4/4	4/4	4/4	4/4
	2013	2/2	2/2	2/2	2/2
MdRH-B-4	2010	2/2	2/2	2/2	1/2*
	2011	4/4	4/4	4/4	4/4
	2012	4/4	4/4	4/4	4/4
	2013	2/2	2/2	2/2	2/2

* 1 of 2 non-detect samples above the numeric target.

** 2 of 2 non-detect samples above the numeric target.

Total PCBs were above the TMDL numeric target in 42 of the 48 samples (Table 8, Figure 5,AppendixG1). The remaining six samples were all non-detects with MDLs greater than the numeric target (resulting in an inconclusive comparison for these samples).

There were no detections of chlordane; however, the MDLs for chlordane were higher than the numeric target. The results of the chlordane comparison, therefore, are inconclusive.

Metals analyses indicated that results for total copper, total lead, and total zinc exceeded the numeric targets in every sample. Copper levels exceeded by a factor of 10, whereas zinc concentrations were approximately twice the numeric target level. Lead concentrations were approximately 1.5 times the numeric target level (Figure 5).

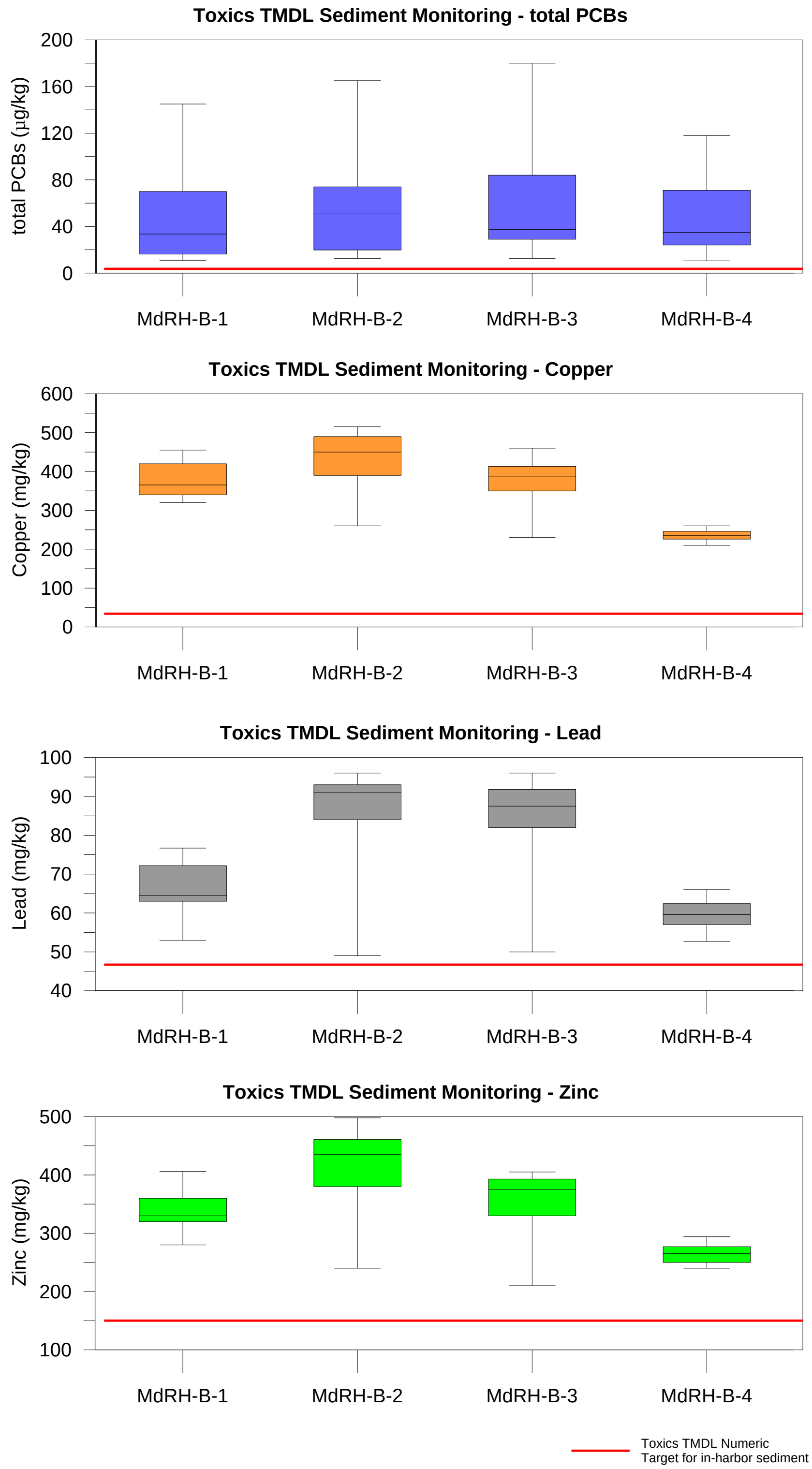


Figure 5. Toxics TMDL Sediment Monitoring Results

2.5 Sediment Toxicity

Sediment toxicity monitoring was conducted quarterly during the first year of the Toxics TMDL monitoring program, and semi-annually for years 2 and 3. Sediment toxicity test endpoints included *Eohaustorius estuarius* survival; *Leptocheirus plumulosus* survival, reproduction, and growth; *Mytilus galloprovincialis* development; and *Strongylocentrotus purpuratus* fertilization.

E. estuarius survival (10-day test) and *M. galloprovincialis* development results were evaluated based on Sediment Quality Objectives (SQO) Part 1 guidelines. At all stations, all eight of the samples resulted in non-toxic SQO classifications for *M. galloprovincialis*. At both MdRH-B-1 and MdRH-B-4, six of the eight samples collected resulted in non-toxic SQO classification for *E. estuarius*. At MdRH-B-2 and MdRH-B-3, four of the eight samples were non-toxic based on the SQO guidelines for *E. estuarius*; whereas, moderate toxicity was observed at MdRH-B-2 in three of the samples and at both MdRH-B-1 and MdRH-B-3 in one sample (Table 9).

Table 9. Toxics TMDL Sediment Toxicity SQO Line of Evidence Classification

Station	Species	Endpoint	n	Percent Non-Toxic	Percent Low Toxicity	Percent Moderate Toxicity
MdRH-B-1	*E. estuarius*	Survival (10 day)	8	75%	12.5%	12.5%
	M. galloprovincialis	Development	8	100%	-	-
MdRH-B-2	*E. estuarius*	Survival (10 day)	8	50%	12.5%	37.5%
	M. galloprovincialis	Development	8	100%	-	-
MdRH-B-3	*E. estuarius*	Survival (10 day)	8	50%	37.5%	12.5%
	M. galloprovincialis	Development	8	100%	-	-
MdRH-B-4	*E. estuarius*	Survival (10 day)	8	75%	25%	-
	M. galloprovincialis	Development	8	100%	-	-

At all of the stations monitored (MdRH-B-1, MdRH-B-2, MdRH-B-3, and MdRH-B-4), *L. plumulosus* survival was significantly reduced compared to the control during six of the eight events. Where significance was analyzed, sublethal endpoint results were also significantly reduced compared to control results. At stations MdRH-B-2 and MdRH-B-4, *S. purpuratus* fertilization was significantly reduced compared to the control during five of the eight events. At MdRH-B-1 and MdRH-B-3, *S. purpuratus* fertilization was significantly reduced compared to the control during four of the eight events (Table 10). Further research into the possible causes of toxicity to *L. plumulosus* and *S. purpuratus* should be explored because the toxicity results are not consistent with the *E. estuarius* and *M. galloprovincialis* results.

Table 10. Toxics TMDL Sediment Toxicity – Samples Significantly Different from Control

Species	Endpoint	MdRH-B-1	MdRH-B-2	MdRH-B-3	MdRH-B-4
L. plumulosus	Mean Growth (28 day)	6/8†	6/8†	6/8†	6/8†
	Mean Reproduction	5/8†	5/8†	5/8†	5/8†
	Mean Survival (28 day)	6/8^	6/8^	6/8^	6/8^
S. purpuratus	Mean Fertilization	4	5	4	5

†Sub-lethal endpoints not analyzed statistically for one or more sampling events.
^Controls did not meet acceptability criteria for one or more sampling events.

2.6 Fish Tissue

The Toxics TMDL fish tissue numeric target of 3.6 µg/kg for total PCBs is the Office of Environmental Health Hazard Assessment (OEHHA) Fish Contaminant Goal (FCG). Mussels and fish tissue samples were collected at three locations in Back Basins MdRH-B-1, MdRH-B-2, and MdRH-B-3 in October 2010, October 2011, and October 2012 (Appendix G2). All samples collected exceeded the numeric target for total PCBs in fish tissue. Only two Aroclors were detected. Aroclor 1254 was detected in every sample, and Aroclor 1260 was detected in California halibut at all three sampling locations, in Shiner perch at MdRH-B-3, and in bat ray at MdRH-B-1. Average total PCB concentrations were highest in Shiner perch and white croaker and lowest in bat ray (Table 11).

Table 11. Average Total Polychlorinated Biphenyl Concentrations in Fish Tissue

Species	Number of Samples	Total PCBs Average Concentration (µg/kg)
Cymatogaster aggregata (Shiner perch)	12	66.58
Myliobatis californica (bat ray)	2	15.85
Mytilus galloprovincialis (Mussel)	45	52.09
Paralichthys californicus (California halibut)	26	32.68
Genyonemus lineatus (white croaker)	9	62.33

2.7 Water Column

Water column sampling under the Toxics TMDL commenced in August of 2010 and was conducted on a monthly basis at four stations in the Back Basins, MdRH-B-1, MdRH-B-2, MdRH-B-3, and MdRH-B-4 (Figure 2). Analyses included total and dissolved metals, chlordane, and PCBs. The Toxics TMDL final numeric target for total PCBs in the water column is 0.00017 µg/L. The TMDL also includes a water column numeric target for dissolved copper equal to the saltwater CTR CMC (4.8 µg/L).

Dissolved copper exceeded the TMDL numeric target (4.8 µg/L) at every station. Average concentrations were greatest at MdRH-B-1 and MdRH-B-2 and lowest at MdRH-B-3 (Table 12, Figure 6,AppendixG1).

Table 12. Summary of Back Basin Dissolved Copper Water Column Results

Constituent	TMDL Numeric Target	Year	Average Concentration (µg/L)	Exceedances of Dissolved Copper TMDL Target
MdRH-B-1	**4.8 µg/L**	2010	8.00	5/5
		2011	4.83	5/12
		2012	5.28	6/12
		2013	8.85	7/7
MdRH-B-2		2010	6.01	4/5
		2011	4.87	8/12
		2012	6.03	6/12
		2013	6.50	6/7
MdRH-B-3		2010	5.52	4/5
		2011	3.94	2/12
		2012	4.05	5/12
		2013	5.84	4/7
MdRH-B-4		2010	6.37	5/5
		2011	4.09	3/12
		2012	4.43	5/12
		2013	6.13	6/7

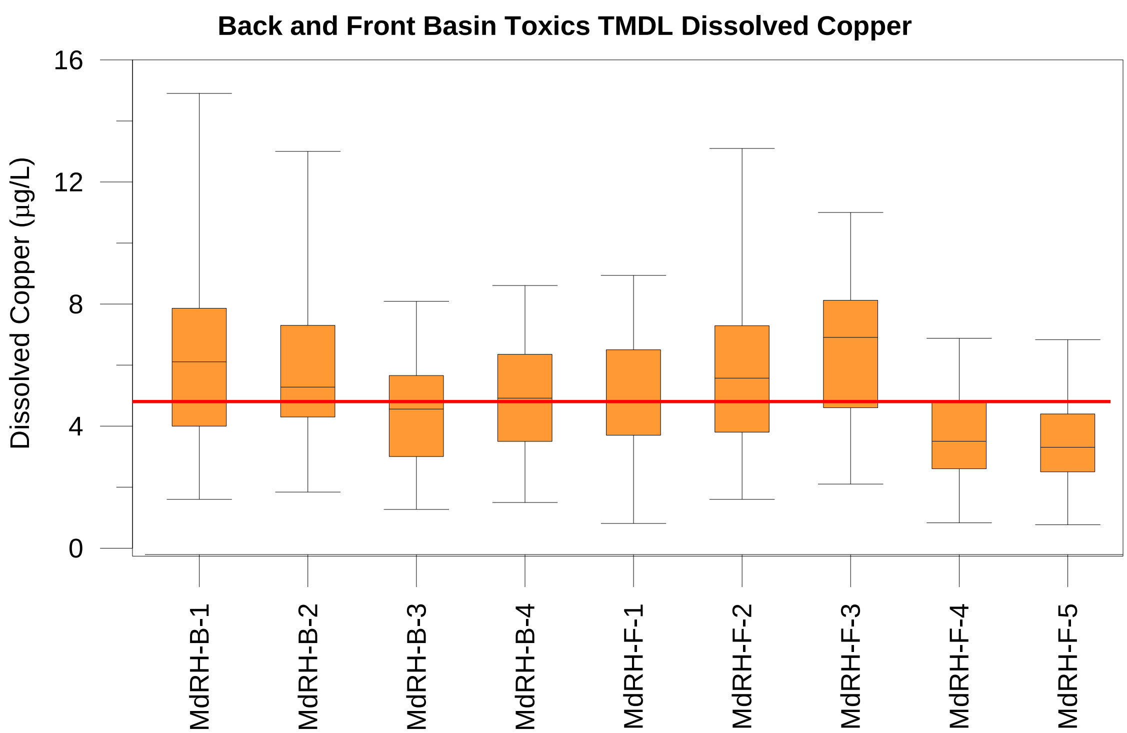


Figure 6. Marina del Rey Harbor Dissolved Copper Concentrations (Both Back and Front Basins)

There were no detections of PCBs in any of the samples collected. However, the MDLs used in the PCB analyses exceeded the TMDL numeric target; therefore, the comparison is inconclusive.

Chlordane results exceeded the saltwater CMC in only one sample, MdRH-B-1, in October 2011.

In addition to the water column monitoring in the Back Basins, five stations in the Front Basins were monitored on a monthly basis for total and dissolved copper (MdRH-F-1, MdRH-F-2, MdRH-F-3, MdRH-F-4, and MdRH-F-5) (Figure 2). Exceedances of the dissolved copper TMDL numeric target (saltwater CTR CMC) were observed at every station every year with the exception of MdRH-F-4 and MdRH-F-5 during 2011 (Table 13, Appendix G). Average concentrations were lowest at MdRH-F-4 and MdRH-F-5 (Table 13, Figure 6Appendix G).

