Reasonable Assurance Analysis for Long Beach

Submitted to:

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1. Introduction

The Municipal Separate Storm Sewer System Permit (Permit) for the City of Long Beach[1] includes optional provisions for a Watershed Management Program (WMP) that allows permittees the flexibility to customize their stormwater programs to achieve compliance with applicable receiving water limitations (RWLs) and water quality based effluent limitations (WQBELs) through implementation of control measures. A key element of each WMP is the Reasonable Assurance Analysis (RAA), which is used to demonstrate "that the activities and control measures…will achieve applicable WQBELs and/or RWLs with compliance deadlines during the Permit term" (NPDES Permit Order No. R4-2014-0024, Section C.5.h.vii.[2]). This report presents the RAA for the Long Beach WMP, including City of Long Beach and Port of Long Beach areas discharging to San Pedro Bay (including beaches), Los Angeles River Estuary, Dominguez Channel, and Long Beach Harbor.

While the Permit prescribes the RAA as a quantitative demonstration that control measures (best management practices [BMPs]) will be effective, the RAA also promotes a modeling process to identify and prioritize potential control measures to be implemented by the WMP. In other words, the RAA not only demonstrates the cumulative effectiveness of BMPs to be implemented, it also supports their *selection*. Furthermore, the RAA incorporates the applicable compliance dates and milestones for attainment of the WQBELs and RWLs, and therefore supports BMP scheduling.

On March 25, 2014, the Los Angeles Regional Water Quality Control Board (Regional Board) issued "RAA Guidelines" (LARWQCB 2014) to provide information and guidance to assist permittees in development of the RAA. The approach herein is consistent with the RAA Guidelines.

This report is organized in nine sections, as follows:

- Section 1: Introduction
- Section 2: Applicable Interim and Final Requirements
- Section 3: Modeling System to be used for the RAA
- Section 4: Current/Baseline Pollutant Loading
- Section 5: Estimated Required Pollutant Reductions
- Section 6: Determination of BMP Capacity for RAA
- Section 7: Volume Reduction Goals to Achieve Required Pollutant Reductions for the Dominguez and Harbors Toxics TMDL
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- Section 9: References

[1] National Pollutant Discharge Elimination System Permit Order No. R4-2014-0024

2. Applicable Interim and Final Requirements

The Long Beach WMP follows the process outlined in the Permit and identifies the Water Quality Priorities (WQ Priorities) including the highest WQ Priority (Category 1) that are subject to Total Maximum Daily Loads (TMDLs) and WQBELs. The TMDL and WMP milestones/compliance dates establish the pace at which BMPs must be implemented. Traditionally, TMDL implementation plans have been focused on *final* TMDL compliance, whereas the Permit compliance paths offered to WMPs increases the emphasis on *milestones*. The TMDL milestones for Long Beach are shown in Table 2-2. Only one of the TMDLs for Long Beach includes an associated compliance schedule that is considered in this RAA.

The Permit requires the WMP to provide reasonable assurance for the TMDL milestones that occur in the current Permit term. If applicable TMDLs do not prescribe a milestone in the current Permit, milestones must be established that occur in the next two Permit cycles. For each milestone, the RAA identifies the combination of BMPs expected to result in progress toward attainment of the corresponding Permit limits.

The array of TMDLs creates a potentially complicated sequence based on multiple pollutants, and thus this RAA includes a limiting pollutant analysis. The final 2032 milestone for the Dominguez Channel and Greater Los Angeles and Long Beach Harbor Waters Toxic Pollutants TMDL (Dominguez and Harbors Toxics TMDL) establishes the pace of stormwater BMP implementation. The Beach City Beaches and Los Angeles River Estuary TMDLs for Indicator Bacteria (Beaches Bacteria TMDL) was established by USEPA and therefore no milestones are defined. To be consistent with the final compliance date for the LA River Bacteria TMDL, a final wet weather milestone of 2037 has been created for the WMP, which is on pace with BMPs necessary to meet the Harbors Toxics TMDL. (References in this document to Bacteria TMDL compliance milestones generally refer to wet weather—dry weather milestones for the beaches and Los Angeles River Estuary are included in Sections 5.3 and 5.4 of the WMP, respectively.)

The final 2018 milestone for the Colorado Lagoon OC Pesticides, PAHs, PCBs, and Metals and Sediment Toxicity TMDL (Colorado Lagoon Toxics TMDL) will be met based on a separate BMP implementation and lagoon remediation strategy defined in the WMP, and therefore will not be a focus of this RAA—see WMP Section 4.5 for additional information. In summary, a 10% pollutant reduction will be assumed based on nonstructural control measures outlined in the WMP, implemented City-wide and consistent with those prescribed to meet interim milestones defined below for the Harbors Toxics TMDL and Beaches Bacteria TMDL. Combined with a Colorado Lagoon remediation plan to directly address WQBELs within the lagoon, this alternative strategy is determined most responsible for meeting the 2018 milestone, which occurs near the end of the current Permit term.

As described in Section 5, the identified limiting pollutant for wet weather is zinc to address the Harbors Toxics TMDL for all areas addressed by this RAA, in addition to bacteria for Long Beach City beaches. The wet weather milestones established for the current Permit include the following:

- **Colorado Lagoon Toxics TMDL:** The restoration activities described in WMP Section 3.4.1.5 that have been and will be implemented for the lagoon will directly address final WQBELs for lagoon bed sediments with the final compliance milestone of July 28, 2018. See WMP Section 4.5 for a discussion of the associated analysis. The 10% pollutant load reduction for non-modeled activities referenced above and described in detail in Chapters 3 and 5 of the WMP will also apply to the Colorado Lagoon subwatershed as they are city-wide programs, providing additional assurance for the achievement of the final milestone.
- **Dominguez and Harbors Toxics TMDL:** Achieve 10% of the required reduction[2] by March 28, 2019. This milestone was created for the WMP, as no interim milestones were specified in the TMDL other than concentration-based WQBELs in the receiving water bed sediments to support monitoring assessments and

[2] The interim milestones are expressed in terms of the *required* reduction not total reduction (e.g., if the required reduction to attain final limits is 50%, then the 10% milestone equates to a 5% reduction). These reductions are calculated in Section 5.

potential remediation activities. Achievement of the 2019 milestone for zinc provides reasonable assurance of achieving a similar or greater reduction for other WQ Priorities.

- **Beaches Bacteria TMDL:** Achieve 10% of the required reduction[3] by March 28, 2019. This milestone was created for the WMP since the Beaches Bacteria TMDL was established by USEPA and included no milestones to demonstrate compliance. Achievement of this milestone for bacteria provides reasonable assurance of achieving a similar or greater reduction for other WQ Priorities.

The pollutant reduction plan to achieve these milestones is described in Section 8, along with the plan to achieve the milestones for the next Permit term (achieve 20% of the required reduction to address the Harbors Toxics TMDL and Beaches Bacteria TMDL). A summary of the milestones within the current and next Permit terms and final milestones based on final TMDLs are summarized in Table 2-1. The required reductions that form the basis of the milestones are calculated in Section 5.

Table 2-1. Summary of schedule for interim and final milestones

WMP Area	Milestone 1 (2019[1])	Milestone 2 (2024[2])	Milestone 3 (2032[3])	Milestone 4 (2037[4])
All	10%	20%	100%	
Long Beach City Beaches	10%	20%		100%

[1] End of current Permit term.

[2] Anticipated end of next Permit term.

[3] Final compliance for Dominguez and Harbors Toxics TMDL.

[4] Final compliance for LA River Bacteria TMDL.

[3] The interim milestones are expressed in terms of the *required* reduction not total reduction (e.g., if the required reduction to attain final limits is 50%, then the 10% milestone equates to a 5% reduction). These reductions are calculated in Section 5.

Table 2-2. Schedule of TMDL milestones

TMDL	Constituents	Compliance Goal	Weather Condition	**Compliance Dates and Compliance Milestone** (Bolded numbers indicated milestone deadlines within the current Permit term) [1]									
				2014	**2018**	**2016**	**2017**	**2018**	**2019**	2023	2024	2032	2037
Colorado Lagoon Toxics	Sediment: OC Pesticides, PAHs, PCBs, Lead, Zinc	Meet WQBELs	Wet[2]	**3/28**				**7/28**					
				Interim				Final					
Dominguez and Harbors Toxics TMDL	Sediment: DDTs, PCBs, Copper, Lead, Zinc, PAHs	Meet WQBELs	Wet[2]	**3/28**								3/23	
				Interim								Final	
Beaches Bacteria TMDL	Total Coliform, Fecal Coliform, Enterococcus	Meet WQBELs	All	USEPA TMDLs, which do not contain interim milestones or implementation schedule. The Permits allow MS4 Permittees to propose a schedule in a WMP.									

[1] The current Permit term expires on March 28, 2019.

[2] Sources of sediment toxicity are due to legacy issues or ongoing toxic pollutants delivered to the waterbody via sediment from the watershed. Practically all watershed sediment loads are transported during stormwater events.

3. Modeling System used for the RAA

The Watershed Management Modeling System (WMMS) was used to develop this RAA. WMMS is specified in the Permits as a potential tool to conduct the RAA. The Los Angeles County Flood Control District (LACFCD), through a joint effort with U.S. Environmental Protection Agency (USEPA), developed WMMS specifically to support informed decisions associated with managing stormwater. The ultimate goal of WMMS is to identify cost-effective water quality improvement projects through an integrated, watershed-based approach. The WMMS encompasses Los Angeles County's coastal watersheds of approximately 3,100 square miles, representing 2,566 subwatersheds (Figure 3-1). WMMS is a modeling system that incorporates three tools: (1) a watershed model for prediction of long-term hydrology and pollutant loading, (2) a BMP model, and (3) a BMP optimization tool to support regional, cost-effective planning efforts. WMMS is available for public download from LACFCD.

The version of WMMS to be used for the RAA in the Long Beach WMP is customized from the public download version, including the following modification/enhancements:

- Updates to meteorological records to represent the last 10 years (per the RAA Guidelines) and to allow for simulation of the design storm;
- Calibration adjustments to incorporate the most recent 10 years of water quality data collected at the nearby mass emission station;
- Application of a second-tier of BMP optimization using System for Urban Stormwater Treatment and Analysis INtegration (SUSTAIN), which replaces the Nonlinearity-Interval Mapping Scheme (NIMS) component of WMMS.
- Optimization of BMP effectiveness for removal of bacteria pollutants (rather than metals only); and
- Updates to Geographic Information System (GIS) layers, as available.

The subwatersheds in the Long Beach RAA area that are represented by WMMS are shown in Figure 3-2, which includes modifications to confine to jurisdictional boundaries included in this WMP area. Also shown are the "RAA Assessment Zones," which are used to calculate required load reductions (described in Section 5).

3.1. Watershed Model - LSPC

The watershed model included within WMMS is the Loading Simulation Program C++ (LSPC) (Shen et al. 2004; Tetra Tech and USEPA 2002; USEPA 2003). LSPC is a watershed modeling system for simulating watershed hydrology, erosion, and water quality processes, as well as in-stream transport processes. LSPC also integrates a geographic information system (GIS), comprehensive data storage and management capabilities, and a data analysis/post-processing system into a convenient PC-based Windows environment. The algorithms of LSPC are identical to a subset of those in the Hydrologic Simulation Program–FORTRAN (HSPF) model with selected additions, such as algorithms to dynamically address land use change over time. Another advantage of LSPC is that there is no inherent limit to the size and resolution of the model than can be developed, making it an attractive option for modeling the Los Angeles region watersheds. USEPA's Office of Research and Development (Athens, Georgia) first made LSPC available as a component of USEPA's National TMDL Toolbox (http://www.epa.gov/athens/wwqtsc/index.html). LSPC has been further enhanced with expanded capabilities since its original public release.

The WMMS development effort culminated in a comprehensive watershed model of the Los Angeles County Flood Control District that includes the unique hydrology and hydraulics of the system and characterization of water quality loading, fate, and transport for all the key TMDL constituents (LACDPW 2010a, 2010b). Since the original development of the WMMS LSPC model, Los Angeles County has updated the model with meteorological data through April 2012.

To support the objectives of this RAA, jurisdictional boundaries were also intersected with the WMMS LSPC model subwatersheds resulting in a finer resolution spatial unit for modeling. Consideration was also given to subtract areas addressed separately for WMPs developed for Lower Los Angeles River, Los Cerritos Channel, and Lower San Gabriel River (LLARWG 2015, LCCWG 2015, LSGRWG 2015). Model land use was then resampled using this subwatershed-jurisdiction intersect, properly distributing land use categories at the jurisdictional level for attributing sources, while maintaining hydrologic connectivity within the watershed model. This refinement introduced a new layer of resolution, facilitating the rollup of modeled results for the City of Long Beach to better support source attribution and implementation responsibilities.

Figure 3-1. WMMS model domain and represented land uses and slopes by subwatershed

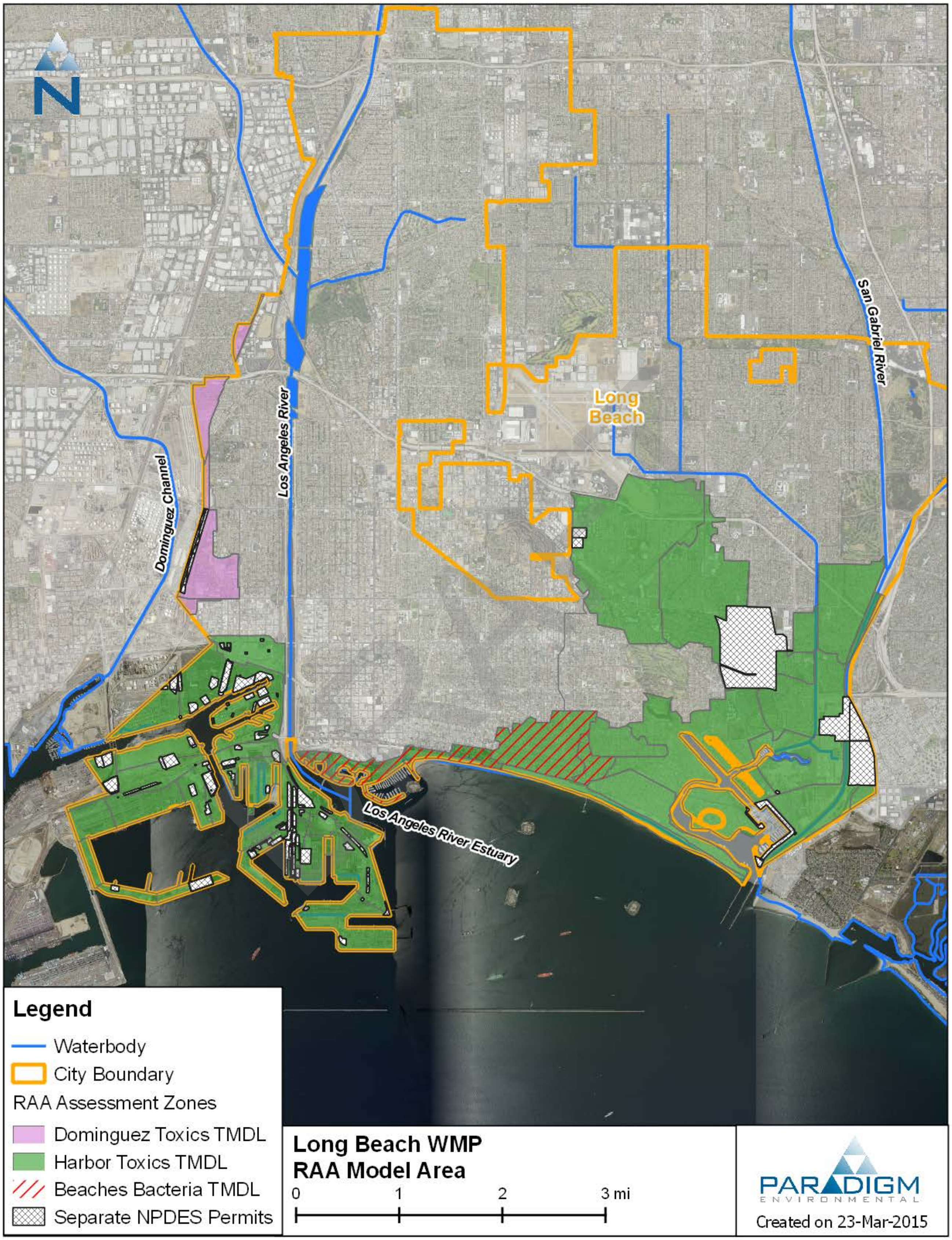


Figure 3-2. Long Beach WMP Area subwatersheds represented by WMMS.

3.2. Small-Scale BMP Model – SUSTAIN

The System for Urban Stormwater Treatment and Analysis INtegration (SUSTAIN) was developed by USEPA to support practitioners in developing cost-effective management plans for municipal storm water programs and evaluating and selecting BMPs to achieve water resource goals (USEPA, 2009). It was specifically developed as a decision-support system for selection and placement of BMPs at strategic locations in urban watersheds. It includes a process-based continuous simulation BMP module for representing flow and pollutant transport routing through various types of structural BMPs. Users are given the option to select from various algorithms for certain processes (e.g., flow routing, infiltration, etc.) depending on available data, consistency with coupled modeling assumptions, and the level of detail required. Figure 2-3 shows images from the SUSTAIN model user interface and documentation depicting some of the available BMP simulation options in a watershed context.

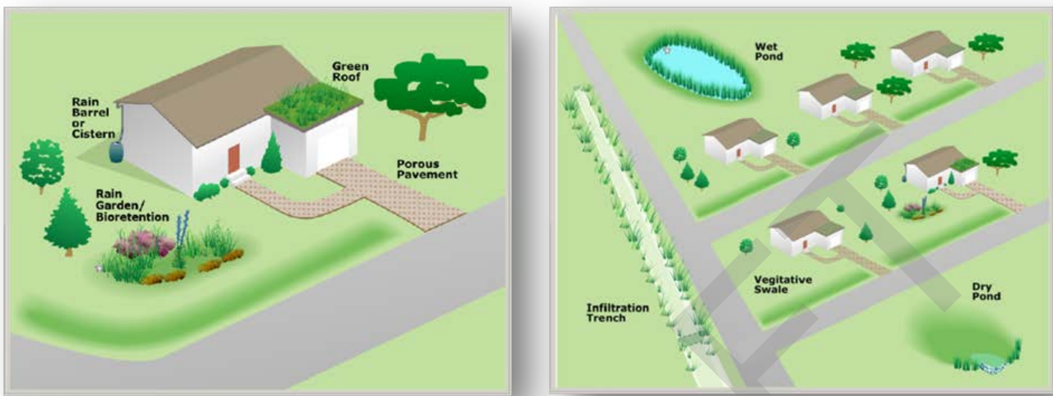


Figure 2-3. SUSTAIN model interface illustrating some available BMPs in watershed settings

SUSTAIN extends the capabilities and functionality of traditionally available models by providing integrated analysis of water quantity, quality, and *cost factors*. The SUSTAIN model in WMMS includes a cost database comprised of typical BMP component cost data from a number of published sources including BMPs constructed and maintained in Los Angeles County. SUSTAIN considers certain BMP properties as "decision variables," meaning that they are permitted to change within a given range during model simulation to support BMP selection and placement optimization. As BMP size changes, so do cost and performance. SUSTAIN runs iteratively to generate a cost-effectiveness curve comprised of optimized BMP combinations within the modeled study area (e.g., the model evaluates the optimal width and depth of certain BMPs to determine the most cost-effective configurations for planning purposes).

3.3. Large-Scale BMP Optimization Tool – NIMS/SUSTAIN

WMMS was specifically designed to dynamically evaluate effectiveness of BMPs implemented in subwatersheds for meeting downstream RWLs while maximizing cost-benefit. WMMS employs optimization based on an algorithm named the Nonlinearity-Interval Mapping Scheme (NIMS) to navigate through the many potential scenarios of BMP strategies and identify the strategies that are the most cost effective (Zou et al. 2010). Given the relatively small spatial scale of the RAA area, NIMS was not applied for this study. Instead, a two-tiered approach was applied using the NSGA-II solution technique available in SUSTAIN. For Tier 1, treatment capacities were optimized for each contributing segment, which resulted in unique cost-effectiveness curves for each segment based on available opportunities therein. For Tier 2, the search space was composed of Tier 1 solutions, thereby streamlining the search process. The resulting Tier 2 curve represents the optimal large scale solution because it is comprised of optimized Tier 1 solutions. This approach is especially useful for prioritizing areas for management and scheduling implementation milestones as described in Section 8.

4. Current/Baseline Pollutant Loading

The LSPC model within WMMS was reconfigured and recalibrated specifically for the Long Beach RAA area to provide an estimate of current/existing pollutant loads from the jurisdiction of the City of Long Beach. These calibrations were performed to meet specifications of the RAA Guidelines (LARWQCB 2014) and have resulted in minimal revisions to the process-based parameters derived for the RAAs prepared for WMPs for Lower Los Angeles River, Los Cerritos Channel, and Lower San Gabriel River (LLARWG 2015, LCCWG 2015, LSGRWG 2015). Reconfiguration of model subwatersheds was performed to provide specific accounting of loadings from the City of Long Beach, and to subtract areas already addressed by the separate WMPs.

4.1. Model Calibration to Existing Conditions

The LSPC watershed model was originally calibrated for hydrology using a regional approach relying on USGS observed daily streamflow datasets through Water Year (WY) 2006 (LACDPW 2010a). Water Quality was then calibrated using small-scale, land use level water quality monitoring data to develop representative event mean concentrations by land use (LACDPW 2010b). Model performance was also validated at the mass emissions monitoring stations in the context of a county-wide modeling effort. The calibration period for the original WMMS LSPC model began in 1996 and ended in 2006.

Since development of the Lower Los Angeles River, Los Cerritos Channel, and Lower San Gabriel River WMPs (LLARWG 2015, LCCWG 2015, LSGRWG 2015), additional calibration efforts have been performed to tailor the WMMS model for more robust instream performance accounting for prominent engineered and lined channels throughout many of the watersheds. LACDPW has also extended the precipitation and evapotranspiration climate input time series beyond WY 2011. For this RAA, an analysis was performed to evaluate performance of the LSPC model as it relates to the RAA area to understand and benchmark its applicability for use as a baseline condition.

The evaluation of monitoring data was extended beyond the original WMMS-LSPC calibration to include the period from 10/1/2001 through 9/30/2011 incorporating both the average year (WY 2008) and 90th percentile year (WY 2003). Through the incorporation of engineered channels, spreading grounds and other physical features, the hydrology representation became consistently more reliable when compared to observed data which minimal revisions to the original WMMS or Gateway WMP watershed model hydrology parameters (LLARWG 2015, LCCWG 2015, LSGRWG 2015). A quantitate analysis of the model calibration as required by the RAA Guidelines necessitates the use of long-term, continuous flow data.

Data available at strategic points along Coyote Creek were used for calibration and validation of the updated RAA watershed model. Since the objective of this calibration effort was to accurately represent the rainfall runoff response, rather than account for all heavily engineering instream features, a USGS gage, Fullerton Creek below Fullerton Dam near Brea CA (USGS 11089500), was selected for calibration as it was minimally impacted by hydromodifications. Validation was performed with data from the nearby LACDPW streamflow monitoring station, Coyote Creek below Spring Street (F-354) to check the model response after incorporating generalized representation of upstream hydromodifications. These monitoring stations were also selected for comparison due to their long-term records, high temporal sampling density, spatial relationship with county mass emission station (S13), and proximity to the Long Beach RAA area. The location of these gages in relation to the Long Beach WMP is presented in Figure 4-1. Statistical summaries and calibration plots for both hydrology and water quality are presented in Attachment E.

Other county streamflow gages along the San Gabriel River and Los Angeles River main stems were not relied upon due to heavy influence from many of the point source and engineered features described previously. Local City of Long Beach monitoring data was also examined for water quality validation. This dataset consistent primarily of composite samples a comparison of observed vs. modeled event mean concentrations (EMCs) for the Belmont Pump Station monitoring location (Figure 4-1) is also presented in Attachment E.

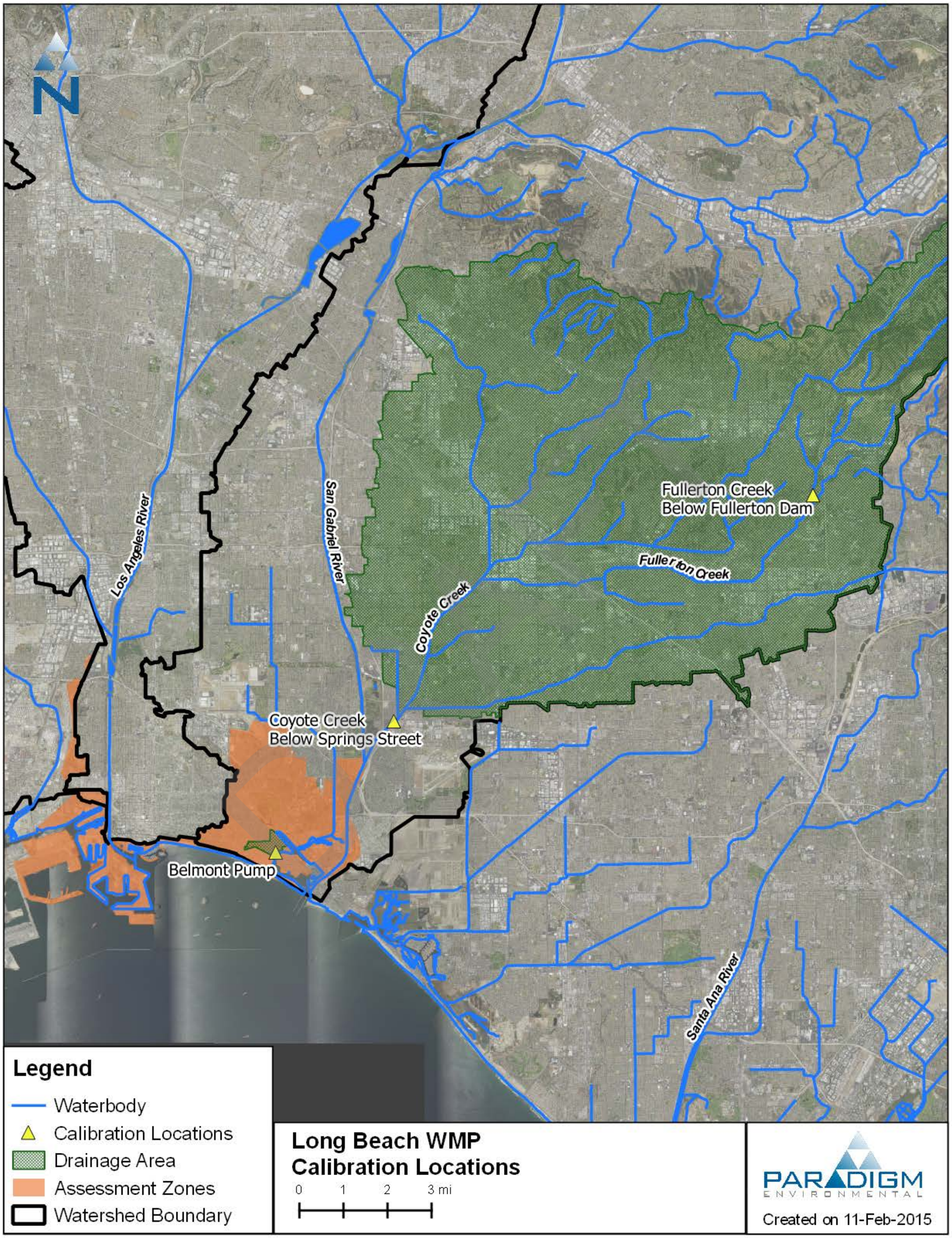


Figure 4-1. Long Beach WMP model calibration and validation locations in proximity to the RAA area.

To demonstrate the ability to predict the effect of watershed processes and management actions, model calibration and validation are necessary and critical steps in any model application. Acceptable model calibration criteria for benchmarking an RAA were developed by the Regional Board and are listed below in Table 4-1 (LARWQCB 2014). The objectives of establishing model assessment criteria are to ensure the calibrated model reflects all the model conditions and properly utilizes the available modeling parameters, thus yielding meaningful results. The lower bound of "Fair" level of agreement listed in Table 4-1 is considered a target tolerance for the model calibration process.

Table 4-1. Model assessment criteria from the RAA Guidelines

Constituent Group	Percent Difference Between Modeled and Observed		
	Very Good	Good	Fair
Hydrology / Flow	0 – 10	>10 – 15	>15 – 25
Sediment	0 – 20	>20 – 30	>30 – 40
Water Quality	0 – 15	>15 – 25	>25 – 35
Pesticides / Toxics	0 – 20	>20 – 30	>30 – 40

4.1.1. Hydrology Calibration

Table 4-2 presents the hydrology calibration assessment for the Brea Creek below Brea Dam, near Fullerton, CA (USGS 11088500) streamflow gage. Table 4-3 presents the hydrology validation assessment for the Coyote Creek below Spring Street (F-354) streamflow gage to examine the response after adding a generalized representation of instream engineered features. The two other nearby gages (main stem Los Angeles River and San Gabriel River) both have large drainage areas and heavily influenced by hydromodifications and diversions and highly variable precipitation patterns not fully reflective of the localized coastal precipitation around the Long Beach WMP area; therefore both of them are less representative of local runoff conditions.

Table 4-2. Summary of model hydrology calibration for Fullerton Creek below Fullerton Dam CA (USGS 11089500)

Hydrology Parameter	Model Period	Modeled vs. Observed Volume (% Error)	Regional Board Guidance Assessment
Total Annual Volume	10/1/2002 – 9/30/2011	-5.9%	Very Good
Annual Storm Volume		-15.7%	Fair

Table 4-3. Summary of model hydrology validation for Coyote Creek below Spring Street (LAC DPW F-354)

Hydrology Parameter	Model Period	Modeled vs. Observed Volume (% Error)	Regional Board Guidance Assessment
Total Annual Volume	10/1/2002 – 9/30/2011	-16.3%	Fair
Annual Storm Volume		5.2%	Very Good

The Coyote Creek drainage area includes certain notable instream hydromodification features such as Brea and Fullerton Dams. Each of those two dams had a downstream USGS flow gage. During model calibration, performance improved after incorporating a basic representation of those dams in the model while retaining overland process hydrology parameters consistnet with other regional modeling efforts. The drainage area downstream of those dams to the flow gage below Spring Street (F354) also includes flow from Orange County and other possible unrepresented hydraulic features--the two dams together represent 25 out of the 150 sq-mi drainage area to F354. In the future, a more detailed and complete representation of the instream hydromodification features would likely result in a tightening of hydrology calibration metrics without extensive revision of the overland parameters which drive runoff generation. During the next RAA update during adaptive management, if additional data are available regarding hydromodification features in Coyote Creek watershed (e.g., flow data from the outlets of hydromodification structures), those data can be incorporated into the model in attempt to further refine the hydrologic calibration.

