Multi-Pollutant TMDL Implementation Plan for the Unincorporated County Area of Los Angeles River Watershed

Submitted to:

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The County of Los Angeles would like to thank Tetra Tech, Inc. for their efforts in the development of this Multi-Pollutant TMDL Implementation Plan. Their technical expertise and guidance was critical to the successful development of the plan.

Executive Summary

This report documents the results of the County of Los Angeles effort to address impairments in the Los Angeles River watershed with a comprehensive, phased approach of best management practice (BMP) implementation. The goal of the multi-pollutant implementation plan is to address all current Total Maximum Daily Loads (TMDLs) established for waters within the Los Angeles River watershed, with consideration of future potential TMDLs. The metals and nutrients TMDLs are considered the primary focus of this implementation plan. Nutrient source characterizations are provided in the plan, although the nutrient TMDL focuses only on dry weather flows from publicly owned treatment works and minor point sources, and no nutrient load reductions for urban runoff are specified to meet TMDL wasteload allocations (WLAs). A secondary focus is placed on trash, because reporting on progress toward TMDL implementation occurs annually and through a separate process. The plan also considers BMPs to address bacteria and other toxics, although TMDLs have not been established for these pollutants in the Los Angeles River watershed.

This implementation plan describes management options that are limited to unincorporated County areas outside federal lands. Although the implementation plan is limited to those areas, opportunities for partnerships with incorporated cities and other responsible agencies will be explored, especially in cases where projects have a regional benefit and drainage areas that cross multiple jurisdictional boundaries.

To develop this plan, BMPs to treat stormwater and dry weather flows to reduce metals were identified and selected. As part of this process, benefits of management activities were estimated, in terms of pollutant load reductions or improvement in water quality, to meet WLAs defined by approved TMDLs. The process of BMP selection included considering cost-effectiveness to provide assurance that the plan is practical and implementable. The plan also includes integrated water resources approaches that consider BMPs that can address multiple pollutants cost-effectively, while considering parallel water resources planning strategies for the watershed.

The Los Angeles River TMDLs include schedules for attaining associated WLAs, which vary for each pollutant and, in some cases, for wet and dry weather conditions. For the metals WLAs, different implementation schedules are defined for wet and dry weather. The metals implementation schedules are based on phases expressed as the percent of total drainage area served by the municipal separate storm sewer system (MS4) that is effectively meeting the WLAs. The phases can be considered as interim goals for developing strategies to address TMDL implementation. A summary of the Los Angeles River WLAs and associated compliance schedules are summarized in Table ES-1.

Table ES-1. WLA Implementation Schedules for Los Angeles River TMDLs

TMDL	Condition	Interim Phased Implementation	Final Compliance
Metals	Wet weather	October 29, 2012: 25% of total drainage area October 29, 2024: 50% of total drainage area	October 29, 2028: 100% of total drainage area
	Dry weather	October 29, 2012: 50%of total drainage area October 29, 2020: 75% of total drainage area	October 29, 2024: 100% of total drainage area
Nutrients	N/A	N/A	N/A
Trash[a]	N/A	September 30, 2009: 50% of baseline WLA 10% incremental reduction of baseline WLA annually thereafter	September 30, 2016: zero trash

a. Trash TMDL is addressed in a separate implementation plan.

To meet the phased TMDL implementation schedules, a combination of structural and nonstructural BMPs were identified to be implemented in increasing number and intensity. A self-evaluation was conducted to identify opportunities for improvements to existing nonstructural BMPs and new nonstructural BMPs that would support meeting WLAs. Table ES-2 lists the new nonstructural BMPs, enhancements to existing nonstructural BMPs, and the TMDL pollutants and flow conditions addressed.

Table ES-2. Summary of Nonstructural Solutions to Support TMDL Implementation

Nonstructural BMP	Condition		TMDL Pollutant Addressed				
	Wet Weather	Dry Weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Enhancements to Existing BMPs							
Smart Gardening Program Enhancements	✓	✓	◗	◗	◗	◗	○
TMDL-Specific Stormwater Training	✓	✓	◗	◗	◗	◗	◗
Enhancement of Commercial and Industrial Facility Inspections	✓	✓	◗	◗	◗	◗	○
Enforcement Escalation Procedures	✓	✓	◗	●	◗	◗	○
Improved Street Sweeping Technology[a]	✓		◗	◗	◗	◗	○
New BMP							
Reduction of Irrigation Return Flow	✓	✓	●	●	◗	●	○

● addresses the pollutant
◗ partially addresses the pollutant
○ does not address the pollutant

a. The scores for Improved Street Sweeping Technology represent the change in pollutant removal effectiveness compared to current street sweeping practices. Trash removal is expected to remain high but not improve.

For identification of structural BMPs, both distributed and centralized BMPs were considered. Distributed BMPs refer to those practices that provide the control or treatment (or both) of stormwater runoff at the site level. Centralized BMPs refer to stormwater treatment, storage, or infiltration facilities that provide benefits on a larger scale (e.g., regional). Table ES-3 summarizes the structural BMPs identified to address TMDL implementation.

Table ES-3. Summary of Structural Solutions to Support TMDL Implementation

Structural BMP	Condition		TMDL Pollutant Addressed				
	Wet weather	Dry weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Catch Basin Distributed BMPs							
Full Capture Devices	✓		○	○	○	○	●
Catch Basin Inserts	✓		○	●	◗	●	●
Other Distributed BMPs on Public Land							
Distributed BMPs on Public Land	✓	✓	●	●	●	●	●
Pilot Distributed BMP Project for a County Road	✓	✓	●	●	●	●	●
Centralized BMPs on Public Land							
Enterprise Park	✓	✓	●	●	●	●	●
Magic Johnson Park	✓	✓	●	●	●	●	●
Mona Park	✓	✓	●	●	●	●	●

Structural BMP	Condition		TMDL Pollutant Addressed				
	Wet weather	Dry weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
G.W. Carver Park	✓	✓	●	●	●	●	●
Ted Watkins Park	✓	✓	●	●	●	●	●
Roosevelt Park	✓	✓	●	●	●	●	●
Bethune Park	✓	✓	●	●	●	●	●
Northside Drive Median	✓	✓	●	●	●	●	●
Salazar Park	✓	✓	●	●	●	●	●
Obregon Park	✓	✓	●	●	●	●	●
Belvedere Park	✓	✓	●	●	●	●	●
Whittier Narrows Park	✓	✓	●	●	●	●	●
Whittier Narrows Recreation Area	✓	✓	●	●	●	●	●
Hugo Reid Park	✓	✓	●	●	●	●	●
Farnsworth Park	✓	✓	●	●	●	●	●
Loma Alta County Park	✓	✓	●	●	●	●	●
Charles White County Park	✓	✓	●	●	●	●	●
Two Strike Park	✓	✓	●	●	●	●	●
Compton Creek Wetland	✓	✓	●	●	●	●	◗
Centralized BMPs on Private Land							
Infiltration Basins	✓	✓	●	●	●	●	●
Dry Detention Basins	✓	✓	●	●	●	●	●