Table 13. Summary of Front Basin Dissolved Copper Monitoring

Constituent	TMDL Numeric Target	Year	Average Concentration (µg/L)	Dissolved Copper TMDL Numeric Target (Exceedances/n)
MdRH-F-1	**4.8 µg/L**	2010	6.70	4/5
		2011	4.14	3/12
		2012	4.51	5/12
		2013	6.02	6/7
MdRH-F-2		2010	6.82	4/5
		2011	4.43	4/12
		2012	5.21	5/12
		2013	7.72	7/7
MdRH-F-3		2010	8.45	5/5
		2011	5.10	6/12
		2012	6.32	8/12
		2013	8.64	7/7
MdRH-F-4		2010	4.58	3/5
		2011	2.84	0/12
		2012	3.68	3/12
		2013	4.66	3/7
MdRH-F-5		2010	4.24	2/5
		2011	3.00	0/12
		2012	3.52	3/12
		2013	4.08	2/7

2.8 Toxics TMDL Special Studies

Two special studies were completed as required under the Toxics TMDL, the Low Detection Limit (LDL) Study (Brown and Caldwell, 2011a) and the Partitioning Coefficient Study (Brown and Caldwell, 2011b). The LDL study was completed to evaluate alternative laboratory techniques to assess concentrations of contaminants where standard laboratory methods do not enable detection of contaminants at low enough levels to ascertain compliance with CTR standards or to estimate source loading from stormwater. The Partitioning Coefficient Special Study was conducted to evaluate partitioning coefficients between sediments and the water column for metals (specifically copper) in order to assess the contribution of water column discharges to sediment concentrations in MdRH.

2.8.1 Low Detection Limit Toxics TMDL Special Study

Stormwater Monitoring – Low-Detection Limit Study
Stormwater sampling was conducted for 4 months in 2011 concurrent with the stormwater monitoring under the Toxics TMDL. Samples were collected at stations MdR-3, MdR-4 Mdr-5, MdRU-C-1, and MdRU-C-2. Samples were analyzed using EPA Method 1668 for PCBs and United States Environmental Protection Agency (EPA) Method 625 for chlordane. Although the TMDL does not include a numeric target for total PCBs in stormwater, it is useful to compare the results monitored from stormwater to the numeric targets established for the MdRH water column. Results indicate that all samples at all stations would exceed the final total PCB numeric target of (0.00017 µg/L) by a factor of at least 12. All samples at stations MdR-4, MdR-5, and MdRU-C-1 met the interim numeric target of 0.03 µg/L. One sample exceeded the interim target at MdR-3 (one out of four samples) and two samples exceeded the interim target at MdRU-C-2 (two out of four samples). However, once the results were corrected for blank contamination, only one sample at MdRU-C-2 exceeded the interim target (Brown & Caldwell, 2011a). The highest average concentrations of total PCBs were seen at MdRU-C-2.

Chlordane analysis results indicate all stormwater samples met the CTR CMC for freshwater and for saltwater. Only two of the four samples from MdR-3 and two of the four samples from MdRU-C-2 had detectable amounts of chlordane above the MDL. The MDL for several samples in this analysis was greater that the human health criterion established in the CTR. A reanalysis was performed to lower the MDL and resulted in additional detections above the human health criterion (Brown and Caldwell, 2011a).

Harbor Water Monitoring – Low-Detection Limit Study
Sampling of MdRH water was conducted for 4 months in 2011 concurrent with monitoring under the Toxics TMDL. Samples were analyzed for PCBs using EPA Method 1668. Results (Appendix G2) of this analysis indicate that all samples exceeded the final numeric target for PCBs (0.00017 µg/L) by a factor of at least 12. Highest PCB concentrations were observed in Basin F at MdRH-B-3.

There were no detections of chlordane above the MDL in the initial chlordane analysis. The MDL (1 ng/L) was greater than the human health criterion established in the CTR (0.57 ng/L). A reanalysis was completed to achieve an MDL of 0.028 ng/L and resulted in chlordane detections above the MDL. Only one detection was above the human health criterion established in the CTR; however, the trip blank associated with this sample also had a detection greater than the CTR human health criterion.

Sediment – Low Detection Limit Study

2.8.2 Sediment samples were collected during two quarterly sediment monitoring events conducted under the Toxics TMDL (March and June 2011). Sediment samples were analyzed using EPA Method 1668. Results (Appendix G2) indicate that all samples exceeded the TMDL numeric target for total PCBs in sediment (3.2 µg/kg). EPA Method 8270 was used for chlordane analysis and all results were non-detect. However, the MDL used for this analysis was above the TMDL numeric target; therefore, the results of the monitoring are inconclusive regarding TMDL numeric targets compliance.Partitioning Coefficient Toxics TMDL Special Study

Stormwater – Partitioning Coefficient Study

Stormwater samples were collected during the five storm events monitored under the Toxics TMDL in 2011. Stormwater was analyzed for total and dissolved copper, lead, and zinc as well as suspended sediment concentration (SSC). The results from the analysis performed by this study indicated that copper concentrations in stormwater are higher than background levels and that stormwater discharges may be impacting sediment copper concentrations (Brown and Caldwell, 2011b).

Sediment and Harbor Water – Partitioning Coefficient Study

Sediment samples were collected during March and June 2011 (Appendix G2). Harbor water samples were collected during 6 months in 2011 (February to July) at each of the Front Basin and Back Basin monitoring locations under the Toxics TMDL (Figure 2). Water samples were collected at the surface, mid-depth, and at-depth. Results of the study indicate that concentrations of dissolved copper were highest in the surface water samples and lowest in the at-depth water samples (Appendix G2). This may be indicative of copper paint leaching from boat hulls (Brown & Caldwell, 2011b).

3.0 Annual Monitoring Reports

3.1 Sediment

Sediments in MdRH were monitored at 20 locations on an almost annual basis for more than 25 years under the Los Angeles County Department of Beaches and Harbors (LACDBH) annual monitoring program (ABC 2001-2008) (Figure 7). Monitoring under this program ended after the 2007 to 2008 monitoring year. Sediment sampling included chemical analysis of metals, pesticides, and PCBs.

Figure 7. Annual Monitoring Historic Sampling Locations

Concentrations of heavy metals have remained consistent over the years and were generally found to be higher in the mid-channel and in Back Basins than near the entrance to MdRH. Long-term metal spatial trends were investigated by averaging concentrations for each station from 2002 to 2007. Several metals, including arsenic, chromium, copper, mercury, nickel, and zinc, were higher in the mid-channel and Back Basins and lower toward the marina entrance. The presence of these metals may be the result of continuing deposition through both dry- and wet-weather runoff, boating, and historical deposits. The average concentrations of lead and zinc were higher in Oxford Basin than average concentrations measured in the mid-channel and Back Basins, indicating that urban runoff may be a contributor of these constituents to the marina. In comparison, copper and mercury were lower in Oxford Basin compared to the marina, indicating that their sources may be internal to the marina (Table 14, Figure 8).

Table 14. Average Concentrations of Metals (2002 to 2007)

Station	Station Description	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
	ER-M	70	9.6	370	270	218	0.71	51.6	3.7	410
	ER-L	8.2	1.2	81	34	46.7	0.15	20.9	1.0	150
1	Ballona Creek	5.38	0.86	30.6	**54.2**	**60.4**	0.12	17.56	0.89	**234.8**
12	Ballona Creek	5.42	0.97	26.2	**45.4**	**91.6**	**0.21**	14.96	0.92	**185.6**
13	Oxford Basin	4.86	1.07	33.2	**83**	**90.2**	0.09	19.78	**1.72**	**202.2**
22	Oxford Basin	6.28	1.08	43.4	**127.4**	**132.6**	**0.21**	**24.02**	0.81	**474.8**
2	Harbor Entrance	5.4	0.82	31.4	**47.2**	**54.2**	**0.18**	18.72	**1.21**	**177.4**
3	Harbor Entrance	2.36	0.08	9.2	14.8	17.8	0.05	5.3	0.41	115.8
4	Front Main Channel	5.7	0.3	29.4	**68.2**	**52.2**	0.15	13.92	0.96	**179.2**
25	Main Channel	**9.96**	0.83	75.2	**246.8**	**113**	**0.46**	**33.04**	**2.48**	**373**
5	Main Channel	**8.56**	0.32	59.2	**172.4**	**87.6**	**0.41**	**27.54**	**1.64**	**312**
11	Back of Main Channel	**10.9**	0.35	76.4	**412.2**	**87.6**	**0.67**	**36.68**	**1.59**	**375.2**
6	Basin B	7.88	0.24	51.4	**220.8**	**79.4**	**0.78**	**24.34**	**1.03**	**310.2**
7	Basin H	7.02	0.25	45	**158.2**	**56.8**	**0.36**	**22.66**	0.94	**295.6**
26	Basin C	7.6	0.42	57	**210**	**69.33**	**0.31**	**26.13**	**1.35**	**310**
8	Basin D	**8.24**	0.31	58.4	**366.8**	**72.4**	**0.7**	**27.94**	**1.13**	**393.4**
9	Basin F	**9.94**	0.32	73.2	**347.4**	**109.8**	**0.79**	**34.46**	**1.71**	**291**
10	Basin E	**9.22**	0.68	62.4	**260**	**75.2**	**0.64**	**37.22**	**1.71**	**334.8**

Bold values above ER-L.
Underlined values above ER-M.

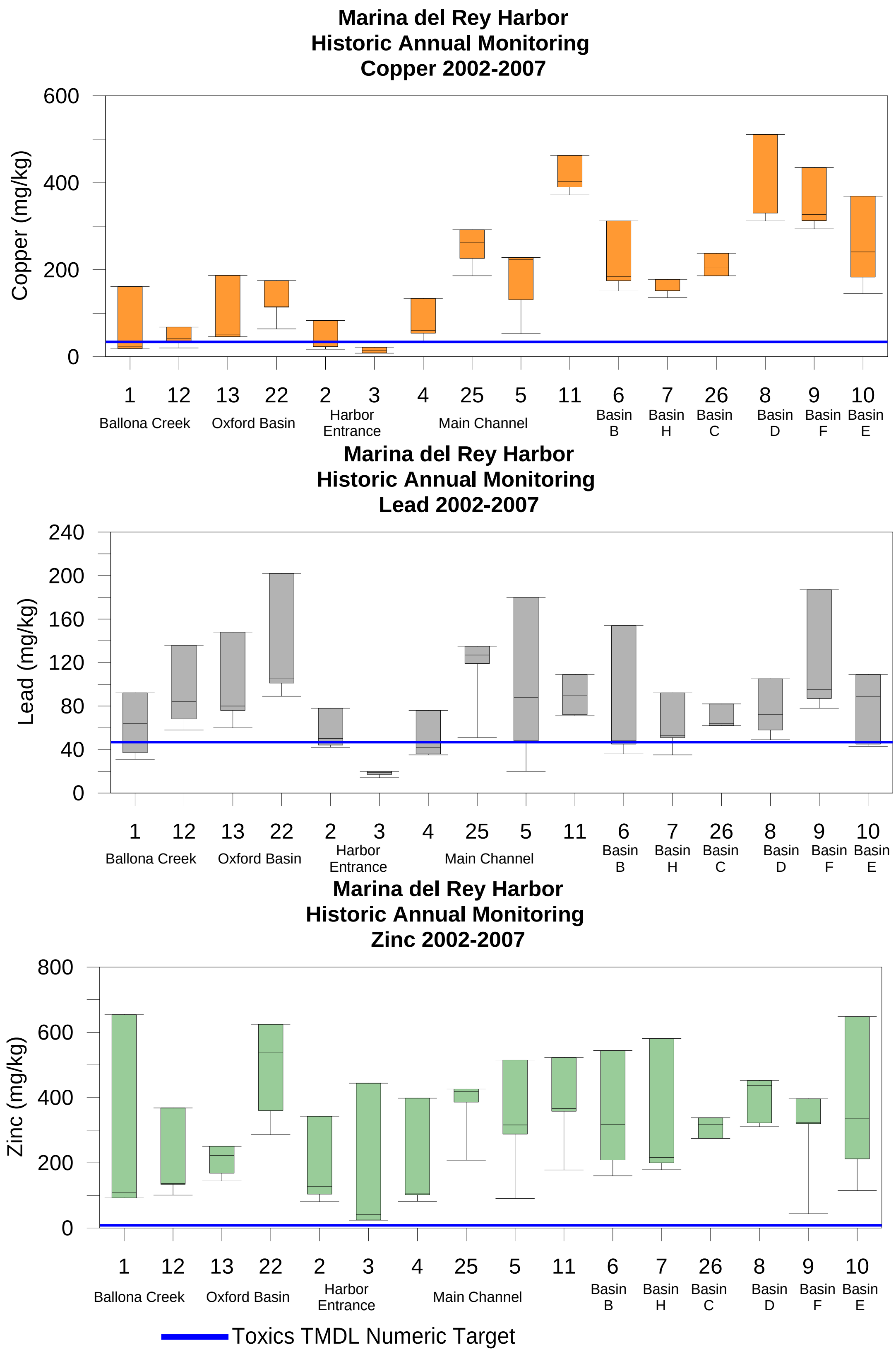


Figure 8. Summary of Marina del Rey Harbor Historical Metals Annual Monitoring Data, 2002-2007

Average concentrations of PCBs were assessed for monitoring conducted from 2002 to 2007. The highest average concentrations of PCBs were observed in Basin F (Station 9), Basin E (Stations 11 and 10), and Oxford Basin (Station 22) (Table 15, Figure 9). Whereas numerous samples exceeded the effects range-low (ER-L), only one sample during this time period exceeded the effects range-median (ER-M) for total PCBs, Station 22 (near the back of Oxford Basin) in 2003.

The highest average concentrations of DDTs during the 2002 to 2007 time period were found near the mouth of MdRH (Station 2), in the main channel (Station 25), in Basin F (Station 9), and near the mouth of Ballona Creek (Station 1) (Table 15, Figure 9). These results may point to different sources of DDTs near the Back Basins as compared to the mouth of the harbor.