4.1.2. Water Quality Calibration

Water quality calibration for the Long Beach WMP relied on sampling from the LA County mass emission station S13 located near the mouth of Coyote Creek where it joins the San Gabriel River main stem. The observed concentration data collected at this site were used to benchmark the calibration and benchmark model performance. Daily observed loads were calculated by multiplying observed concentration and daily observed flow. The percent error between this daily observed load and the daily modeled load was then calculated for each constituent. The results of this evaluation at the two gages are presented in Table 4-4.

The Coyote Creek monitoring data was the primary dataset used in water quality calibration for this RAA as it isolates the loading from MS4 areas while minimizing the influence of other processes and features. There are no significant upstream point source inputs (unlike the main stem San Gabriel and Los Angeles Rivers). Also, the effects of natural baseflow are eliminated since Coyote Creek is a fully concrete lined channel.

Additional storm sampling data provided by the City of Long Beach was also evaluated. The dataset consisted primarily of composite samples rather than grab samples with continuous flow data that were used to calculate the statistics presented in Table 4-4. Consequently, this dataset was used primarily to validate the model response by comparing EMCs for the Belmont Pump Station gage (Figure 4-1). The validation comparison was performed graphically and results of this comparison are presented at the end of Attachment E.

Table 4-4. Summary of model performance by constituent at the Coyote Creek (S13) monitoring location

Water Quality Parameter	Sample Count	Modeled vs. Observed Load (% Error)	Regional Board Guidance Assessment
Total Sediment	52	10.8%	Very Good
Total Copper	20	5.0%	Very Good
Total Zinc	28	2.8%	Very Good
Total Lead	30	-1.9%	Very Good

For pollutants not explicitly represented in the WMMS LSPC model, 90th percentile concentrations were calculated based on observed monitoring data at the LACDPW mass emission sites. Due to the fact that the Dominguez and Harbors Toxics TMDL was focused on sediment-bound pollutants, which are characteristically transported during wet weather, only wet-weather monitoring data were used to calculate 90th percentile concentrations. The 90th percentile concentration was used for compliance with the Regional Board RAA guidelines (LARWQCB 2014). A summary of the 90th percentile concentrations for each constituent and waterbody are presented below in Table 4-5. For subsequent load reduction analyses, these concentrations were assumed for all modeled wet-weather flows to represent existing conditions within their respective watersheds.

Table 4-5. 90th percentile concentrations assumed for non-modeled pollutants

Waterbody	Pollutant	90th Percentile Concentration	Units
All Waterbodies Associated with the Dominguez and Harbors Toxics TMDL	DDT	0.005[1]	ug/L
	PCBs	0.0325[1]	ug/L
	PAHs	0.835[1]	ug/L
Dominguez Channel Estuary	Cadmium	1.106[2]	ug/L
	Chromium	12.03[3]	ug/L

[1] DDT, PCBs and PAHs were below MDL, so concentrations were assumed half MDL.

[2] Based on particulate cadmium. Mass Emission Station S28 data was used to determine 90th percentile concentrations of total cadmium (1.476 ug/L) and dissolved cadmium (0.3705 ug/L). The difference between the dissolved and total cadmium was assumed to be particulate.

[3] Based on particulate chromium. Mass Emission Station S28 data was used to determine 90th percentile concentrations of total chromium (15.72 ug/L) and dissolved chromium (3.687 ug/L). The difference between the dissolved and total cadmium was assumed to be particulate.

4.2. Current Best Management Practices / Minimum Control Measures

It is important to note the model calibration incorporates local stormwater BMPs implemented through late 2012 into the baseline condition. All existing BMPs prior to 2012, which individually were assumed to have a small effect on water quality at the watershed scale, are implicitly represented in the baseline condition. BMPs implemented in 2013 can be categorized as WMP implementation measures and their volume/load reductions are a component of the pollutant reduction plan for attaining interim and final milestones. More information on the existing and planned BMPs can be found in Section 8.1, Attachment A, and Attachment D.

5. Estimated Required Pollutant Load Reductions

This section provides a description of the process for identifying critical conditions and calculating required load reductions to meet interim and final limitations.

5.1. Selected Average (Interim) and Critical (Final) Conditions

The RAA Guidelines specify that average conditions shall be used to establish load reductions for interim milestones and critical conditions shall be used to establish load reductions for final limits. In addition, the Permit provide two pathways for addressing WQ Priorities (see Figure 5-1):

- Volume-based: Retain the standard runoff volume from the 85th percentile, 24-hour storm
- Load-based: Achieve the necessary pollutant load reductions to attain Permit limits

Both types of numeric goals were evaluated as part of this RAA.

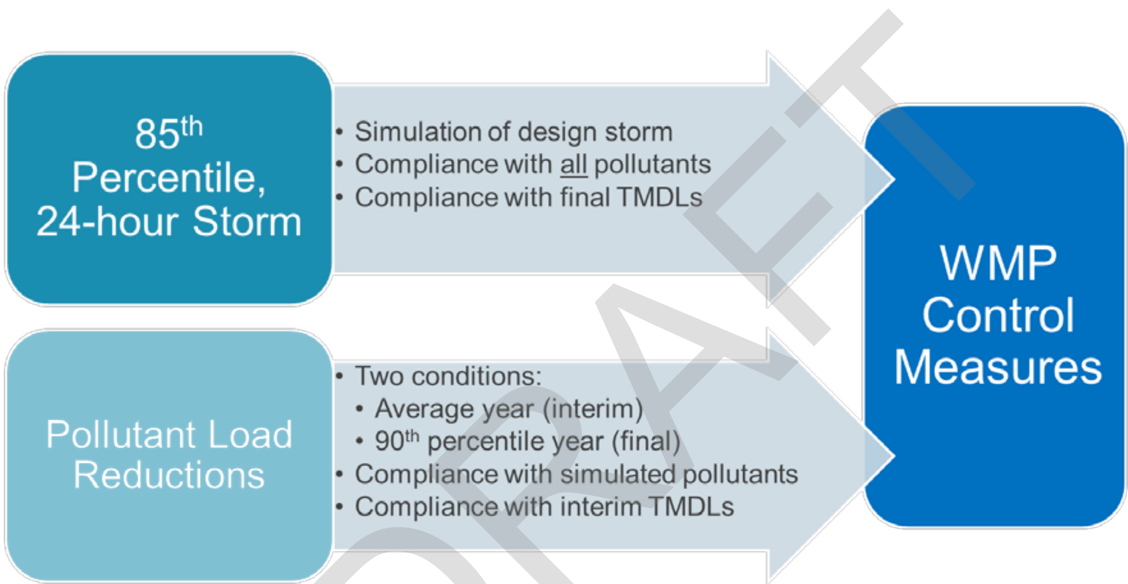


Figure 5-1. Two Types of Numeric Goals and WMP Compliance Paths according to the Permits

5.2. Representative Conditions for Wet Weather

Two approaches were considered and ultimately used in the RAA to represent wet weather critical conditions: the 90th percentile wet year; and the 85th percentile, 24-hour (design) storm, as described in the following subsections.

5.2.1. Average and 90th Percentile Wet Years

This RAA is based on continuous simulation, and a "representative" year-long time period was selected to represent average and critical conditions, which allows the modeling to capture the variability of rainfall and storm sizes/conditions. To address the Dominguez and Harbors Toxics TMDL for Long Beach, WY2008 was selected as the representative year for average conditions and WY2003 was selected as the representative year for the 90th percentile critical wet conditions.

To select these average and critical years for the RAA, the following steps were taken:

1. **Calculated key rainfall metrics for the last 25-years:** the average and critical years were identified by aggregating data from available rain gages across the entire Los Angeles River, Dominguez Channel and San Gabriel River watersheds (Long Beach is co-located in all three watersheds). For comparison, other regional watersheds were also analyzed and presented. The two key metrics evaluated were: (1) total annual

rainfall, and (2) average rainfall per wet day (with wet days defined as days with rainfall totals greater than 0.1 inches). The first is clearly an indicator of volume, while the second is an indicator of rainfall intensity. To evaluate long-term conditions, the analysis covered 25 water years (WY) from 1987 through 2011—the total rainfall for each precipitation gage was area-weighted and aggregated into annual totals by water year (i.e. previous October through current September).

2. **Selected years from the most recent 10-years that are most representative of average and 90th percentile**: per the RAA Guidelines, the most recent 10-year period represented in the available data were used to develop the RAA. Table 5-1 and Table 5-2 show average rainfall volumes and intensities (inches per wet day), respectively, for the most recent 10 years compared against the entire 25-years. Both the average and 90th percentile values were compared across the 10- and 25-year records. For San Gabriel River, Los Angeles River, and Dominguez Channel, 2007-08 is a representative average year based on both the rainfall volume (Table 5-1) and intensity (Table 5-2) metrics. Because BMP performance is typically intensity-dependent, average rainfall per wet day (Table 5-2) was selected as a better metric for use in determining the 90^{th} percentile than annual average rainfall (Table 5-1), which led to selection of 2002-03 as the critical year.

It should be noted that wet weather conditions were also reflective of the definition of dry/wet days. As described in Section 5, for analysis of non-bacteria pollutants (including the limiting pollutant zinc) days with greater than 90^{th} percentile daily average flow were flagged as "wet," which aligns with the critical condition used for the Los Angeles River and San Gabriel River metals TMDLs.

For bacteria, an additional analysis of a "critical bacteria storm" was assessed based on BMPs demonstrated in the RAA to meet the final milestones for the Dominguez and Harbors Toxics TMDL during the 90^{th} percentile wet year. The critical bacteria storm is the 90th percentile wet day when bacteria RWLs apply. Section 8.3 provides a description of the methodology and results of the analysis of additional BMP capacity to address the final milestone for the Beaches Bacteria TMDL.

5.2.2. 85^{th} Percentile, 24-hour Storm

The design storm is identified in the RAA Guidelines as an acceptable critical condition, and capture of design storm volumes by BMPs is a specified compliance metric in the Permit for TMDLs. The design storm was evaluated and used as a wet weather critical condition for the RAA. As described above, the design storm is a volume-based standard. Each subwatershed within the RAA area has a unique 85th percentile runoff volume, due to varying rainfall amounts and land characteristics (imperviousness, soils, slope, and the like). The rainfall depths associated with the 85th percentile, 24-hour storm are shown in Figure 5-2, based on rolling 24-hour intervals for the 25-year period between October 1, 1987 and September 30, 2011. Within the RAA area, the 85th percentile rainfall depth values range between 0.71 and 0.85 inches.

To determine the "standard volume" associated the design storm, initial conditions were set in LSPC to reflect representative conditions at the start of the simulation, along with regionally derived infiltration rates, and 85th percentile rainfall depths were used as rainfall boundary conditions. At each location the storm distribution presented in Figure 5-3 was used to temporally distribute the 24-hour rainfall volumes (LACDPW 2006). The model was then run to predict the associated runoff volumes for each subwatershed in the RAA area. Those runoff volumes represent the volumes that would need to be retained in order to attain the numeric goals associated with the 85th percentile, 24-hour storm.

Shown in Figure 5-4 are the rainfall depths and runoff depths (runoff volume divided by subwatershed area) associated with the design storm for each subwatershed in the RAA area. About 50 percent of the subwatersheds in the RAA area experiences 0.4 inches or more of runoff under the 85th percentile, 24-hour storm, while about 10 percent of the area experiences about 0.55 inches or more of runoff. The total design storm capture volume for the RAA area is 309 acre-feet. The runoff depths for each subwatershed in the RAA area is shown graphically in Figure 5-5.

Table 5-1. Average Rainfall Depths (Water Years 2002–2011 vs. 25-year Average and 90th Percentile)

Year	Average Rainfall Totals (in./year)				
	Ballona Creek	Dominguez Channel	Malibu Creek	San Gabriel River	Los Angeles River
2001-02	25.4	19.1	28.1	30.6	30.5
2002-03	17.1	13.9	20.8	23	20.4
2003-04	10.2	8.1	9.2	13.7	11.2
2004-05	39.3	28.4	42.6	49.6	46.7
2005-06	14.1	9.8	16.9	17.9	17.5
2006-07	4.3	3.1	6.8	6.4	5.8
2007-08	13.2	11.9	18.6	19.4	17.5
2008-09	9.6	8.5	12.3	14.6	12.5
2009-10	16.8	14.9	20.3	24.1	20.5
2010-11	21.2	18.5	25.3	28.5	25.7
Avg. (1987-2011)	**15.9**	**12.5**	**18.4**	**20.7**	**19.2**
90th %ile (1987-2011)	**30.8**	**22.9**	**34.7**	**37.8**	**36.9**

Red Box: WMP Watersheds. Blue highlighted cells are the two years in each basin with the smallest difference from the 25-year average. Orange cells have the smallest difference from the 90th percentile of the 25-year record.

Table 5-2. Average Rainfall Intensity (Water Years 2002–2011 vs. 25-year Average and 90th Percentile)

Year	Average Rainfall Per Wet Day (in./wet day)				
	Ballona Creek	Dominguez Channel	Malibu Creek	San Gabriel River	Los Angeles River
2001-02	0.36	0.32	0.41	0.42	0.36
2002-03	0.79	0.66	0.88	0.92	0.84
2003-04	0.61	0.48	0.61	0.66	0.58
2004-05	0.98	0.69	1.03	1.07	1.03
2005-06	0.53	0.41	0.61	0.64	0.61
2006-07	0.31	0.27	0.39	0.41	0.37
2007-08	0.56	0.52	0.68	0.76	0.71
2008-09	0.49	0.48	0.56	0.65	0.57
2009-10	0.64	0.6	0.71	0.82	0.72
2010-11	0.62	0.58	0.73	0.76	0.7
Avg. (1987-2011)	**0.59**	**0.52**	**0.67**	**0.72**	**0.66**
90th %ile (1987-2011)	**0.78**	**0.66**	**0.91**	**0.97**	**0.89**

Red Box: WMP Watersheds. Blue highlighted cells are the two years in each basin with the smallest difference from the 25-year average. Orange cells have the smallest difference from the 90th percentile of the 25-year record.

As a validation of the selecting WY 2003 for representing the 90th percentile critical condition, the annual rainfall intensity metric presented in Table 5-2 for the San Gabriel River was compared against annual runoff volume for a selected subwatershed (5035) coincident with a calibration gage near the WMP area. Both metrics were compiled for the most recent 10-year period and are presented in Table 5-3 sorted in decending order. The comparison in Table 5-3 suggests that the rainfall intensity metric of average rainfall per wet day is a consistent surrogate for runoff volume, the dominant force for mobilizing pollutants at the subwatershed scale and driving factor for sizing BMPs.

Table 5-3. Comparison of Average Rainfall Intensity (Water Years 2002–2011) critical condition metric for the San Gabriel River with annual runoff volume from a selected subwatershed (SWS 5035)

San Gabriel River Average Rainfall Intensity (from Taable 5-2)		Example Subwatershed 5035 Annual Runoff Volume	
Year	Average Rainfall Per Wet Day (in./wet day)	Year	Subwatershed Runoff Volume (in-acre/year)
2004-05	1.07	2004-05	2,420.3
2002-03	0.92	2002-03	947.1
2009-10	0.82	2009-10	942.9
2010-11	0.76	2010-11	824.6
2007-08	0.76	2007-08	658.0
2003-04	0.66	2005-06	657.4
2008-09	0.65	2003-04	597.1
2005-06	0.64	2008-09	565.3
2001-02	0.42	2006-07	261.8
2006-07	0.41	2001-02	133.7

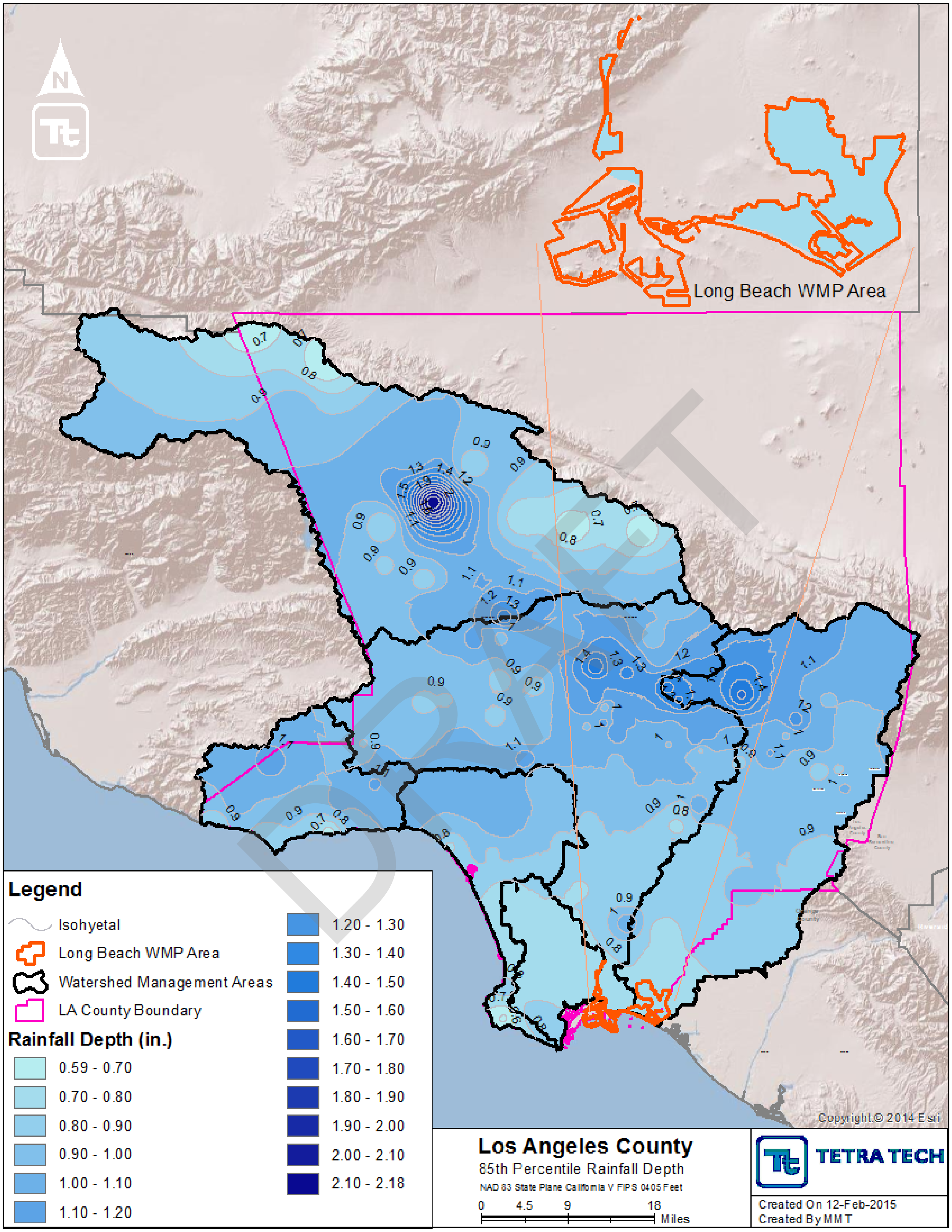


Figure 5-2. Rainfall depths associated with the 85th percentile, 24-hour storm.

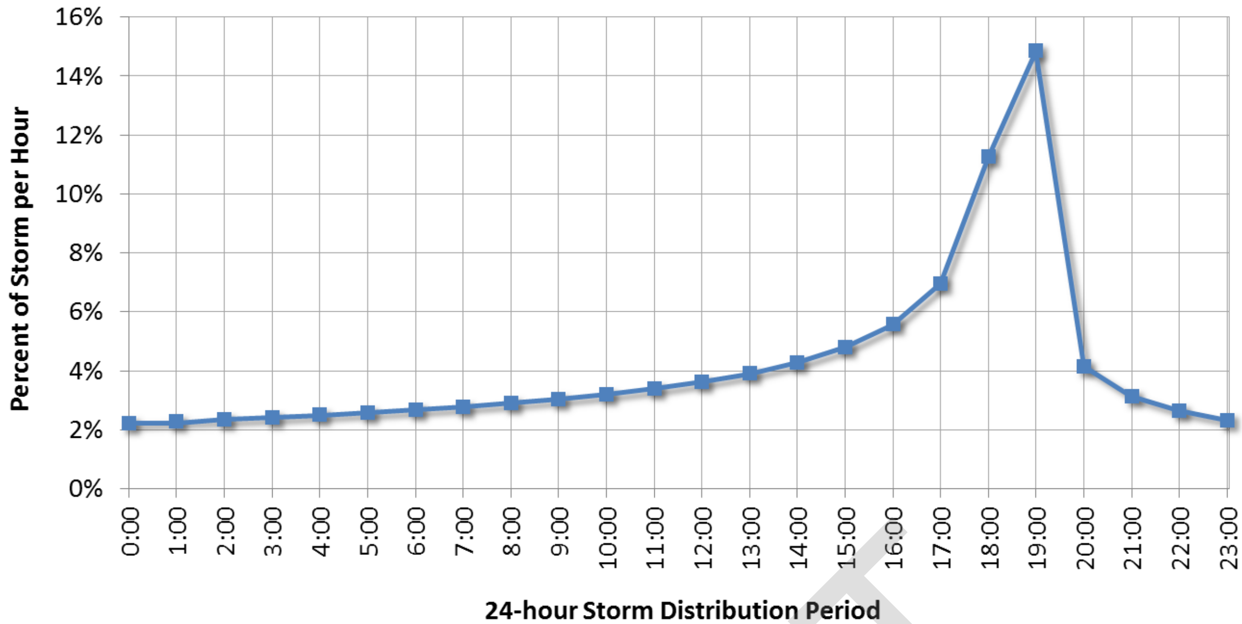


Figure 5-3. Temporal Distribution for 85th Percentile 24-hour Storm for LSPC Simulation.

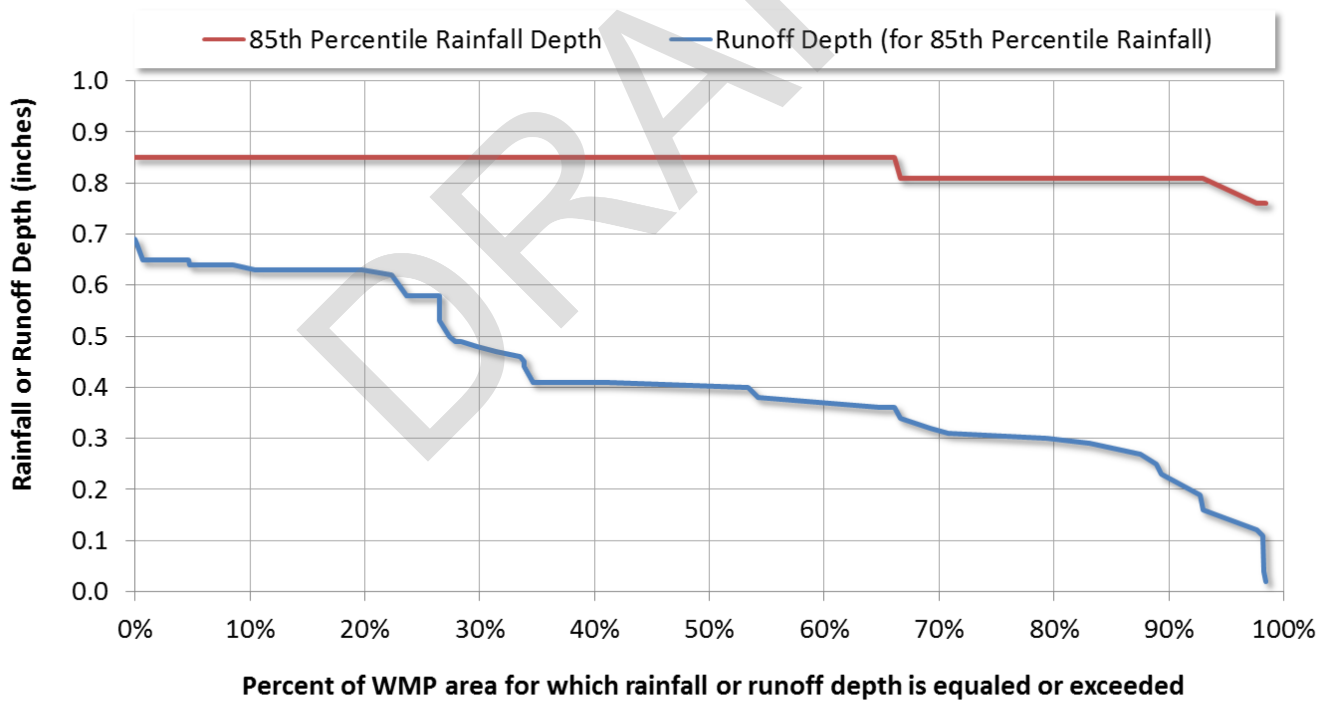


Figure 5-4. Rainfall and Runoff Depths Associated with 85th Percentile Rainfall in the RAA subwatersheds.

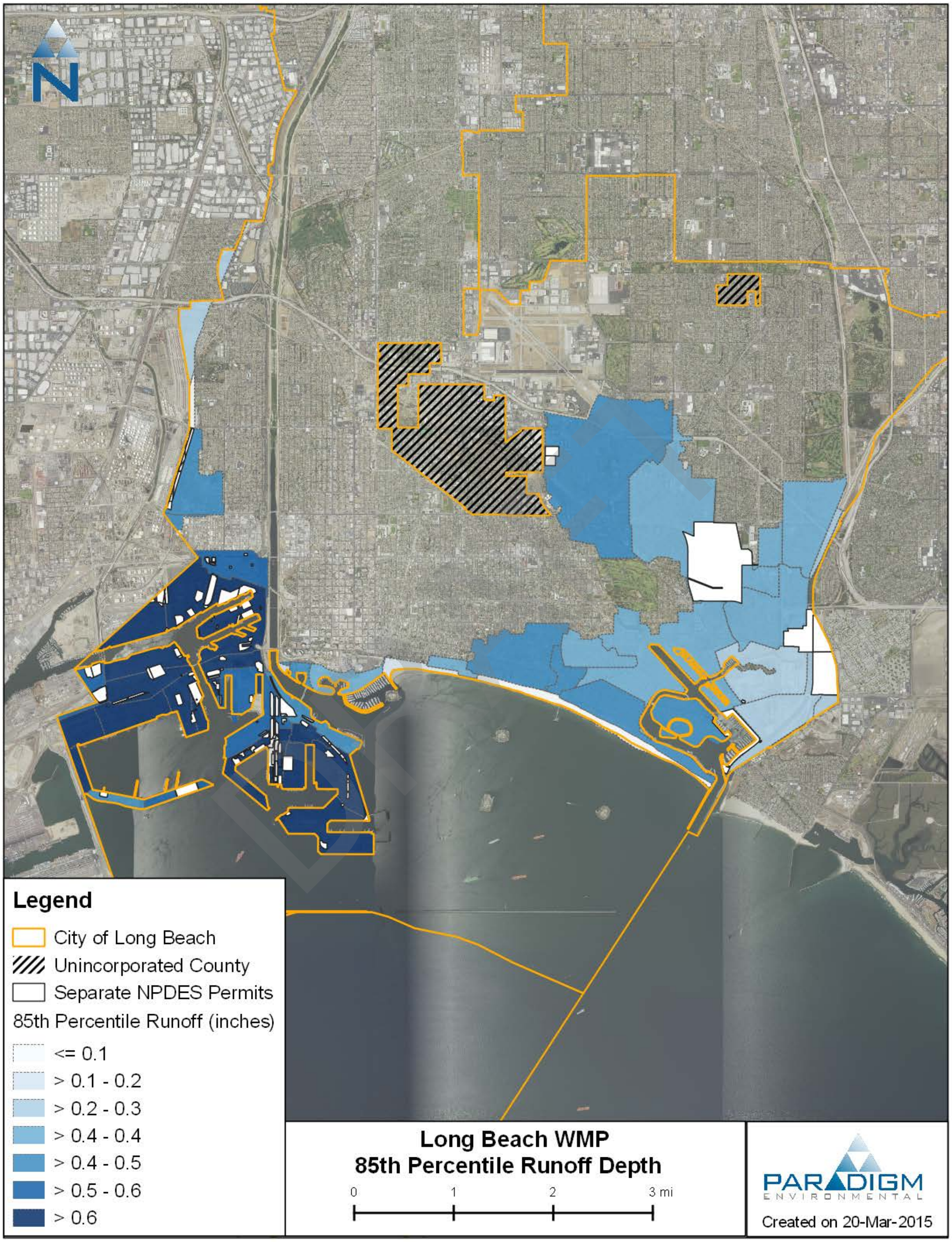


Figure 5-5. Runoff Associated with the 85th Percentile, 24-hour Storm for the RAA area.

5.2.3. Representative Conditions for Dry Weather

Although clearly defined definitions exist for wet periods, definitions for dry periods are less clearly defined. Wet weather periods are either defined in terms of rainfall or instream flow. For bacteria, a wet day is one with a rainfall total greater than 0.1 inches plus the three subsequent days, while metals criteria define wet days as those with instream flow above the 90th percentile. One seemingly intuitive way of defining a dry period is simply to use the "non-wet" days represented as the inverse of wet days. However, summary of model results indicate some residual influence of wet weather among the "non-wet" days.

The Lower San Gabriel, Lower Los Angeles River, and Los Cerritos Channel WMPs performed an analysis of critical dry periods by counting the number of consecutive dry days by month. Within the two selected years (Critical WY 2003 and Average WY 2008), the 45-day period between 8/17 and 9/30 was found to be the most representative of dry weather conditions because (1) no rainfall occurred at any of the gages throughout all three WMP areas, (2) it was during a time of the year that was historically shown to experience the least amount of spatially-weighted rainfall in a year, and (3) it was late in the summer following an extended period of no rainfall for both 2003 and 2008. Figure 5-6 illustrates graphically the analysis to identify a representative dry period. A 30-day period falling between 8/17 and 9/20 during the average year was used for subsequent dry weather simulations for the dry weather component of the RAA.