● addresses the pollutant
◗ partially addresses the pollutant
○ does not address the pollutant

Qualitative and quantitative analyses were performed to evaluate the ability of BMPs to meet load reduction targets associated with WLAs. For most nonstructural BMPs, quantification of benefits in terms of pollutant load reductions are challenging and often require extensive survey and monitoring information to gage performace. For the purposes of this plan, a qualitative approach was used to evaluate the effectiveness and feasibility of the nonstructural BMPs. Additional modeling analysis was performed to provide optimization of the most cost-effective combination and size of structural BMPs to meet WLAs. Four optimization scenarios were formulated as shown in Table ES-4. Figure ES-1 summarizes results of optimization for copper, which was determined the limiting pollutant for metals (i.e., controlling copper tends to ensure that other metals WLAs are met). Table ES-5 summarizes specific points in the optimization curve, including the type of BMPs considered and associated pollutant load reductions achieved (Scenario 4 results are omitted from table due to lack of added benefit over Scenario 3, as shown in Figure ES-1). Results are based on simulation of hydrologic year 2003, which was determined to best represent typical rainfall frequencies and magnitudes observed over the recent 20-year rainfall record.

Table ES-4. Optimization Scenario Matrix

Scenario	Baseline Scenario (Nonstructural BMPs + Catch Basin Inserts)	Structural BMPs		
		Public Centralized	Public Distributed	Private Centralized
1	Fixed	Variable		
2	Fixed	Fixed (Optimal solution derived in 1)	Variable	
3	Fixed	Fixed (Optimal solution derived in 1)	Fixed (Optimal solution derived in 2)	Variable
4	Fixed	Fixed (Optimal solution derived in 1)		Variable

Fixed: Corresponding BMPs are included as a fixed condition.
Variable: Corresponding BMPs are included as decision variables to be optimized for cost-effectiveness.

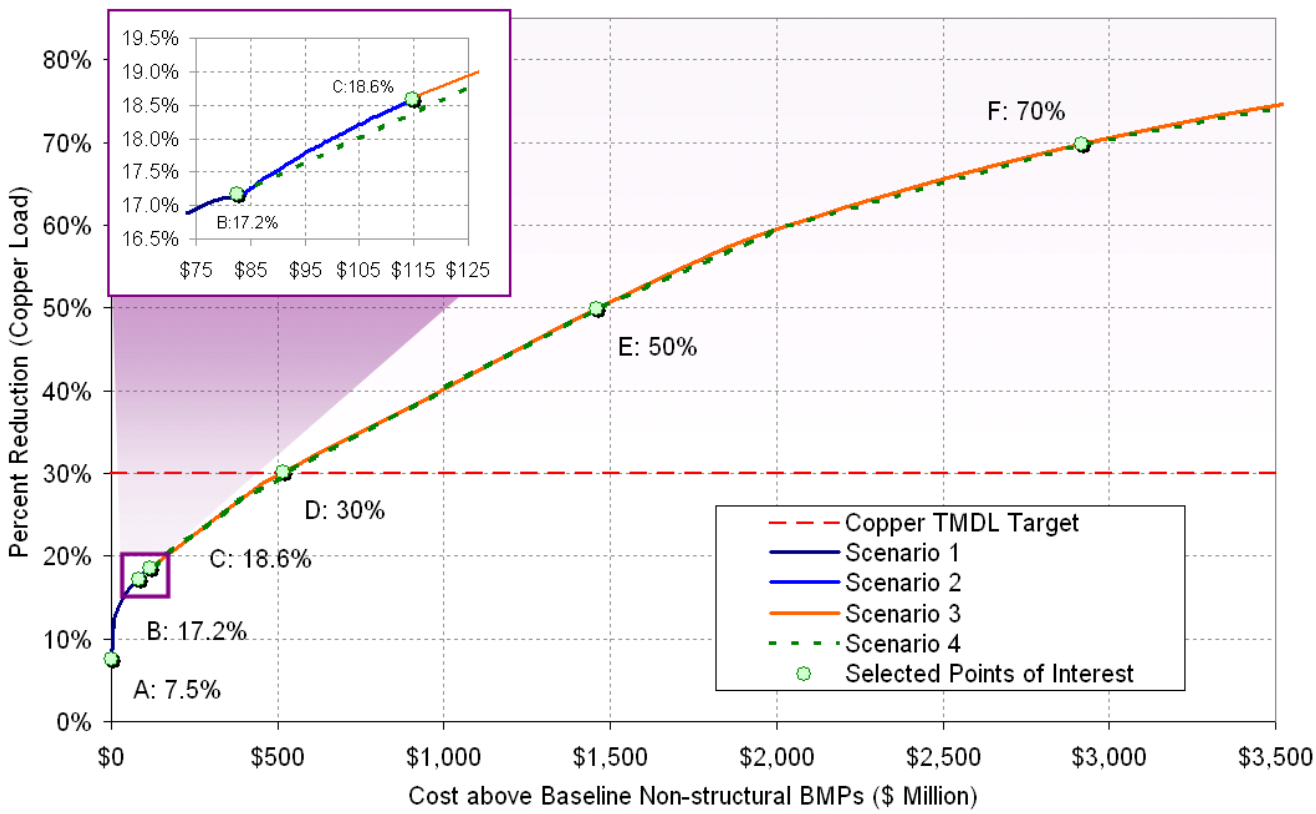

Figure ES-1. Pollutant Reduction vs. Minimum Cost Relationship Derived from Scenarios 1-4

Table ES-5. Costs and Pollutants Reduction of the Selected Solutions Corresponding to Figure ES-1

Pollutants	Existing Load	TMDL Reduction Target (%)	A: Nonstructural + CB Inserts	Scenario 1	Scenario 2	Scenario 3		
				B: Public Central	C: Public Ctrl + Dist	D: Metals TMDL	E	F
Flow Volume (ft^3/yr)	991,014,657	--	1.6%	9%	11%	23%	44%	62%
TSS (lb/yr)	10,518,165	--	2.7%	6%	8%	15%	24%	33%
Copper (lb/yr)	1,502	30%	7.5%	17.2%	18.6%	30%	50%	70%
Lead (lb/yr)	1,232	0%	9.1%	19%	20%	33%	56%	77%
Zinc (lb/yr)	12,854	23%	8.1%	19%	21%	32%	57%	78%
Cadmium (lb/yr)	37.1	0%	1.6%	9%	11%	23%	44%	62%
Fecal Coliform (#/yr)	1.85E+15	--	0.8%	12%	13%	26%	46%	67%

The following conclusions were drawn from the optimization analysis:

- The metals TMDL reduction target (indicated as 30 percent reduction in copper annual load) can be met by implementing centralized BMPs on public and private land.
- Nonstructural BMPs and catch basin inserts are effective at reducing pollutant loads before or as they enter the storm drain system and are recommended for TMDL implementation.
- Implementing structural BMPs solely on public land does not result in meeting the metals TMDL reduction target. Therefore, implementing BMPs on private land is necessary.
- Public centralized BMPs are the most cost-effective options; therefore, they should be implemented first. Public distributed BMPs are the second cost-effective options; however, given the limited public distributed BMP opportunities, it will still be necessary to implement centralized BMPs on private land to achieve TMDL reduction targets.
- Recommendations for private centralized BMPs vary by factors such as infiltration potential and typical rainfall intensity.
- The most cost-effective strategy for meeting WLAs will not include treating 100 percent of the drainage area with structural BMPs, but rather with strategically placed BMPs where their benefits are most realized (e.g., high polluting areas; high infiltration potential for improved BMP functionality).