Table 15. Average Concentration of Total DDTs and PCBs (2002 to 2007)

Station	Average Total DDTs (µg/kg)	Average p,p' DDE (µg/kg)	Average Total PCBs (µg/kg)
TMDL Numeric Target	**1.58**	**2.2**	**3.2**
1**	**28.02**	**18.93**	**12.50**
2	**44.72**	**25.25**	**19.16**
3	**11.60**	1.55	0.82
4	**13.98**	**8.15**	2.84
5	**21.68**	**17.98**	**16.38**
6	**11.32**	**8.38**	**12.11**
7	**17.26**	**14.05**	**11.96**
8	**15.44**	**4.90**	**10.52**
9	**32.80**	**36.88**	**55.34**
10	**24.48**	**26.18**	**28.40**
11	**27.08**	**24.80**	**33.28**
12**	**10.10**	**5.80**	**19.02**
13*	**15.06**	**3.50**	**13.67**
22*	**23.40**	**15.93**	**49.06**
25	**41.16**	**17.75**	**19.31**
26	**1.73**	2.07	1.57

* Oxford Basin Stations.
** Ballona Creek.
Bold text indicates values above TMDL numeric target.

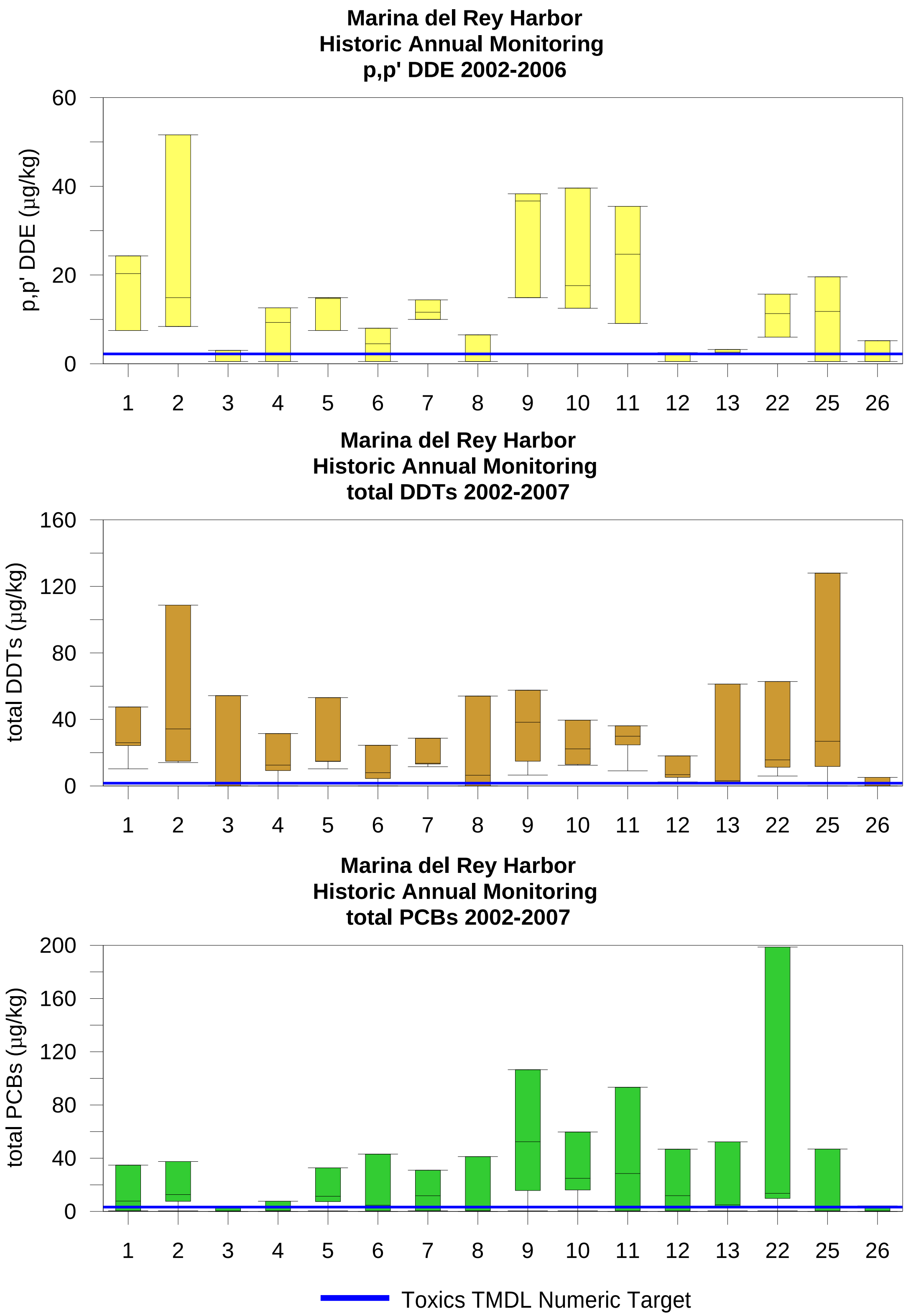


Figure 9. Summary of Marina del Rey Harbor Historical p,p'-DDE, DDT and PCB Annual Monitoring Data, 2002 to 2007

3.2 Water Quality

Bacteria and water quality parameters were monitored on a monthly basis at 18 locations in MdRH, Oxford Basin, and at the Ballona Creek outlet (ABC 2001-2008) (Figure 7). Bacteria results are discussed with the Historical Bacteria Monitoring results (Section 3.5). Overall, results of monitoring suggest that stormwater discharges have led to increases in ammonia, bacteria counts, and biochemical oxygen demand (BOD) and decreases in clarity, salinity, and ph. The water quality in MdRH may be impacted by urban runoff from Ballona Creek, Boone Olive Pump Station and Oxford Basin. Freshwater intrusion in the Back Basins generally leads to lower salinity. Dissolved oxygen is highest near the harbor entrance and decreases toward the Back Basins.

3.3 Benthic Infauna

Benthic infauna assessments were conducted annually in MdRH with assessments divided into three areas of the marina: the entrance, mid-channel, and Back Basins (ABC 2001-2008). As in most surveys, the composition of infauna in MdR was divided into two geographic areas: (1) the entrance and outer mid-channel, and (2) the Back Basins. The entrance and mid-channel were characterized by high species abundances and numbers of species. In contrast, the Back Basins had generally lower abundances and numbers of species and diversity.

3.4 Fish Surveys

Semiannual fish surveys have been conducted for more than 25 years in MdRH (ABC 2001-2008). In the past decade, fish surveys have used trawl netting (for bottom-dwelling fish), gill net (for mid-level fish), plankton net sampling (for larval fish and eggs), beach seine (for inshore fish), and diver-biologist-transect sampling (for reef fish). Combining all past surveys, 117 species of fish have been collected in the harbor, suggesting greater diversity than many other estuaries in the area. The majority of samples collected were composed of eggs, larvae, or juveniles, suggesting that the harbor is an important nursery.

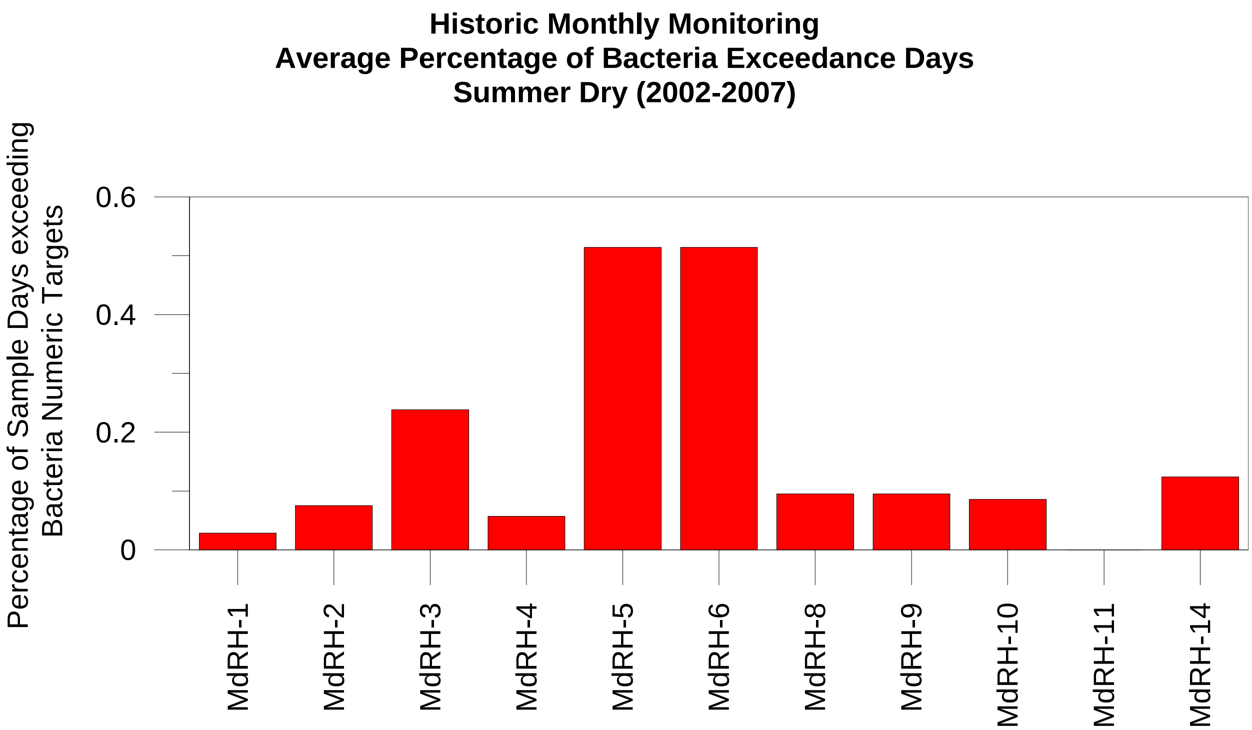
3.5 Bacteria Monitoring

Historical monitoring for bacteria has been conducted by LACDBH on an annual basis prior to the implementation of the Bacteria TMDL (ABC 2001-2008) . For purposes of the MdR EWMP Work Plan, data collected under this program were compiled from 2002 through March 2007. Station identifiers were adjusted to align with the current naming convention (Figure 2), for example MdRH-2 is also known as the City of Los Angeles' site S9 and was monitored between five to seven times each week in accordance with the City's Hyperion Treatment Plant NPDES permit. Data were separated by season (summer dry and winter dry) and compared to existing TMDL targets (Table 16, Figure 10) at each station.

Table 16. Summary of Historical Single-Sample Bacteria Monitoring Exceedances Results

Station*	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Summer Dry						
MdRH-1	-	14.3% (7)	0% (7)	0% (7)	0% (7)	0% (3)
MdRH-2	-	0.5% (214)	8.5% (212)	12.1% (214)	6.1% (165)	10.5% (152)
MdRH-3	-	28.6% (7)	28.6% (7)	28.6% (7)	0% (7)	33.3% (3)
MdRH-4	-	14.3% (7)	14.3% (7)	0% (7)	0% (7)	0% (3)
MdRH-5	-	42.9% (7)	42.9% (7)	57.1% (7)	14.3% (7)	100% (3)
MdRH-6	-	57.1% (7)	14.3% (7)	57.1% (7)	28.6% (7)	100% (3)
MdRH-8	-	14.3% (7)	0% (7)	0% (7)	0% (7)	33.3% (3)
MdRH-9	-	0% (7)	0% (7)	14.3% (7)	0% (7)	33.3% (3)
MdRH-10	-	14.3% (7)	14.3% (7)	14.3% (7)	0% (7)	0% (3)
MdRH-11	-		0% (7)	0% (7)	0% (7)	0% (3)
MdRH-14	-	0% (7)	14.3% (7)	14.3% (7)	0% (7)	33.3% (3)
Winter Dry						
MdRH-1	33.3% (3)	0% (5)	0% (5)	0% (5)	20% (5)	-
MdRH-2	17.8% (90)	24.5% (151)	25.5% (149)	37% (127)	22% (109)	20% (93)
MdRH-3	66.7% (3)	20% (5)	40% (5)	40% (5)	20% (5)	-
MdRH-4	33.3% (3)	0% (5)	20% (5)	20% (5)	20% (5)	-
MdRH-5	33.3% (3)	60% (5)	60% (5)	80% (5)	40% (5)	-
MdRH-6	100% (3)	60% (5)	60% (5)	40% (5)	60% (5)	-
MdRH-8	66.7% (3)	20% (5)	0% (5)	0% (5)	20% (5)	-
MdRH-9	0% (3)	0% (5)	0% (5)	20% (5)	20% (5)	-
MdRH-10	66.7% (3)	0% (5)	0% (5)	20% (5)	20% (5)	-
MdRH-11	-	-	0% (5)	0% (5)	20% (5)	-
MdRH-14	0% (3)	0% (5)	20% (5)	40% (5)	20% (5)	-

*Station names were adjusted to correspond with current naming conventions under the Bacteria TMDL



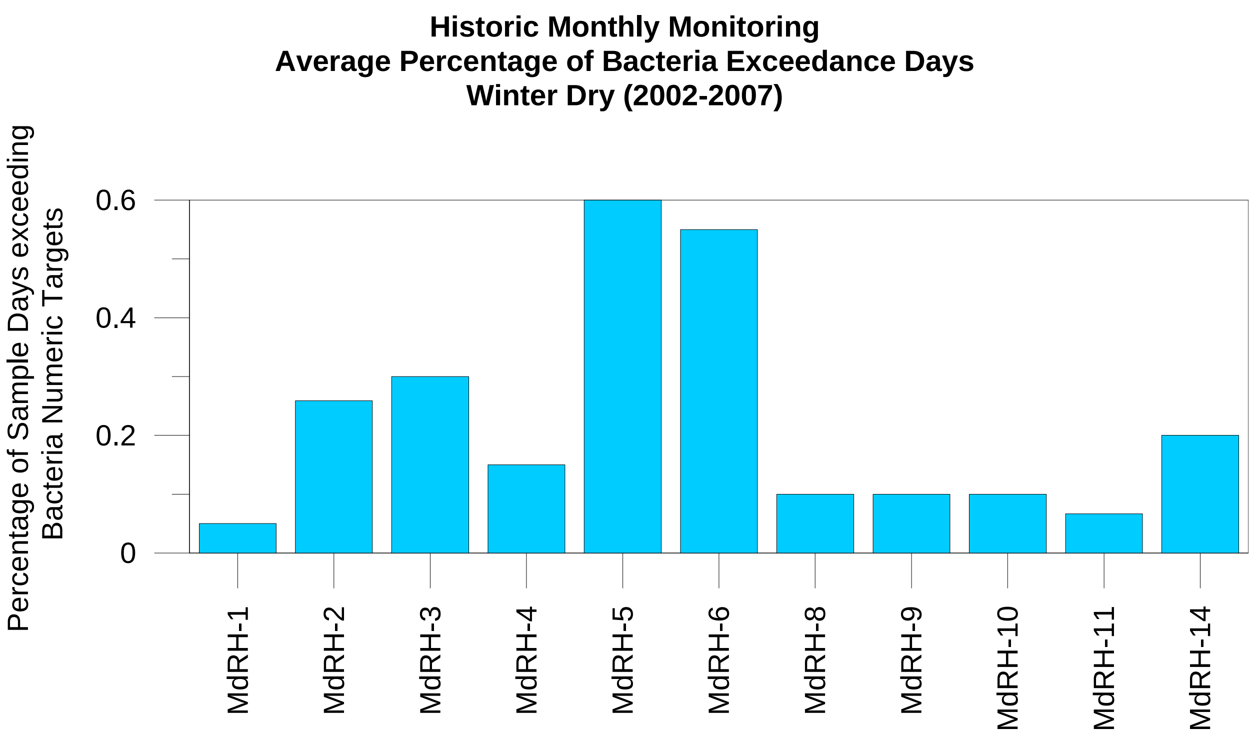


Figure 10. Historical Monthly Monitoring Average Proportion of Exceedance Days

4.0 Sediment Characterization Study (2008)

In 2008, the Marina del Rey Harbor Sediment Characterization Study (Weston 2008b) was conducted in order to comply with the “Requirement to Submit Information” letter from the Regional Board regarding sediment contamination in MdRH The study was designed to assess the extent of sediment contamination in the harbor for constituents included in the Toxics TMDL (total PCBs, chlordane, copper, lead, and zinc).