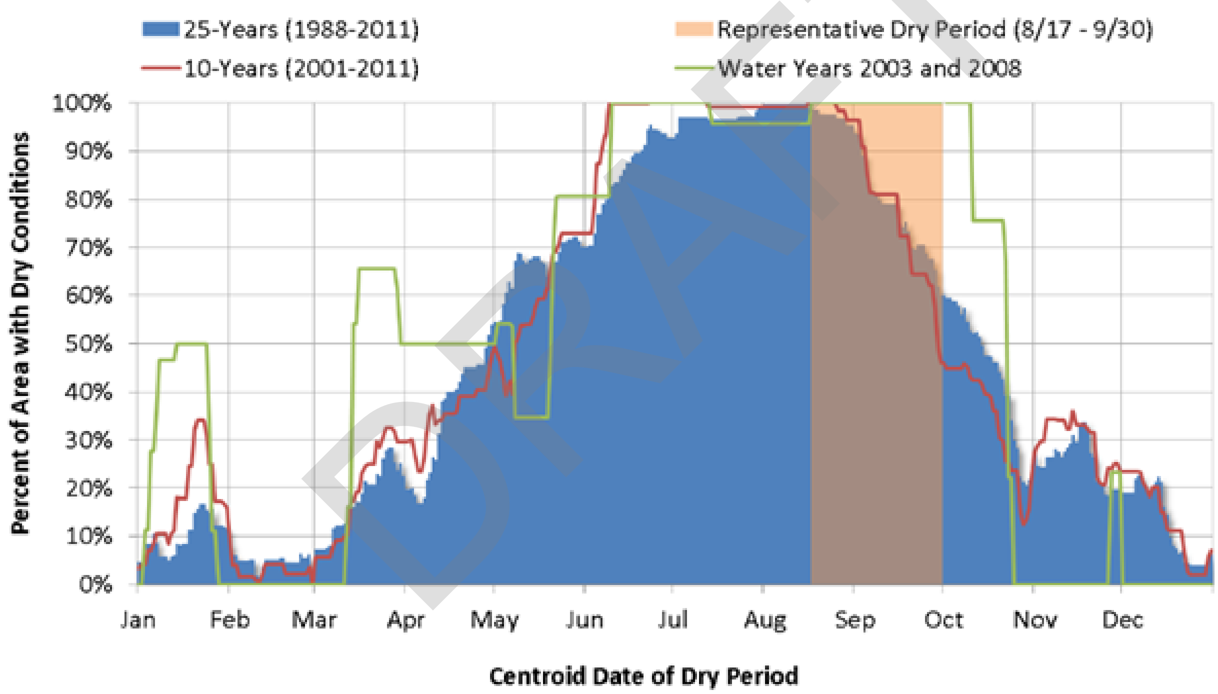


Figure 5-6. Spatiotemporal summary of non-wet weather conditions in the Lower San Gabriel River WMP area.

5.3. Calculated Required Pollutant Reductions to Achieve Final Limits for the Dominguez and Harbors Toxics TMDL

Using the average storm year (2007-08) and 90th percentile storm year (2002-03), required pollutant reductions were calculated for attainment of interim and final limitations, respectively, for areas applicable to the Dominguez and Harbors Toxics TMDL. Per the RAA Guidelines, the percent reduction used to determine the control measures necessary to attain interim milestones shall be based on the average year, while the control measures for attainment of the final limits are based on the 90th percentile year.

Required load reductions for the Dominguez and Harbors Toxics TMDLs were evaluated for separate RAA Assessment Zones for the Dominguez Estuary (Dominguez Toxics TMDL RAA Assessment Zone) and the remaining greater Los Angeles and Long Beach Harbor waters (Harbors Toxics TMDL RAA Assessment Zone), as shown in Figure 3-2. The RAA Assessment Zones represent locations where the collective discharge from City of Long Beach and Port of Long Beach jurisdictions within the RAA area can be assessed to contribute to pollutant loads to the receiving waters. Pollutant loads outside of the WMP area are not considered in this loading analysis for the RAA Assessment Zones, although in reality other loads exist. The result is an accounting system that provides reasonable tracking and estimation of required load reductions throughout each RAA Assessment Zone so that meaningful goals can be set for BMP implementation planning.

Applicable targets for Category 1 WQ Priorities (corresponding to the Dominguez and Harbors Toxics TMDL) are listed in Table 5-4. All targets, expressed as sediment concentrations, were multiplied by model-predicted loads of total suspended sediment to calculate allowable pollutant loads. The differences in these allowable loads and model-predicted existing loads were tracked across the average year and 90th percentile year and used to calculate the required pollutant reduction.

Table 5-4. Applicable TMDL targets for Category 1 WQ Priorities for the Dominguez and Harbors Toxics TMDL

RAA Assessment Zone	Waterbody	Pollutant	Target	Source
Harbors Toxics TMDL & Dominguez Toxics TMDL	All	Copper	34 mg/kg TSS	Dominguez and Harbors Toxics TMDL
		Lead	46.7 mg/kg TSS	Dominguez and Harbors Toxics TMDL
		Zinc	150 mg/kg TSS	Dominguez and Harbors Toxics TMDL
		DDT	1.58 ug/kg TSS	Dominguez and Harbors Toxics TMDL
		PCBs	3.2 ug/kg TSS	Dominguez and Harbors Toxics TMDL
		PAHs	4,022 ug/kg TSS	Dominguez and Harbors Toxics TMDL
Dominguez Toxics TMDL	Dominguez Channel Estuary	Cadmium	1.2 mg/kg TSS	Dominguez and Harbors Toxics TMDL
	Consolidated Slip	Chromium	91 mg/kg TSS	Dominguez and Harbors Toxics TMDL

5.3.1. Required Pollutant Reductions to address the Dominguez and Harbors Toxics TMDL

The wet weather pollutant baseline loads, allowable loads, and reduction targets for average and critical conditions are summarized in Table 5-5 through Table 5-7 and shown graphically in Figure 5-7 and Figure 5-8. These analyses were used to determine the limiting pollutant. The limiting pollutant is defined as the pollutant requiring the greatest load reduction, and BMPs implemented to achieve the limiting pollutant reductions are protective of other pollutant reductions via sediment or volume reductions (e.g., bacteria). Zinc was identified as the limiting pollutant for the RAA area.

Although DDT and PCBs were estimated to have high load reduction requirements to meet WQBELs, they were not identified as limiting pollutants because the maximum detection limits (MDLs) used for the analysis heavily affected the calculated required reductions. Rather than use LSPC for reduction calculations, monitoring data were used directly and many reported concentrations for DDT, PCBs, and PAHs were below MDLs, so concentrations were assumed in the model to equal half the MDL. The MDL is above the target leading to non-detects requiring reductions. Of course, toxics will be addressed by control measures implemented for zinc. As a result, DDT, PCBs, and PAHs were not represented in Figure 5-7.

After excluding organics, total zinc becomes the limiting pollutant in each of the RAA Assessment Zones during the 90^{th} percentile year. In other words, reductions of zinc during WMP implementation will drive reduction of other pollutants, particularly because the pollutant reduction plan emphasizes sediment control (other pollutants are typically transported with sediment) and retention/infiltration rather than pollutant treatment.

Table 5-5. Pollutant baseline loads by year and WMP area

RAA Assessment Zone	Year	Organics (kg/year)			Particulate Metals (lbs/year)				
		DDT	PCB	PAH	Cu	Pb	Zn	Cd	Cr
Harbor Toxics TMDL	2003	0.031	0.203	5.226	894.8	681.0	4,224.9	---	---
	2008	0.020	0.131	3.360	628.0	474.8	3,044.4	---	---
Dominguez Toxics TMDL	2003	0.002	0.011	0.275	53.5	---	253.9	0.23	2.48
	2008	0.001	0.009	0.224	42.6	---	199.5	0.20	2.22

Table 5-6. Pollutant allowable load by year and WMP area

RAA Assessment Zone	Year	Organics (kg/year)			Particulate Metals (lbs/year)				
		DDT	PCB	PAH	Cu	Pb	Zn	Cd	Cr
Harbor Toxics TMDL	2003	0.003	0.006	4.03	400.9	656.5	1,559.0	---	---
	2008	0.002	0.004	2.48	287.0	455.3	1,117.3	---	---
Dominguez Toxics TMDL	2003	< 0.001	< 0.001	0.24	22.3	---	88.4	0.09	2.24
	2008	< 0.001	< 0.001	0.16	17.8	---	69.8	0.08	1.65

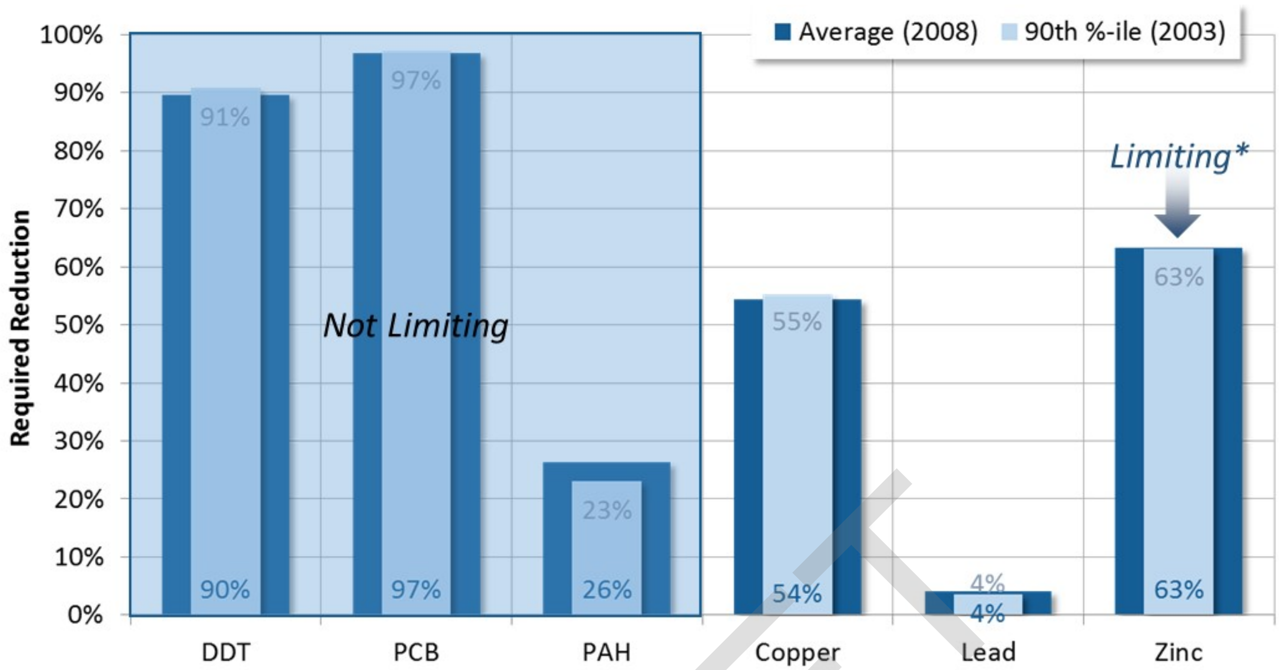
Table 5-7. Pollutant reduction targets by WMP area with analysis of limiting pollutants[4]

RAA Assessment Zone	Year	Organics			Particulate Metals				
		DDT	PCB	PAH [2]	Cu	Pb	Zn [3]	Cd	Cr
Harbor Toxics TMDL	2003	91.0%	97.2%	22.9%	55.2%	3.6%	63.1%	---	---
	2008	89.8%	96.8%	26.3%	54.3%	4.1%	63.3%	---	---
Dominguez Toxics TMDL	2003	90.0%	96.9%	13.1%	58.3%	---	65.2%	59.1%	9.7%
	2008	90.2%	97.0%	30.3%	58.2%	---	65.0%	59.6%	25.6%

Color ramps highlight potentially limiting (Red) vs. pollutants determined to be non-limiting for this analysis (Blue)

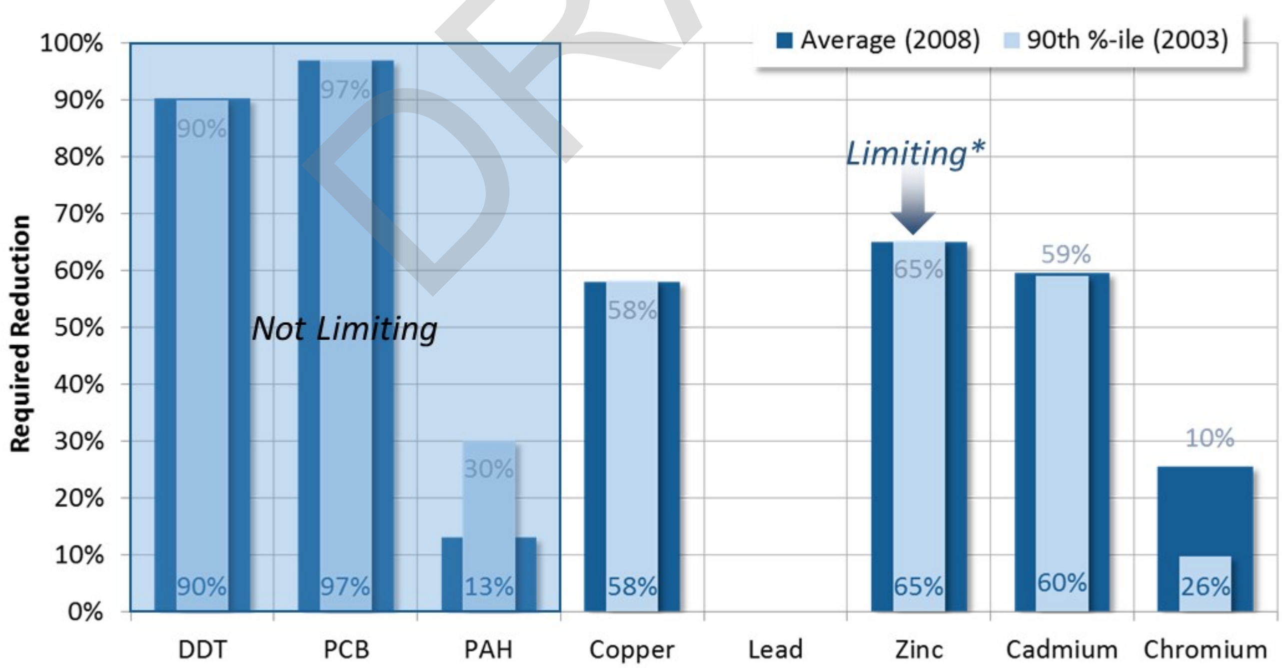
1. Average year is 2008 and 90^{th} percentile year is 2003
2. Red box: Organics managed through sediment and associated metals reduction. Organic load reductions above influenced by assigned concentrations at half the MDLs (monitoring data below MDLs), and therefore are suspect and not considered limiting.
3. Blue Box: Zinc is limiting pollutant for the 90^{th} percentile year
4. Bacteria reduction target is lower in 2003 than 2008 because more days were classified as high-flow suspension (HFS)

[4] The LSPC model predicts total copper, lead, and zinc, whereas the TMDL targets are sediment concentrations and therefore only relevant to particulate portions of metals. To convert model-predicted total metals to particulate metals, dissolved/total metals translators for copper, lead, and zinc were based on values reported in the Los Angeles River Metals TMDL (0.65, 0.82, and 0.61, respectively). The remaining undissolved portion of the total metals was assumed particulate, and compared directly to particulate metals allowable loads for load reduction calculations.



* Organics managed through sediment and associated metals reductions. Organic load reductions above influenced by assigned concentrations at half the MDLs (monitoring data below MDLs), and therefore are suspect and not considered limiting.

Figure 5-7. Pollutant reduction targets and limiting pollutant for Harbor Toxics TMDL RAA Assessment Zone.



* Organics managed through sediment and associated metals reductions. Organic load reductions above influenced by assigned concentrations at half the MDLs (monitoring data below MDLs), and therefore are suspect and not considered limiting.

Figure 5-8. Pollutant reduction targets and limiting pollutant for Dominguez Toxics TMDL RAA Assessment Zone.

6. Determination of Potential BMP Capacity for RAA

The process for determining the necessary cumulative BMP capacity depends on the type of numeric goal being addressed. As shown in Figure 6-1, the volume-based (design storm) approach, necessary BMP capacity was determined through a design storm analysis. For the load-based (pollutant reduction), the analysis leveraged the optimization routines in the customized WMMS. An initial step in the RAA was a comparison of the volume reductions required by the load-based and volume-based numeric goals, to support selection of the wet weather critical conditions.

For Long Beach, the 90th percentile WY (2002-03) weather was selected as the critical condition to assess load reductions and associated BMP capacities necessary to meet milestones and the Dominguez and Harbors Toxics TMDLs.

Details on the analyses performed to determine potential BMP treatment capacity are provided in Attachment A and Attachment F. The attachment describes the approach for incorporating nonstructural BMPs and identifying potential retrofit opportunities.

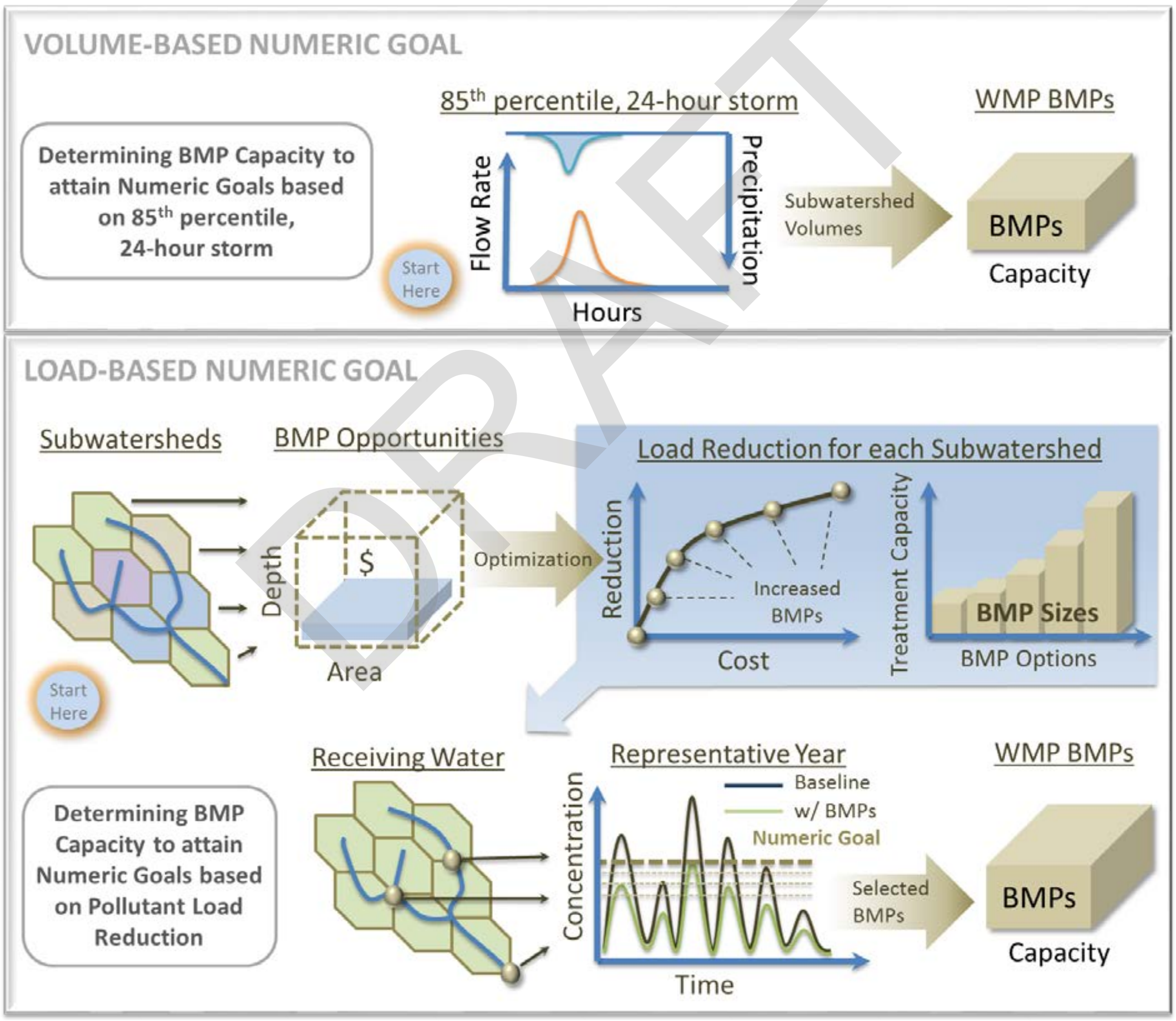


Figure 6-1. Illustration of Process for Determining Required BMP Capacities for the WMP using Volume-Based (top panel) and Load-Based (bottom panel) Numeric Goals.

7. Volume Reduction Goals to Achieve Required Pollutant Reductions for the Dominguez and Harbors Toxics TMDL

The first output of the RAA is a series of "volume reduction goals" for each subwatershed in the RAA area. WMMS was used to determine the stormwater retention volumes for each subwatershed that would achieve the required load reductions, as reported in this section. These calculated runoff reduction volumes for each subwatershed are a surrogate compliance metric for the responsible agencies. These volumes also form the basis for selection of BMPs to achieve those volume reductions, as described in Section 8 and Attachment B. It should be noted that upon implementation, opportunities may arise where flow-through BMPs may provide similar ultimate pollutant load reduction, and may replace the need to implement volume-based reduction BMPs.

Structural BMPs were modeled using the assumptions outlined in Attachment A. BMP capacities were optimized across the entire study area to achieve the final milestone pollutant reduction requirements within each of the RAA Assessment Zones. Instead of summarizing optimization results in terms of BMP capacity, which is really specific to the network described in Attachment A, the results were summarized as required *annual* wet-weather retention volume (in acre-feet). This provides a volumetric basis that is (1) closely related to load reduction and (2) readily transferable as a control target for parallel BMP modeling at a finer resolution.

Using the structural BMP routing network in WMMS (described in Attachment A), the required *annual* wet-weather retention volume (in acre-feet) were calculated using the critical year time series. For milestones, the percent reduction was based on average year targets while final limits were based on critical year targets. The reported annual volumes are (1) based on required load reductions and (2) readily available for BMP modeling at a finer resolution. A 10 percent load reduction was assumed to result from implementation of all nonstructural control measures outlined in the WMPs, setting the foundation of WMP implementation, and structural control measures provide additional load reduction.

Table 7-1 presents incremental and cumulative retention volumes required to achieve each load reduction milestone within each RAA Assessment Zone for the Harbors Toxics TMDL and Dominguez Toxics TMDL, respectively. The milestones were developed specifically for the WMP as described in Section 2. In order to calculate the incremental volume reductions for each milestone, optimization was performed to (1) emphasize BMP implementation in subwatersheds that volume reduction could most cost effectively reduce pollutants and (2) establish a cost-effective sequence of subwatersheds to achieve the milestones over time. In other words, WMMS was used to develop an implementation schedule that provides early gains in receiving water quality.

Table 7-1. Annual volume reduction goals to achieve interim and final milestones for the Harbors Toxics and Dominguez Channel Toxicity TMDLs by RAA Assessment Zone

RAA Assessment Zone	Total Critical Year Storm Volume Target (acre-ft/year)		
	Milestone	Incremental	Cumulative[1]
Harbor Toxics TMDL	2019	1.0	1.0
	2024	77.7	78.7
	2032	1,649.0	1,727.7
Dominguez Toxics TMDL	2019	0.1	0.1
	2024	17.7	17.8
	2032	66.9	84.7

1: Color Ramp highlights relative amount of required retention volume for milestones: darker is more, lighter is less

2: Includes full implementation of planned non-structural practices

8. Pollutant Reduction Plan

The BMPs used to achieve the volume reduction goals in Section 7 are not, per se, a component of the Permit compliance determination. Instead, over time each agency will report and demonstrate that the *cumulative* effect of projects implemented over time add up to the required reductions for interim milestones and final targets. However, the initial scenario of BMPs for WMP implementation (referred to as a Pollutant Reduction Plan in the RAA Guidelines) and their costs may be the most beneficial outcome of the WMP. A detailed WMP implementation scenario is presented in Attachment B, broken down by City or Port area and model subwatershed. The volume reductions are separated among right-of-way (ROW) BMPs and Low Impact Development (LID) on public parcels (in combination with nonstructural BMPs).

The Pollutant Reduction Plan is considered an "initial" scenario because over time, through adaptive management, the responsible agencies will likely "shift" among different types of BMPs (e.g., increase implementation of green streets and reduce implementation of regional BMPs) or substitute alterative BMPs altogether (e.g., implement dry wells instead of green streets). These shifts will be supported by analyses to show the substituted BMPs provide an equivalent volume reduction as the replaced BMPs.

8.1. Existing/Planned Distributed Control Measures

Existing and planned BMPs play an integral part in measuring the current reductions and need for future control measures. The existing and planned BMPs were integrated into the optimization model to measure their impact on the required reduction targets. When drainage area and size of the BMP were not explicitly known, they were assumed to be sized to capture the 85th percentile design storm volume. The total existing and planned BMP volumes are tabulated in Table 8-1 and Table 8-2. Modeling details for the existing and planned BMPs can be found in Attachment A. Detailed tables describing the existing distributed BMPs included in the model are found in Attachment D.

8.2. Future Control Measures for Attainment of Interim Milestones and the Dominguez and Harbors Toxics TMDL

The Pollutant Reduction Plan illustrates the sequential BMP implementation strategy to attain all interim milestones, including final targets for the Dominguez and Harbors Toxics TMDL. Section 8.3 provides a detailed discussion of the methodology and results of the additional Pollutant Reduction Plan to address the final milestone for the Beaches Bacteria TMDL, which builds upon the BMPs to meet the Dominguez and Harbors Toxics TMDL. The subwatershed subareas were individually prioritized and associated with milestones on the basis of cost-effectiveness for zinc removal. The optimization modeling results presented in Section 7 and Figure 8-1 through Figure 8-2 shown below identify the prioritization of subwatershed implementation based on the most effective combination of BMPs (results for the 10% milestone are not shown in maps since implementation is achieved with nonstructural BMPs). The implementation schedule outlined in the Pollutant Reduction Plan are based upon this prioritization.

The interim and final targets are presented in acre-feet per year that should be retained by structural BMPs. To properly capture the annual volume, BMPs are sized to the minimum volume needed to capture the target annual volume. Thus, the BMPs are presented as a volume (acre-feet) that has the ability to retain the required annual total volume to meet compliance.

Table 8-1 outlines the jurisdiction-wide BMP volume targets necessary to meet the annual volume interim and final limits established in Section 7. The incremental column shows the total additional BMP volume required for each milestone while the cumulative measures the total BMP volume required by each milestone to hit the final compliance targets. Table 8-2 outlines the pollutant reduction plan for the final limits (determination of BMP capacities to meet the Beaches Bacteria TMDL is presented in the following section). The BMP volumes are the sum of existing distributed BMPs, potential green street BMPs, LID on public parcels, and remaining BMP volume that must be implemented as regional (or other) projects as necessary to meet the annual volume reduction target.

The remaining BMP volume after accounting for existing distributed BMPs (see Section 8.1) is spread across right-of-way BMPs, LID on public parcels, and remaining BMP volume including potential regional projects. Priority was given to LID on public parcels, followed by right-of-way BMPs and finally other BMPs. Detailed discussion on how the BMPs in the right-of-way and LID on public parcels were determined is found in Attachment F. Detailed tables are provided in Attachment B for each subwatershed.