The optimization results provided the foundation for BMP strategies recommended for phasing of TMDL implementation. Results guided the recommended order and phasing for the structural BMPs and two nonstructural BMPs (reduction in irrigation return flow and improved street sweeping technology). The remaining nonstructural BMPs were placed in implementation phases on the basis of the feasibility of accomplishing a BMP within a phase and the need for achieving a WLAs requirement by a certain date.

The TMDL Implementation Plan provides the timing and planning-level costs for BMPs in the unincorporated County areas of the Los Angeles River watershed. Table ES-6 summarizes the BMP strategies to meet phased WLAs. Currently, none of the BMP strategies identified in this plan are funded, and the implementation of these strategies is subject to the availability of the necessary funding.

This TMDL Implementation Plan is meant to be iterative and adaptive to allow for modifcations and improvements informed by ongoing study of the drainage system, extensive source investigations, emergence of new technologies and methodologies for dry and wet weather treatment, and quantified benefits of BMPs through performance monitoring.

Table ES-6. Recommended TMDL Implementation BMPs

Phase	BMP Type	Quantified In Model	Cost
1	Structural Centralized BMP: G.W. Carver Park – Infiltration Basin	●	$3,630,000
	Structural Centralized BMP: Mona Park – Infiltration Basin	●	$2,680,000
	Structural Centralized BMP: Compton Creek Wetland	●	$8,830,000
	Structural Centralized BMP: Ted Watkins Park (Right) – Infiltration Basin	●	$4,020,000
	Structural Centralized BMP: Belvedere Park – Infiltration Basin	●	$5,640,000
	Structural Centralized BMP: Bethune Park – Infiltration Basin	●	$900,000
	Structural Centralized BMP: Charles White County Park – Infiltration Basin	●	$8,100,000
	Structural Centralized BMP: Farnsworth Park – Infiltration Basin	●	$740,000
	Structural Centralized BMP: Hugo Reid Park – Infiltration Basin	●	$1,570,000
	Structural Centralized BMP: Northside Drive Median	●	$1,050,000
	Structural Centralized BMP: Roosevelt Park – Infiltration Basin	●	$1,950,000
	Structural Centralized BMP: Salazar Park – Infiltration Basin	●	$3,750,000
	Structural Centralized BMP: Ted Watkins Park (Left) – Infiltration Basin	●	$1,480,000
	Nonstructural BMP: Smart Gardening Program Enhancements		$370,000
	Nonstructural BMP: TMDL-Specific Stormwater Training		$320,000
	Nonstructural BMP: Enforcement Escalation Procedures		N/A[a]
	Nonstructural BMP: Enhancement of Commercial and Industrial Facility Inspections		$10,000
	Total Phase 1 Costs		**$45,040,000**
2	Structural Centralized BMP: Magic Johnson Park – Infiltration Basin	●	$7,020,000
	Structural Centralized BMP: Two Strikes Park – Infiltration Basin	●	$4,740,000
	Structural Centralized BMP: Whittier Narrows Park – Infiltration Basin	●	$1,040,000
	Structural Centralized BMP: Whittier Narrows Recreation Area – Infiltration Basin	●	$980,000
	Structural Distributed BMP: Public Roads (1-acre pilot project)	●	$280,000
	Structural Distributed BMP: Catch Basin Inserts Phase 2 (66%)	●	$14,910,000
	Nonstructural BMP: Reduction of Irrigation Return Flow	●	$6,160,000
	Nonstructural BMP: Improved Street Sweeping Technology	●	$9,940,000
	Total Phase 2 Costs		**$45,070,000**
3	Structural Centralized BMP: Enterprise Park – Infiltration Basin	●	$1,370,000
	Structural Centralized BMP: Loma Alta County Park – Infiltration Basin	●	$3,210,000
	Structural Centralized BMP: Obregon Park – Extended Detention	●	$6,730,000
	Structural Distributed BMP: On Publicly Owned Areas (High Infiltration Soils)	●	$7,110,000
	Structural Distributed BMP: On Publicly Owned Areas ((Low Infiltration Soils)	●	$8,090,000
	Structural Distributed BMP: Catch Basin Inserts Phase 3 (34%)	●	$5,860,000
	Structural Centralized BMP: On Private Property – Infiltration Basins	●	$169,660,000
	Total Phase 3 Costs		**$202,030,000**
Total TMDL Implementation Plan Costs			**$292,140,000**

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Acronyms and Abbreviations

AF	acre-feet
AFY	acre-feet per year
ASR	aquifer storage recovery
ASTM	American Society for Testing and Materials
BMP	best management practice
BMPDSS	Best Management Practice Decision Support System
Caltrans	California Department of Transportation
CASQA	California Stormwater Quality Association
CCTV	closed circuit television
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CTR	California Toxics Rule
CWA	Clean Water Act
DCE	dichlorinated ethyelne
DDT	dichlorodiphenyltrichloroethanes
DEM	digital elevation model
EMC	event mean concentration
EPD	Environmental Programs Division
GIS	geographic information system
HSG	hydrologic soil group
HSPF	Hydrologic Simulation Program—FORTRAN
IRWMP	Integrated Regional Watershed Management Plan
LACDPW	County of Los Angeles Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LID	low impact development
LSPC	Loading Simulation Program in C++
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	operation and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	perchloroethylene
PEC	Probable Effect Concentrations
POTW	publicly owned treatment works
PSA	public service announcement
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments

SCCWRP	Southern California Coastal Water Research Project
SSMP	Sewer System Management Plan
SSO	sanitary sewer overflow
SUSMP	Standard Urban Stormwater Mitigation Plan
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TCE	trichloroethylene
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
TRI	Toxics Release Inventory
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WLA	wasteload allocation
WMD	Watershed Management Division
WQO	water quality objective
WRP	water reclamation plant

1. Introduction

This report documents the results of an effort to address impairments in the Los Angeles River watershed with a comprehensive, phased approach of best management practice (BMP) implementation. To develop this plan, BMPs to treat stormwater and dry weather flows to reduce metals, bacteria, nutrients, and toxic pollutants were identified and selected. As part of that process, benefits of management activities were estimated, in terms of pollutant load reductions or improvement in water quality, to meet wasteload allocations (WLAs) defined by approved total maximum daily loads (TMDLs) established for waters within the Los Angeles River watershed. The process of BMP selection included considering cost-effectiveness to provide assurance that the plan is practical and implementable. The plan also includes integrated approaches that consider BMPs that can address multiple pollutants cost-effectively, while considering parallel water resources planning strategies for the watershed.