This study included collection of cores at 23 sampling locations as well as surficial samples at 16 locations (Figure 11). Sediment samples were analyzed for benthic infauna, toxicity, and physical/chemical composition with regard to sediment grain size, TOC, metals, organochlorine pesticides, and PCBs.

Figure 11. Sediment Characterization Study Sampling Locations (Weston, 2008)

4.1 Sediment Chemistry

Results from the surface sediment analyses indicate that the highest concentrations of chlordane were found near the mouth of the main channel (Figure 12, Appendix G). Total PCB concentrations were highest at MC-1.

The highest copper concentrations in surficial sediment were observed in the Back Basins at stations D-3 and E-3 (Figure 13, Table 17). The highest lead concentrations were observed at stations B-2 and E-3 as well as in the main channel at MC-3 (Figure 14, Table 17). Highest zinc concentrations were also observed at stations B-2 and E-3 (Table 17).

Chlordane concentrations were highest in the main channel (Figure 12, Table 17).

Table 17. 2008 Sediment Characterization Study Selected Results

Analyte	Units	Toxics TMDL Numeric Target	A-2	B-2	C-2	D-2	D-3	E-1	E-3	E-4
4,4'-DDE	ng/dry g	2.2	**7**	**14.7**	**13.6**	**13.7**	**9**	**32.5**	**26**	**20.4**
Total detectable DDTs	ng/dry g	1.58	**10**	**15.9**	**14.9**	**16.3**	**9**	**50.6**	**36.5**	**26.9**
Total detectable chlordane	ng/dry g	0.5	**1.6**	**5.6**	ND	**1.1**	**1.3**	**5.5**	ND	**3.8**
Copper (Cu)	µg/dry g	34	**154.6**	**376.3**	**251.9**	**311.1**	**418.8**	**286.9**	**433.6**	**209.2**
Lead (Pb)	µg/dry g	46.7	**71.17**	**116.9**	**64.7**	**60.62**	**68.78**	**63.23**	**98.73**	**55.06**
Zinc (Zn)	µg/dry g	150	**184.5**	**404.5**	**286.7**	**298.1**	**368.9**	**293.7**	**452.1**	**295.8**
Total PCBs (aroclors)	ng/dry g	3.2	**60.3**	**34.4**	**77.4**	**20.3**	**19.1J**	**20.3**	**70.7**	**20.8**
Total PCBs (congeners)	ng/dry g	3.2	**17.5**	**47.6**	**65.7**	**58.4**	**29.6**	**33.3**	**44.2**	**26.6**
Analyte	**Units**	**Toxics TMDL Numeric Target**	**F-1**	**G-2**	**H-2**	**MC-1**	**MC-2**	**MC-3**	**MC-4**	**MC-5**
4,4'-DDE	ng/dry g	2.2	**28.1**	**21.7**	**14.1**	**17.8**	**27.6**	**19.9**	**19.1**	**24.5**
Total detectable DDTs	ng/dry g	1.58	**40.3**	**29.8**	**22.9**	**31.1**	**44.6**	**31.6**	**24.5**	**24.5**
Total detectable chlordane	ng/dry g	0.5	**5.2**	**6.4**	ND	**1.1**	**10.3**	**15.4**	**11.4**	**21.4**
Copper (Cu)	µg/dry g	34	**382**	**331.7**	**137**	**221.2**	**184.5**	**232**	**136.7**	**146.4**
Lead (Pb)	µg/dry g	46.7	**95.54**	**105.2**	43.1	**65.85**	**62.07**	**97.84**	**74.46**	**123**
Zinc (Zn)	µg/dry g	150	**384.5**	**323.5**	**162.8**	**246.9**	**219.6**	**301**	**204.1**	**309**
Total PCBs (Aroclors)	ng/dry g	3.2	**31.1**	**25.7**	**13.5J**	**35.6**	**33.3**	**29.4**	**17.2J**	**38.8**
Total PCBs (congeners)	ng/dry g	3.2	**47.2**	**46.1**	**14.6**	**189.9**	**46.6**	**35.6**	**38.3**	**50.4**

Bold – Detected result exceeds the TMDL numeric target.
J – Result greater than MDL but less than RL.

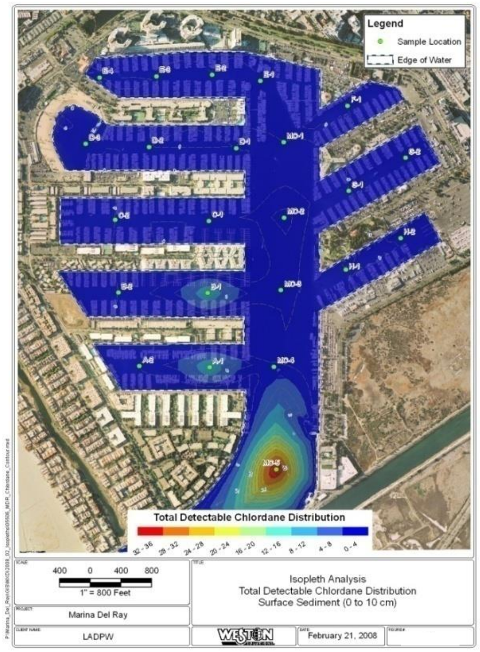


Figure 12. Distribution of Total Chlordane in Surface Sediment in Marina del Rey Harbor (Weston, 2008)

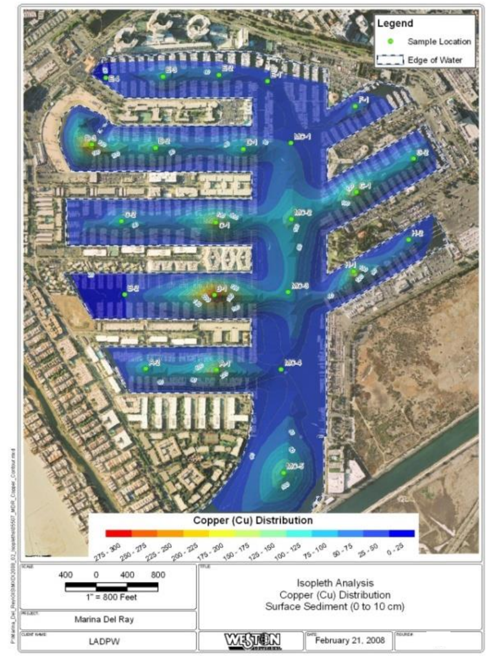


Figure 13. Distribution of Total Copper in Surface Sediment in Marina del Rey Harbor (Weston, 2008)

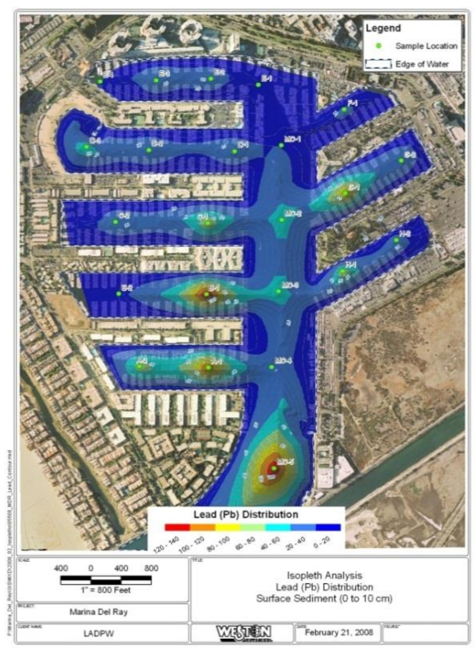


Figure 14. Distribution of Total Lead in Surface Sediment in Marina del Rey Harbor (Weston, 2008)

4.2 Sediment Toxicity

Solid phase toxicity testing was conducted with *E. estuarius* (survival endpoint). Mean percent survival was generally low across all samples (45.0% to 77.0%) with the exception of MC-4 (91.0%), H-2 (85.0%), and A-2 (83.8%). Samples D-3, E-4, F-1, B-2, MC-2, MC-3, MC-5, E-3, E-1, MC-1, G-2, D-2, and C-2 had less than 80% survival and were significantly different from the associated control . This study did not include analysis for *M. galloprovincialis,* which is required to complete SQO analysis.

4.3 Sediment Quality Objectives Analysis

Sediment quality from MdRH was assessed using California's SQOs as described in the, Water Quality Control Plan for Enclosed Bays and Estuaries (SWRCB –Cal EPA, 2009). These SQOs are based on a multiple lines of evidence (MLOE) approach in which the lines of evidence (LOEs) are sediment toxicity (Table 18), sediment chemistry (Table 19), and benthic community condition (Table 20). Note that the sediment toxicity LOE is based on one species, not two as required in the SQO guidance.

Table 18. Sediment Toxicity Category

Sample Name	Amphipod Toxicity (% diff from control)	Sediment Toxicity Category
A-2	84	Non-toxic
B-2	55	High Toxicity
C-2	72	Moderate Toxicity
D-2	69	Moderate Toxicity
D-3	75	Moderate Toxicity
E-1	65	Moderate Toxicity
E-3	57	Moderate Toxicity
E-4	63	Moderate Toxicity
F-1	57	Moderate Toxicity
G-2	45	High Toxicity
H-2	85	Non-toxic
MC-1	59	Moderate Toxicity
MC-2	74	Moderate Toxicity
MC-3	77	Moderate Toxicity
MC-4	91	Non-toxic
MC-5	67	Moderate Toxicity

Table 19. Sediment Chemistry Category

Sample Name	Chemistry Guideline		Sediment Chemistry Category
	CA LRM	CSI	
A-2	0.63	2.18	Moderate Exposure
B-2	0.76	2.79	High Exposure
C-2	0.69	2.47	High Exposure
D-2	0.70	2.31	Moderate Exposure
D-3	0.77	2.66	High Exposure
E-1	0.70	2.97	High Exposure
E-3	0.79	2.74	High Exposure
E-4	0.70	2.72	High Exposure
F-1	0.75	2.86	High Exposure
G-2	0.74	2.86	High Exposure
H-2	0.56	2.12	Moderate Exposure
MC-1	0.66	2.68	Moderate Exposure
MC-2	0.63	2.97	Moderate Exposure
MC-3	0.72	2.97	High Exposure
MC-4	0.64	2.97	Moderate Exposure
MC-5	0.77	2.89	High Exposure

Table 20. Sediment Benthic Category

Station Name	IBI Score	RBI Score	BRI Score	RIVPAC Score	Benthic Score
A-2	1	0.10	43.98	0.73	Moderate Disturbance
B-2	2	0.08	46.00	0.36	Moderate Disturbance
C-2	0	0.09	55.32	0.61	Moderate Disturbance
D-2	1	0.10	52.64	0.61	Moderate Disturbance
D-3	2	0.03	47.54	0.24	High Disturbance
E-1	1	0.09	49.63	0.48	Moderate Disturbance
E-3	2	0.03	36.86	0.12	High Disturbance
E-4	2	0.04	38.46	0.36	Moderate Disturbance
F-1	0	0.10	54.95	0.61	Moderate Disturbance
G-2	1	0.07	47.81	0.61	Moderate Disturbance
H-2	0	0.38	47.04	0.73	Low Disturbance
MC-1	1	0.08	48.42	0.61	Moderate Disturbance
MC-2	1	0.10	52.38	0.48	Moderate Disturbance
MC-3	1	0.12	41.33	0.24	Moderate Disturbance
MC-4	0	0.45	36.10	0.73	Reference
MC-5	1	0.23	31.03	0.85	Low Disturbance

4.4 Integration: Station Assessment

The severity of biological effects (i.e., integration of toxicity LOE and benthic condition LOE categories) and the potential for chemically mediated effects (i.e., the integration of the toxicity LOE and chemistry LOE categories) were used to determine the station level assessment. According to the SQO guidelines, sediment is considered to be impacted if a site is found to be “Likely Impacted” or “Clearly Impacted.” Two stations were found to be likely unimpacted and one possibly impacted (Table 21). Four stations were found to be likely impacted and nine stations clearly impacted. A gradient of cleaner stations near the mouth of MdRH is suggested.