Table 8-1. Long Beach pollutant reduction plan for attainment of interim limits for the Dominguez and Harbors Toxics TMDL

RAA Assessment Zone	Milestone Year	COMPLIANCE TARGETS: Measurable & Enforceable BMP Goal		WMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT								
		Retention Volume (acre-ft/year)		Milestone	Existing/ Planned LID		Public LID		Green Streets		Regional BMPs	
		Incremental	Cumulative		Incremental (ac-ft)	Cumulative (ac-ft)	Incremental (ac-ft)	Cumulative (ac-ft)	Incremental (ac-ft)	Cumulative (ac-ft)	Incremental (ac-ft)	Cumulative (ac-ft)
Harbor Toxics TMDL	2019	1.0	1.0	10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2024	77.7	78.7	20%	6.6	6.6	5.6	5.6	0.0	0.0	0.0	0.0
	2032	1,649.0	1,728.7	100%	26.1	32.7	38.1	43.7	24.7	24.7	234.1	234.1
Dominguez Toxics TMDL	2019	0.1	0.1	10%	---	---	0.0	0.0	0.0	0.0	0.0	0.0
	2024	17.7	17.7	20%	---	---	2.1	2.1	0.0	0.0	0.0	0.0
	2032	66.9	84.7	100%	---	---	5.8	7.9	0.9	0.9	2.1	2.1

Table 8-2. Long Beach Pollutant Reduction Plan for Attainment of Final Limits for the Dominguez and Harbors Toxics TMDL and Beaches Bacteria TMDL

RAA Assessment Zone	COMPLIANCE TARGETS: Measurable & Enforceable BMP Goal		WMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT							
	For Toxicity by 2032	For Bacteria by 2037	For Harbors Toxics TMDL Attainment by 2032						For Beaches Bacteria TMDL Attainment by 2037	
				Low-Impact Development		Green Streets	Regional BMPs			
	Annual Wet-Weather Runoff to be Retained (acre-ft)	Additional 24-hour Volume to be Retained (ac-ft)	% Wet-Weather Zinc Load Reduction	Existing/ Planned (ac-ft)	Public LID (ac-ft)	Green Streets, All Components (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)
Dominguez Toxics TMDL	84.7	0.0	65%	---	7.9	0.9	2.1	**10.9**	---	**10.9**
Harbors Toxics TMDL	1,727.7	2.3	63%	32.7	43.7	24.7	234.1	**335.2**	2.3	**337.5**
Total	**1,812.4**	**2.3**	**---**	**32.7**	**51.6**	**25.6**	**236.2**	**346.1**	**2.3**	**348.4**

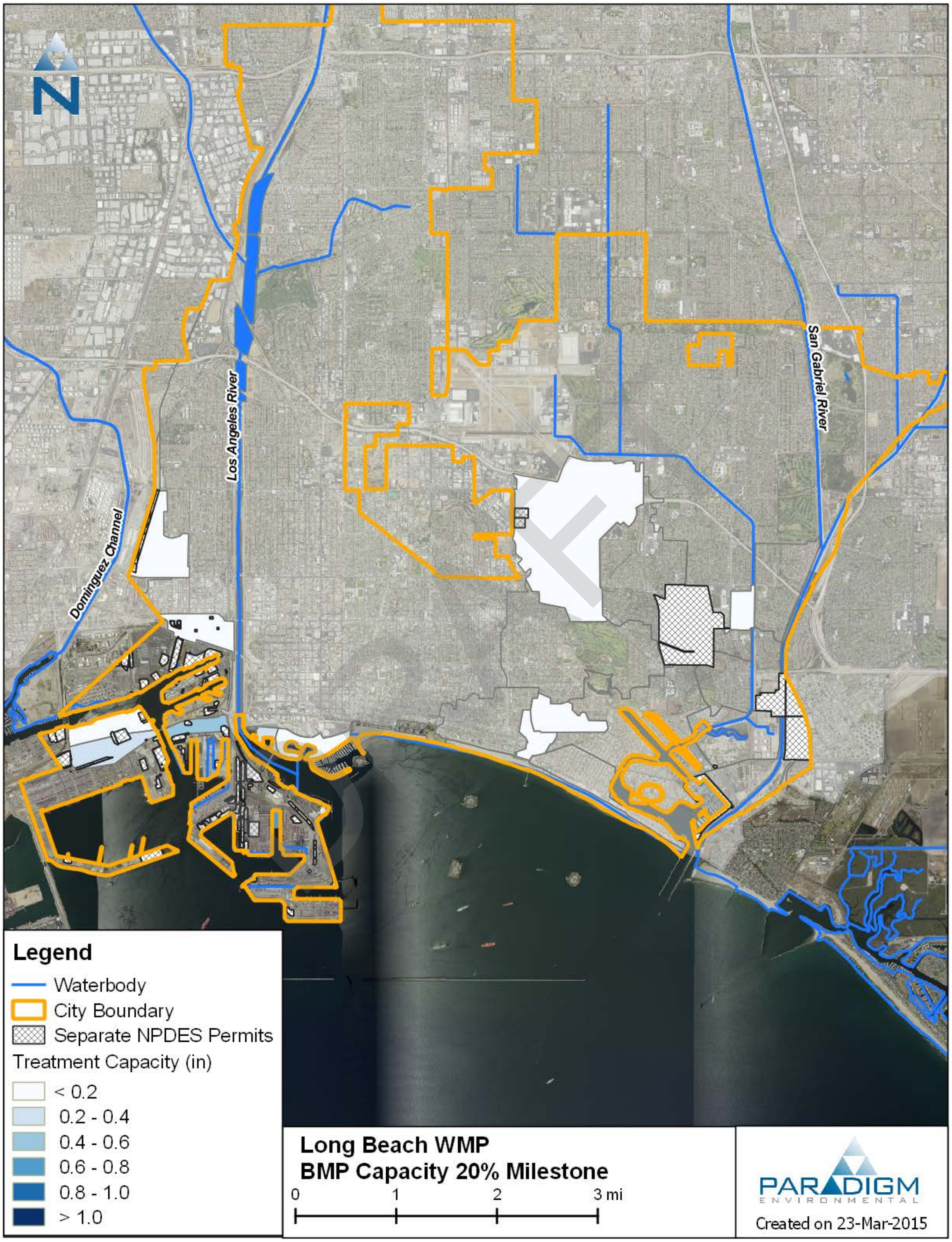


Figure 8-1. Long Beach implementation areas associated with 20% milestone

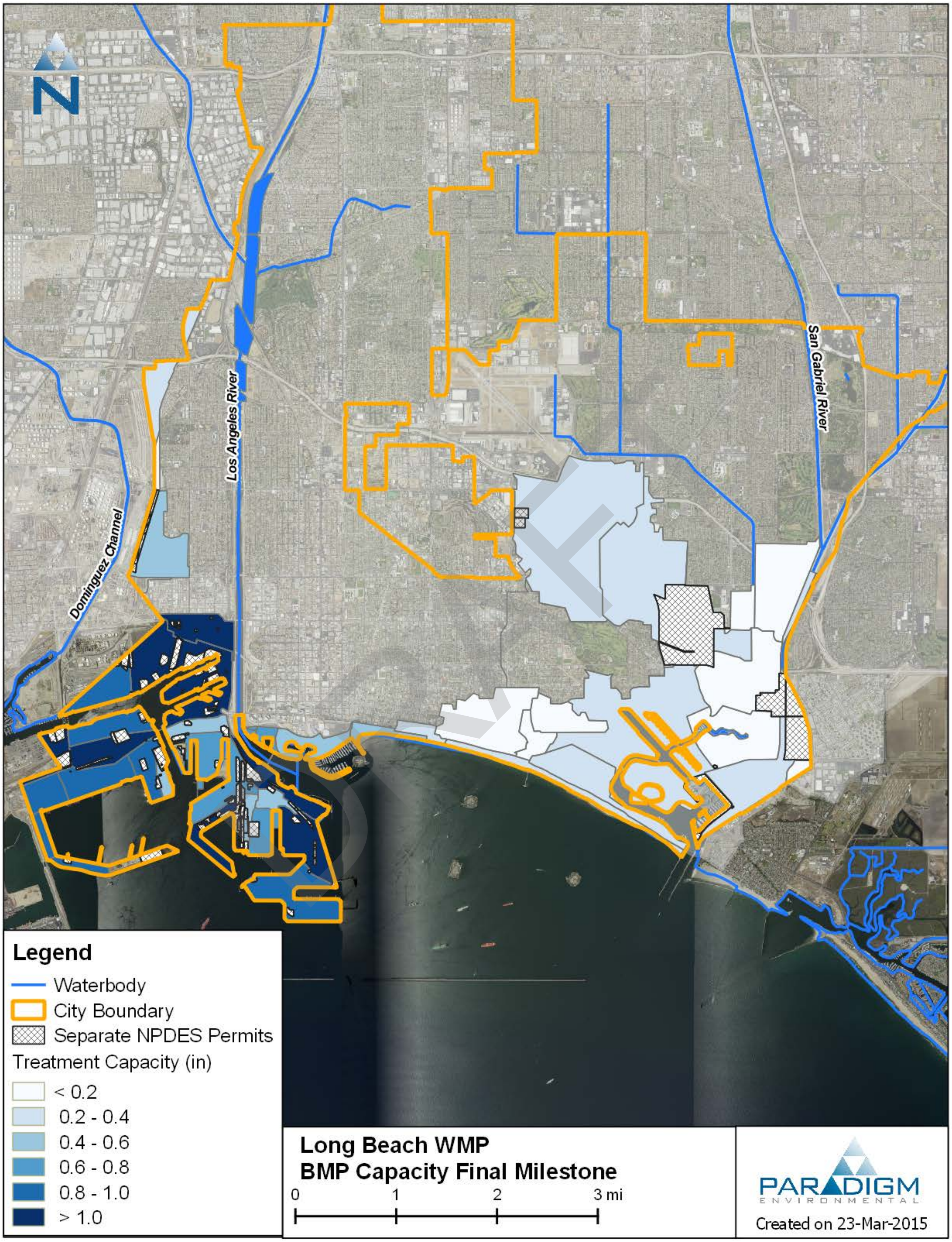


Figure 8-2. Long Beach implementation areas associated with the final milestone for the Dominguez and Harbors Toxics TMDL

8.3. Additional Control Measures for Attainment of the Final Milestone for the Beaches Bacteria TMDL

This section describes the modeling methodology for determining the additional BMP capacity required to address the final milestone for the Bacteria Beaches TMDL.

8.3.1. Wet Weather Pollutant Reduction Plan to meet final milestone for the Beaches Bacteria TMDL

In order to determine whether additional BMP capacity beyond the interim milestones is needed to address the Beaches Bacteria TMDL, the BMPs for final compliance with the Dominguez and Harbors TMDL Toxics TMDL were "locked down" and the storm associated with the bacteria critical condition ("critical bacteria storm") was routed through them. If stormwater was discharged from the BMPs, then additional BMP capacity was added to fully retain the critical bacteria storm. Full retention is required because stormwater BMPs are generally unable to achieve bacteria RWLs in BMP effluent. As such, full retention of the critical bacteria storm assures compliance with WQBELs for bacteria. This approach also addresses the challenges of accurately simulating bacteria *concentrations* in stormwater runoff – the RAA for bacteria is essentially based on hydrology rather than bacteria loading.

The critical bacteria storm is the 90th percentile wet day when bacteria RWLs apply. A total of 17 additional Exceedance Days are allowed by the Beaches Bacteria TMDL. To determine the critical bacteria storm for each subwatershed in Long Beach, each year in the decade of 2001 through 2011 was analyzed and the first day when RWLs apply was determined for each year (one 17^{th}-wettest day per year). Of those days, the critical bacteria storm is the 2nd wettest in the 10-year record (the 2nd highest value of 10 values is 90th percentile). It should be noted that rainfall associated with the critical bacteria storm tends to be less than the 85th percentile, 24-hour design storm, ranging between 0.30 inches and 0.35 inches with a median value of 0.31 inches.

Because a vast majority of public land opportunities for BMPs were assumed to be utilized for attainment of the Dominguez and Harbors Toxics TMDL, the additional BMP capacity (beyond the metals BMPs) for retention of the critical bacteria storm was assumed to be regional BMPs on *private* land. If *public* land opportunities are still available after final implementation of the Dominguez and Harbors Toxics TMDL, then the WMP can be updated in the future to incorporate distributed and regional BMPs on public land for addressing bacteria impairments.

The amount of effluent from the BMPs implemented for the Beaches Bacteria TMDL under the critical bacteria condition was simulated and used to determine the additional regional BMP capacity needed to address bacteria impairments. For some subwatersheds, no additional BMP capacity was required. The results are presented as follows:

- **Table 8-2** presents the total additional BMP capacity (beyond capacities needed to meet the Dominguez and Harbors Toxics TMDL) required to retain the critical bacteria storm (see far right columns). An additional 2.3 acre-feet of BMP capacity is needed within the Harbors Toxics TMDL RAA Assessment Zone.
- **Attachment B** presents the additional capacities for each subwatershed (see far right columns).
- **Figure 8-3** presents a spatial representation of the additional BMP capacity required to retain the critical bacteria storm in each subwatershed applicable to the Beaches Bacteria TMDL. BMP capacity was calculated based on the remaining runoff volume from the critical bacteria storm after treatment through the BMPs needed to meet the Dominguez and Harbors Toxics TMDL. For subwatersheds subject to the Beaches Bacteria TMDL, this additional runoff (as BMP effluent) ranged between 0.0 and 0.07 inches with a median value of 0.02 inches.

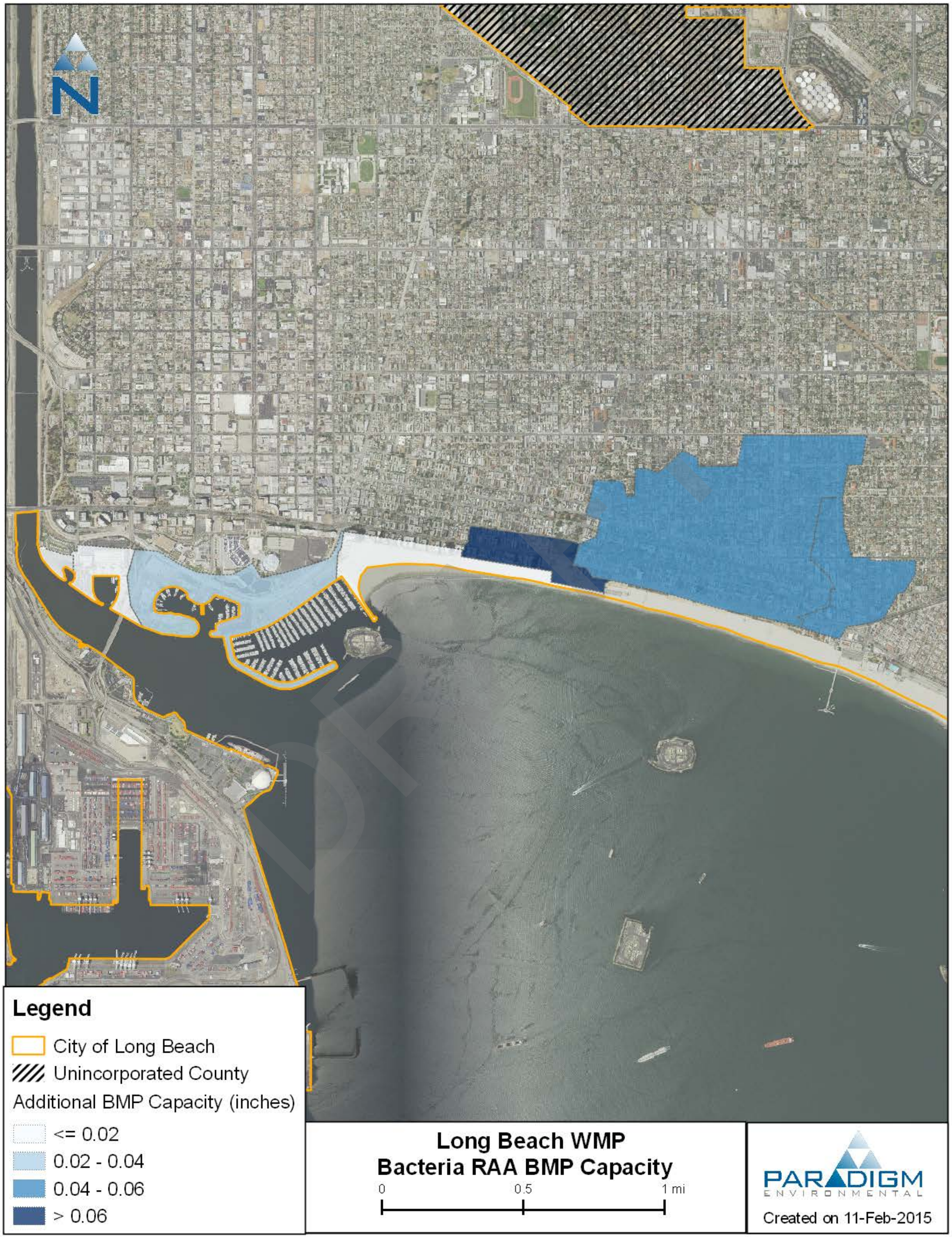


Figure 8-3. Additional regional BMP capacity to address the Beaches Bacteria TMDL

8.3.2. Dry Weather Pollutant Reduction Plan to meet final milestone for the Beaches Bacteria TMDL

Pollutant reductions for dry weather conditions apply to subwatersheds subject to the Beaches Bacteria TMDL, which can primarily be addressed through a complete elimination of dry weather flow volume. Dry weather runoff from MS4 areas is caused by a number of anthropogenic sources and is extremely difficult to reliably predict using a process-based representation. Several studies have shown positive correlation between dry weather runoff and both total drainage area and population (Ackerman 2005).

Outdoor water use was characterized through a literature review compiling typical per capita outdoor water use in southern California. The available estimates primarily considered residential land uses. A number of critical conditions were evaluated to understand the range of expected flow magnitude. A median (50th percentile) outdoor water use value of 68 gallons per person per day was selected as the critical dry weather flow condition. Population estimates were also calculated using United States Census Bureau 2010 population and housing unit counts by block (US Census Bureau 2010). The block-scale population density data were spatially intersected with the Long Beach subwatersheds, and the total estimated population was then tabulated for each modeled area.

The subwatershed level population estimates were multiplied by the median outdoor water use estimate to determine a daily dry weather runoff volume by subwatershed. This daily volume was then run through the BMPs required to meet the final milestone (based on the wet weather analysis presented in Section 8.3.1) for the critical dry weather period of August 21, 2008 through September 20, 2008 identified in Section 5.2.3 to determine the volume of dry weather runoff that remains after implementation of the wet-weather BMPs. Simulating this dry-weather runoff time series through the BMP model also allows subjected the volume to potential evapotranspiration processes.

This analysis resulted in complete retention of dry weather flow volumes by the bacteria BMPs presented in the previous section. A summary of the dry weather analysis is presented below in Table 8-3. Because the goal of the wet-weather bacteria analysis in the previous section was to fully retain runoff, the wet-weather bacteria BMPs have an effect of 100% capture of dry weather runoff in the Beaches Bacteria TMDL subwatersheds.

Table 8-3. Dry weather analysis results for Beaches Bacteria TMDL subwatersheds

U.S. Census 2010 Population (capita)	Median Outdoor Water Use (ac-ft/day)	Required Additional Reduction (ac-ft/day)	Percent Reduction
24,831	6.96	0.0	100%

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Attachment A: BMP Design Assumptions

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March 23, 2015

Contents

A1. BMP Design Assumptions

This appendix presents details on BMP design assumptions. These assumptions were generated using best available data to represent the opportunities and limitations in the RAA area.

The routing schematic used for BMP routing in the RAA model (SUSTAIN) is shown in **Figure A-1**. Note that hydrologic response units (HRU) are analogous with land uses for modeling purposes. The allocations and available BMP opportunities vary by jurisdictional watershed. Information on the identification of the BMP opportunities for Public LID and Green Streets can be found in Attachment F. Information on existing and planned BMPs can be found in Attachment D. Area and runoff from non-WMP and non-MS4 permittees – including non-traditional Phase 2 MS4 areas, parcels with industrial stormwater permits, and the extent of the Caltrans right-of-way – was not routed to BMPs and was excluded from compliance target calculations.

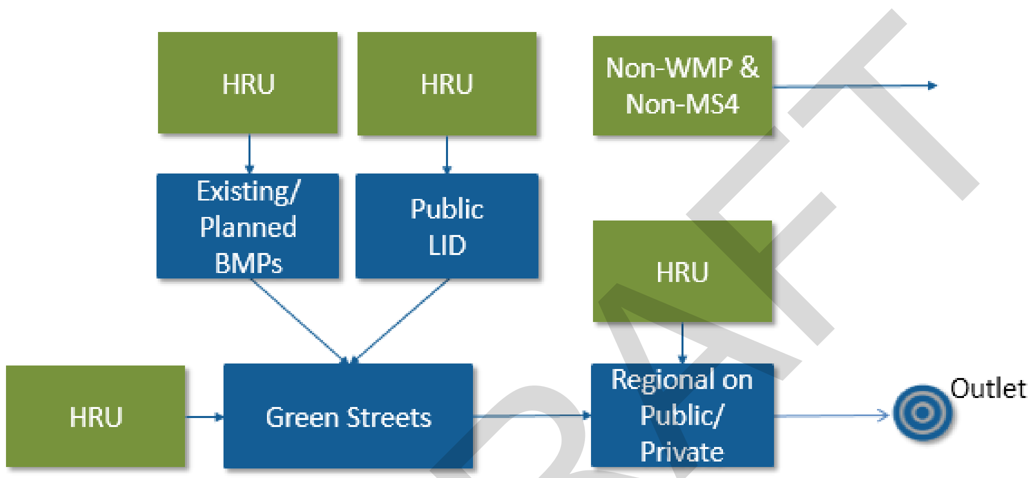

Figure A-1. Conceptual schematic illustrating BMP routing for the RAA

A1.1 Institutional BMPs

At this time, it was assumed institutional BMPs will reduce 10% of the target load, and this reduction was assumed implicitly – no modeling performed.

A1.2 Existing/Planned Distributed BMPs, LID on Public Parcels

Table A-1 provides the modeled sizing criteria for existing/planned distributed BMPs and LID on public parcels.

Table A-1. Existing/Planned Infiltration/Filtration BMP design criteria

Parameter		Value	Units
Surface	Design Drainage Area	*Sized to capture up to the 85th percentile volume*	
	BMP Footprint		
	Ponding Depth	9	*in.*
Soil	Depth	2	*ft.*
	Media Porosity	0.35	*n/a*
	Media Infiltration Rate	2	*in/hr*
Underdrain	Use underdrain if underlying soils are less than	0.3	*In/hr*
	Depth	1.5	*ft.*
	Media Porosity	0.4	*n/a*
	Subsoil Infiltration Rate	*Match underlying soils*	

A1.3 Green Streets

Green street design criteria and drainage areas are provided in **Table A-2** below, and permeable pavement is included to simulate "additional storage", which would be in the form of permeable pavements, suspended pavements, or other subsurface storage.

Table A-2. Green Street BMP design criteria

Parameter		Value	Units
Bioretention Assumptions			
Surface	Design Drainage Area	*Specified for each subwatershed, jurisdiction, and land use combination based on available opportunities*	
	BMP Footprint		
	Ponding Depth	7	*in.*
Soil	Depth	2	*ft.*
	Media Porosity	0.35	*n/a*
	Media Infiltration Rate	2	*in/hr*
Underdrain	Use underdrain if underlying soils are less than	0.3	*In/hr*
	Depth	1.5	*ft.*
	Media Porosity	0.4	*n/a*
	Subsoil infiltration Rate	*Match underlying soils*	
Permeable Pavement Assumptions			
Surface	Design Drainage Area	*Specified for each subwatershed, jurisdiction, and land use combination based on available opportunities*	
	BMP Footprint		
	Ponding Depth	0.12	*in.*
Aggregate	Depth	1	*ft.*
	Media Porosity	0.4	*n/a*
	Media Infiltration Rate	2	*in/hr*
Underdrain	Use underdrain if underlying soils are less than	0.3	*In/hr*
	Depth	1.5	*ft.*
	Media Porosity	0.4	*n/a*
	Subsoil Infiltration Rate	*Match underlying soils*	

A1.4 Remaining BMP Capacity (Potential Public/Private Regional)

Remaining untreated areas and effluent from upstream BMPs are assumed to drain to other BMP opportunities downstream including regional opportunities on both public and private land. This category acts as the remainder of runoff volume requiring treatment that has not been previously treated through the already presented measures.

For areas that drain to the Port, this remaining capacity category should not be defined as an infiltrating practice within the model. Infiltration is not feasible on the Port and a filtration system (underdrain) will be required to help meet the load reduction requirements.

Table A-3. Remaining BMP Capacity design criteria

Parameter		Value	Units
Infiltration Basin			
Surface	Design Drainage Area	*All areas not routed to upstream BMPs. Footprint is allowed to vary until compliance is met.*	
	BMP Footprint		
	Ponding Depth	36	*in.*
Diversion Type	*Assume 100% routed to facility*		
Bioretention Assumptions (Sand Filter Type Unit also possible)			
Surface	Design Drainage Area	*All Port areas not routed to upstream BMPs. Footprint is allowed to vary until compliance is met.*	
	BMP Footprint		
	Ponding Depth	7	*in.*
Soil	Depth	2	*ft.*
	Media Porosity	0.35	*n/a*
	Media Infiltration Rate	100	*in/hr*
Underdrain	Depth	1.5	*ft.*
	Media Porosity	0.4	*n/a*
	Subsoil Infiltration Rate	0.0	*in/hr*
	Pollutant Percent Removal	*Same as previous assumptions*	

Attachment B: Detailed Jurisdictional Compliance Tables

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Contents

B1. Long Beach WMP – Compliance Tables

B1.1. Dominguez Channel Toxics TMDL

Subwatershed ID	COMPLIANCE TARGETS: Measurable & Enforceable BMP Goal		WMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT							
	For Toxicity by 2032	For Bacteria by 2040	For Harbors Toxics TMDL Attainment by 2032						For Beaches Bacteria TMDL Attainment by 2040	
				Low-Impact Development		Green Streets	Regional BMPs			
	Annual Wet-Weather Runoff to be Retained (ac-ft)	Additional 24-hour Volume to be Retained (ac-ft)	% Wet-Weather Zinc Load Reduction	Existing/ Planned (ac-ft)	Public LID (ac-ft)	Green Streets, All Components (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)
200148	0.0	0.0	10%	---	---	0.00	0.00	**0.0**	---	**0.0**
200248	47.6	0.0	59%	---	6.39	0.44	0.00	**6.8**	---	**6.8**
200348	0.6	0.0	82%	---	0.27	0.00	0.00	**0.3**	---	**0.3**
200448	36.3	0.0	87%	---	1.26	0.43	2.12	**3.8**	---	**3.8**
200648	0.1	0.0	46%	---	0.01	0.00	0.00	**0.0**	---	**0.0**
Total	**84.7**	**0.0**	**65%**	**---**	**7.9**	**0.9**	**2.1**	**10.9**	**---**	**10.9**

B1.2. Harbor Toxicity TMDL

Subwatershed ID	COMPLIANCE TARGETS: Measurable & Enforceable BMP Goal		WMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT							
	For Toxicity by 2032	For Bacteria by 2040	For Harbors Toxics TMDL Attainment by 2032						For Beaches Bacteria TMDL Attainment by 2040	
				Low-Impact Development		Green Streets	Regional BMPs			
	Annual Wet-Weather Runoff to be Retained (ac-ft)	Additional 24-hour Volume to be Retained (ac-ft)	% Wet-Weather Zinc Load Reduction	Existing/ Planned (ac-ft)	Public LID (ac-ft)	Green Streets, All Components (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)
500148	61.89	0.00	84%	---	5.18	0.00	2.74	7.9	0.00	7.9
500248	0.03	0.00	10%	---	0.02	0.00	0.00	0.0	0.00	0.0
549548	188.30	0.00	79%	---	7.20	2.09	8.84	18.1	0.00	18.1
549748	29.84	0.00	53%	---	0.07	2.22	0.00	2.3	0.00	2.3
549848	54.93	0.00	78%	---	---	0.00	3.50	3.5	0.00	3.5
549948	73.75	0.00	75%	---	0.39	0.15	5.12	5.7	0.00	5.7
550048	7.56	0.00	18%	---	1.37	0.00	0.00	1.4	0.00	1.4
550148	181.56	0.00	80%	---	2.91	0.63	10.98	14.5	0.00	14.5
550248	245.29	0.00	52%	---	10.03	11.58	0.00	21.6	0.00	21.6
550348	1.13	0.00	14%	---	0.13	0.00	0.00	0.1	0.00	0.1
553248	71.41	0.00	42%	---	0.82	4.79	0.00	5.6	0.00	5.6
553348	14.84	1.36	39%	---	0.05	1.02	0.00	1.1	1.36	2.4
553448	76.66	0.34	75%	---	1.54	0.00	4.44	6.0	0.34	6.3
800148	67.19	0.00	79%	---	---	0.08	4.10	4.2	0.00	4.2
800248	1.65	0.00	57%	---	3.92	0.03	0.00	3.9	0.00	3.9
800348	4.37	0.00	26%	---	0.93	0.22	0.00	1.2	0.00	1.2
800448	2.81	0.26	42%	---	2.12	0.12	0.00	2.2	0.26	2.5
800548	27.49	0.05	66%	---	4.93	0.06	0.00	5.0	0.05	5.0
800648	12.52	0.29	91%	---	1.60	0.05	0.00	1.7	0.29	1.9
800748	1.04	0.01	95%	---	0.14	0.00	0.00	0.1	0.01	0.2
800848	0.56	0.00	63%	---	0.33	0.00	0.00	0.3	0.00	0.3
211699	30.95	0.00	69%	0.38	---	1.67	8.51	10.6	0.00	10.6
800999	57.69	0.00	58%	---	---	0.00	19.65	19.7	0.00	19.7
801099	52.24	0.00	68%	2.05	---	0.00	16.15	18.2	0.00	18.2
801199	5.15	0.00	56%	1.93	---	0.00	0.00	1.9	0.00	1.9
801299	12.20	0.00	81%	4.58	---	0.00	0.00	4.6	0.00	4.6

Subwatershed ID	COMPLIANCE TARGETS: Measurable & Enforceable BMP Goal		WMP IMPLEMENTATION PLAN: APPROACH TO ACHIEVE COMPLIANCE TARGETS, SUBJECT TO ADAPTIVE MANAGEMENT							
	For Toxicity by 2032	For Bacteria by 2040	For Harbors Toxics TMDL Attainment by 2032						For Beaches Bacteria TMDL Attainment by 2040	
				Low-Impact Development		Green Streets	Regional BMPs			
	Annual Wet-Weather Runoff to be Retained (ac-ft)	Additional 24-hour Volume to be Retained (ac-ft)	% Wet-Weather Zinc Load Reduction	Existing/ Planned (ac-ft)	Public LID (ac-ft)	Green Streets, All Components (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)	Regional BMPs (ac-ft)	Total BMP Capacity (ac-ft)
801399	2.24	0.00	81%	0.76	---	0.00	0.00	0.8	0.00	0.8
801499	3.45	0.00	55%	1.26	---	0.00	0.00	1.3	0.00	1.3
801599	22.66	0.00	62%	0.03	---	0.00	7.73	7.8	0.00	7.8
801699	40.87	0.00	84%	---	---	0.00	14.37	14.4	0.00	14.4
801799	37.64	0.00	80%	15.08	---	0.00	0.00	15.1	0.00	15.1
801899	0.00	0.00	10%	---	---	0.00	0.00	0.0	0.00	0.0
801999	0.00	0.00	10%	---	---	0.00	0.00	0.0	0.00	0.0
802099	7.55	0.00	57%	2.75	---	0.00	0.00	2.8	0.00	2.8
802199	98.99	0.00	59%	0.04	---	0.00	33.73	33.8	0.00	33.8
802299	30.49	0.00	56%	---	0.04	0.00	10.33	10.4	0.00	10.4
802399	0.02	0.00	10%	---	---	0.00	0.00	0.0	0.00	0.0
802499	8.83	0.00	60%	---	---	0.00	3.02	3.0	0.00	3.0
802599	9.42	0.00	57%	---	0.00	0.00	3.19	3.2	0.00	3.2
802699	24.96	0.00	57%	---	---	0.00	8.52	8.5	0.00	8.5
802799	13.07	0.00	67%	---	---	0.00	4.49	4.5	0.00	4.5
802899	37.59	0.00	57%	---	---	0.00	12.82	12.8	0.00	12.8
802999	21.77	0.00	58%	---	---	0.00	7.42	7.4	0.00	7.4
803099	3.07	0.00	56%	1.12	---	0.00	0.00	1.1	0.00	1.1
803199	34.33	0.00	66%	2.56	---	0.00	9.45	12.0	0.00	12.0
803299	32.24	0.00	59%	0.11	---	0.00	10.89	11.0	0.00	11.0
803399	15.45	0.00	59%	---	---	0.00	24.08	24.1	0.00	24.1
Total	**1,727.7**	**2.3**	**63%**	**32.7**	**43.7**	**24.7**	**234.1**	**335.2**	**2.3**	**337.5**