The report includes background information on the Los Angeles River watershed and its impairments and associated TMDLs (Sections 1 and 2). In Section 3, pollutants and their sources are characterized and evaluated. Section 4 details an evaluation of existing programs, mainly nonstructural in nature, to address the pollutants of concern. Section 5 presents candidate sites for structural BMP implementation, and Section 6 presents a qualitative and quantitative evaluation of different structural and nonstructural BMP management options. Section 7 includes a discussion of the integrated nature of the plan and its relation to other water resources efforts in the region. Section 8 describes the regulatory and permit requirements that might apply to the proposed BMPs and that might affect the timing, feasibility, and cost of management alternatives. Section 9 presents cost estimates for the BMP alternatives, and Section 10 analyzes the alternatives on the basis of a number of criteria, including effectiveness, cost, feasibility, and other factors. Section 11 documents schedules for implementing BMPs to meet phased WLA schedules.

1.1. Geographic Setting

The Los Angeles River flows for 55 miles from the Santa Monica Mountains at the western end of the San Fernando Valley to Queensway Bay between the port of Long Beach and the city of Long Beach. It drains a watershed with an area of 834 square miles (Figure 1). Approximately 44 percent of the watershed area can be classified as forest or open space. Such areas are primarily within the headwaters of the Los Angeles River in the Santa Monica, Santa Susana, and San Gabriel mountains, including the Angeles National Forest, which composes approximately 200 square miles of the watershed. Approximately 36 percent of the land use can be categorized as residential, 10 percent as industrial, 8 percent as commercial, and 3 percent as agriculture, water, and other. The more urban uses are in the lower portions of the watershed (USEPA and LARWQCB 2005).

The natural hydrology of the Los Angeles River watershed has been altered by channelization and the construction of dams and flood control reservoirs. The Los Angeles River and many of its tributaries are lined with concrete for most or all of their lengths. Soft-bottomed segments of the Los Angeles River occur where groundwater upwelling prevented armoring of the river bottom. Those areas typically support riparian habitat.

The mainstem of the Los Angeles River begins, by definition, at the confluence of Arroyo Calabasas (which drains the northeastern portion of the Santa Monica Mountains) and Bell Creek (which drains the Simi Hills). McCoy Canyon Creek and Dry Canyon Creek are tributaries to Arroyo Calabasas. The river flows east from its origin along the southern edge of the San Fernando Valley. The Los Angeles River also receives flow from Browns Canyon, Aliso Creek, and Bull Creek, which drain the Santa Susana Mountains. The lower portions of Arroyo Calabasas and Bell Creek are channelized. Browns Canyon, Aliso Creek, and Bull Creek are completely channelized.

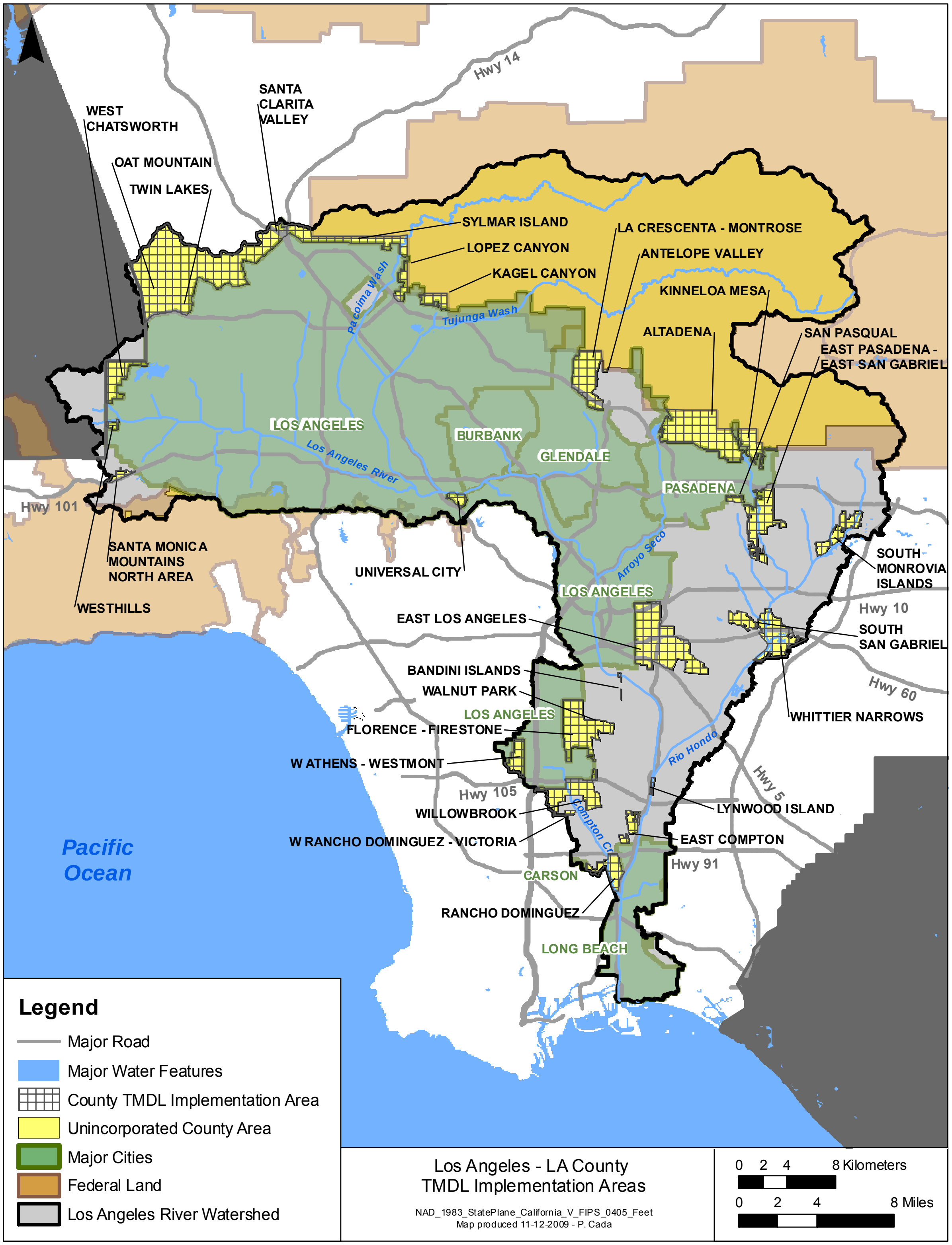

Figure 1. Los Angeles River Watershed with Major Cities, Unincorporated County Areas, and TMDL Implementation Areas

Reach 5 of the Los Angeles River runs through Sepulveda Basin. The Sepulveda Basin is a 2,150-acre open space designed to collect floodwaters during major storms. Because the area is periodically inundated, it remains in natural or semi-natural conditions and supports a variety of low-intensity land uses. The D.C. Tillman Wastewater Reclamation Plant (WRP), a publicly owned treatment works (POTW) operated by the City of Los Angeles, discharges to Reach 5 indirectly via two lakes in the Sepulveda Basin that are used for recreation and wildlife habitat. The POTW has a treatment design capacity of 80 million gallons per day (mgd) and contributes a substantial flow to the Los Angeles River. Most of the POTW flow discharges directly to Reach 4 of the Los Angeles River just below the Sepulveda Dam.