Table 21. Station Level Assessment

Station Name	Severity of Biological Effects		Potential for Chemically Mediated Effects		Station Assessment
A-2	Moderate Effect	+	Low Potential	=	Possibly Impacted
B-2	Moderate Effect	+	High Potential	=	Clearly Impacted
C-2	Moderate Effect	+	High Potential	=	Clearly Impacted
D-2	Moderate Effect	+	Moderate Potential	=	Likely Impacted
D-3	High Effect	+	High Potential	=	Clearly Impacted
E-1	Moderate Effect	+	High Potential	=	Clearly Impacted
E-3	High Effect	+	High Potential	=	Clearly Impacted
E-4	Moderate Effect	+	High Potential	=	Clearly Impacted
F-1	Moderate Effect	+	High Potential	=	Clearly Impacted
G-2	Moderate Effect	+	High Potential	=	Clearly Impacted
H-2	Unaffected	+	Low Potential	=	Likely Unimpacted
MC-1	Moderate Effect	+	Moderate Potential	=	Likely Impacted
MC-2	Moderate Effect	+	Moderate Potential	=	Likely Impacted
MC-3	Moderate Effect	+	High Potential	=	Clearly Impacted
MC-4	Unaffected	+	Low Potential	=	Likely Unimpacted
MC-5	Low Effect	+	High Potential	=	Likely Impacted

The grain size data suggest toxicity test results may have been confounded by percent fines. If it is assumed fines contributed to 10% mortality, then C-2, D-3, and MC-4 change from “clearly impacted” to “likely impacted” and MC-2 is reduced to “possibly impacted.” If fines are assumed to contribute 20% toward mortality, then E-1 and E-4 also change from “clearly impacted” to “likely impacted.”

5.0 Oxford Basin Sediment and Water Quality Characterization Study

The Oxford Basin Sediment and Water Quality Characterization Study was completed in 2010 to further assess the contribution of Oxford Basin to dry- and wet-weather bacteria and metals loading. The study also assessed sediment quality in Oxford Basin to evaluate alternatives to improve the overall sediment and water quality within Oxford Basin and Basin E (Weston, 2010). Sampling locations for wet-and dry-weather water samples were in the Oxford Basin, Basin E, and Boone Olive Pump Station. Sediment sampling was confined to the Oxford Basin. Multiple cores per location were collected and, based on sediment stratification, split into vertical segments (assessed as either loose recently deposited unconsolidated or denser consolidated material) to evaluate the vertical resolution of potential chemical contamination.

Sediment samples were analyzed for bacteria, grain size, metals, pesticides, PCBs, and general chemistry. In addition, native layers and excavation layers underwent additional testing for disposal assessment purposes. Each water sample, collected during dry or wet weather, was analyzed for metals, nutrients, bacteria, PCBs, volatile organic compounds, total and dissolved organic carbon, and total suspended and dissolved solids.

The sediment characterization portion of the study indicated the following:

- Grain size analysis of the excavation sediments indicated predominantly silts and clays.
- Total PCBs were detected in the unconsolidated layer sediments at two main sites, one in the easternmost portion of Oxford Basin and one in the mid-portion of Oxford Basin. The PCB concentrations did not exceed the Total Threshold Limit Concentration (TTLC). However, they did exceed the ER-L and ER-M (22.7 µg/kg and 180 µg/kg, respectively). These sites were also the locations with the highest concentrations of chromium and lead.
- Unconsolidated layers showed below detection limit concentrations for nutrients and all samples were below federal Toxicity Characteristic Leaching Procedure (TCLP) criteria for metals.
- Total and fecal coliforms were higher in sediments from the northeastern portion of Oxford Basin compared with concentrations in the western most portion, which discharges into Basin E (please see Figure 1. Marina del Rey Watershed for Oxford Basin location)..

The dry-weather water quality portion of the study indicated the following:

- Bacteria concentrations were below California Ocean Plan (COP) water quality objectives (WQOs) at all sites during ebb tides, but during flood tides were above WQOs within Oxford Basin.
- Within Oxford Basin and the exchange, metals concentrations were below COP WQOs for both total and dissolved states.
- Basin E had dissolved copper concentrations above the COP WQO during ebb tides.

The wet-weather water quality intertransfer portion of the study indicated the following:

- Bacteria concentrations exceeded WQOs in the Boone-Olive Pump Station, Oxford Basin, the exchange, and Basin E. Bacteria concentrations were not significantly higher in the Oxford Basin compared to Basin E. However, Enterococcus concentrations were significantly higher in discharges from the Boone Olive Pump Station.
- Dissolved copper exceeded the CTR saltwater criteria in the exchange water and in Basin E. No other metals exceedances were observed. These results suggest copper is not entering Basin E from the Oxford Basin.

Overall, these results indicate that the dry weather low flow diversion installed at the inflow to Oxford Basin has reduced the bacteria loading and the occurrence of exceedances of bacteria indicator concentrations in the Oxford Basin. These results differ from previous studies conducted prior to the construction of the diversions. However, there continue to be sources, such as birds and poor circulation in the upstream narrow section of Oxford Basin that result in isolated exceedances of WQOs. The results of this study, which include sampling through the tidal cycle, indicate other more predominant sources of bacteria indicator concentrations above the WQO in Basin E. These other sources likely include birds and potentially the MS4 outfalls that discharge directly to the Back Basins.

The results of this study also indicate that during dry-weather conditions, Oxford Basin is not a source of metals loading to the Back Basins. Metals loading to the Back Basins is likely from marina activities and air deposition. The results also indicate that sediments within Oxford Basin do not represent a measurable load of metals, PCBs, and pesticides to the Back Basins.

6.0 Southern California Bight '03

The Southern California Bight '03 study (Southern California Coastal Water Research Project [SCCWRP], 2007) included sampling at six locations in MdRH for sediment chemistry, sediment toxicity, and benthic infauna (Figure 15).

Figure 15. Southern California Bight '03 and Bight '08 Sampling Locations

6.1 Bight '03 Sediment Chemistry Results

Chlordane was detected above the MDL and Toxics TMDL Numeric Target at two stations, B03-4085 and B03- 4149, both of which are located near the mouth of the harbor. It should be noted that although the chlordane was not detected at the other stations, the MDL was greater than the Toxics TMDL numeric target; therefore, a true comparison cannot be made.

The Bight '03 study analyzed PCB congeners (as opposed to Aroclors which are analyzed under the Toxicity TMDL monitoring program). PCBs were detected at three of the stations, B03-4085 (located near the mouth of the harbor), B03-BRI-01 (located in Basin E), and B03-4117 (located in Basin F) (Figure 15). Concentrations at these three stations exceed the Toxics TMDL numeric target of 3.2 µg/kg (Table 22, Appendix G).

Numeric targets for copper, lead, and zinc were exceeded at all six sampling locations. The highest levels of copper and zinc were found at B03-BRI-01 (located in Basin E), B03-4117 (located in Basin F), and B03-BRI-02 (located in Basin B). The lowest concentrations of copper and zinc were observed at the two stations near the mouth of MdRH, B03-4085 and B03-4149. Lead concentrations were highest at the two stations near the mouth of the harbor (B03-4058 and B03-4149) and at B03-4341 (located in the main channel).

The concentration of total DDTs exceeded the TMDL numeric target at all six stations, with the highest concentrations at B03-4149 and B03-4085, near the mouth of the harbor. Concentrations of p,p'-DDE exceeded the TMDL numeric target at all stations with the exception of B03-BRI-02. The highest concentrations of p,p' DDE were also found at stations B03-4149 and B03-4085.

6.2 Bight '03 Sediment Toxicity Results

E. estuarius toxicity was observed for three of six samples (stations B03-4149, B03-BRI-01, and B03-BRI-02) where the percent survival was both less than 80% of the control and significantly different from the control samples. These samples were located in the mouth of the MdRH (station B03-4149), at the western end of Basin E (B03-BRI-01), and at the western end of Basin B (B03-BRI-02). *M. galloprovincialis* was not assessed during Bight '03.

The results of the Bight study suggest toxicity at the mouth of MdRH, which correlates with the highest PCB, chlordane, and DDT concentrations. These data points add to the hypothesis that sources external to MdRH likely contribute to water quality impacts within the MdRH. Ballona Creek has been identified as a potential source. The highest concentrations of copper, lead, and zinc were observed in Basins B, E, and F, suggesting a more localized source.

Table 22. Bight '03 Sediment Concentrations of Constituents with TMDL Targets

Analyte	TMDL Numeric Target	Unit	B03-4085	B03-4117	B03-4149	B03-4341	B03-BRI-01	B03-BRI-02
			Mouth	Basin F	Mouth	Main Channel	Basin E	Basin B
			9/2/2003	9/2/2003	9/2/2003	9/2/2003	1/09/02/20	2/09/02/20
		Depth	6.5	4.8	6	5.2	3.5	3.4
Copper, total	34	mg/Kg dw	**101**	**362**	**93.8**	**249**	**407**	**359**
Lead, total	46.7	mg/Kg dw	**130**	**96.2**	**134**	**127**	**101**	**112**
Zinc, total	150	mg/Kg dw	**315**	**388**	**293**	**355**	**492**	**380**
Chlordane (calculated)[1]	0.5	µg/Kg dw	**5**	<1	**16.2**	<1	<1	<1
DDE(p,p'), total	2.2	µg/Kg dw	**11.1**	**10.7**	**45.8**	**3.1J**	**8.9**	2.2J
Total DDTs (calculated)	1.58	µg/Kg dw	**14.60**	**13.50**	**45.80**	**3.10**	**8.90**	**2.20**
Total PCB congeners (calculated)	3.2	µg/Kg dw	**22.60**	**14.70**	<1	<1	**15.30**	<1

1 Chlordane (calculated) calculated by summing cis and trans chlordane.

< Analyte not detected above MDL.

Bold result exceeds TMDL numeric target

J Analyte detected above MDL but below RL.

7.0 Bight '08 Sediment Monitoring

7.1 Bight '08 Sediment Chemistry Results

The Southern California Bight '08 study (SCCWRP, 2011) included monitoring at five locations in MdRH (Figure 15).

The Bight '08 study analyzed PCB congeners (as opposed to Aroclors, which are analyzed under the Toxicity TMDL monitoring program). PCBs were detected at all five sampling locations. The highest concentrations of PCBs were observed in the main channel (B08-6518) and near the mouth of the harbor (B08-6513). High concentrations of PCBs were also observed in the basins, with the lowest result in Basin C. Overall, concentrations during Bight '08 were higher than Bight '03, with a similar pattern (higher concentrations at the mouth and in the main channel compared to the basins) (Table 23).

Total chlordane (calculated) exceeded the TMDL numeric target at all five stations. The highest concentrations were found near the mouth of MdRH at station B08-6513 and in the main channel at station B08-6518. This is consistent with Bight '03 monitoring data (Table 23).

TMDL numeric targets for total copper, total lead, and total zinc were exceeded at all five monitoring stations. The highest concentrations of total copper and total zinc were observed at station B08-6530 (Basin E) and B08-6527 (Basin G). The lowest concentrations of total copper were observed in the main channel at station B08-6513 and near the mouth of MdRH at station B08-6518. This is consistent with Bight '03 data. The highest concentration of lead was observed at B08-6513 near the mouth of the harbor and the lowest concentration was observed in Basin C (B08-6649) (Table 23).

Total DDTs and p,p'-DDE exceeded the TMDL numeric target at all five stations. The highest concentrations were found in the main channel at station B08-6518 and in Basin E at B08-6530. The lowest concentrations were observed in Basin C at station B08-6649 (Table 23).

Table 23. Bight '08 Sediment Concentrations of Constituents with TMDL Targets

Analyte	Unit	TMDL Target	B08-6513	B08-6518	B08-6527	B08-6530	B08-6649
			Mouth	Main Channel	Basin G	Basin E	Basin C
			9/29/2008	9/29/2008	9/29/2008	9/29/2008	9/17/2008
Copper, total	mg/Kg dw	34	**94.62**	**159.8**	**388.7**	**444.1**	**277.3**
Lead, total	mg/Kg dw	46.7	**113**	**109.4**	**110**	**93.36**	**70.48**
Zinc, total	mg/Kg dw	150	**313.3**	**317.3**	**369.9**	**435**	**303.2**
DDE(p,p'), total	µg/Kg dw	2.2	**50.9**	**71.9**	**59.4**	**63.9**	**22.7**
Total DDTs (calculated)	µg/Kg dw	1.58	**50.9**	**137**	**59.4**	**97.3**	**25.8**
Total chlordane (calculated)[1]	µg/Kg dw	0.5	**62.8**	**31.7**	**4.7**	**5.8**	**1**
Total PCB congeners (calculated)	µg/Kg dw	3.2	**94.4**	**101.1**	**85.5**	**61.5**	**12**

1 Chlordane calculated by summing oxychlordane, cis- and trans-nonachlor, cis- and trans-chlordane.

Bold result exceeds TMDL Numeric Target.

7.2 Bioavailability Analysis

An evaluation of the likely bioavailability of metals was conducted using the additional information collected during the Bight ’08 study, in particular, acid volatile sulfide (AVS), simultaneously extracted metals (SEM), and TOC results. AVS and TOC are known to inhibit bioavailability of divalent metals, thereby reducing the impact to the benthic community (Di Toro et al., 2005; Wenning et al., 2005).

Measurement of AVS and SEM concentrations associated with AVS extraction can provide insight into the bioavailability of metals in anaerobic (anoxic) sediments (EPA, 2001). A model for predicting toxicity from divalent trace metals is based on the binding of these metals to AVS. When the sum of the moles of the SEM (including cadmium, copper, nickel, lead, silver, and zinc) is exceeded by the molar concentration of AVS, the metals are considered insoluble and largely unavailable to biota. However, if the AVS is less than the SEM, metals may or may not be toxic due to other controlling factors (e.g., TOC content) (EPA, 2001) as discussed in the following section for the ESB determination.

Equilibrium partitioning sediment benchmarks (ESBs) are mechanistic sediment quality metrics that use the theories of equilibrium partitioning (EqP) to derive sediment-specific predictions of available contaminant exposures. EPA has derived ESBs for a suite of divalent metals (EPA, 2005).

AVS ESB values can provide a more accurate prediction of toxicity because the presence of organic carbon is considered along with AVS using the following equation:

$$\left(\sum SEM - AVS\right)/\ f_{oc} = \left(\sum \frac{SEM - AVS}{f_{oc}}\right)$$

where

SEM	=	simultaneously extracted divalent metal (micromoles [µmol])
AVS	=	Acid volatile sulfides (µmol)
foc	=	fraction organic carbon (% TOC)

For the multiple metals (cadmium, copper, lead, nickel, and zinc), the following assumptions are useful to derive a benchmark:

- SEM-AVS/foc < 130 µmol/g organic carbon: Metals should pose a low risk for adverse biological effects.
- SEM-AVS/foc > 130 µmol/g organic carbon < 3,000 µmol/g organic carbon: Metals may have adverse biological effects.
- SEM-AVS/foc > 3,000 µmol/g organic carbon: Metals expected to cause adverse biological effects.