Attachment C: Supporting Figures for Watershed Control Measures

Submitted to:

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March 23, 2015

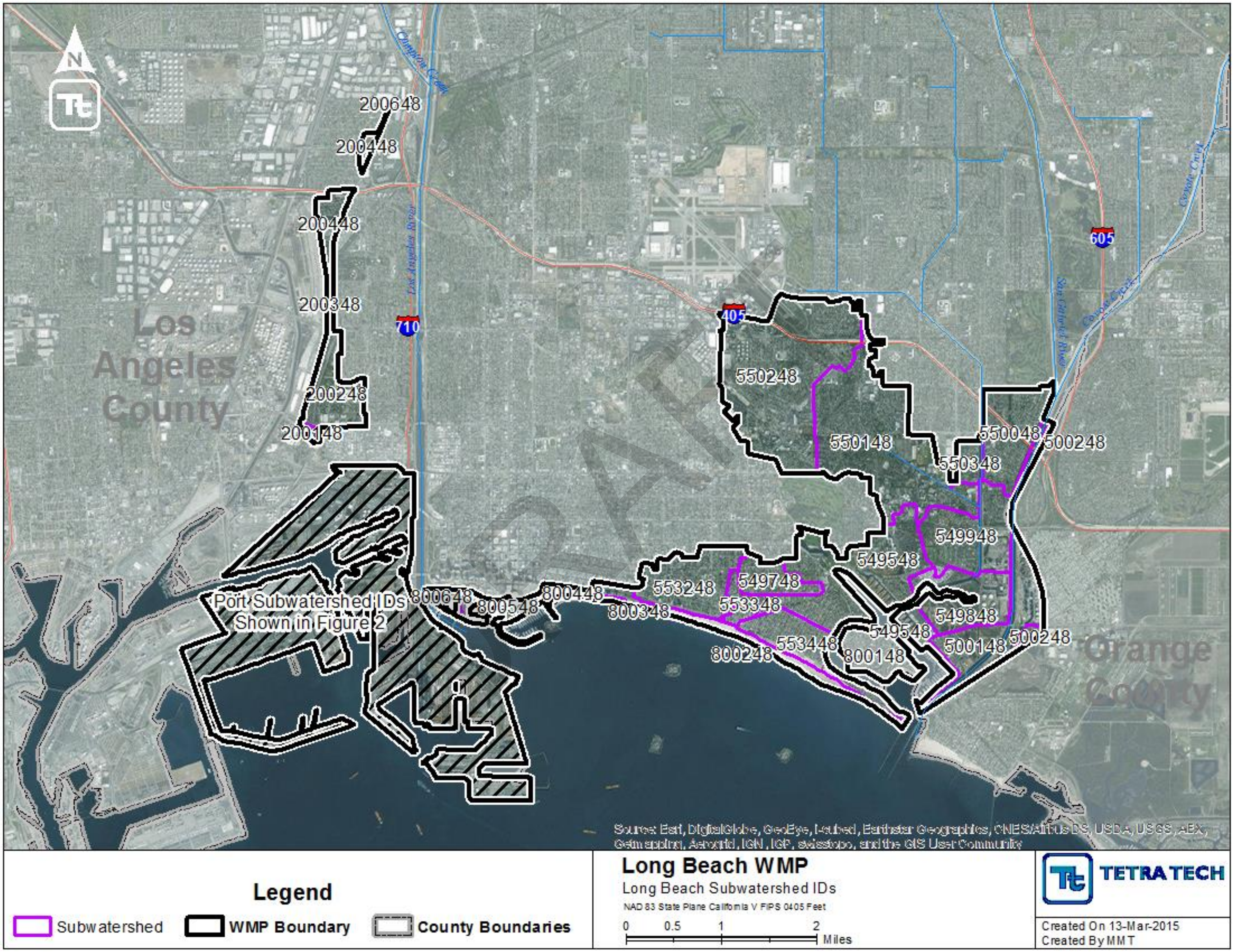

Figure 1. Long Beach WMP Subwatershed IDs

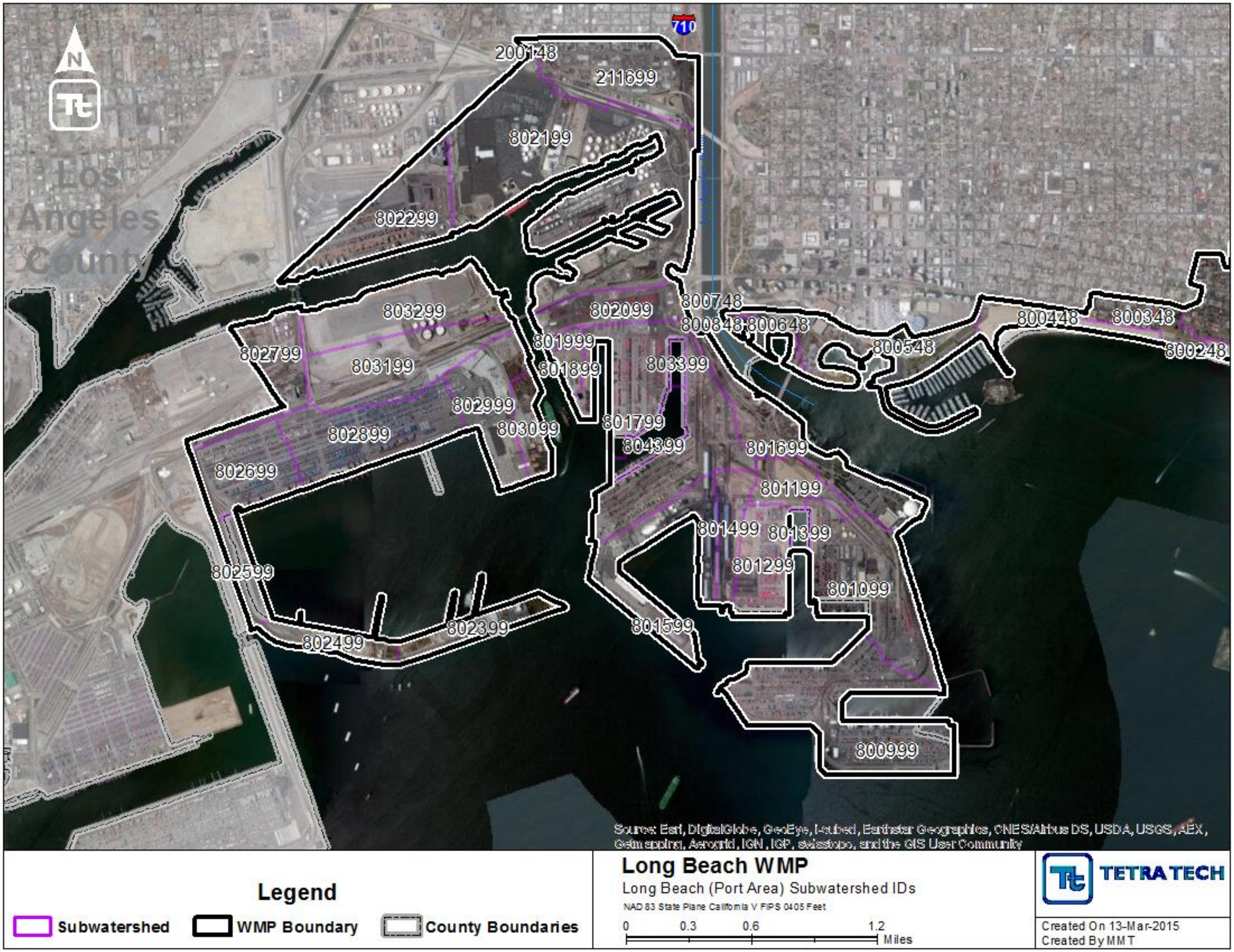

Figure 2. Long Beach WMP (Port Area) Subwatershed IDs

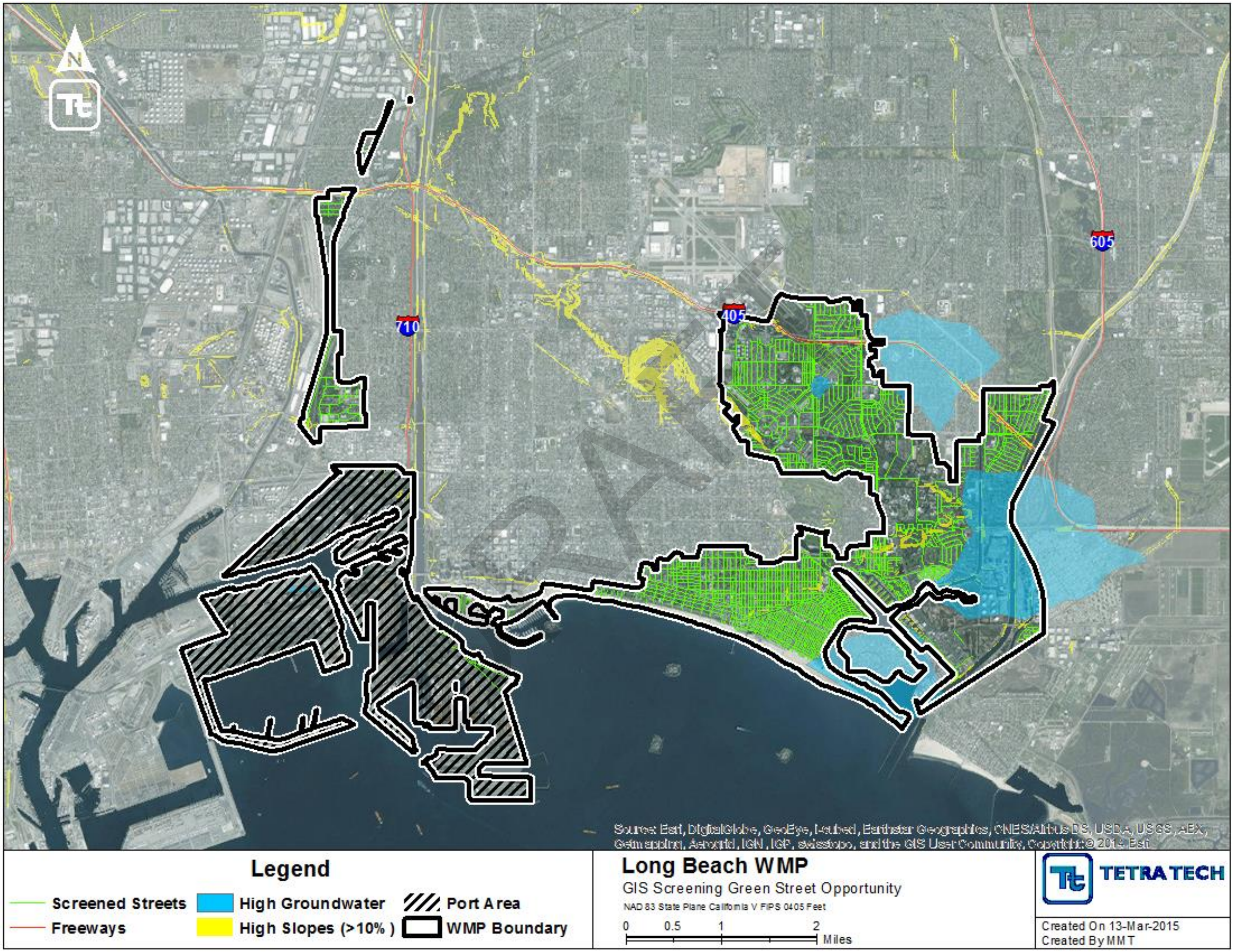

Figure 3. Long Beach WMP ROW BMP Potential Opportunities (Green Streets)

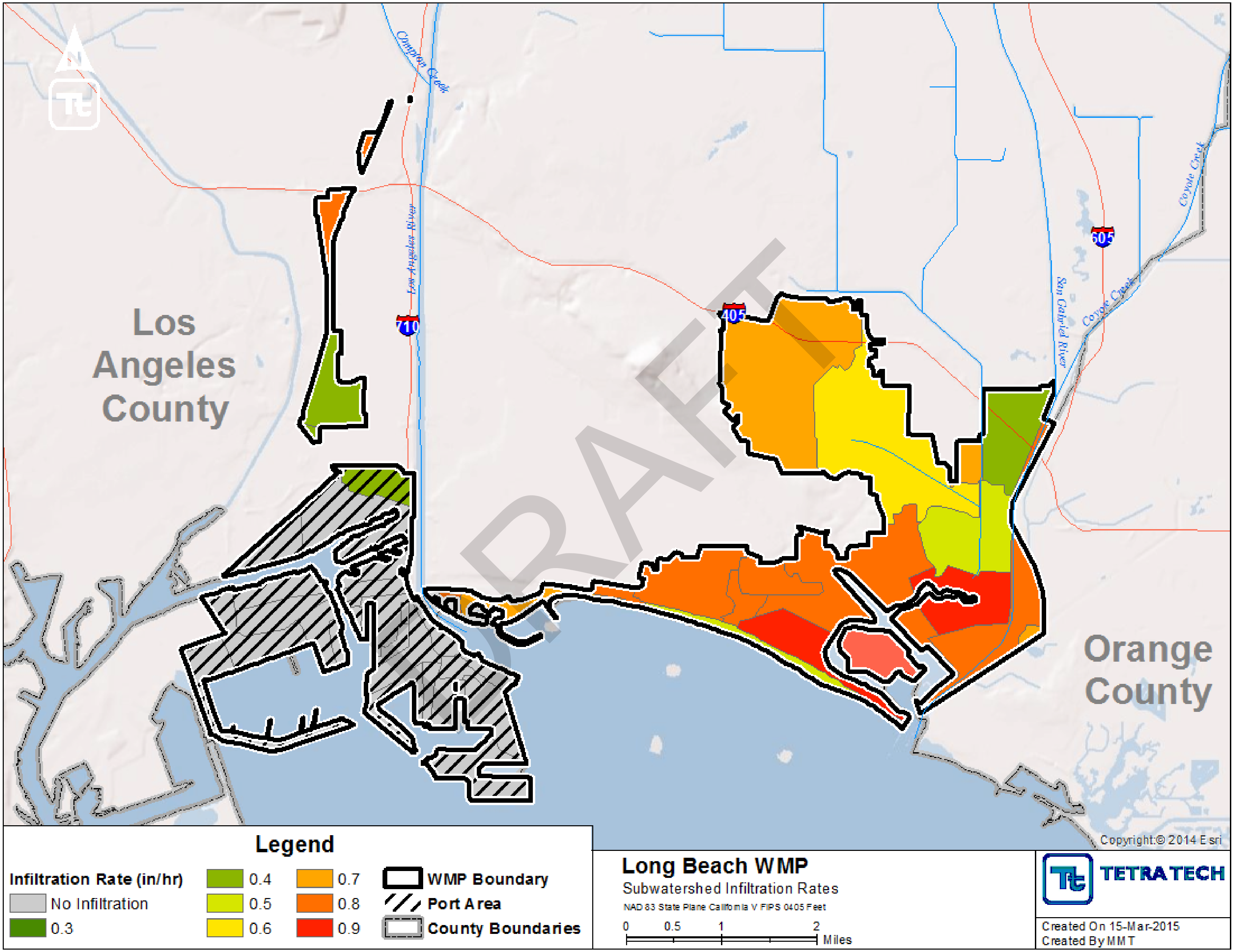

Figure 4. Long Beach WMP Subwatershed Infiltration Rates

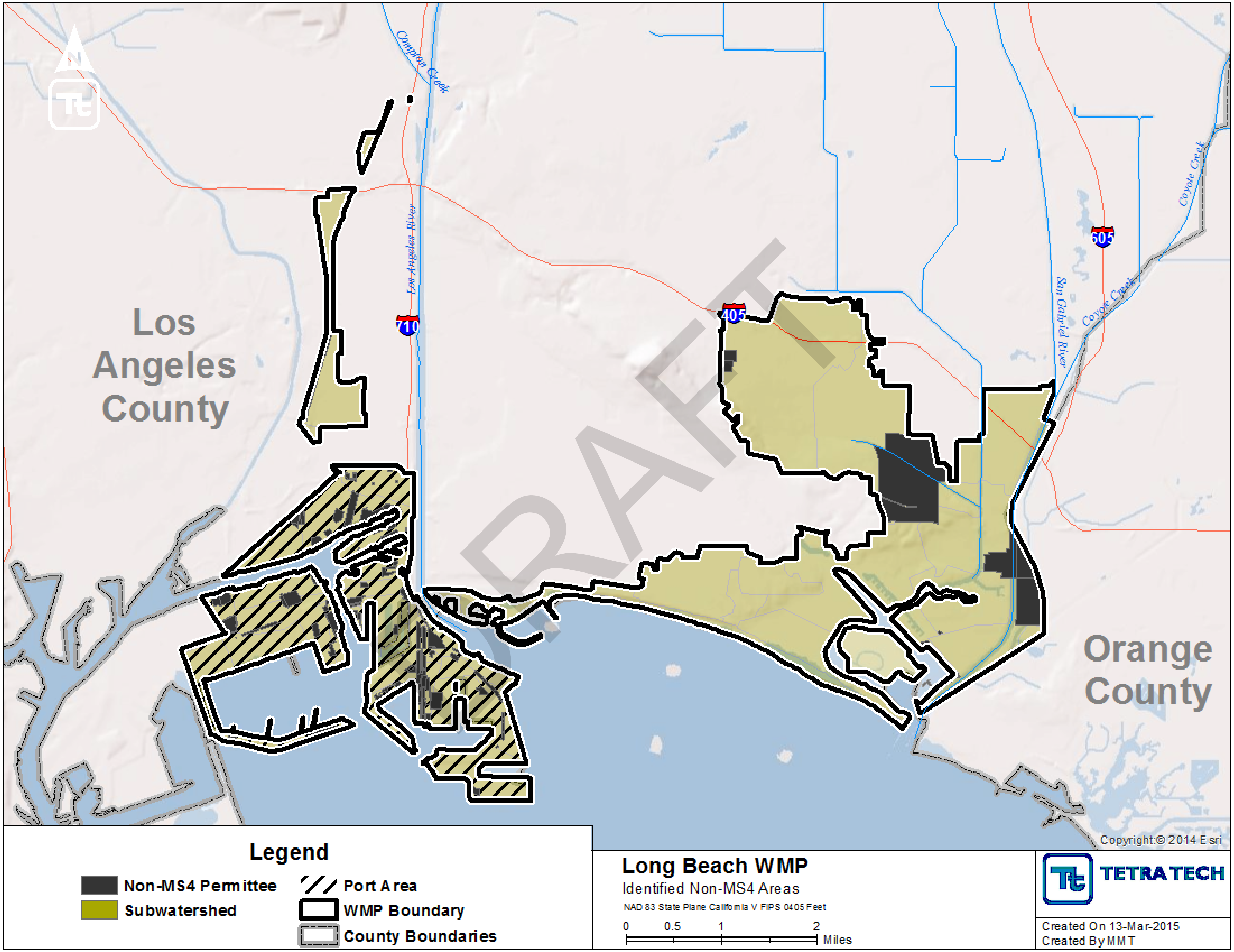

Figure 5. Long Beach WMP Non-MS4 Permittees

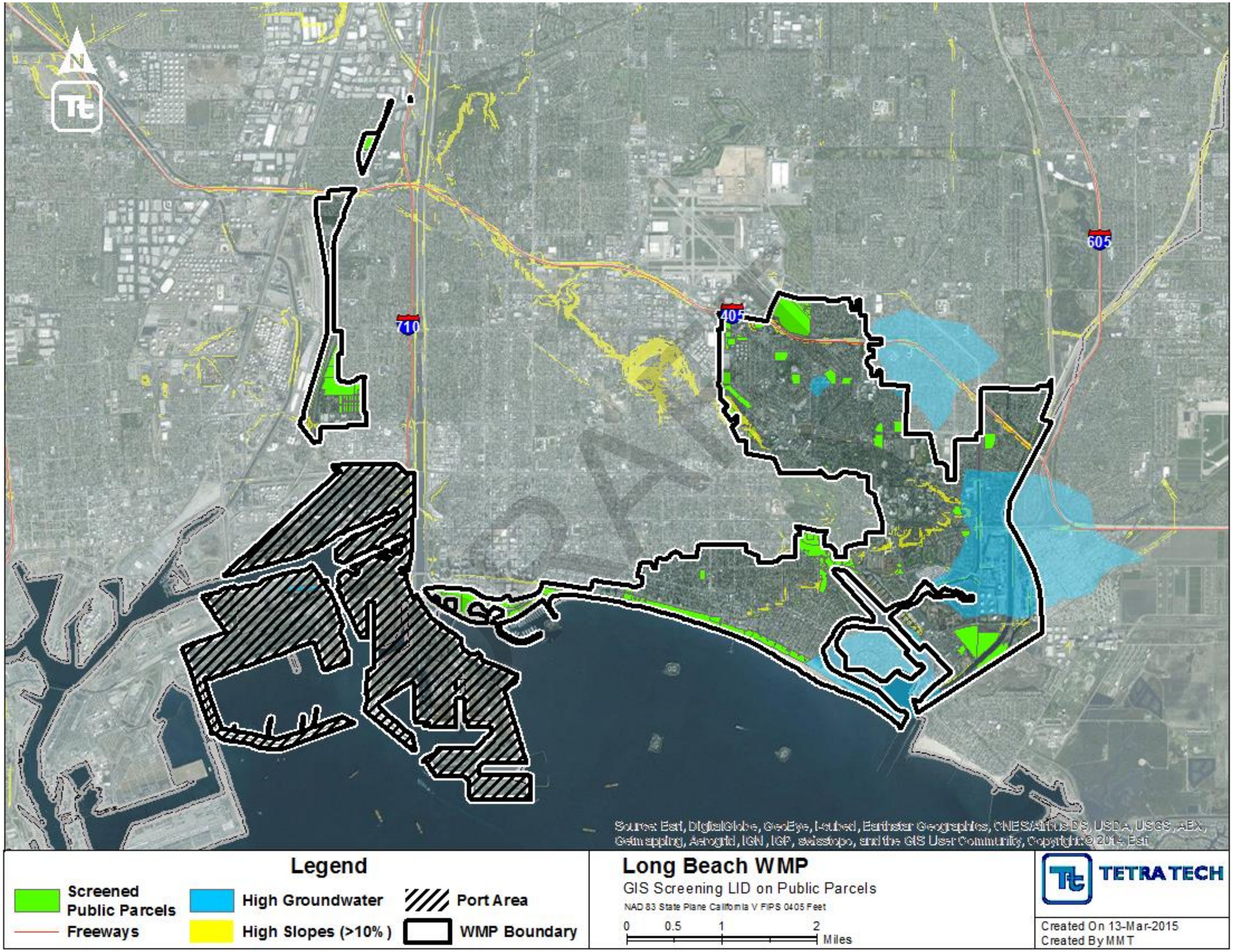

Figure 6. Long Beach WMP identified public parcels

Attachment D: Existing and Planned BMPs

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Contents

D1. Existing and Planned BMPs

The following tables summarize existing and planned BMPs in each jurisdiction.

D1.1. City of Long Beach

Type of BMP	Existing or Planned	BMP Name	Year Constructed or Planned	Location (Lat/long, or cross streets)	Latitude	Longitude	Sub-watershed	Contributing Area	Unit	Total Capture Volume or Flow Rate	Unit
Flow-Through Treatment BMP	Existing	Automatic Retractable Screens	2013	118 total - Most public curb inlets in Harbor district							
Bioretention/ Biofiltration	Existing	Anaheim Green Street	2014	Anaheim Street, between 9th street and Fashion Ave.	33.782741	-118.214382	211699				
Bioretention/ Biofiltration	Existing	Anaheim Street - Biofiltration	2014	EB, east side of 9th Street	33.782607	-118.219204	211699	0.13	ac		
Bioretention/ Biofiltration	Existing	Anaheim Street - Biofiltration	2014	WB side west of Canal Street	33.782879	-118.214038	211699	1	ac		
Bioretention/ Biofiltration	Existing	Anaheim Street - Biofiltration	2014	WB site east of Canal Street	33.782875	-118.213588	211699	1.3	ac		
Bioretention/ Biofiltration	Existing	Anaheim Street - Bioswale	2014	Between Santa Fe and Caspian	33.782727	-118.213808	211699	3.59	ac		
Flow-Through Treatment BMP	Existing	CDS Unit	2010	Weyerhaeuser	33.756476	-118.220522	802899	17	ac	4.5	cfs
Flow-Through Treatment BMP	Existing	Catch Basin Filter Insert	2010	Weyerhaeuser				0.84	ac	1.51	cfs
Flow-Through Treatment BMP	Existing	Catch Basin Filter Insert	2010	Weyerhaeuser				0.54	ac	1.06	cfs
Flow-Through Treatment BMP	Existing	Catch Basin Filter Insert	2010	Weyerhaeuser				0.69	ac	1.24	cfs
Flow-Through Treatment BMP	Existing	Catch Basin Filter Insert	2010	Weyerhaeuser				1.57	ac	2.64	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2012	POLB Maintenance Yard	33.753649	-118.200435	801099	7.3	ac	1.2	cfs
Bioretention/ Biofiltration	Existing	Bioswale	2012	POLB Maintenance Yard	33.752795	-118.197623	801099	1.45	ac	0.45	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2009	Pier S	33.760281	-118.236570	802999	22.00	ac		
Flow-Through Treatment BMP	Existing	CDS Unit	2009	Pier S	33.760747	-118.232253	802999	22.00	ac		
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.752212	-118.203721	801299	20.25	ac	4.5	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.745977	-118.201307	801199	20.25	ac	4.5	cfs

Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.748667	-118.201519	801199	20.25	ac	4.5	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.748449	-118.194597	800999	4.95	ac	1.1	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.746680	-118.191510	800999	4.95	ac	1.1	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.745760	-118.193837	800999	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.744563	-118.190751	800999	3.15	ac	0.7	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.750100	-118.200426	801199	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.747524	-118.200009	801199	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.747520	-118.202613	801199	3.15	ac	0.7	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.744830	-118.202264	801199	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.752334	-118.199678	801099	20.25	ac	4.5	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.750581	-118.197732	801399	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.750599	-118.198440	801399	5.40	ac	1.2	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.750123	-118.198119	801399	4.50	ac	1	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.749894	-118.197662	801399	7.20	ac	1.6	cfs
Flow-Through Treatment BMP	Existing	CDS Unit	2011	Pier G/ITS	33.749931	-118.198439	801399	5.40	ac	1.2	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.764126	-118.210992	801899	43.7	ac	9.6	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2017	Middle Harbor	33.761704	-118.210369	801599	69.1	ac	15.6	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2017	Middle Harbor	33.762369	-118.212016	801599	64.3	ac	14.51	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.760575	-118.211989	801599	1.5	ac	0.34	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2017	Middle Harbor	33.760292	-118.210297	801599	4.9	ac	1.07	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.759688	-118.206229	801599	15.5	ac	3.39	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.757552	-118.205401	801599	13.6	ac	2.97	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.755496	-118.205164	801599	15.9	ac	3.47	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.754976	-118.207630	801599	15.3	ac	3.45	cfs
Flow-Through Treatment BMP	Planned	CDS Unit	2015	Middle Harbor	33.753545	-118.207695	801599	15.6	ac	3.41	cfs
Flow-Through	Planned	CDS Unit	2017	Middle Harbor	33.754057	-118.209410	801599	9.9	ac	2.23	cfs

Treatment BMP											
Flow-Through Treatment BMP	Planned	CDS Unit	2017	Middle Harbor	33.752798	-118.209064	801599	15.7	ac	3.54	cfs

Attachment E: Supporting Calibration Data for RAA

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March 23, 2015

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Tables

Figures

1. Hydrology Calibration

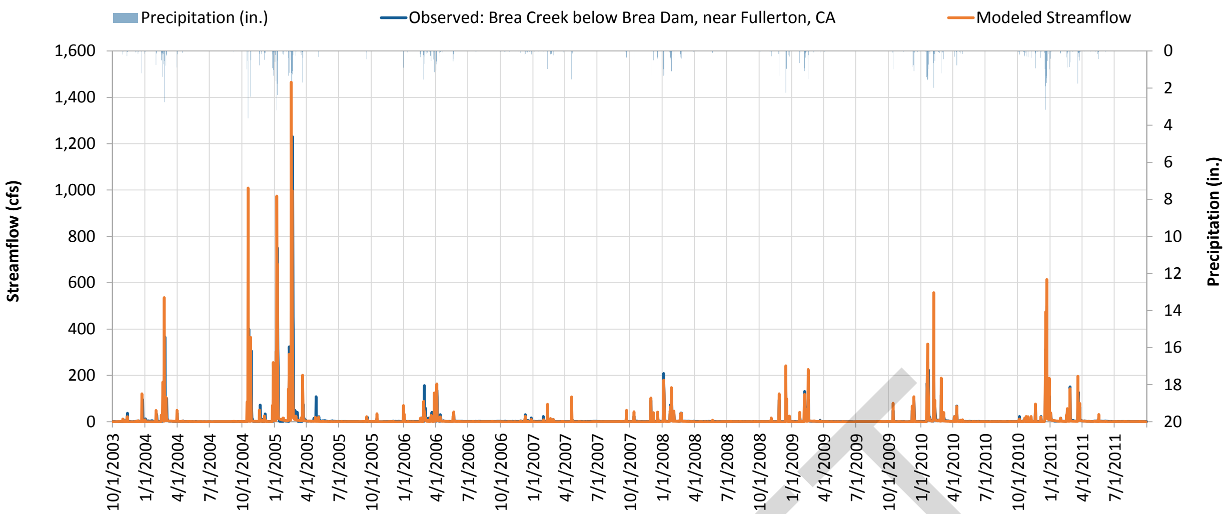

Figure E-1. Daily flow at Brea Creek below Brea Dam, near Fullerton, CA (Station ID: 11088500).