Reach 4 of the Los Angeles River runs from Sepulveda Dam to Riverside Drive. Pacoima Wash and Tujunga Wash are the two main tributaries to this reach. Both tributaries drain portions of the Angeles National Forest in the San Gabriel Mountains. Pacoima Wash is channelized below Lopez Dam to the Los Angeles River. Tujunga Wash is channelized for the 10-mile reach below Hansen Dam. The Tujunga Wash Greenway and Stream Restoration Project diverts the flows from the wash into a 1.5-mile meandering, soft bottom stream. An average of 325,000 gallons per year of stream flow is diverted from the flood control channel to the newly created, natural streambed. Some of the discharge from Hansen Dam is diverted to spreading grounds for groundwater recharge, but most of the flow enters the channelized portion of the stream.

Reach 3 of the Los Angeles River runs from Riverside Drive to Figueroa Street. The two major tributaries to this reach are the Burbank Western Channel and Verdugo, which drain the Verdugo Mountains. Both tributaries are channelized. The Western Channel receives flow from the Burbank WRP, a POTW with a design capacity of 9 mgd.

At the eastern end of the San Fernando Valley, the Los Angeles River turns south around the Hollywood Hills and flows through Griffith Park and Elysian Park in an area known as the Glendale Narrows. This area is fed by natural springs during periods of high groundwater. The river is channelized, and the sides are lined with concrete. The river bottom in this area is unlined because the water table is high, and groundwater routinely discharges into the channel in varying volumes depending on the height of the water table. The Los Angeles-Glendale WRP, operated by the city of Los Angeles, has a design capacity of 20 mgd and discharges to the Los Angeles River in the Glendale Narrows.

Reach 2 of the Los Angeles River runs from Figueroa Street to Carson Street. The first major tributary below the Glendale Narrows is the Arroyo Seco, which drains areas of Pasadena and portions of the Angeles National Forest in the San Gabriel Mountains. In wet periods, rising stream flows in the Los Angeles River above Arroyo Seco have been related to the increase of rising groundwater. There is up to 3,000 acre-feet (AF) of recharge from the Pollock Well Field area that adds to the rising groundwater.

The next major tributary is the Rio Hondo. The Rio Hondo and its tributaries drain a large area in the eastern portion of the watershed. Flow in the Rio Hondo is managed by the Los Angeles County Department of Public Works (LACDPW). During storm events, Rio Hondo flow is composed of both stormwater and treated wastewater effluent from the Whittier Narrows WRP. Monrovia Canyon Creek, in the foothills of the San Gabriel Mountains in the National Forest, is a tributary to Sawpit Creek, which runs into Peck Lake and ultimately to Rio Hondo Reach 2.

Reach 1 of the Los Angeles River runs from Carson Street to the estuary. Compton Creek is the last large tributary to the system before the river enters the estuary. The creek is channelized for most of its 8.5-mile length.

The tidal portion of the Los Angeles River begins at Willow Street and runs approximately 3 miles before joining with Queensway Bay between the port of Long Beach and the city of Long Beach. In this reach, the channel has a soft bottom with concrete-lined sides. Sandbars accumulate in the portion of the river where tidal influence is limited.

During dry weather, most of the flow in the Los Angeles River is composed of wastewater effluent from the Tillman, Los Angeles-Glendale, and Burbank treatment plants. In the dry season, POTW mean monthly discharges contribute 70 to 100 percent of the monthly average flow in the river. The median daily flow in the Los Angeles River is 94 mgd (145 cubic feet per second [cfs]), based on flows measured at the LACDPW Wardlow station over a 2-year period (October 1998 through December 2000). During wet weather, the river's flow can increase by two to three orders of magnitude because of stormwater runoff. Average daily flows greater than 322 mgd (501 cfs) were observed 10 percent of the time. In months with rain events, POTW monthly average discharges together were less than 20 percent of the monthly average flow in the river.

The high flows in the wet season originate as storm runoff both from the areas of undeveloped open space in the mountains of the tributaries' headwaters and from the urban land uses in the watershed's flat, low-lying areas Rainfall in the headwaters flows rapidly because the watershed and stream channels, for the most part, are steep. In the urban areas, about 5,000 miles of storm drains in the watershed convey stormwater flows and urban runoff to the Los Angeles River. The watershed produces storm flow in the river with a sharply peaked hydrograph where flow increases quite rapidly after the beginning of rain events in the watershed and declines rapidly after rainfall ceases.

1.2. History of Impairments and TMDLs

The federal Clean Water Act (CWA) requires the Los Angeles Regional Water Quality Control Board (LARWQCB) to develop water quality objectives (WQOs) to protect beneficial uses for each waterbody in its region. Comparing water quality data to those objectives resulted in the LARWQCB identifying portions of the Los Angeles River and its tributaries as impaired for several pollutant classes. The CWA section 303(d) list identifies a number of water quality limited segments in the Los Angeles River watershed, which are shown in Figure 2. Table 1 summarizes the pollutant/stressor for each segment included in the 1998 and 2008 303(d) lists.

On the basis of the impairments and a 1999 Consent Decree between the U.S. Environmental Protection Agency (USEPA); Heal the Bay, Inc.; and BayKeeper, Inc., USEPA and the LARWQCB were compelled to develop TMDLs for the impaired waters within 13 years of the consent decree. Since then, the LARWQCB approved three TMDLs for the Los Angeles River: metals, nutrients, and trash. The approved TMDLs are reflected in the 2008 303(d) list of impairments summarized in Table 1 (Table 2 and Table 3 summarize the remaining impairments requiring TMDLs). The schedule for developing and approving Basin Plan amendments for the TMDLs varies depending on the pollutants addressed. A summary of each TMDL, along with TMDL effective dates and implementation plan due dates, is included for all Los Angeles River TMDLs in Table 4. Appendix A includes amendments to the Basin Plan to incorporate the TMDLs for the Los Angeles River watershed.