Results of the AVS/SEM and ESB analysis are presented on Table 24. The sum of the moles of SEM is less than the AVS for all samples; therefore, sulfide is likely binding divalent metals in the sediments. Additionally, the ESB calculation results are <130 µmol/g organic carbon for all samples, which adds additional weight to the finding that the divalent metals are not likely biologically available. Therefore, although the metals concentrations (Table 24) are above the TMDL numeric targets (ER-L), the levels of sulfides and organic carbon indicate that the bioavailability of the divalent metals is low and not likely to cause toxicity.

Table 24. Bight '08 Metals Bioavailability Analysis

Analyte	Units	B08-6513	B08-6518	B08-6527	B08-6530	B08-6649
		Mouth	Main Channel	Basin G	Basin E	Basin C
		9/29/2008	9/29/2008	9/29/2008	9/29/2008	9/17/2008
Acid volatile sulfides (AVS)	µmol/g	1.931	0.536	1.150	0.934	2.129
Total organic carbon (TOC)	%	3.07	2.16	1.55	1.42	1.21
SEM – cadmium	µmol/g	0.002	0.002	0.002	0.002	0.002
SEM – copper	µmol/g	0.006	0.006	0.006	0.006	0.006
SEM – lead	µmol/g	0.009	0.031	0.028	0.018	0.007
SEM – nickel	µmol/g	0.008	0.008	0.005	0.005	0.007
SEM – zinc	µmol/g	0.219	0.447	0.513	0.691	0.762
SEM – silver	µmol/g	0.005	0.005	0.005	0.005	0.005
sum SEM	µmol/g	0.246	0.495	0.557	0.725	0.786
SEM/AVS analysis	ratio	0.13	0.92	0.48	0.78	0.37
ESB [sum SEM-AVS)/f_{oc}]	µmol/g TOC	-0.55	-0.02	-0.38	-0.15	-1.11

SEM – simultaneously extracted divalent metal (micromoles [µ/mol]).

7.3 Sediment Toxicity Results

Sediment toxicity results, as reported in the Bight '08 sediment toxicity report (SCCWRP, 2011), were non-toxic for three of the five stations, low toxicity for one of the five stations, and moderate toxicity of one of the five stations. These findings support the biological availability analysis, which illustrates that metals are not likely bioavailable and therefore not likely to cause toxicity. Station B08-6527 exhibited moderate toxicity, which may have been caused by sediment conditions, grain size, or another physical condition because the chemicals observed at the station were not different from those at other stations in the MdRH that did not exhibit toxicity to *E. estuarius* or *M. galloprovincialis.* Findings of the toxicity identification evaluation (TIE) were inconclusive because the baseline toxicity decreased during the TIE testing compared to the initial toxicity evaluation. However, porewater was evaluated for toxicity and it is possible that pyrethroids may be present in the sample and effecting the survival of *E. estuarius* (SCCWRP, 2011) (Table 25).

Table 25. Bight '08 Toxicity Results

Species/Endpoint	Unit	TMDL Target (SQO LOE)	B08-6513	B08-6518	B08-6527	B08-6530	B08-6649
			Mouth	Main Channel	Basin G	Basin E	Basin C
			9/29/2008	9/29/2008	9/29/2008	9/29/2008	9/17/2008
E. estuarius survival	% control	80	97	89	**21**	96	94
M. galloprovincialis development/survival	% control	80	99	99	95	101	116
SQO line of evidence result			Non-toxic	Low toxicity	Moderate toxicity	Non-toxic	Non-toxic

Bold result indicates toxic response.

8.0 Bacteria TMDL Coordinated Monitoring

8.1 Single Sample Analysis

Monitoring under the Bacteria TMDL began in March 2007 with monitoring at nine compliance stations and five ambient stations. Monitoring at the ambient stations (MdRH-10, MdRH-11, MdRH-12, MdRH-13, and MdRH14) was discontinued in 2009. The remaining stations are monitored on a weekly basis, with the exception of MdRH-1, which is monitored on a daily basis. Stations MdRH-4, MdRH-6, MdRH-8, and MdRH-9 are monitored at the surface and at depth (Figure 16). Monitoring results were separated by TMDL season (summer dry, winter dry, and wet) and compared to the TMDL single sample targets (Table 26 to Table 28, Appendix G). The number of exceedances was calculated and compared to the total number of samples for wet, summer dry, and winter dry days (Table 26, Table 27, and Table 28, respectively). The average number of exceedance days was calculated and presented for each station by TMDL season (wet, summer dry, and winter dry). The highest proportion of wet weather exceedances occurred at MdRH-4 and MdRH-6 Surface and Depth stations (Figure 17, Figure 18). The highest proportion of summer dry exceedance days occurred at MdRH-5 and MdRH-7, and the highest proportion of winter dry exceedance days occurred at MdRH-1, MdRH-3, and MDRH-12. For stations monitored on a weekly basis, the compliance day specified in the TMDL (Monday) was used to assess compliance with the single sample targets. If the compliance day fell on a holiday, the following day was used for the compliance assessment.

Figure 16. Marina del Rey Harbor Bacteria and Toxics TMDL Monitoring Locations

Table 26. Single Sample Wet Weather Bacteria Exceedances

Station	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Wet							
MdRH-1	47.9% (48)	34.8% (46)	62.2% (45)	37.1% (89)	37.2% (43)	43.5% (62)	20% (5)
MdRH-2	66.7% (9)	66.7% (6)	42.9% (7)	46.7% (15)	57.1% (7)	33.3% (9)	0% (1)
MdRH-3	33.3% (9)	50% (6)	42.9% (7)	33.3% (15)	57.1% (7)	55.6% (9)	0% (1)
MdRH-4 Depth	55.6% (9)	33.3% (6)	16.7% (6)	26.7% (15)	28.6% (7)	11.1% (9)	0% (1)
MdRH-4 Surface	44.4% (9)	33.3% (6)	33.3% (6)	37.5% (15)	28.6% (7)	44.4% (9)	0% (1)
MdRH-5	44.4% (9)	66.7% (6)	85.7% (7)	73.3% (15)	85.7% (7)	44.4% (9)	100% (1)
MdRH-6 Depth	44.4% (9)	50% (6)	16.7% (6)	37.5% (15)	42.9% (7)	44.4% (9)	0% (1)
MdRH-6 Surface	66.7% (9)	83.3% (6)	50% (6)	66.7% (15)	57.1% (7)	66.7% (9)	0% (1)
MdRH-7	66.7% (9)	83.3% (6)	66.7% (6)	66.7% (15)	57.1% (7)	44.4% (9)	0% (1)
MdRH-8 Depth	44.4% (9)	33.3% (6)	16.7% (6)	26.7% (15)	14.3% (7)	11.1% (9)	0% (1)
MdRH-8 Surface	44.4% (9)	33.3% (6)	33.3% (6)	46.7% (15)	14.3% (7)	22.2% (9)	0% (1)
MdRH-9 Depth	33.3% (9)	33.3% (6)	16.7% (6)	26.7% (15)	14.3% (7)	11.1% (9)	0% (1)
MdRH-9 Surface	44.4% (9)	50% (6)	50% (6)	46.7% (15)	28.6% (7)	33.3% (9)	0% (1)

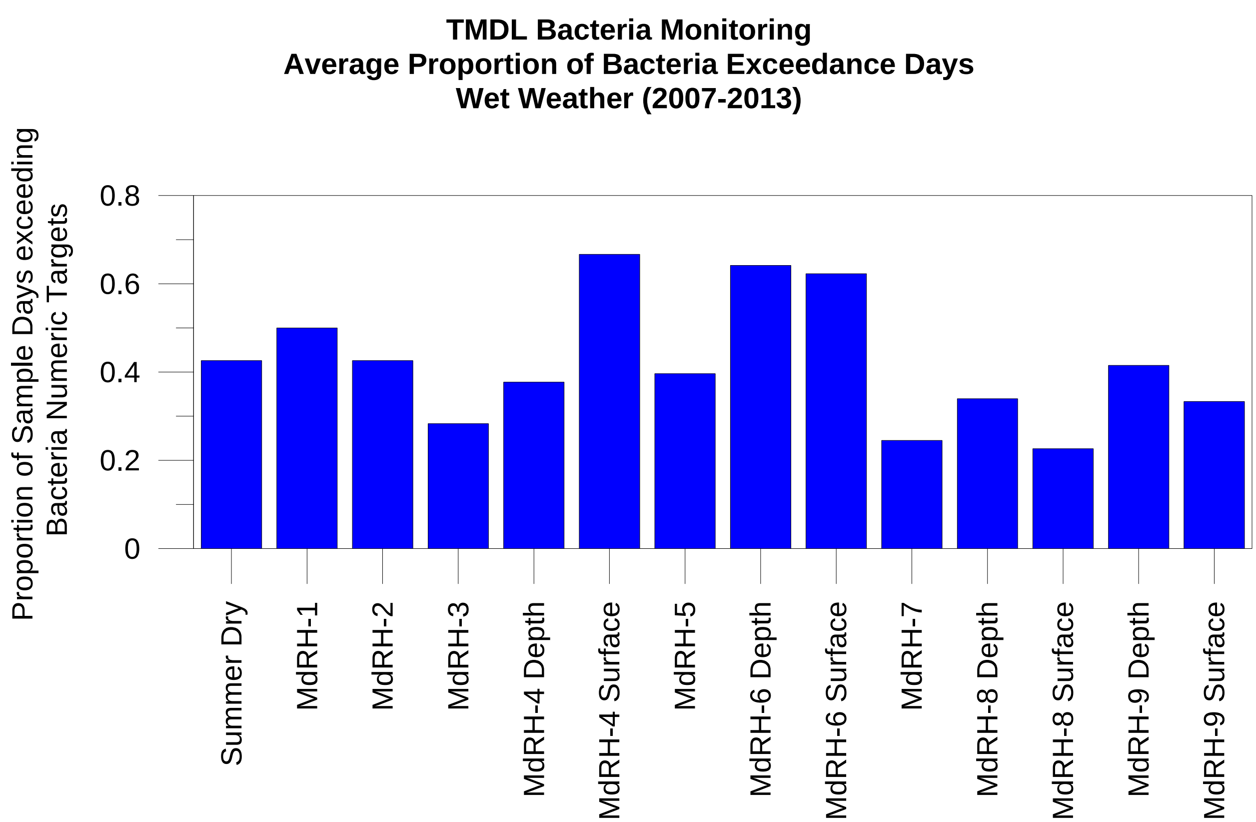


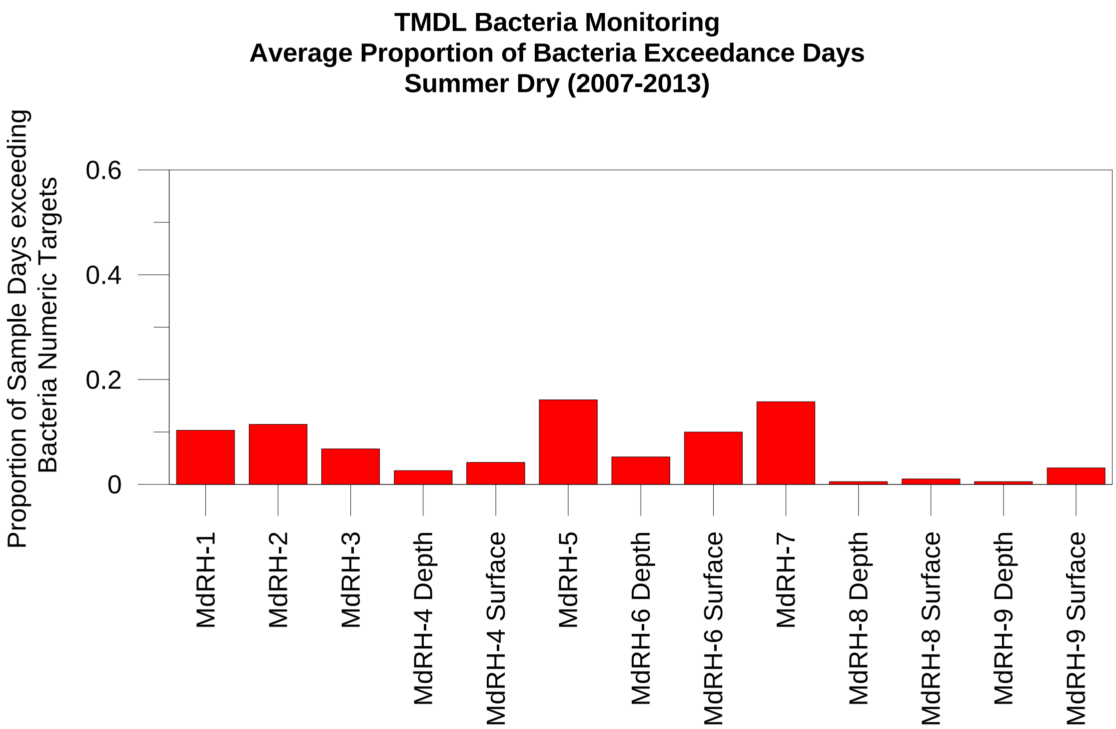
Figure 17. Bacteria TMDL Wet Weather Average Proportion of Exceedance Days