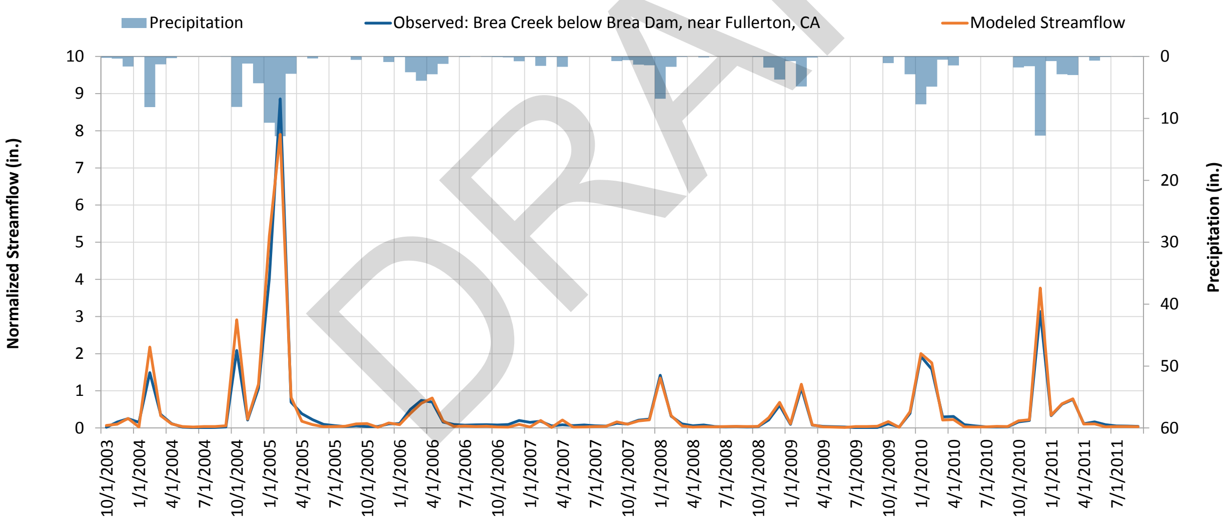

Figure E-2. Monthly flow at Brea Creek below Brea Dam, near Fullerton, CA (Station ID: 11088500).

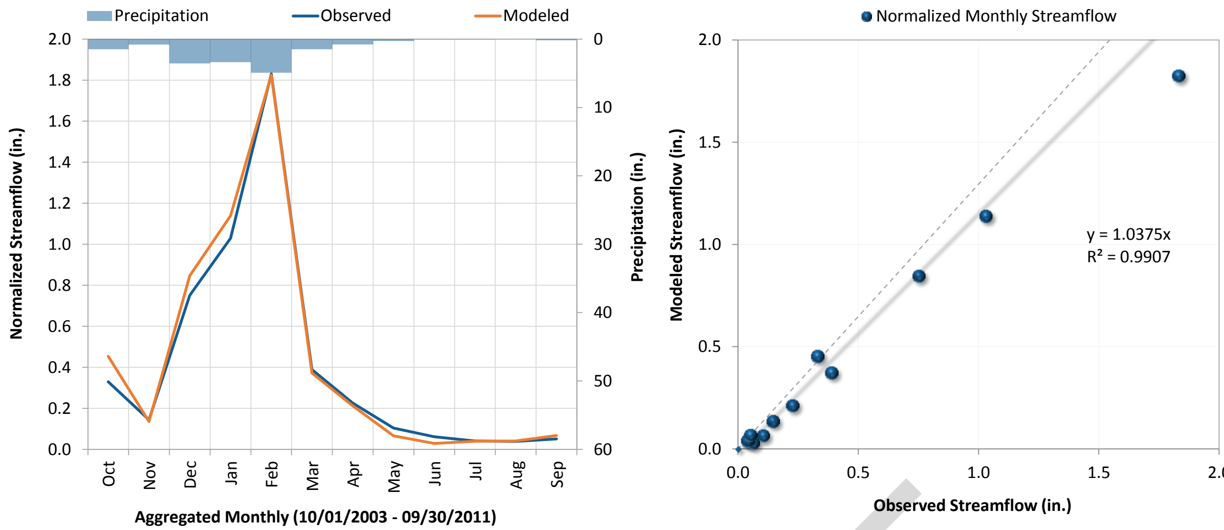

Figure E-3. Average monthly flow at Brea Creek below Brea Dam, near Fullerton, CA (Station ID: 11088500).

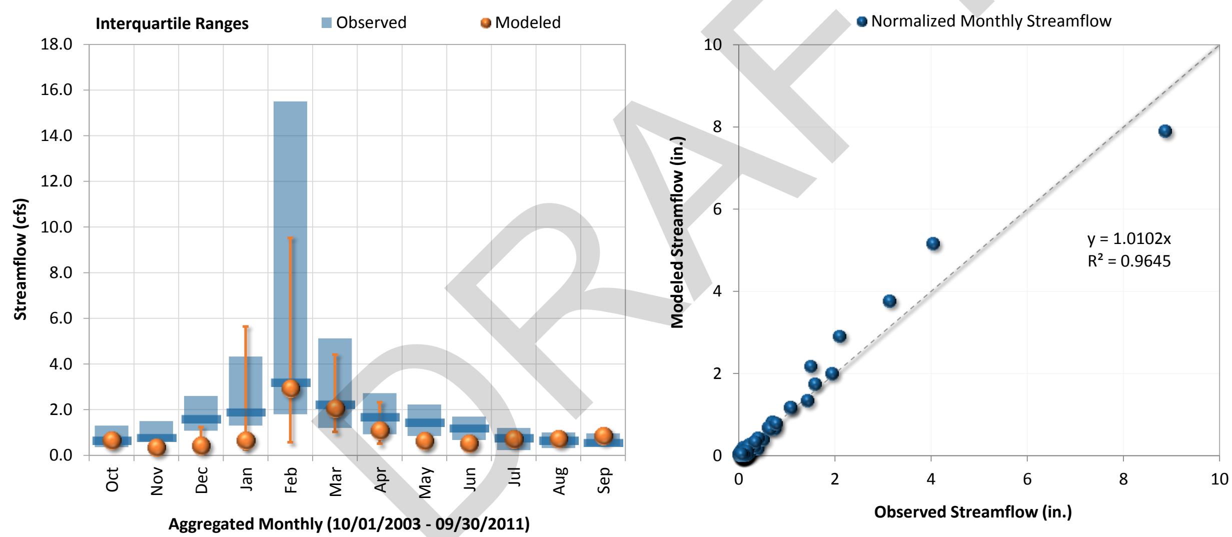

Figure E-4. Monthly flow interquartiles at Brea Creek below Brea Dam, near Fullerton, CA (Station ID: 11088500).

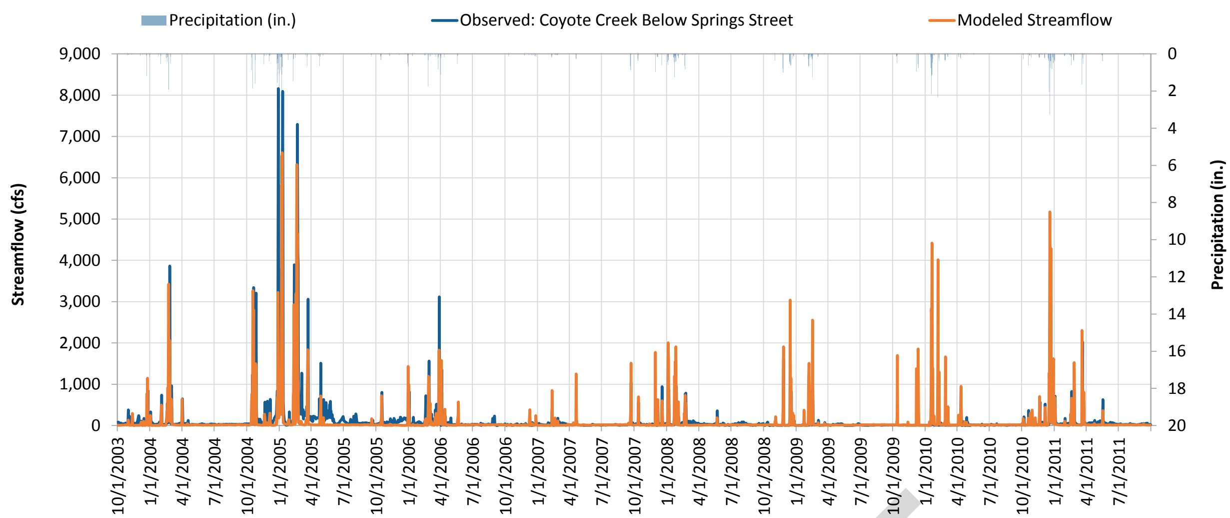

Figure E-5. Daily flow at Coyote Creek Below Springs Street (Station ID: F354).

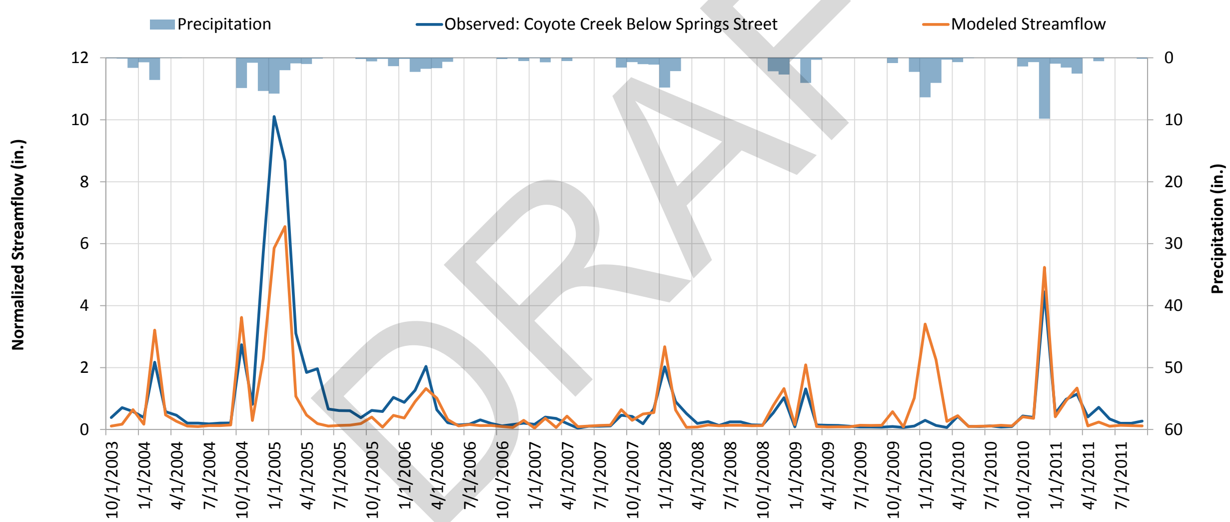

Figure E-6. Monthly flow at Coyote Creek Below Springs Street (Station ID: F354).

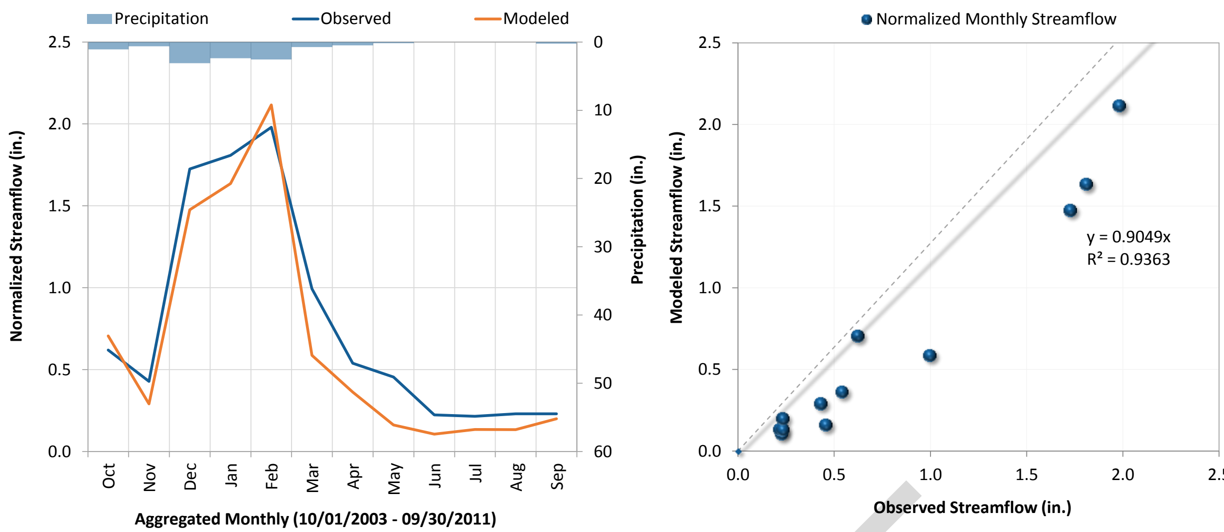

Figure E-7. Average monthly flow at Coyote Creek Below Springs Street (Station ID: F354).

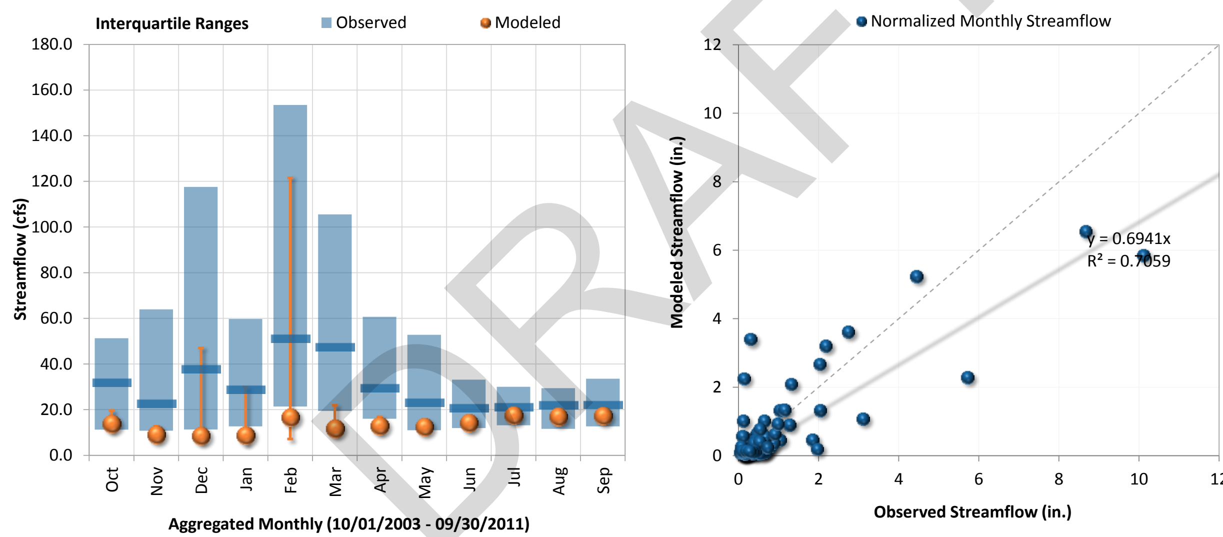

Figure E-8. Monthly flow interquartiles at Coyote Creek Below Springs Street (Station ID: F354).

2. Water Quality Calibration

Table E-1. Summary of water quality data evaluated for Coyote Creek below Spring Street (S13)

Constituent	Minimum	Q1	Median	Q3	Maximum
TSS (mg/L)	1.0	48.0	97.0	230.5	1556.0
Total Copper (ug/l)	0.5	11.8	28.1	48.3	351.0
Total Lead (ug/l)	0.2	1.1	10.2	19.2	147.0
Total Zinc (ug/l)	1.0	62.0	135.0	241.5	2010.0

Table E- 2. Summary of water quality data evaluated for Belmont Pump Station

Constituent	Minimum	Q1	Median	Q3	Maximum
TSS (mg/L)	12.0	55.0	90.0	160.0	650.0
Total Copper (ug/l)	17.0	32.3	47.0	80.3	280.0
Total Lead (ug/l)	8.3	15.3	27.5	44.8	150.0
Total Zinc (ug/l)	76.0	162.5	225.0	402.5	920.0

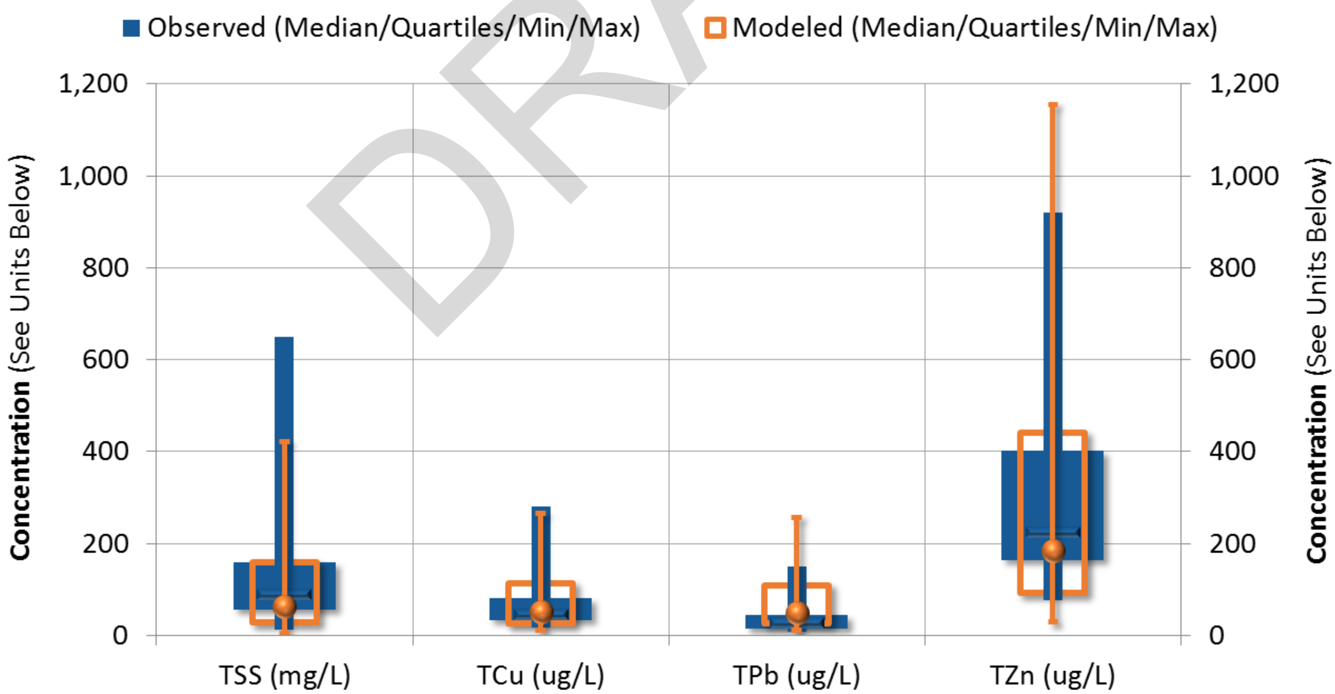

Figure E-9. Modeled vs. observed event mean concnetrations at Belmont Pump Station (10/1/2002 through 9/30/2011).

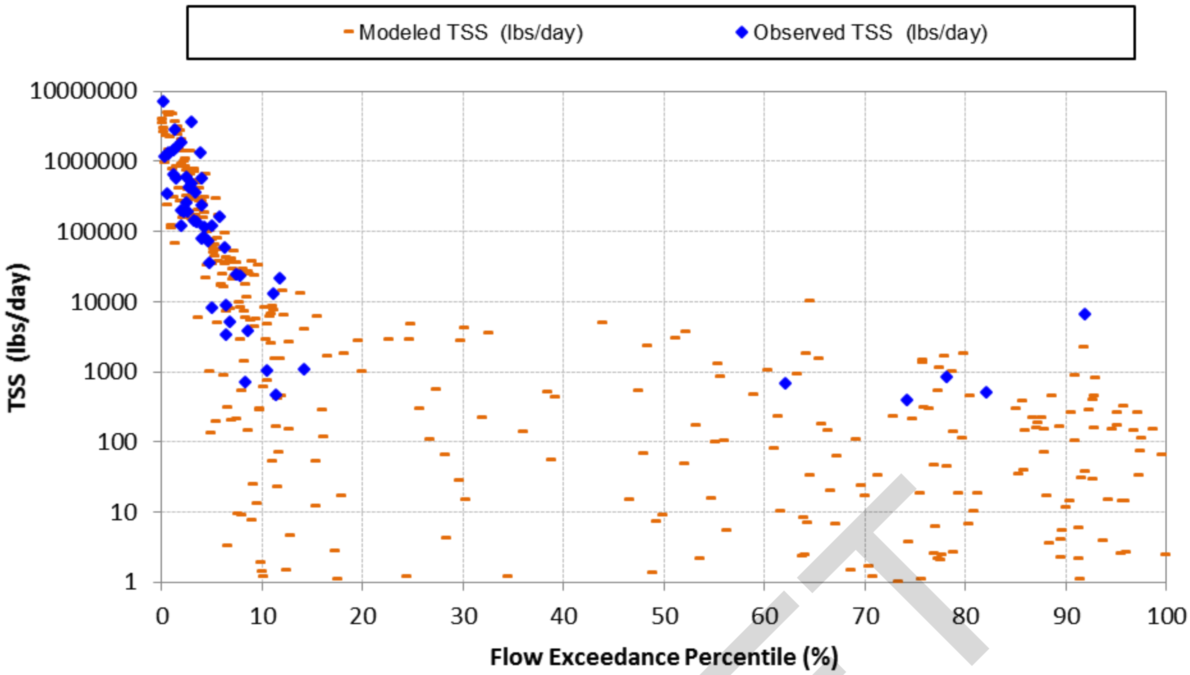

Figure E-10. Simulated vs. observed load duration plots for Total Sediment (10/1/2006 through 9/30/2011) at Coyote Creek below Spring Street (S13).

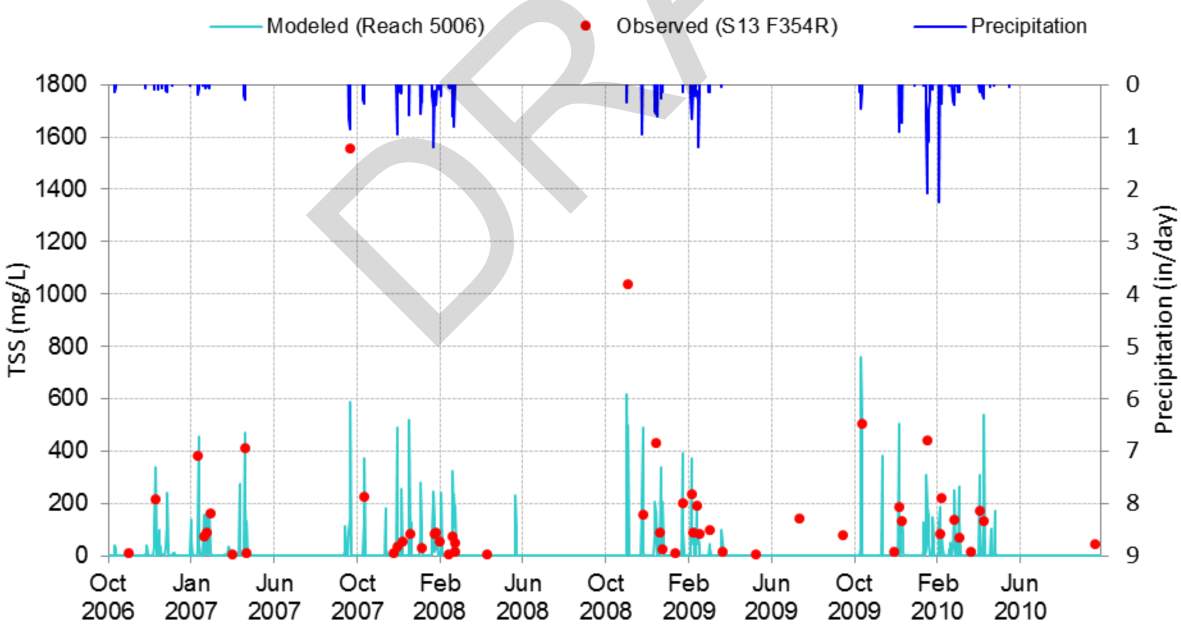

Figure E-11. Simulated vs. observed timeseries plots for Total Sediment (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

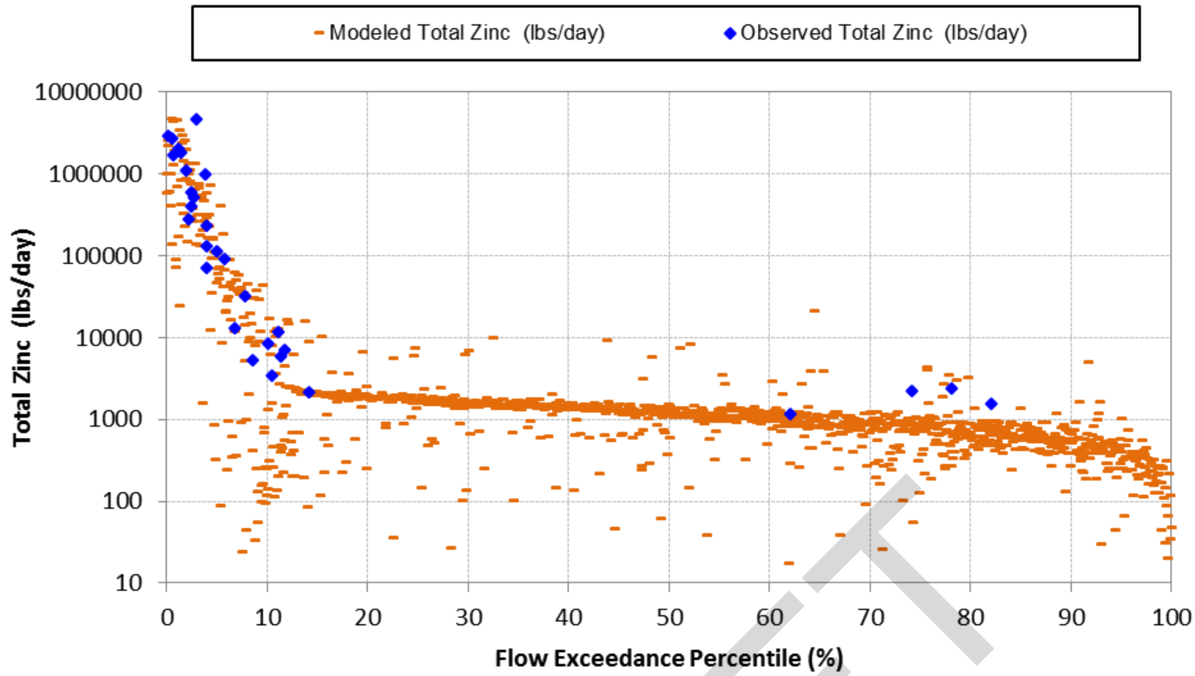

Figure E-12. Simulated vs. observed load duration plots for Total Zinc (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

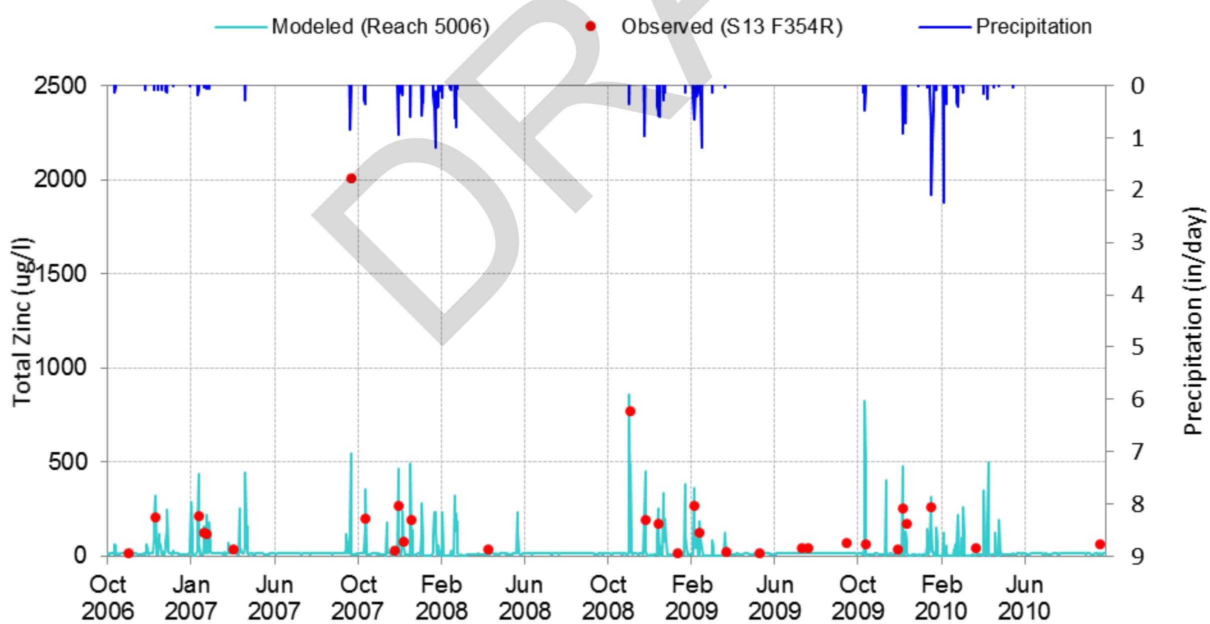

Figure E-13. Simulated vs. observed timeseries plots for Total Zinc (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