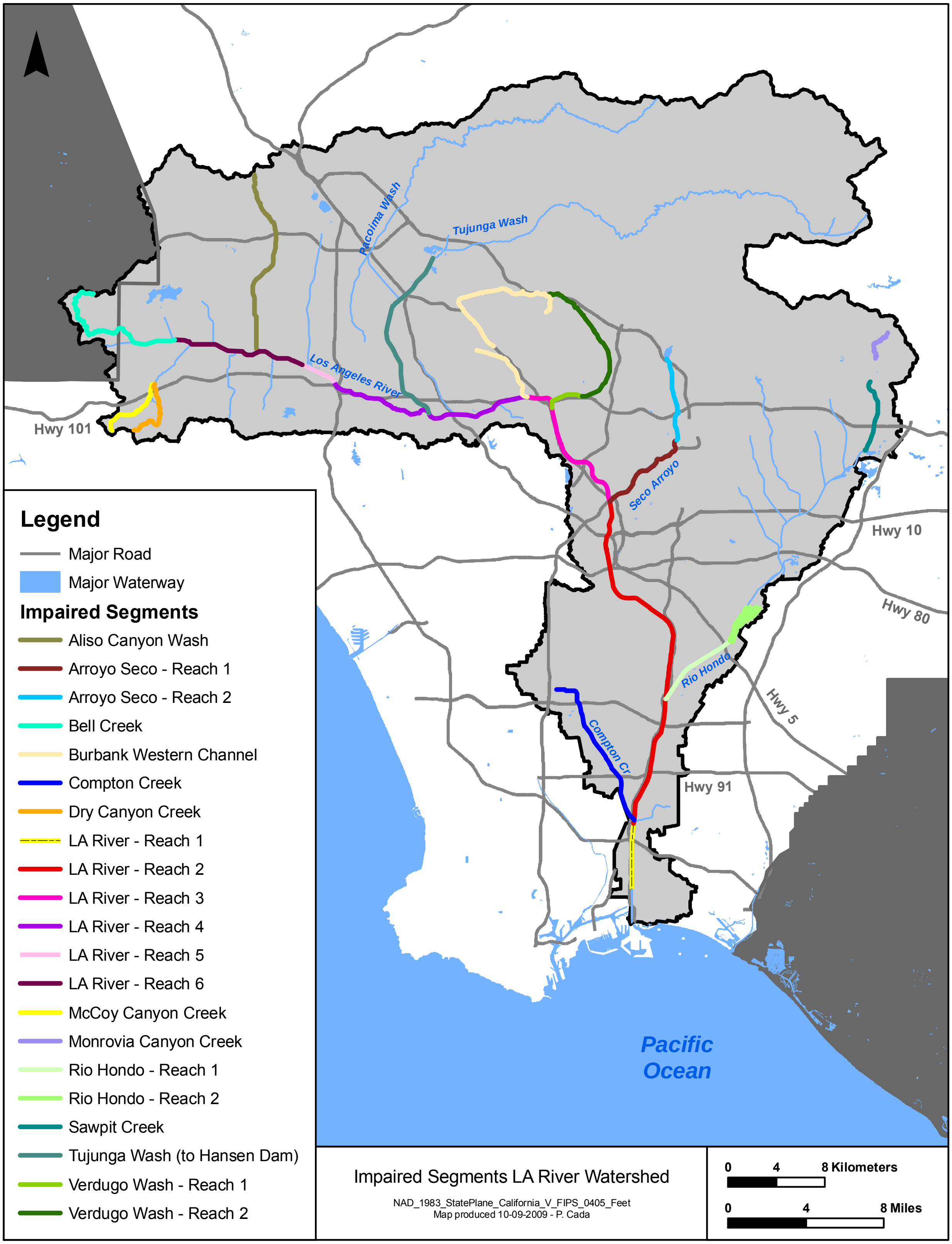

Figure 2. Water Quality Impaired Segments within the Los Angeles River Watershed

Table 1. History of Impairments for the Los Angeles River and its Tributaries—Pollutants with Approved TMDLs

Waterbody	Metals					Nutrients		Trash
	Cadmium	Copper	Lead	Selenium	Zinc	Nutrients (Algae)	Ammonia	
Los Angeles River and Estuary								
Los Angeles River Estuary								2008
Los Angeles River Reach 1	2008	2008	1998/ 2008		2008	1998/ 2008	1998/ 2008	1998/ 2008
Los Angeles River Reach 2		2008	1998/ 2008			1998/ 2008	1998/ 2008	1998/ 2008
Los Angeles River Reach 3		2008	2008			1998/ 2008	1998/ 2008	1998/ 2008
Los Angeles River Reach 4		2008	1998/ 2008			1998/ 2008	1998/ 2008	1998/ 2008
Los Angeles River Reach 5		2008	2008			1998/ 2008	1998/ 2008	1998/ 2008
Los Angeles River Reach 6				2008				
Tributaries								
Aliso Canyon Wash		2008		1998/ 2008				
Arroyo Seco Reach 1						1998		1998/ 2008
Arroyo Seco Reach 2						1998		1998
Burbank Western Channel	1998	2008	2008	2008		1998	1998	1998/ 2008
Compton Creek		1998/ 2008	1998/ 2008					2008
Dry Canyon Creek				2008				
Monrovia Canyon Creek			1998/ 2008					
Peck Road Park Lake			1998/ 2008					1998/ 2008
Rio Hondo Reach 1		1998/ 2008	1998/ 2008		1998/ 2008			1998/ 2008
Rio Hondo Reach 2							1998	
Tujunga Wash		1998/ 2008					1998/ 2008	1998/ 2008
Verdugo Wash Reach 1		2008				1998		1998/ 2008
Verdugo Wash Reach 2						1998		1998/ 2008

Source: 1998 and 2008 CWA section 303(d) lists.

Table 2. History of Impairments for the Los Angeles River and its Tributaries—Toxic Organic Chemicals

Pollutant	Bis(2ethylhexyl)-phthalate (DEHP)	ChemA	Chlordane	Chlorpyrifos	DDT	Diazinon	Dichloroethylene/ 1,1-DCE	PCBs	Tetrachloro-ethylene/PCE	Toxicity	Trichloroethylene/ TCE
Los Angeles River and Estuary											
Los Angeles River Estuary			2008		2008			2008			
Los Angeles River Reach 1						2008					
Los Angeles River Reach 5		1998		1998							
Los Angeles River Reach 6							1998		1998		1998
Tributaries											
Peck Road Park Lake			1998/ 2008		1998/ 2008						
Rio Hondo Reach 1										2008	
Sawpit Creek	2008										

Table 3. History of Impairments for the Los Angeles River and its Tributaries—Other Pollutants and Sediment

Waterbody	Bacteria	Cyanide	Odors	Oil	Organic Enrichment/ Low Dissolved Oxygen	pH	Scum/Foam	Sediment Toxicity
Los Angeles River and Estuary								
Los Angeles River Estuary								2008
Los Angeles River Reach 1	1998/ 2008	2008				1998/ 2008	1998	
Los Angeles River Reach 2	1998/ 2008		1998	1998/ 2008			1998	
Los Angeles River Reach 3			1998				1998	
Los Angeles River Reach 4	1998		1998	2008			1998	
Los Angeles River Reach 5			1998	1998/ 2008			1998	
Los Angeles River Reach 6	1998/ 2008							
Tributaries								
Aliso Canyon Wash	2008							
Arroyo Seco Reach 1[a]	1998/ 2008							
Arroyo Seco Reach 2	1998/ 2008							

Waterbody	Bacteria	Cyanide	Odors	Oil	Organic Enrichment/ Low Dissolved Oxygen	pH	Scum/Foam	Sediment Toxicity
Bell Creek	1998/ 2008							
Burbank Western Channel	2008	2008	1998				1998	
Compton Creek [a]	1998/ 2008					1998/ 2008		
Dry Canyon Creek	2008							
McCoy Canyon Creek	2008							
Peck Road Park Lake			1998/ 2008		1998/ 2008			
Rio Hondo Reach 1	1998/ 2008	2008				1998/ 2008		
Rio Hondo Reach 2	1998/ 2008							
Tujunga Wash	1998/ 2008		1998				1998	
Verdugo Wash Reach 1	1998/ 2008							
Verdugo Wash Reach 2	1998/ 2008							

a. Arroyo Seco Reach 1 and Compton Creek are also impaired for benthic community effects and bioassessments.