Table 27. Single Sample Summer Dry Bacteria Exceedances

Station	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Summer Dry							
MdRH-1	16% (167)	9.4% (181)	15.3% (176)	6.1% (179)	7.3% (205)	11.3% (195)	6% (117)
MdRH-2	3.6% (28)	16.7% (30)	10% (30)	7.4% (27)	9.7% (31)	17.2% (29)	17.6% (17)
MdRH-3	7.1% (28)	0% (30)	6.7 (30)	7.4% (27)	3.2% (31)	3.4% (29)	29.4% (17)
MdRH-4 Depth	3.6% (28)	6.6% (30)	3.4% (29)	0% (26)	0% (31)	0% (29)	5.9% (17)
MdRH-4 Surface	7.1% (28)	0% (30)	13.8% (29)	3.8% (26)	3.2% (31)	0% (29)	5.9% (17)
MdRH-5	14.3% (28)	30% (30)	23.3% (30)	18.5% (27)	6.5% (31)	10.3% (29)	5.9% (17)
MdRH-6 Depth	0% (28)	3.3% (30)	6.9% (29)	7.7% (26)	12.9% (31)	3.4% (29)	0% (17)
MdRH-6 Surface	10.7% (28)	26.7% (30)	13.8% (29)	0% (26)	9.7% (31)	3.4% (29)	0% (17)
MdRH-7	14.3% (28)	43.3% (30)	13.8% (29)	7.7% (26)	9.7% (31)	13.8% (29)	0% (17)
MdRH-8 Depth	0% (28)	0% (30)	0% (29)	0% (26)	0% (31)	0% (29)	5.9% (17)
MdRH-8 Surface	3.6% (28)	0% (30)	3.4% (29)	0% (26)	0% (31)	0% (29)	0% (17)
MdRH-9 Depth	3.6% (28)	0% (30)	0% (29)	0% (26)	0% (31)	0% (29)	0% (17)
MdRH-9 Surface	10.7% (28)	3.3% (30)	3.4% (29)	0% (26)	3.2% (31)	0% (29)	0% (17)

Table 28. Single Sample Winter Dry Bacteria Exceedances

Station	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Winter Dry								
MdRH-1	11.8% (17)	22.0% (91)	17.5% (80)	41.4% (87)	23.6% (89)	30.5% (118)	36.1% (108)	-
MdRH-2	0% (3)	20.0% (15)	0% (15)	20% (15)	10% (10)	21.4% (14)	28.6% (14)	-
MdRH-3	0% (3)	6.7% (15)	20% (15)	13.3% (15)	10% (10)	14.3% (14)	85.7% (14)	-
MdRH-4 Depth	0% (3)	0% (15)	7.1% (14)	0% (14)	0% (10)	7.1% (14)	0% (14)	-
MdRH-4 Surface	0% (3)	13.3% (15)	0% (14)	0% (14)	0% (10)	7.1% (14)	0% (14)	-
MdRH-5	0% (3)	6.7% (15)	6.7% (15)	6.7% (15)	30% (10)	0% (14)	7.1% (14)	-
MdRH-6 Depth	0% (3)	6.7% (15)	0% (14)	7.1% (14)	10% (10)	7.1% (14)	14.3% (14)	-
MdRH-6 Surface	0% (3)	13.3% (15)	0% (14)	21.4% (14)	20% (10)	7.1% (14)	14.3% (14)	-
MdRH-7	0% (3)	6.7% (15)	7.1% (14)	7.1% (14)	40% (10)	7.1% (14)	28.6% (14)	-
MdRH-8 Depth	0% (3)	6.7% (15)	0% (14)	7.1% (14)	0% (10)	0% (14)	0% (14)	-
MdRH-8 Surface	0% (3)	0% (15)	0% (14)	0% (14)	0% (10)	0% (14)	0% (14)	-
MdRH-9 Depth	0% (3)	0% (15)	0% (14)	0% (14)	0% (10)	0% (14)	0% (14)	-
MdRH-9 Surface	0% (3)	0% (15)	14.3% (14)	0% (14)	0% (10)	0% (14)	0% (14)	-



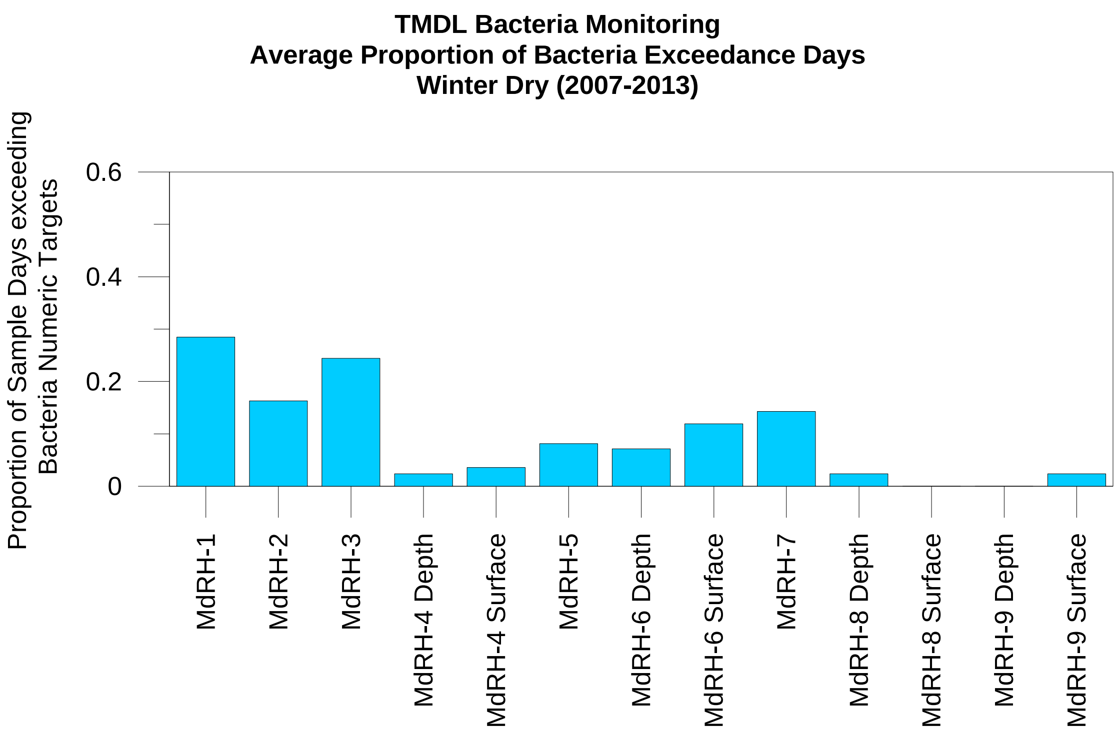


Figure 18. Average Exceedance days for Summer and Winter Dry Bacteria TMDL Monitoring

8.2 Geometric Mean Analysis

In accordance with the Bacteria TMDL, the geometric mean was calculated as a weekly rolling geometric mean using five or more samples for six week periods, starting the calculation weeks on Sunday. No wet weather days were included in the analysis. A minimum of five samples is required to calculate the geometric mean, and if five samples did not occur within the six week period then a geometric mean was not calculated. All available dry weather data were included in the analysis, not only the compliance day specified in the TMDL.

The calculated geometric mean results were compared to the Bacteria TMDL numeric targets to determine whether any indicator bacteria exceeded the numeric target. If any of the indicators exceeded the target, then the day was counted as an exceedance day. Results of the analysis are presented on Table 29 and Table 30. The values in the tables show the percent of samples that exceeded and the number of samples used in the calculation. The highest percent of summer dry Exceedances was observed at MdRH-5, MdRH-6-Surface and MdRH-7 (similar to the single sample exceedance pattern). The highest proportion of winter dry exceedance days was observed at MdRH-1, MdRH-2, MdRH-3 (2013-2014), MdRH-6, and MdRH-7.

Table 29. Geometric Mean Summer Dry Bacteria Exceedances

Station	Percent Exceedance and Number of Samples (n)						
	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
MdRH-1	19.4%(31)	0%(30)	16.6%(30)	9.6%(31)	0%(31)	19.4%(31)	9.6%(21)
MdRH-2	0%(31)	0%(30)	0%(30)	3.2%(31)	0%(30)	0%(31)	0%(21)
MdRH-3	0%(29)	0%(30)	10%(30)	13%(31)	0%(26)	0%(24)	42.2%(19)
MdRH-4-Surface	0%(30)	0%(30)	0%(30)	13%(31)	0%(29)	0%(25)	0%(19)
MdRH-4-Depth				0%(20)	0%(31)	0%(27)	0%(17)
MdRH-5	24.2%(29)	73.4%(30)	20%(30)	51.6%(31)	15.4%(26)	0%(24)	0%(20)
MdRH-6-Surface	65.6%(29)	73.4%(30)	23.4%(30)	48.4%(31)	27.6%(29)	16%(25)	0%(19)
MdRH-6-Depth				20%(20)	16.2%(31)	11.2%(27)	0%(17)
MdRH-7	17.8%(28)	93.4%(30)	26.6%(30)	35.4%(31)	25.8%(31)	12%(25)	0%(19)
MdRH-8-Surface	0%(29)	0%(30)	0%(30)	0%(31)	0%(29)	0%(24)	0%(19)
MdRH-8-Depth				0%(20)	0%(31)	0%(27)	0%(17)
MdRH-9-Surface	0%(29)	0%(30)	0%(30)	0%(31)	0%(29)	0%(24)	0%(19)
MdRH-9-Depth				0%(20)	0%(31)	0%(27)	0%(17)

Table 30. Geometric Mean Winter Dry Bacteria Exceedances

Station	Percent Exceedance and Number of Samples (n)						
	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
MdRH-1	0%(2)	54.6%(22)	0%(22)	100%(22)	57.2%(21)	57.2%(21)	100%(22)
MdRH-2	0%(21)	45.4%(22)	45.4%(22)	81.8%(22)	47.6%(21)	23.8%(21)	77.2%(22)
MdRH-3		18.2%(22)	18.2%(22)	36.4%(22)	0%(4)	6.2%(16)	94.8%(19)
MdRH-4-Surface		18.2%(22)	18.2%(22)	22.8%(22)	0%(1)	0%(15)	0%(5)
MdRH-4-Depth					0%(9)	0%(12)	0%(16)
MdRH-5		27.2%(22)	68.2%(22)	81.8%(22)	75%(8)	0%(14)	0%(11)
MdRH-6-Surface		86.4%(22)	86.4%(22)	100%(22)	100%(6)	87.6%(16)	71.4%(14)
MdRH-6-Depth					33.4%(9)	57.2%(14)	56.2%(16)
MdRH-7		91%(22)	59%(22)	72.8%(22)	75%(8)	40%(15)	0%(15)
MdRH-8-Surface		9%(22)	0%(22)	27.2%(22)	0%(1)	0%(14)	0%(5)
MdRH-8-Depth					0%(9)	0%(12)	0%(16)
MdRH-9-Surface		4.6%(22)	27.2%(22)	0%(22)	0%(1)	0%(14)	0%(5)
MdRH-9-Depth					0%(9)	0%(12)	0%(16)

8.3 Observational Data

Observational data collected as part of the Bacteria TMDL monitoring were analyzed to determine whether patterns between the observational data and the bacterial concentrations could be found. The observational data were recorded as categorical observations (e.g., one to five birds observed was recorded as a "1"), along with pH, tidal height, and salinity recorded as individual results. A Spearman Rank correlation was run between the bacterial results and the continuous parameters (pH, tidal height, and salinity). The results were not informative of a pattern between bacterial results and pH, tidal height, or salinity.

The categorical observation data were assessed for patterns in bacterial concentrations between categories. Beach refuse, ocean debris, seaweed, foam, bathers, animals/birds, excrement, drain flow, and drain position were all assessed. However, the majority of the categories did not contain many observations, therefore limiting the data analysis.

Of interest to this study is a pattern between the number of birds/animals observed and bacterial concentrations. Figure 19, Figure 20, and Figure 21 present the findings of each bacterial indicator by station. The box and whisker plots display the minimum, 25th percentile, median, 75th percentile, and maximum bacterial concentrations at each station for each category of animal/bird numbers. The results are limited to categories zero (no animals or birds observed), one (one to five animals or birds observed), and three (10 to 20 animals or birds observed). The three categories are depicted as different colors on the graphs (light green – zero, orange – one, bright green – three). When the number of animals/birds observed was higher at a station, the median bacterial concentration was also higher at that station. However, the median bacterial concentrations were not significantly higher when more animals/birds were observed. This pattern was found for all three indicator bacteria: Enterococcus, *Escherichia coli*, and total coliform.

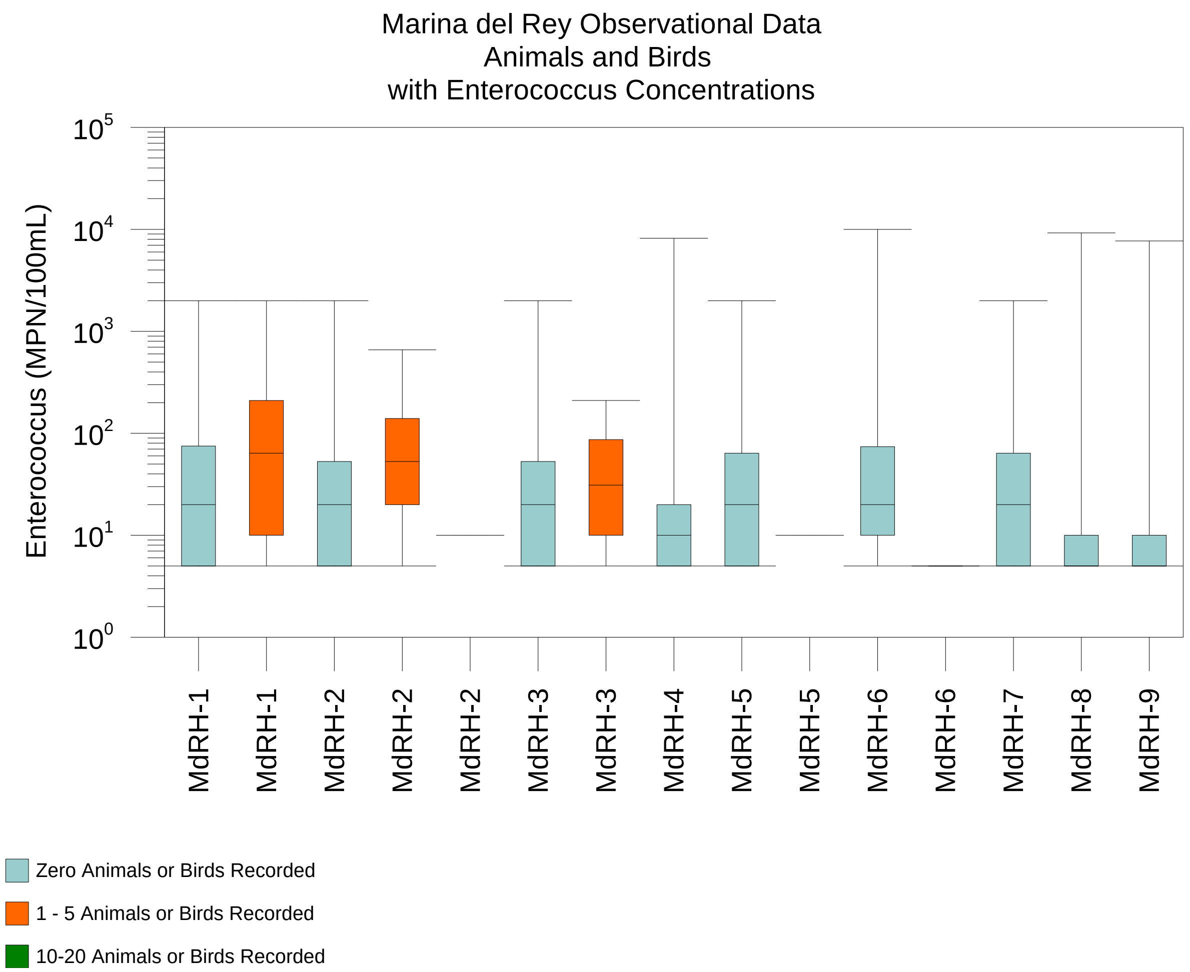


Figure 19. Summary of Enterococcus Monitoring Results Categorized by Animal and Bird Observation Codes