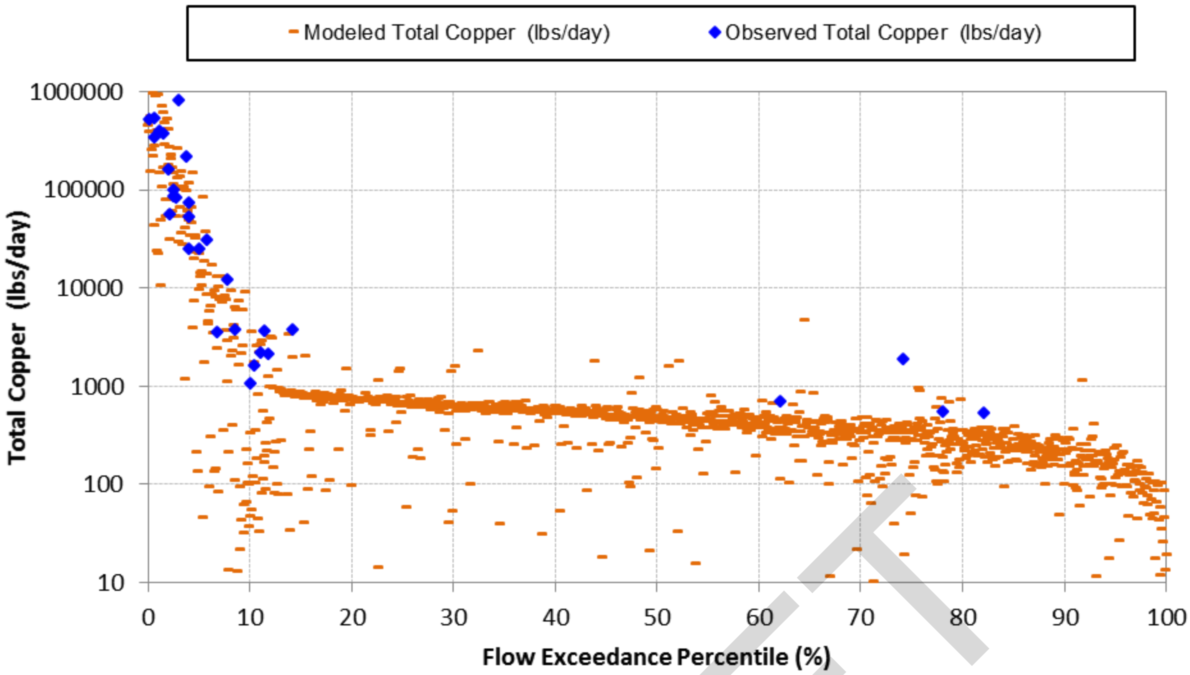

Figure E-14. Simulated vs. observed load duration plots for Total Copper (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

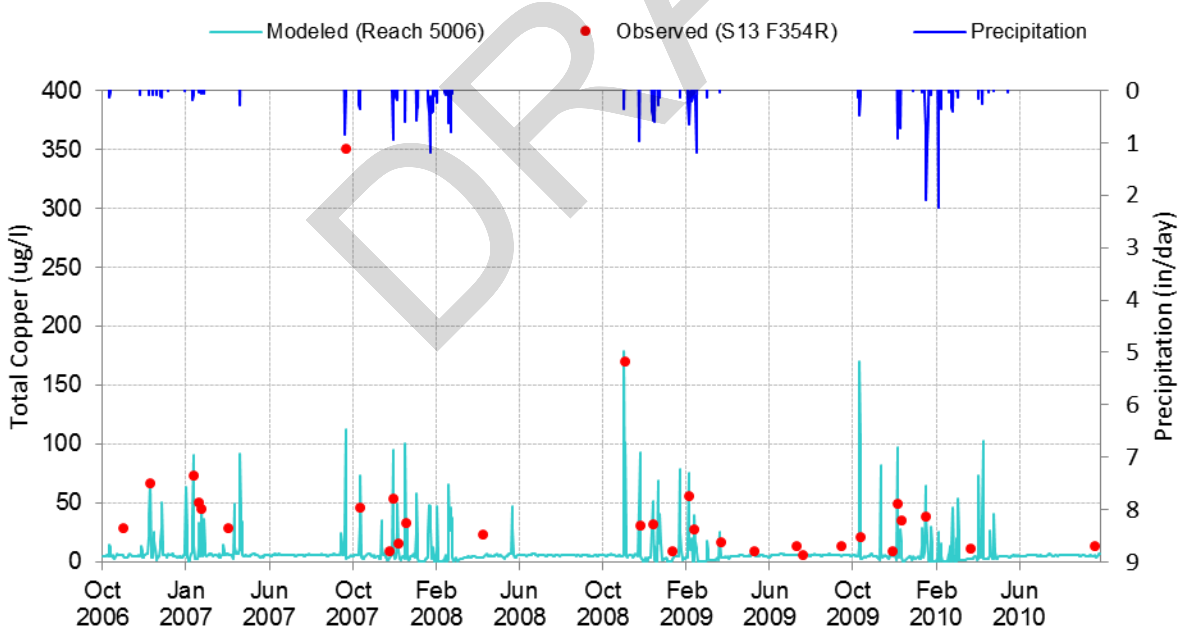

Figure E-15. Simulated vs. observed timeseries plots for Total Copper (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

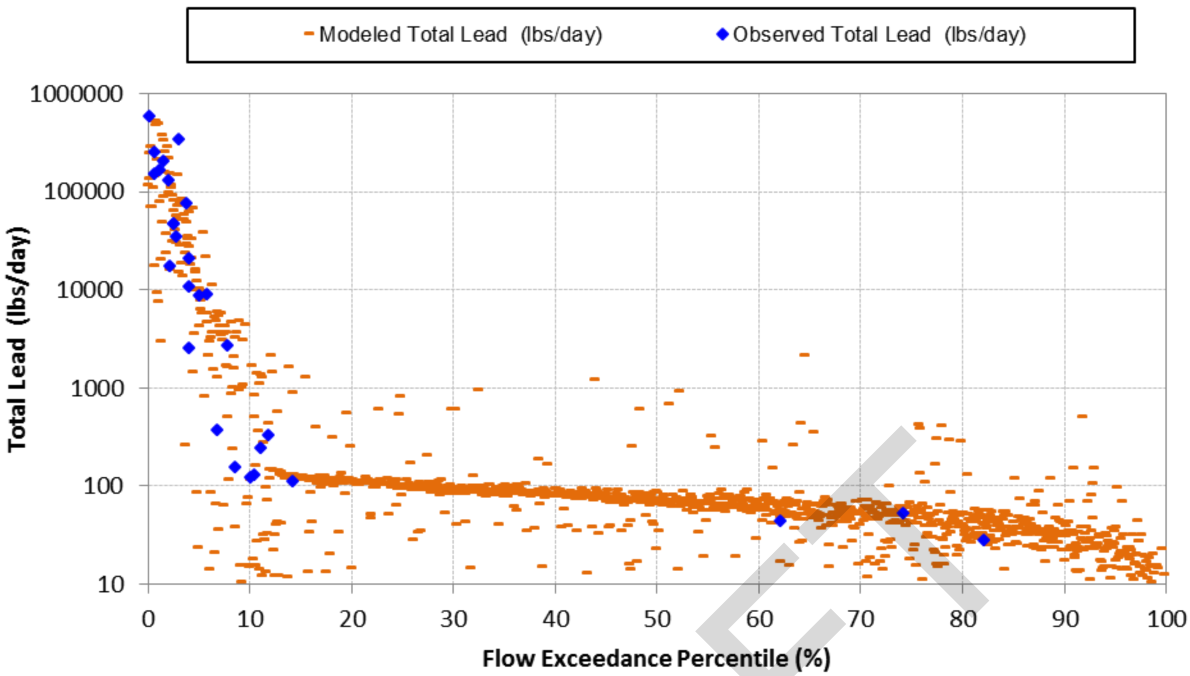

Figure E-16 Simulated vs. observed load duration plots for Total Lead (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

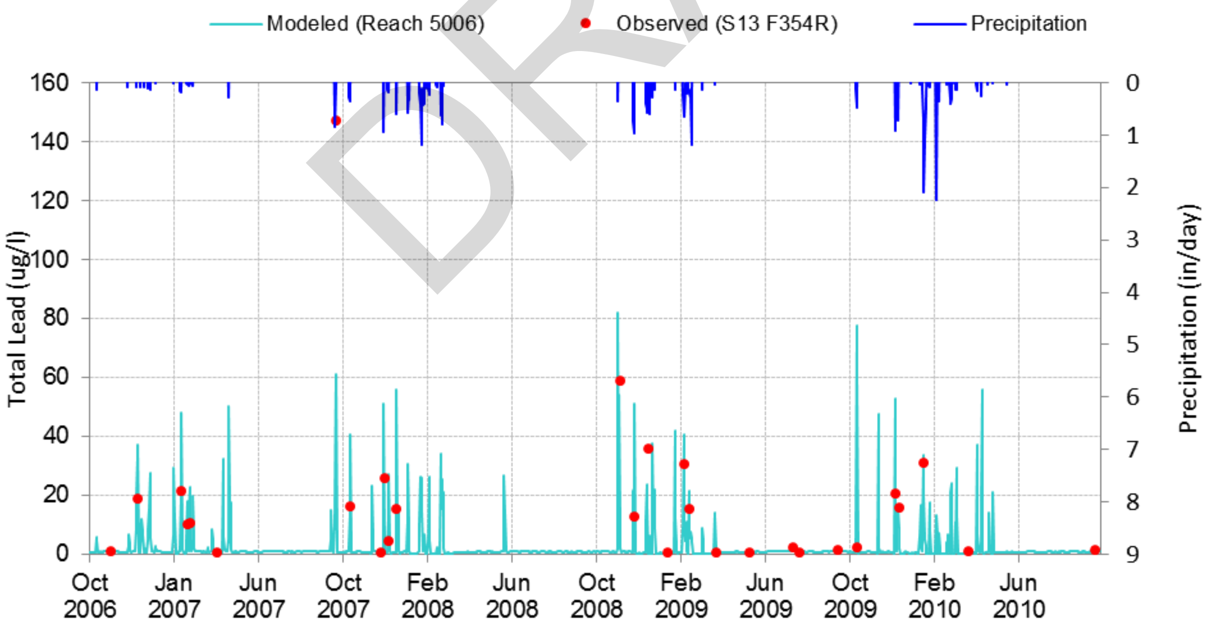

Figure E-17. Simulated vs. observed timeseries plots for Total Lead (10/1/2006 through 9/30/2010) at Coyote Creek below Spring Street (S13).

Attachment F: Green Street Technical Memorandum

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March 23, 2015

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Draft Technical Memorandum

To:	**John Hunter, JLHA**	**Date:**	**19 Dec 2014**
From:	**Merrill Taylor, Tetra Tech Inc.**	**Subject:**	**Green Street Screening Results**
cc:	**[others]**	**Project:**	**Long Beach WMP**

A key consideration for Watershed Management Program (WMP) implementation is the potential BMP capacity that could be provided on publically owned land. In order to highlight the potential structural BMP implementation approaches to meet the volume targets, a BMP opportunity analysis was conducted. Two broad categories of BMPs – right-of-way (ROW) BMPs and low impact development (LID) on public parcels – will be used to describe the networks of BMPs needed to meet the target reductions.

This memo introduces the key components of the public BMP network and describes how ROWs and public parcels were evaluated for opportunities to locate BMPs. The drainage areas that can potentially be treated by public BMPs will be determined once the subwatershed delineation task is completed.

Stormwater BMPs in the ROW are treatment systems arranged linearly within the street ROW and are designed to reduce runoff volumes and improve runoff water quality from the roadway and adjacent parcels. Implementing BMPs in the ROW provides an opportunity to meet water quality goals and avoid the cost of land acquisition by locating BMPs in areas owned or controlled by a municipality. Implementing BMPs in the ROW allows for direct control of construction, maintenance, and monitoring activities by the responsible jurisdiction. Bioretention and permeable pavement are typically best suited for implementation in the ROW (Figure 1).

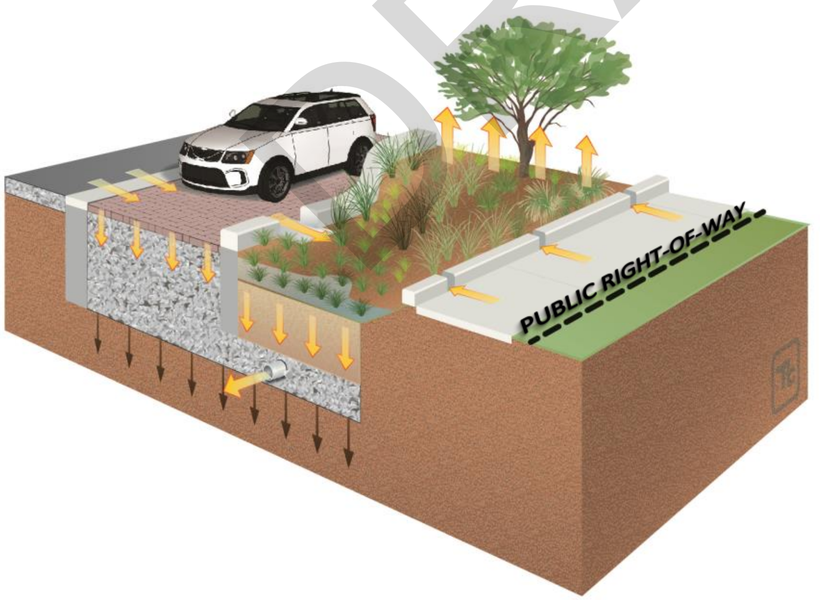

Figure 1. Conceptual schematic of ROW BMPs with an underdrain (arrows indicate water pathways).

Similar to ROW BMPs, LID practices on public parcels are designed for distributed stormwater retention and treatment. Suitable public parcels can be retrofit with bioretention/biofiltration and permeable pavement (see Figure 1) to achieve onsite infiltration and filtration, and/or cisterns to capture and use stormwater onsite.

Not all publically owned land is suited for BMP retrofits; therefore, screening is required to eliminate areas where BMP retrofits are impractical or infeasible due to physical constraints. While BMP retrofits can be implemented in a variety of settings, the local physical characteristics such as road type, topography, and depth to groundwater can significantly influence the practicality of designing and constructing these features. A screening protocol was established to identify realistic opportunities for retrofits based on the best available GIS data. The opportunities identified during this process provide the foundation for the engineering analysis to determine the volume of stormwater that can be treated by public BMP retrofits in the subject watershed. This memo describes the data and the screening process used to identify the best available areas for BMP retrofits.

B1.1. Data Used

To evaluate ROW BMP opportunities and available implementation areas, several key data sets were processed and formatted. Table 1 outlines the data set names, formats, descriptions, and sources.

Table 1. Summary of Data

Data Set	Format	Description	Source
Parcels	GIS Shapefile	Outlines property boundaries and sizes	Los Angeles County (LAC) Assessor
Roads	GIS Shapefile	Shows street centerline network & Functional Classification Federal	City of Long Beach
Land Use	GIS Shapefile	Subdivides the region into predefined land use categories with similar runoff properties. Each individual land use feature identifies the associated percent impervious coverage.	LAC WMMS Model
Slopes	GIS Shapefile	Classifies regions by the slope category	LAC WMMS Model
Soils	GIS Shapefile	Outlines spatial extents of dominant soil types	LAC GIS Portal
Jurisdictions	GIS Shapefile	Establishes city and county boundaries	LAC GIS Portal
Groundwater Contours	GIS Shapefile	Illustrates groundwater depth as measured from the surface	Los Angeles Bureau of Sanitation
Aerial Imagery	Layer File	Orthoimage of entire region	ESRI Maps & Data Imagery

B1.2. ROW BMP Screening

High traffic volumes, speed limits, slopes, and groundwater tables, impact the feasibility of ROW BMP implementation. Road classification data contains information typically useful for determining if the street is subject to high traffic volumes and speeds, and the City of Long Beach road data provides the best available road classification information for the study area. Table 2 shows the Federal Functional Classifications deemed appropriate for ROW BMP retrofit opportunities. Only roads with the Federal Functional Classifications listed in Table 2 can be considered for ROW BMP retrofits in this screening analysis. All other roads are screened out.

Table 2. ROW BMP Functional Class

Functional Classification (Federal)	Description
CLCTR	Collector
LOC	Local Streets
MINOR	Minor Arterial
OTHER	Alleys*

*The "Other" category also includes other features such as private streets, canals, flood control channels, railroads and other designations. To ensure that these other features are not selected, the roads identified in the "Other" category were further screened by Street Type. The street types that were removed from the list of roads included the following; Bay, Canal, Flood Control, Railroad, and Walk.

In addition to the screening of road types, opportunities were further screened to remove segments that have steep slopes. Streets with grades steeper than 10 percent can present engineering challenges that substantially reduce the cost effectiveness of the BMP retrofit opportunity. From the available slope information, roads with slopes less than 10 percent were considered as retrofit opportunities.

The final screen applied to the roads is the depth to groundwater. Implementing ROW BMPs in areas with high groundwater is not recommended because BMP storage capacities are rendered ineffective by groundwater inflow. From the provided groundwater contours, roads were eliminated as opportunities if the depth to groundwater was less than 10 feet below the ground surface. Figure 2 highlights the areas identified with groundwater depths of 10 feet or less. The highlighted areas provided a starting point for elimination, however it should be noted that further evaluation may be necessary based on local knowledge of areas with high groundwater tables or daylighting of perched groundwater layers as identified by the jurisdictions.

The results of the ROW BMP screening are shown in Figure 2. Figure 2 shows the roads available for retrofit (highlighted in green) versus all of the roads within the study area. A majority of roads and alleys – approximately 224 miles – were identified as potential green street retrofits; the actual required length of green streets to meet the water quality targets will be determined during the Reasonable Assurance Analysis. It should be noted that due to the coarse nature of the road classification data, only freeways, highways, and major roads were eliminated in the classification screening process. In practice, retrofitting every street that passed through the screening will likely not be feasible and adaptive management strategies will be necessary in the future to further refine the road classification data layer to more accurately identify road types suitable for ROW BMP retrofits.

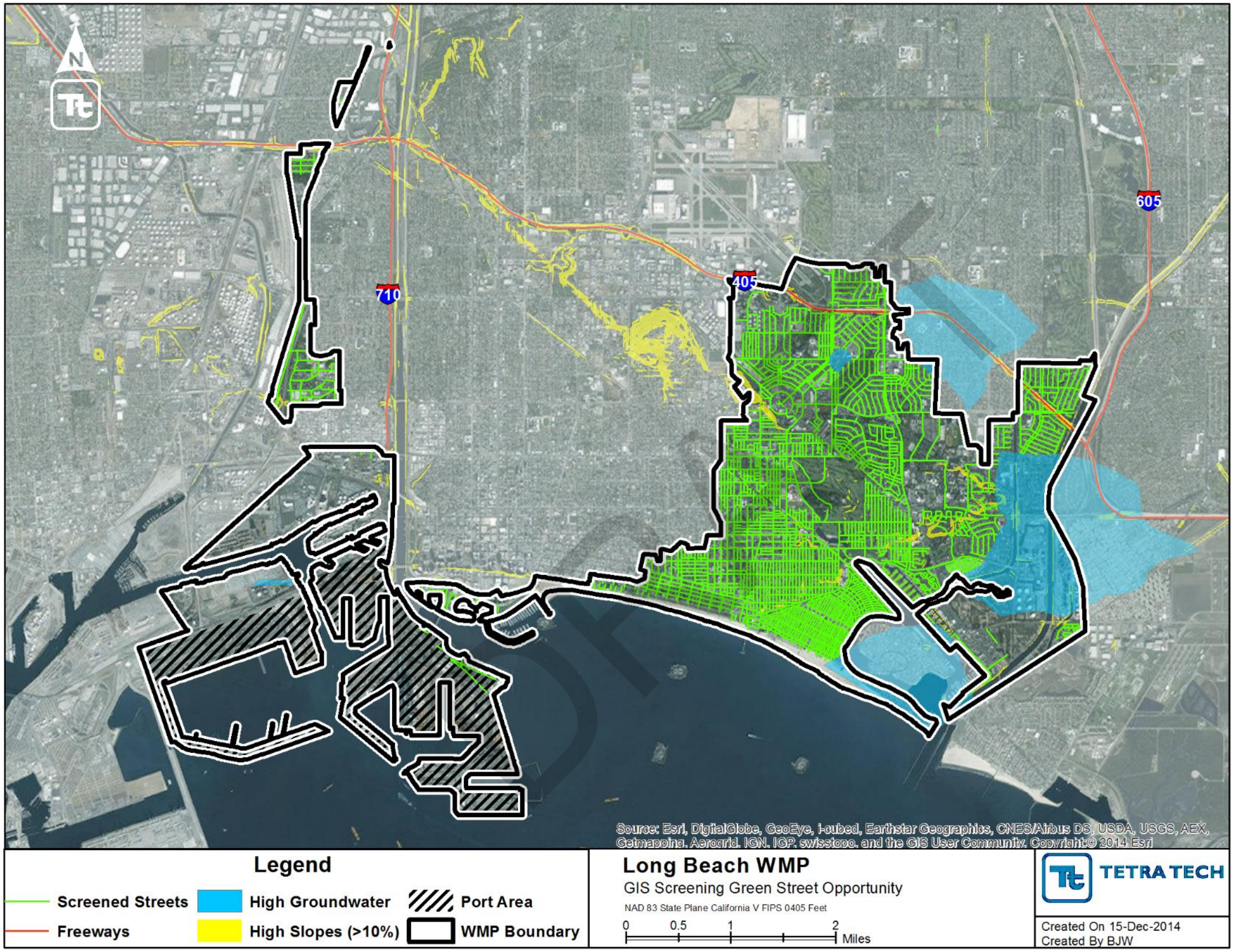

Figure 2. GIS screening - Green Street opportunities.

B1.3. LID ON PUBLIC PARCELS ASSESSMENT

Retrofitting public parcels with LID can be an efficient strategy for reducing stormwater runoff. This method allows municipalities the flexibility to prioritize and schedule stormwater projects to coincide with improvements that are already on the books (such as scheduled parking lot resurfacing, utility work, and public park improvements). Implementing LID on public parcels also allows municipalities the freedom to construct, inspect, and maintain BMPs without the need to purchase private property or to create stormwater easements.

The spatial extent of public parcels was identified by selecting all parcels labeled as public by their assessor's identification number. A total of 581 individual public parcels were initially identified within the Long Beach WMP boundary.

Public parcels in the WMP area were screened for slope and high groundwater using the methods described for ROW BMPs. Additionally, soil contamination can present a risk of mobilizing pollutants from public parcels into the groundwater. To avoid this potential problem, sites that were identified as having open contamination cases (per the State of California GeoTracker database) were eliminated from BMP retrofit potential. Sites that have been remediated or have closed cases were still considered as opportunities to provide a BMP retrofit.

A total of 297 potentially suitable parcels resulted from this screening process (comprising 14% of the total WMP area), as tabulated in Table 3 and shown in Figure 3. The highlighted areas provide a starting point for evaluation, however it should be noted that further evaluation may be necessary based on local knowledge of areas with high groundwater tables, daylighting of perched groundwater layers, or other geotechnical challenges identified by the City of Long Beach.

Table 3. Summary of Screened Public Parcel Area by Owner

Owner	Acreage of Screened Parcel Area	Number of Screened Public Parcels
City of Long Beach	800	199
State	289	12
Schools	170	38
Federal	135	33
Other	88	15
Grand Total	**1,482**	**297**

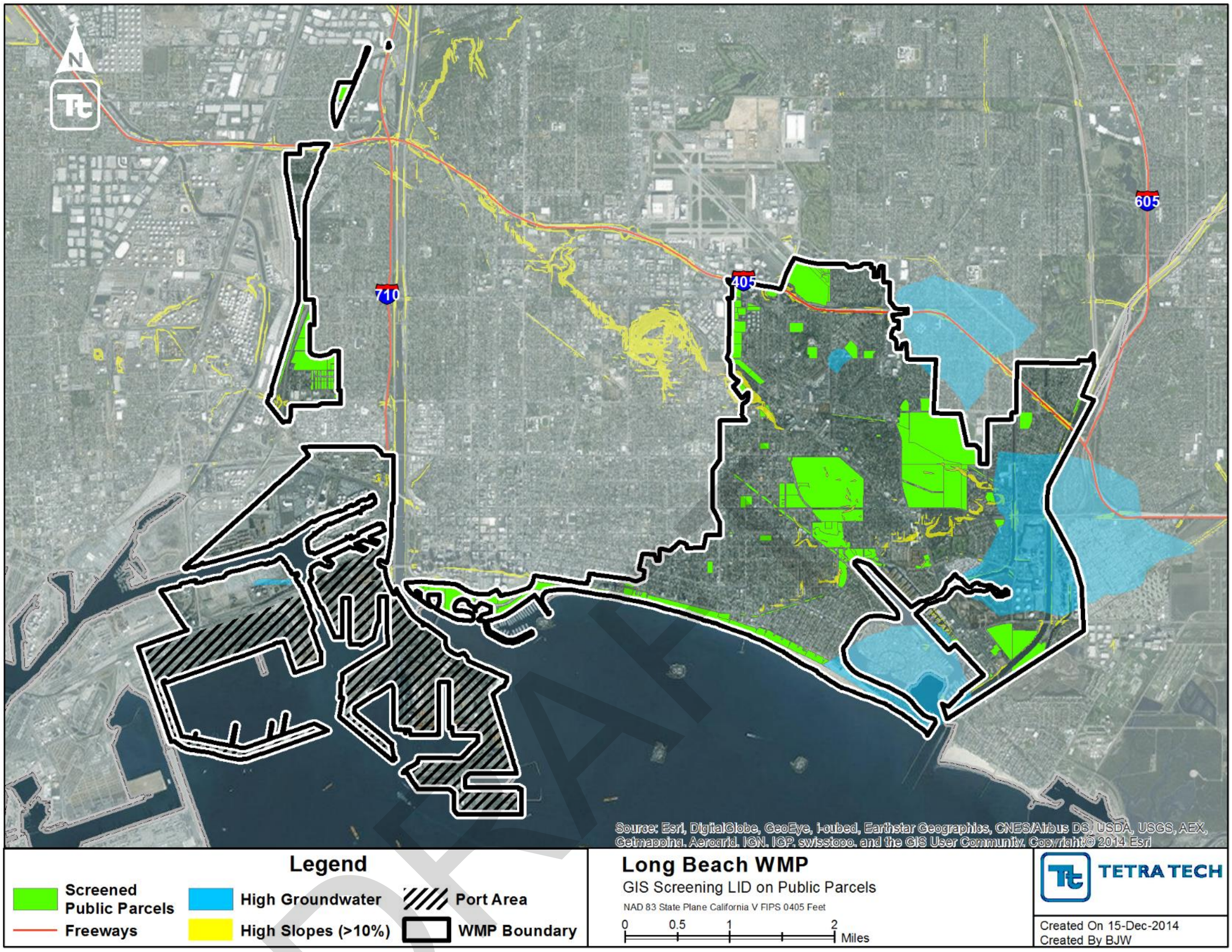

Figure 3. GIS screening - LID on public parcels (excluding the Port).