Table 4. Approved TMDLs for Segments within the Los Angeles River Watershed

TMDL Parameter Group	Dates	Description
Metals	TMDL Effective: January 11, 2006 October 29, 2008 (revision) TMDL Implementation Plan Due: January 11, 2010	Segments of the Los Angeles River and its tributaries exceed WQOs for multiple metals and have established TMDLs (USEPA and LARWQCB, 2005). Numeric targets were developed for the metals TMDLs on the basis of the WQOs described in the California Toxics Rule (CTR). Metals concentrations in POTW effluent are typically low, but loadings are high because the flows are large. Storm drains contribute the next highest percentage of the loadings. During wet weather, stormwater contributes about 40% of the cadmium loading, 80% of the copper loading, 95% of the lead loading, and 90% of the zinc loading. Metals allocations were developed for upstream reaches and tributaries that drain to the impaired reaches.
Nutrients	TMDL Effective: September 27, 2004 TMDL Implementation Plan Due: N/A	Impaired segments of the Los Angeles River watershed exceed WQOs for ammonia, pH, nutrients (including nitrogen compounds such as nitrite and nitrate), algae, odors, scum/foam, and toxicity. A nitrogen TMDL was developed to restore the Los Angeles River to its full beneficial uses (LARWQCB 2003). The critical condition for this TMDL is low flow (dry weather) during summer. Major point sources of nutrients include three POTWs: Tillman, Burbank and Glendale, which represent approximately 85% of the total nitrogen (TN) loadings to the system. The remaining loads were from other small permitted dischargers, tributary flows, and storm drains. Stormwater was considered a minor source. The source assessment suggests that the concentrations of ammonia, nitrate, and nitrite in runoff from land uses during both dry and wet weather are relatively low. WLAs were defined for stream reaches separate from POTW discharges, but the contributon from municipal separate storm sewer systems (MS4s) was not determined within the TMDL. The TMDL Implementation Schedule outlines a number of monitoring and assessment tasks to better evaluate the nutrient loading from MS4s and the effects on receiving waters. No nutrient load reductions for MS4s are required to meet WLAs. Nitrogen loads from nonpoint sources (does not include MS4 stormwater) were not considered significant. Consequently, load allocations were not developed.
Trash	TMDL Effective: August 28, 2002 September 23, 2008 (revision) Annual Compliance Report Due: March 23, 2009	As part of California's 1996 and 1998 303(d) list submittals, the LARWQCB identified the reaches of the Los Angeles River in the Sepulveda Flood Basin and downstream as being impaired due to trash. Storm drains were identified as a major source of trash. The LARWQCB developed a trash TMDL designed to attain the water quality standards for the Los Angeles River (LARWQCB 2007a). The numeric target for the trash TMDL has been set at zero trash and was derived from narrative WQOs with a margin of safety. The TMDL requires permittees discharging into the river to reduce their trash contribution to these waterbodies by 10% each year with the goal of zero trash by 2016. Permittees can use various methods to meet the reductions prescribed WLAs, including full capture systems, partial capture control systems, or institutional controls.

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2. Objectives of the TMDL Implementation Plan

2.1. Focus of the Plan

The Los Angeles River TMDL Implementation Plan must include implementation methods, a schedule, and proposed milestones to achieve compliance of the TMDL WLAs. Plan development requires identifying and selecting BMPs to treat stormwater or reduce pollutant loads, as well as developing estimates of benefits in terms of load reductions to meet WLAs. However, the BMP selection process must consider the cost-effectiveness to provide assurance that plans are practical and implementable.

The goal of the multi-pollutant implementation plan is to address all current TMDLs, with consideration of future potential TMDLs. The metals and nutrients TMDLs are considered the primary focus of this implementation plan. A secondary focus is placed on trash because reporting on progress toward TMDL implementation occurs annually and through a separate process. However, BMPs that address trash have the potential to provide added benefit in addressing other pollutants, which is assessed in this implementation plan. Total nitrogen (TN) and total phosphorus (TP) source characterizations are provided in the plan, although the nutrient TMDL focuses only on dry weather flows from POTWs and minor point sources. This information can support future initiatives for watershed and BMP planning.

This implementation plan includes integrated approaches that consider BMPs that can address multiple pollutants in stormwater and storm drain flows cost-effectively. Additional benefits of BMPs, such as water storage/recharge and reuse, providing recreation space, improved natural habitat, and such, are considered in this implementation plan.

This implementation plan describes management options that are limited to unincorporated Los Angeles County (County) areas outside federal lands. This area is often termed the *County TMDL Implementation Area* in this report and is represented as the yellow areas in Figure 3 (major and minor waterways in Figure 3 include both streams and the storm drain network). . Some of the proposed nonstructural or programmatic BMPs, such as staff training or education programs, could apply countywide.