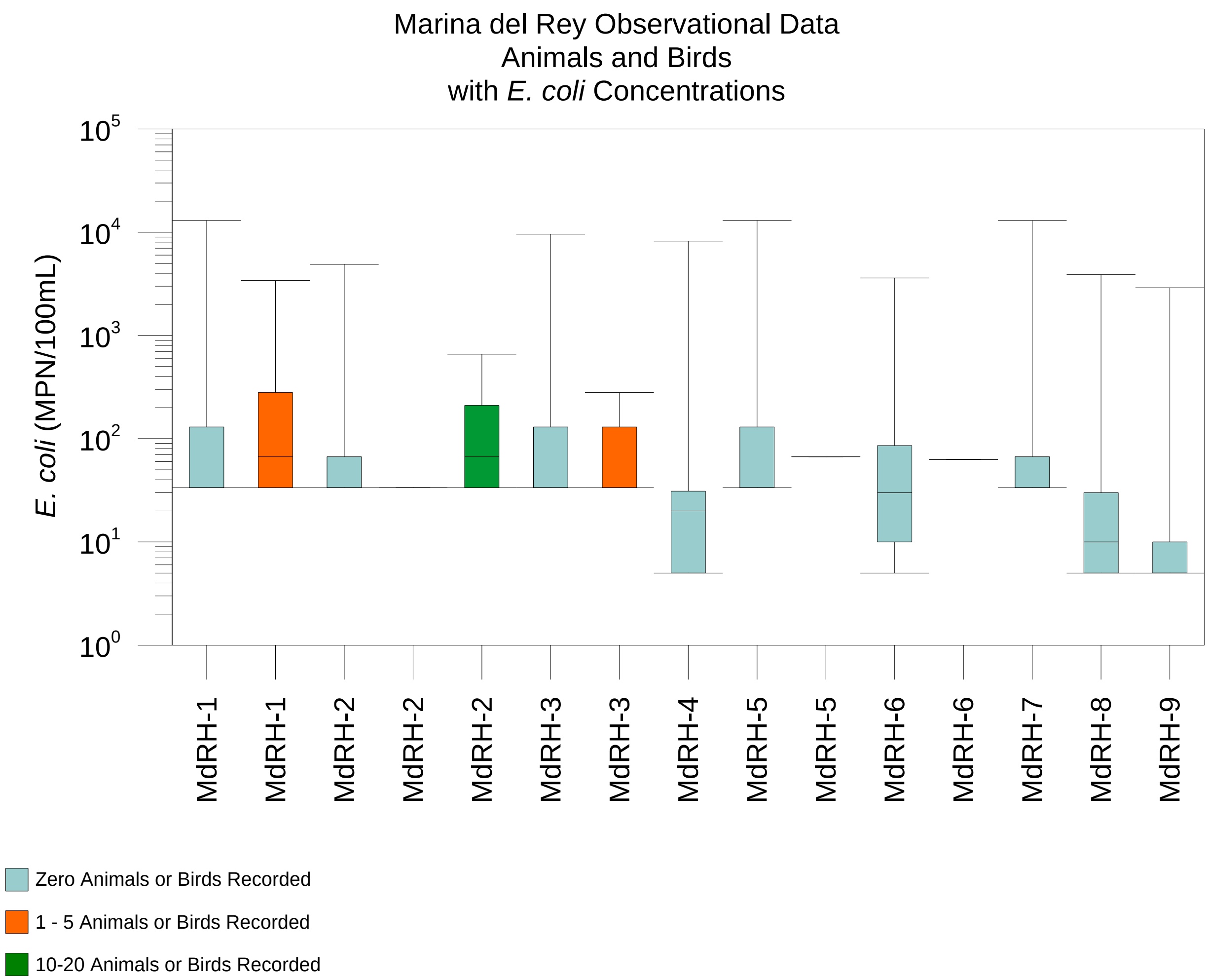


Figure 20. Summary of *E. coli* Monitoring Results Categorized by Animal and Bird Observation Codes

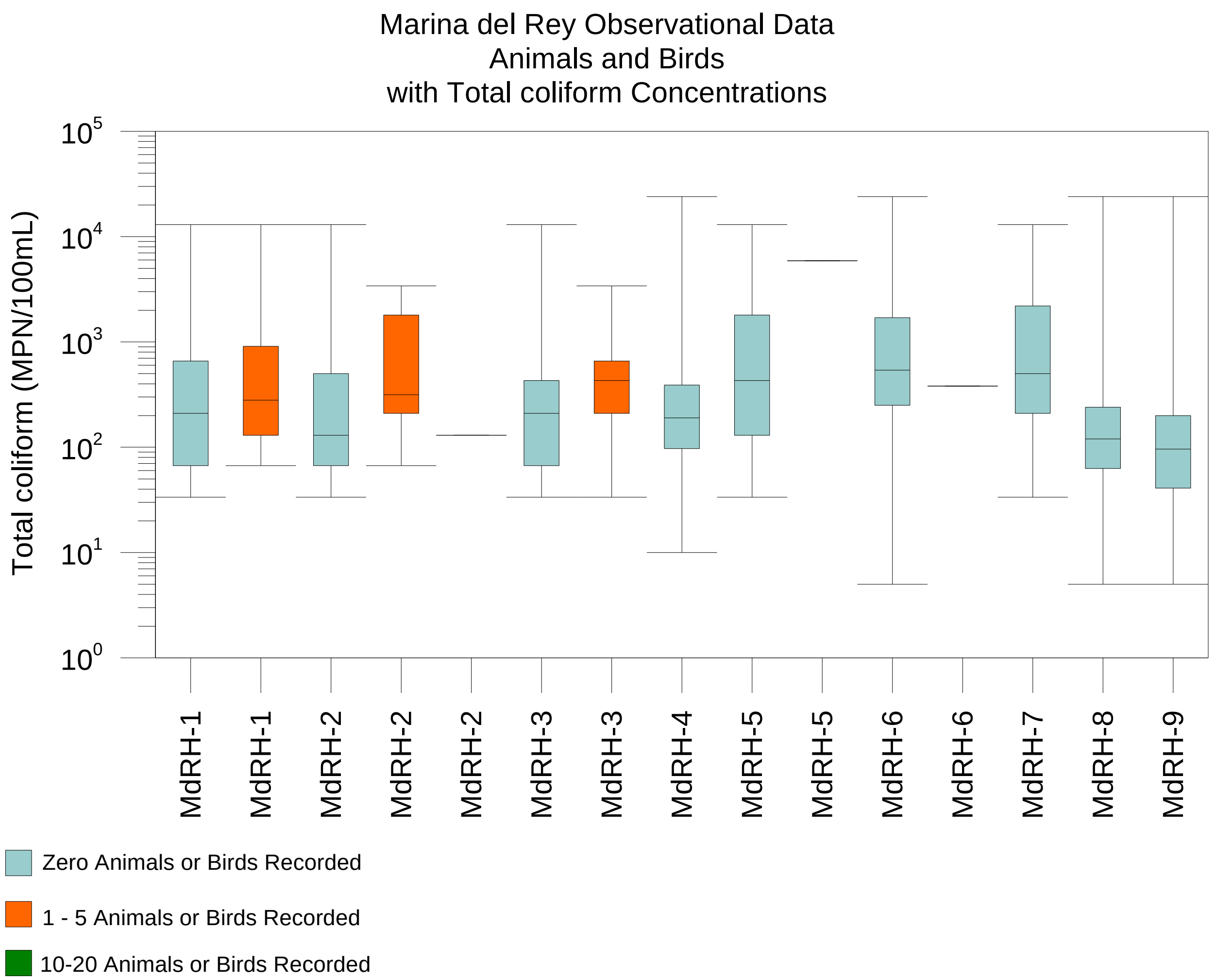


Figure 21. Summary of Total Coliform Monitoring Results Categorized by Animal and Bird Observation Codes

9.0 Mother's Beach and Back Basins Bacteria TMDL Non-Point Source Study

The Mother's Beach and Back Basins' Bacteria TMDL Non-Point Source Study (Weston, 2007) was conducted to assess the bacterial sources that may potentially impact water quality at Mother's Beach and the Back Basins and attribute loads to these sources. The study elements included visual observations, a public questionnaire, temporal and spatial bacteria sampling studies during both wet and dry conditions, an illicit boating discharge investigation, hydrologic modeling, and sewerage infrastructure inspections. Additionally, molecular source tracking using Polymerase Chain Reaction (PCR) for the assessment of the presence or absence of Bacteroides species and ribotyping techniques were used to determine potential non-point sources of contamination to the Back Basins of MdRH and Mother's Beach. A loading analysis was also conducted to assess potential primary sources contributing to bacterial pollution.

Results of the Spatial and Temporal Bacterial Investigation indicated that circulation within MdRH was limited in the Back Basins. Oxford Basin and the Boone Olive Pump Station were identified as potential sources of bacteria through an evaluation of Basin E during both dry and wet weather. It was found that higher fecal coliform concentrations in dry weather were spatially correlated with discharge from Oxford Basin and Boone Olive Pump Station compared with other locations in the harbor. The geometric mean for dry-weather concentrations of Enterococcus was highest from Boone Olive Pump Station (see Appendix G).

PCR analysis showed little human contamination throughout the Back Basins; human sources (direct human and/or sewage) were found to contribute only 3% of the bacteria load for both wet and dry weather overall. These investigations identified birds to be significant contributors to wet and dry weather bacterial loads. During these monitoring activities, visual observations of activities around MdRH were conducted and supplemented with "spot sampling." Anthropogenic sources and transport mechanisms for fecal indictor bacteria included boat-related maintenance activities, trash and food waste, washing activities (restaurants, restrooms, parking areas, and buildings), landscaping, and the MS4.

Results from the Sewerage Infrastructure Investigation determined that the sanitary sewer lines surrounding the Back Basins of MdRH were identified to have structural defects and operation and maintenance (O&M) problems. As a result of this non-point source study and other monitoring data, the sanitary sewer lines were relined and leaks were repaired around the Back Basins during 2007 and 2008.

The Illicit Boat Discharge Investigation results indicated that illegal discharges of sewage from boats in Basins D, E, and F were not likely a major cause of contamination. However, because illegal discharges of sewage from boat holding tanks are inherently episodic, results of this study did not conclusively eliminate this as a potential source.

The sediment investigation conducted at Marina Beach (Mother's Beach) indicated that the surficial sediments in the intertidal zone and beach face generally contained low concentrations of fecal indicator bacteria, suggesting that it was unlikely that sediment resuspension resulting from beach activity was contributing large amounts of bacteria to the water.

An MS Excel-based loading model was developed for the assessment of bacterial loads. Because of the complexities of modeling bacteria in a tidal system, the model was limited in scope and not designed for Best Management Practice (BMP) development but rather as a tool for general assessment of different management actions. The bacterial results of a 1-day comprehensive bacterial sampling event, coupled with the sampling of four upstream sampling locations within the MdRH watershed, were incorporated into a hydrologic mass balance model to estimate bacteria concentrations in Oxford Basin and Basin E during dry weather. The model results suggested impacts to fecal coliform loads were attributable to effluent from Oxford Basin. Additionally, higher bacteria concentrations were measured from the Boone Olive Pump Station and were found to correlate with higher bacteria concentrations in Basin E. Based on the results of this non-point source study and other monitoring data, dry-weather diversions have been installed at the inlets to Oxford Basin and Boone Olive Pump Station.

Overall, the general results of the Mother's Beach and Back Basins Bacteria TMDL Non-Point Source Study suggested that the majority of the indicator bacteria in MdRH originated from direct and indirect (i.e., through storm drains) avian sources. However, in the case of Basin E, dry and wet weather point sources were identified as including discharges from Oxford Basin and Boone Olive Pump Station. As summarized, these results have led to control measures that include bird mitigation measures and dry-weather diversions at the inlets to Oxford Basin and Boone Olive Pump Station.

10.0 Small Drain Survey

A small drain identification report was prepared as a requirement of the Bacteria TMDL (LACDBH, 2004a) and was therefore identified as a deliverable under the Bacteria TMDL CMP in July 2004. The purpose of the document was to identify all storm drain outlets that discharge into MdRH. In this project, approximately 724 storm drains were identified. The City of Los Angeles, Caltrans, and the City of Culver City are not responsible for any outlets that drain directly to MdRH. The Los Angeles County Flood Control District (LACFCD) owns 20 storm drain outlets, including two storm drain inlets that flow into the Oxford Basin. No entity was assigned responsibility for four storm drain outlets. LACDBH is responsible for approximately 700 storm drain outlets associated with leased parcel sites.

11.0 Marina del Rey Vessel Discharge Report

The Marina del Rey Vessel Discharge Report (Discharge Report, [LACDBH, 2004b]) was also prepared to meet requirements in the Bacteria TMDL. The Discharge Report assessed the number of live-aboard vessels in the MdRH, the use of and capacity of pump-out stations for marine sewage devices (MSDs), as well as the likelihood that fish waste could be contributing to elevated bacteria in the MdRH. The report concluded that existing pump-out stations were sufficient to meet public demand but to ensure boater convenience; the LACDBH planned to add requirements to lease extensions and new leases to provide at least one MSD pump-out station in each marina. The report also concluded that fish waste does not appear to be a likely contributor to elevated bacteria counts on the basis of charter boat practices, fish cleaning station availability and the Harbor Masters response to violations.

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