Attachment G: Runoff Volume and Pollutant Loading Tables by Model Subwatershed

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October 28, 2015

Table 1. Baseline and BMP Scenario for Runoff and Metals Loads by Assessment Zone during Toxics Critical Condition (WY 2003) for explicitly modeled pollutants [1]

Assessment Zone	Scenario	Runoff Volume (ac-ft/yr)	Total Copper (lbs/yr)	Total Lead (lbs/yr)	Total Zinc (lbs/yr)	% Total Zinc Reduction
Harbor Toxics TMDL	Baseline	5,074	895	681	4,225	63%
	with BMPs	3,377	337	258	1,566	
Dominguez Toxic TMDL	Baseline	267	53	42	254	67%
	with BMPs	152	18	15.4	82.9	

Table 2. Baseline Runoff and BMP Retention for Subwatersheds Subject to Bacteria Beaches TMDL during Bacteria Critical Condition

Jurished ID	Baseline Runoff during 90th percentile, 17th day (ft3/day)	Runoff with BMPs during 90th percentile, 17th day (ft3/day)
553248	167,527	0.0
553348	37,666	0.0
800348	17,947	0.0
800448	6,784	0.0
800548	44,701	0.0
800648	14,113	0.0
800748	1,100	0.0
800848	751	0.0

Table 3. Baseline Runoff and Pollutant loads (WY 2003) by subwatershed for the City of Long Beach

Jurished ID	Baseline during Toxics Critical Condition (WY2003)				
	Runoff (ft3/year)	Sediment (lbs/year)	Total Copper (lbs/year)	Total Lead (lbs/year)	Total Zinc (lbs/year)
200148	241,194.9	4,930.0	1.2	0.9	5.7
200248	4,834,029.7	95,917.1	21.0	16.2	101.2
200348	45,639.1	863.6	0.3	0.3	1.4
200448	2,147,515.2	37,527.6	9.9	8.1	45.4
200648	23,530.0	480.5	0.1	0.1	0.5
211699	4,358,193.0	89,768.9	20.9	16.8	99.8
500148	5,505,891.1	101,987.8	31.5	25.4	134.6
500248	662,269.7	9,165.2	1.8	1.2	8.3
549548	17,522,333.5	275,295.1	83.8	76.2	340.9
549748	2,989,997.4	41,890.2	12.4	12.2	53.5
549848	5,712,834.3	109,117.9	23.8	16.3	107.0
549948	8,172,567.6	116,107.9	29.5	24.0	125.4
550048	7,589,475.3	82,203.2	22.3	19.8	89.8
550148	17,618,570.7	245,494.8	73.9	64.9	303.9
550248	29,184,938.1	508,527.3	151.1	137.9	660.8
550348	2,209,037.4	28,869.8	6.6	5.2	29.5
553248	9,340,569.6	160,648.5	48.5	47.3	208.6
553348	2,096,293.9	36,794.1	11.3	11.1	48.3
553448	7,349,393.8	143,539.8	43.4	41.3	179.1
800148	6,576,640.1	84,563.4	24.9	23.0	101.2
800248	209,045.4	3,978.0	1.5	1.3	6.0
800348	1,000,492.9	18,843.9	5.5	5.5	24.0
800448	378,391.9	7,251.2	2.3	2.2	10.0
800548	2,507,266.9	50,590.4	12.8	10.1	59.8
800648	786,227.7	15,939.9	3.8	2.7	18.1
800748	61,325.7	1,231.6	0.2	0.1	1.1
800848	45,452.7	851.4	0.2	0.1	0.9
800999	9,133,194.2	185,471.4	28.5	13.6	163.9
801099	6,795,515.1	137,898.8	20.9	9.6	121.1
801199	1,814,256.2	36,804.6	5.5	2.5	32.1
801299	2,761,386.9	56,032.4	8.5	3.9	49.1
801399	504,577.9	10,236.2	1.5	0.7	8.9
801499	1,220,340.9	24,758.3	3.7	1.7	21.6
801599	3,187,128.7	64,685.4	9.8	4.5	56.8
801699	3,310,335.7	67,516.9	19.4	14.9	88.3

Jurished ID	Baseline during Toxics Critical Condition (WY2003)				
	Runoff (ft3/year)	Sediment (lbs/year)	Total Copper (lbs/year)	Total Lead (lbs/year)	Total Zinc (lbs/year)
801799	8,639,799.8	175,286.2	26.4	12.0	153.2
801899	498,194.0	10,107.6	1.5	0.7	8.8
801999	108,894.3	2,209.1	0.3	0.1	1.9
802099	2,588,666.1	52,515.1	7.9	3.5	45.9
802199	15,311,980.5	311,023.5	48.2	23.3	275.8
802299	5,028,050.2	102,033.8	15.4	7.1	89.4
802399	1,089,229.8	22,106.7	3.4	1.6	19.4
802499	1,292,796.5	26,231.6	4.0	1.8	23.0
802599	1,490,143.6	30,229.4	4.5	2.0	26.4
802699	3,997,116.6	81,102.1	12.2	5.6	71.0
802799	1,639,369.2	33,681.4	6.7	4.8	33.8
802899	6,007,330.7	121,880.3	18.3	8.3	106.5
802999	3,458,492.6	70,179.9	10.6	4.9	61.5
803099	1,074,625.0	21,800.2	3.3	1.5	19.0
803199	5,195,344.2	106,577.2	20.4	14.1	105.3
803299	5,014,560.7	101,819.6	15.6	7.4	89.9
803399	2,343,063.3	47,532.9	7.1	3.2	41.5

Table 4. BMP Effluent Runoff and Pollutant loads (WY2003) by subwatershed for the City of Long Beach

Jurished ID	BMP EFFLUENT DURING WY2003 CRITICAL CONDITION				
	Runoff (ft3/year)	Sediment (lbs/year)	Total Copper (lbs/year)	Total Lead (lbs/year)	Total Zinc (lbs/year)
200148	241,194.9	4,437.0	1.1	0.8	5.1
200248	2,755,228.3	34,825.3	9.3	8.5	41.5
200348	20,114.4	171.9	0.1	0.1	0.2
200448	564,821.5	4,323.2	1.2	1.0	5.3
200648	17,974.1	295.8	0.0	0.0	0.3
211699	3,009,573.7	27,903.1	6.3	5.0	30.5
500148	2,806,758.6	16,221.2	5.3	4.3	21.4
500248	661,344.2	8,240.1	1.6	1.0	7.5
549548	9,317,941.2	64,065.4	18.9	16.3	70.7
549748	1,687,034.2	19,780.4	5.9	5.9	25.4
549848	3,324,276.6	28,124.2	6.3	4.0	23.6
549948	4,961,657.6	32,981.4	8.3	6.4	31.8
550048	7,259,378.6	64,960.2	18.6	17.1	73.2

	BMP EFFLUENT DURING WY2003 CRITICAL CONDITION				
Jurished ID	Runoff (ft3/year)	Sediment (lbs/year)	Total Copper (lbs/year)	Total Lead (lbs/year)	Total Zinc (lbs/year)
550148	9,714,439.9	54,939.0	16.2	13.4	60.4
550248	18,488,110.6	238,848.0	74.3	69.1	320.2
550348	2,159,526.4	24,683.1	5.7	4.6	25.4
553248	6,225,375.0	93,097.7	28.3	27.9	121.5
553348	1,451,451.1	22,588.7	6.9	6.8	29.6
553448	4,013,422.6	37,700.9	11.2	10.4	44.8
800148	3,650,644.9	19,512.6	5.6	4.9	21.1
800248	137,271.0	1,870.1	0.6	0.6	2.6
800348	810,423.4	13,731.4	4.1	4.1	17.7
800448	256,206.4	4,203.5	1.4	1.3	5.8
800548	1,305,997.3	17,255.8	4.5	3.8	20.5
800648	241,134.5	1,366.5	0.3	0.3	1.6
800748	15,919.0	68.1	0.0	0.0	0.1
800848	21,097.3	269.2	0.1	0.1	0.3
800999	6,622,210.0	78,343.7	12.0	5.7	69.2
801099	4,520,424.3	43,430.5	6.6	3.0	38.1
801199	1,585,875.0	16,017.0	2.4	1.1	14.0
801299	2,232,425.9	10,803.9	1.7	0.8	9.6
801399	407,417.3	1,933.9	0.3	0.1	1.7
801499	1,071,685.6	11,146.7	1.7	0.8	9.7
801599	2,203,705.6	24,719.3	3.7	1.7	21.7
801699	1,527,047.2	10,783.1	3.0	2.3	14.0
801799	6,998,030.5	34,794.6	5.3	2.5	30.6
801899	498,194.0	9,096.9	1.4	0.6	8.0
801999	108,894.3	1,988.2	0.3	0.1	1.7
802099	2,260,039.1	22,647.1	3.4	1.5	19.8
802199	11,003,055.5	128,630.3	19.9	9.6	113.9
802299	3,700,514.7	45,077.2	6.8	3.1	39.5
802399	1,089,229.8	19,896.0	3.0	1.4	17.5
802499	908,431.5	10,404.7	1.6	0.7	9.1
802599	1,082,690.9	12,876.9	1.9	0.9	11.2
802699	2,908,064.8	34,615.3	5.2	2.4	30.3
802799	1,073,017.0	11,232.5	2.2	1.5	11.2
802899	4,369,188.3	51,955.4	7.8	3.5	45.4
802999	2,511,024.1	29,829.2	4.5	2.1	26.1

	BMP EFFLUENT DURING WY2003 CRITICAL CONDITION				
Jurished ID	Runoff (ft3/year)	Sediment (lbs/year)	Total Copper (lbs/year)	Total Lead (lbs/year)	Total Zinc (lbs/year)
803099	941,499.4	9,648.1	1.4	0.7	8.4
803199	3,697,499.0	35,364.7	6.9	4.9	35.4
803299	3,612,781.9	42,210.3	6.5	3.1	37.2
803399	1,674,013.2	19,531.8	2.9	1.3	17.1

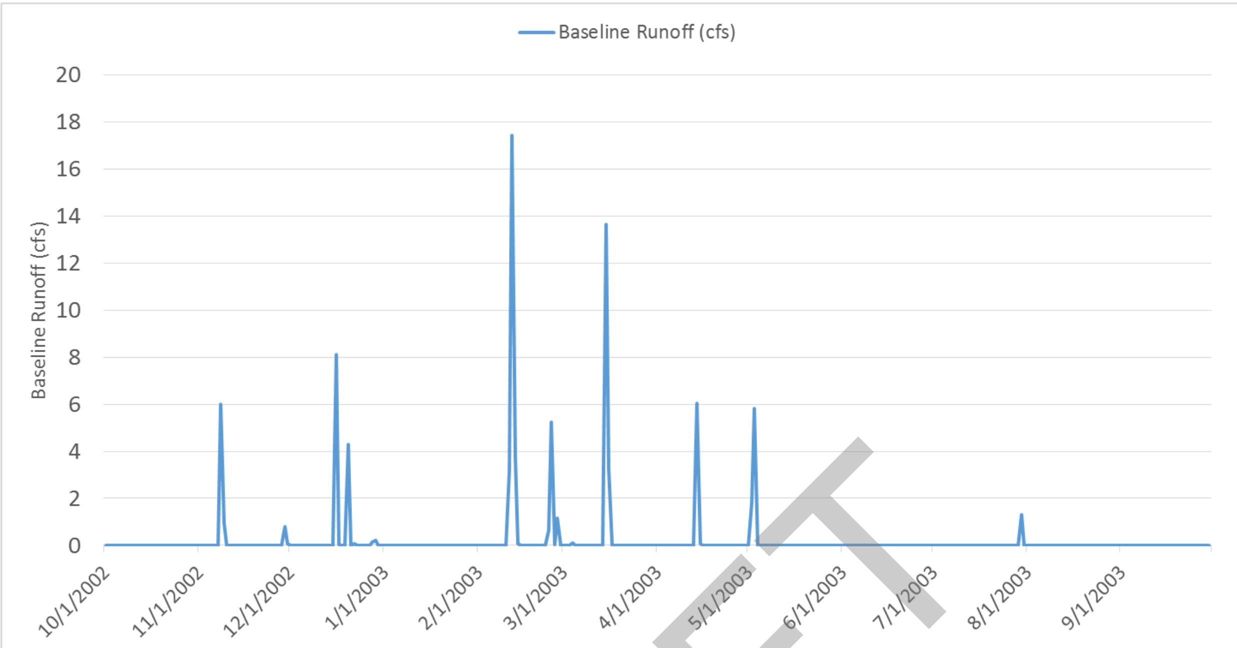

Figure 1. Baseline (WY 2003) runoff for Dominguez Toxics assessment zone.

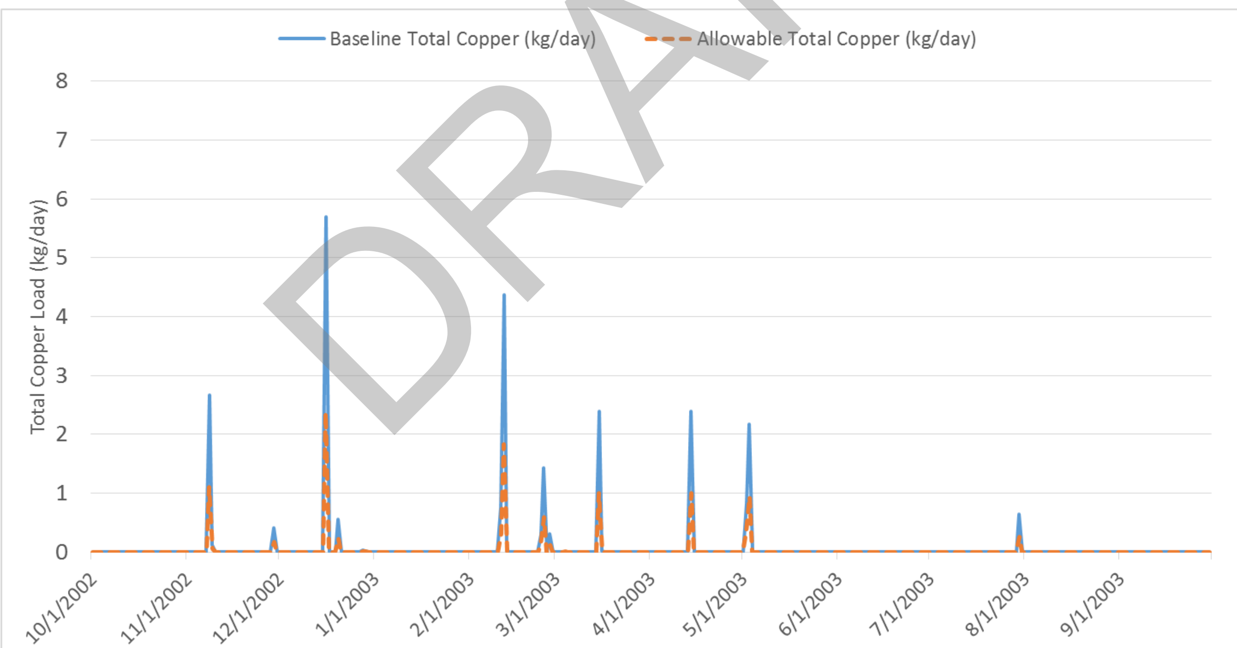

Figure 2. Baseline (WY 2003) and allowable total copper load for Dominguez Toxics assessment zone.

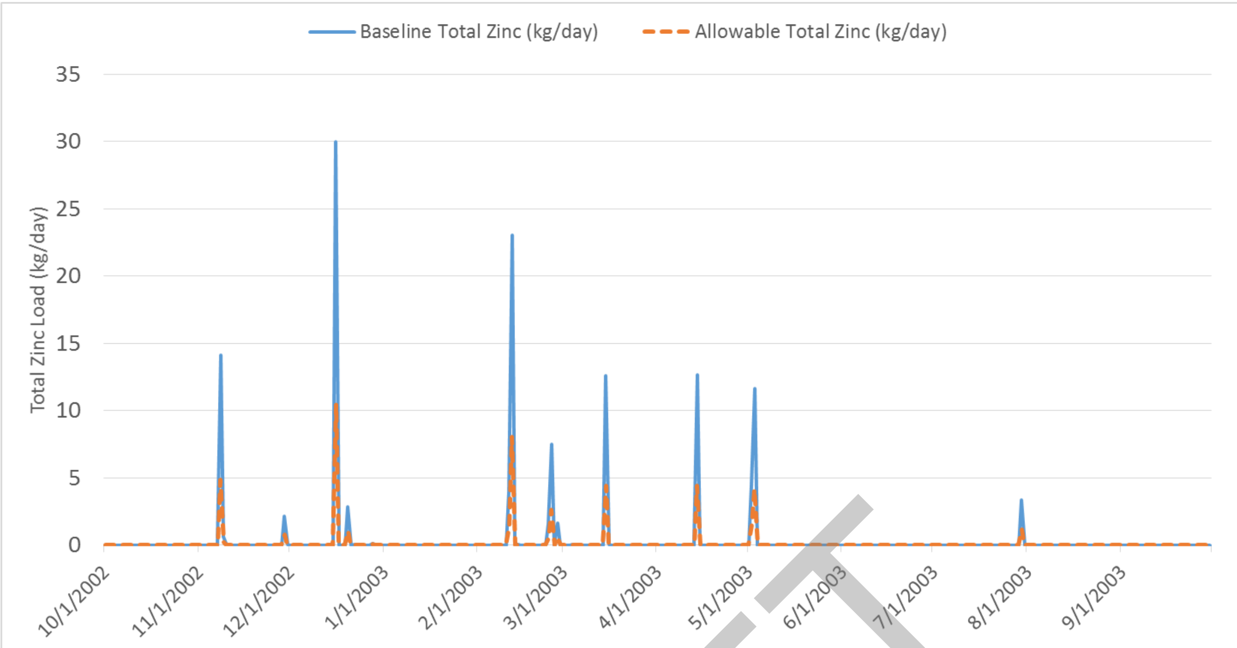

Figure 3. Baseline (WY 2003) and allowable total zinc load for Dominguez Toxics assessment zone.

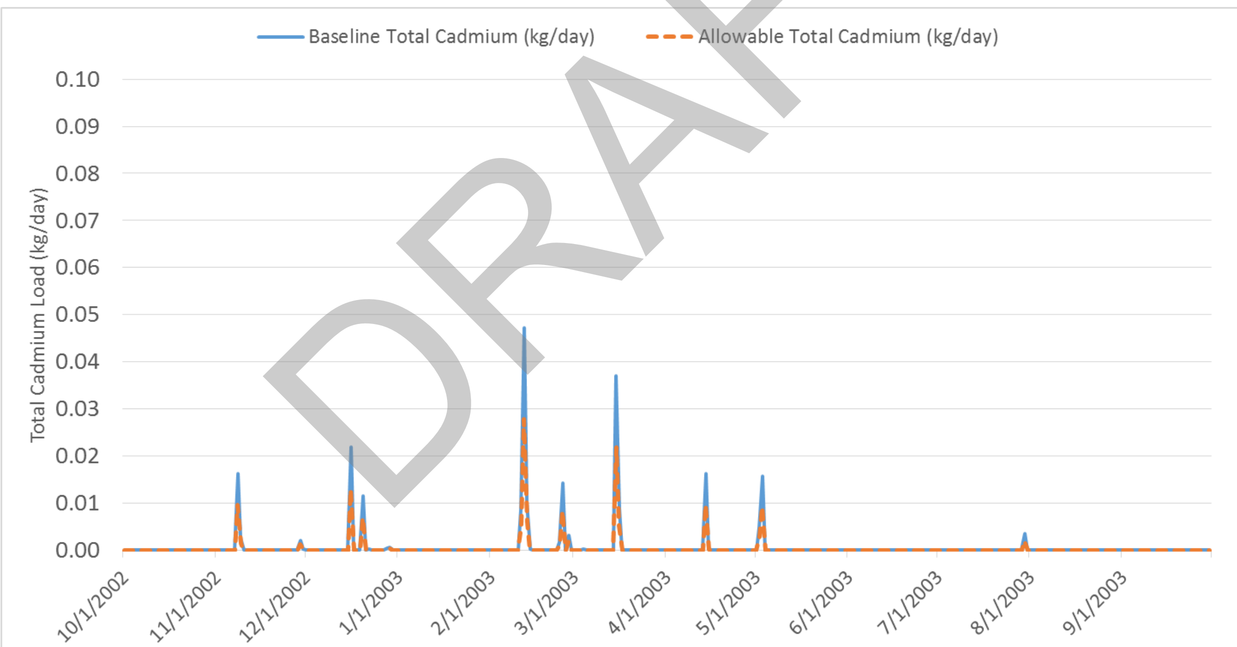

Figure 4. Baseline (WY 2003) and allowable total cadmium load for Dominguez Toxics assessment zone.

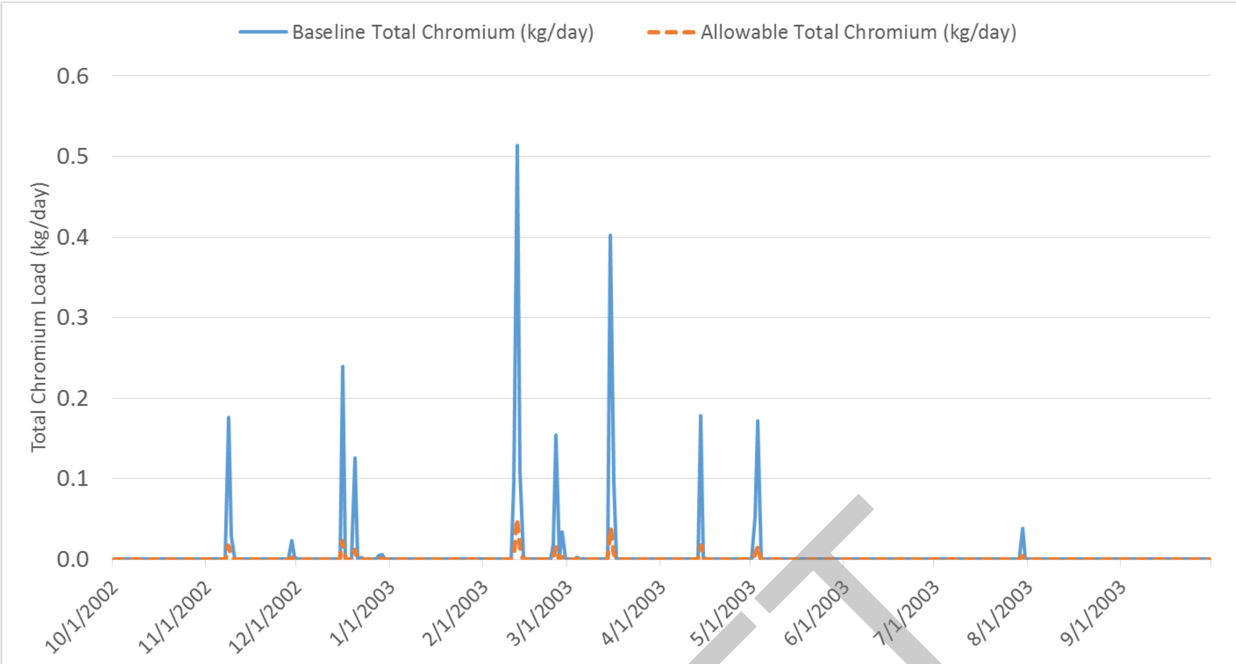

Figure 5. Baseline (WY 2003) and allowable total chromium load for Dominguez Toxics assessment zone.

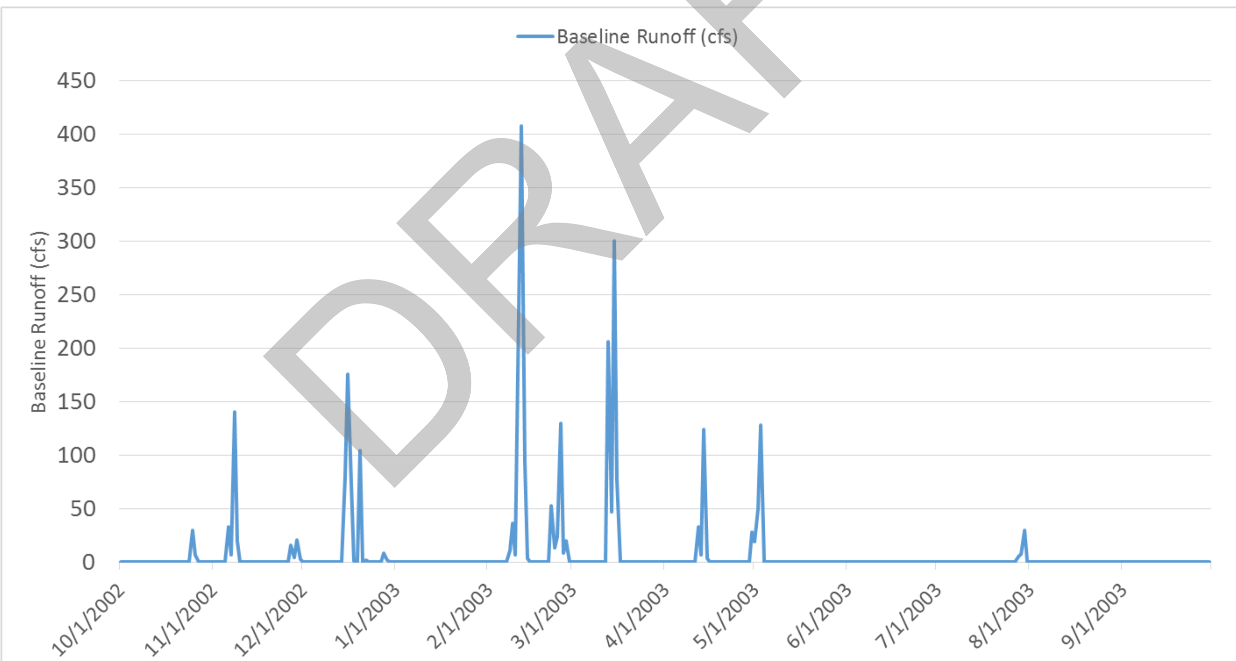

Figure 6. Baseline (WY 2003) runoff for Harbor Toxics assessment zone.

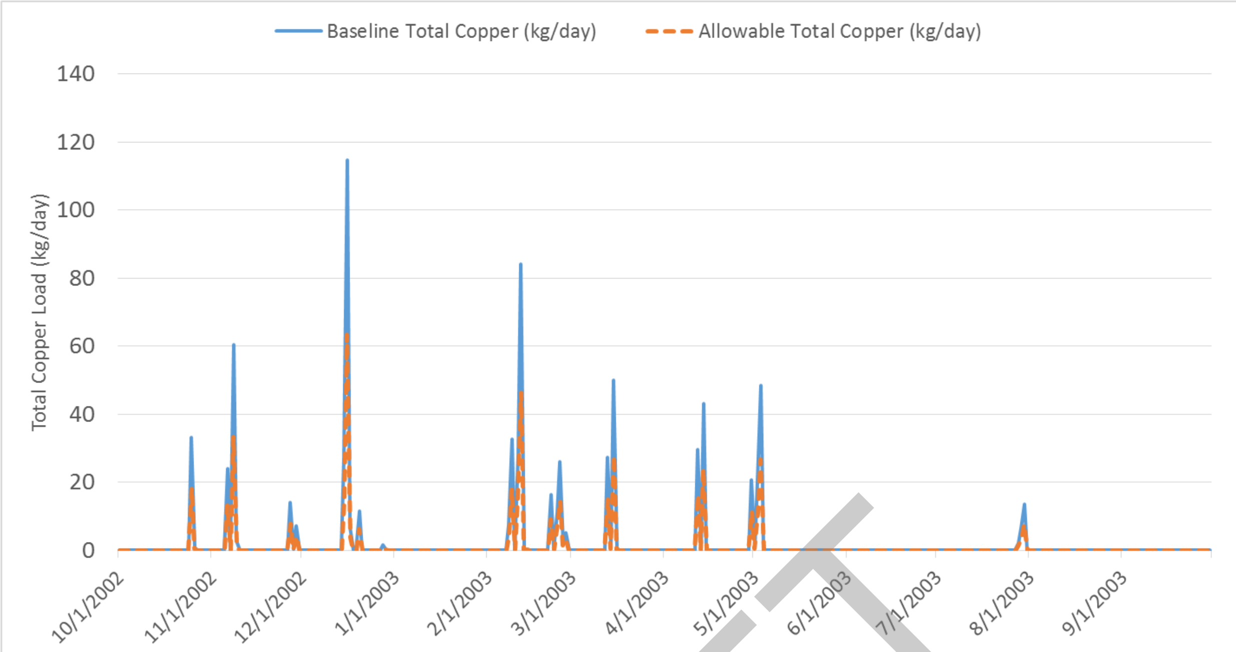

Figure 7. Baseline (WY 2003) and allowable total copper load for Harbor Toxics assessment zone.

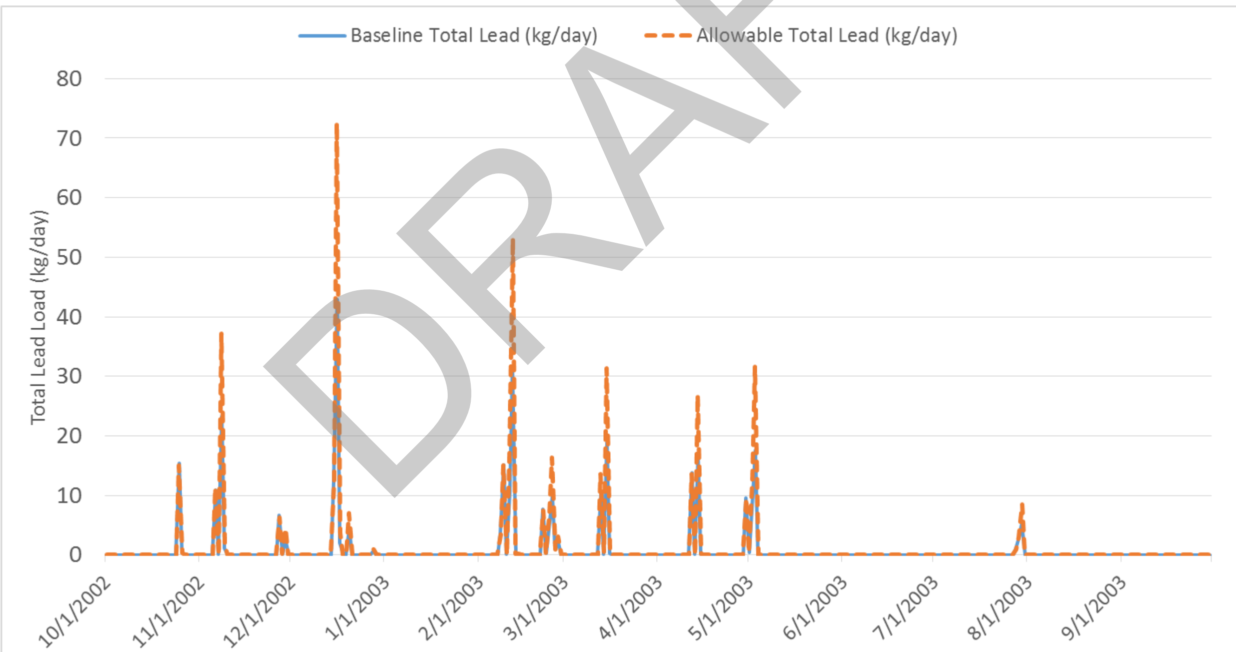

Figure 8. Baseline (WY 2003) and allowable total lead load for Harbor Toxics assessment zone.

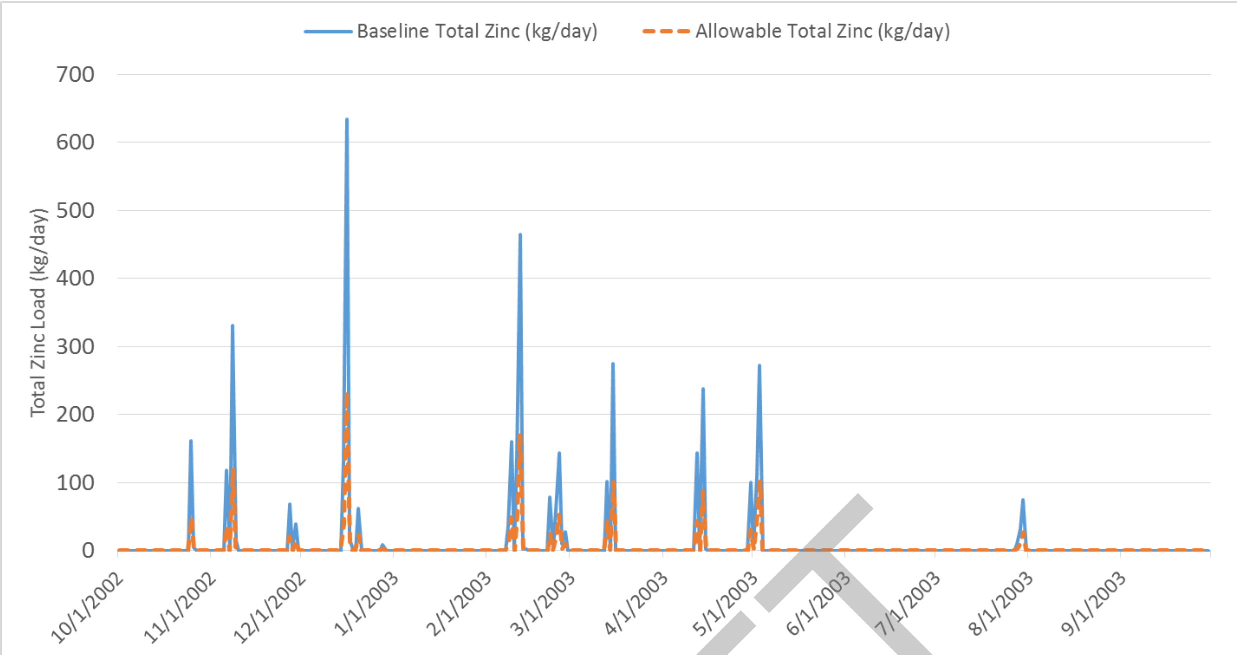

Figure 9. Baseline (WY 2003) and allowable total zinc load for Harbor Toxics assessment zone.