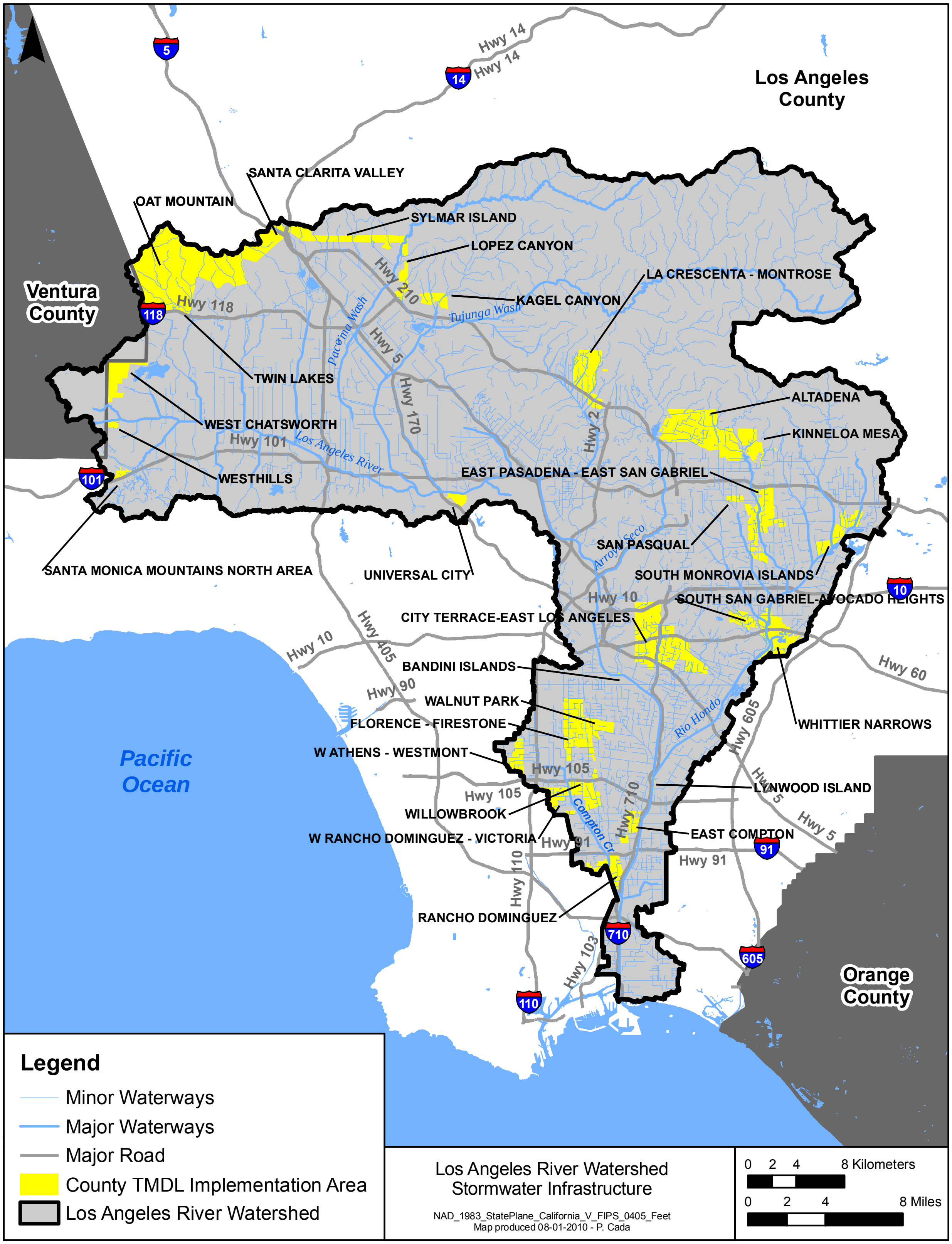

Figure 3. County TMDL Implementation Area and Major and Minor Waterways, Including the Storm Drain Network

2.2. TMDL Targets

Key factors influencing the level of BMP implementation are the stormwater management targets expected to be achieved. For this project, multiple TMDLs and associated WLAs for stormwater runoff have been established for the Los Angeles River, which must be considered as a priority for developing the multi-pollutant TMDL implementation plan. The following provides a summary of applicable wet and dry weather TMDL WLAs and implementation requirements, and methods for translating the requirements into management targets to address wet weather pollution.

2.2.1. Metals

The Los Angeles River metals TMDL includes WLAs for both wet and dry weather, expressed as flow/volumes multiplied by applicable numeric concentration targets. The following summarizes those WLAs and associated implementation schedules.

Wet Weather Metals WLA

For the Los Angeles River metals TMDL (USEPA and LARWQCB 2005), allowable loads to the Los Angeles River and tributaries were based on the CTR and locally derived particulate/dissolved conversion factors. Wet weather WLAs were established for total recoverable cadmium, copper, lead, and zinc. The total wet weather loading capacities are stated as follows:

- Total recoverable cadmium (kg/day): 3.1×10^{-9} (3.1 micrograms per liter [µg/L]) × daily volume (L)
- Total recoverable copper (kg/day): 1.7×10^{-8} (17 µg/L) × daily volume (L)
- Total recoverable lead (kg/day): 6.2×10^{-8} (62 µg/L) × daily volume (L)
- Total recoverable zinc (kg/day): 1.59×10^{-7} (159 µg/L) × daily volume (L)

Additional load allocations and WLAs were established in the TMDL for POTWs, open space, and direct air deposition, which were subtracted from the above loading capacities for determining remaining WLAs for permitted stormwater discharges. WLAs for the MS4s and other permitted stormwater sources (e.g., Caltrans, the general industrial permit, or the general construction permit) were then apportioned on the basis of percent of area of the watershed. The resulting MS4 wet weather WLAs were reported as follows:

- Total recoverable cadmium (kg/day): 2.8×10^{-9} × daily volume (L) – 1.8
- Total recoverable copper (kg/day): 1.5×10^{-8} × daily volume (L) – 9.5
- Total recoverable lead (kg/day): 5.6×10^{-8} × daily volume (L) – 3.85
- Total recoverable zinc (kg/day): 1.4×10^{-7} × daily volume (L) – 83

The WLAs for the County TMDL Implementation Area can be determined based on the CTR numeric targets and stormwater runoff volume discharging from the County TMDL Implementation Area (with unit conversion). These calculations can be based on the same equations previously presented for loading capacity calculations for Los Angeles River and tributaries, except daily volumes are from stormwater discharging only from the County TMDL Implementation Area. The result will be a total allowable daily load of each metal during storms, which can be used to calculate annual loads.

Dry Weather Metals WLA

Consistent with wet weather, the Los Angeles River metals TMDL (USEPA and LARWQCB 2005) expresses allowable loads based on the CTR and locally derived particulate/dissolved conversion factors. The numeric targets varied for different reaches and pollutants, as summarized in Table 5. Dry weather WLAs were established for total recoverable copper, lead, zinc, and selenium. The total dry weather WLAs assigned to the County TMDL Implementation Area are stated as follows (with unit conversion):

Total recoverable metal (kg/day): dry weather numeric target × daily volume (L) (equation 1)

Although TMDLs were established for selenium for dry weather, the Los Angeles River metals TMDL (USEPA and LARWQCB 2005) states that exceedances of the selenium numeric targets are confined to the upper reaches of the watershed and tributaries draining to Reach 6, and because of limited industrial activity in these areas, the sources of selenium are believed to result from natural sources such as marine shales. Separate studies are underway to evaluate whether selenium levels represent a natural condition for this watershed. The LARWQCB will re-consider the TMDL and associated WLAs by January 11, 2011 based on results of this and other studies recommended in the TMDL report. In the meantime, no dry weather WLAs for selenium are assigned to the MS4 permittees (USEPA and LARWQCB 2005). Therefore, this TMDL Implementation Plan does not address selenium for dry weather flows from the County TMDL Implementation Area.

Table 5. TMDL Dry Weather Numeric Targets for Los Angeles River and Tributaries (Total Recoverable Metals)

Waterbody	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)	Selenium (µg/L)
Los Angeles River				
Los Angeles River Reach 1	23	12		
Los Angeles River Reach 2	22	11		
Los Angeles River Reach 3 (above Los Angeles-Glendale Water Reclamation Plan [WRP] and Verdugo)	23	12		
Los Angeles River Reach 3 (below Los Angeles-Glendale WRP)	26	12		
Los Angeles River Reach 4	26	10		
Los Angeles River Reach 5	30	19		5
Los Angeles River Reach 6	30	19		5
Tributaries				
Arroyo Seco	22	11		
Bell Creek	30	19		5
Burbank Western Channel (above WRP)	26	14		
Burbank Western Channel (below WRP)	19	9.1		
Compton Creek	19	8.9		
Monrovia Canyon		8.2		
Rio Hondo Reach 1	13	5	131	

2.2.2. Nutrients

The Los Angeles River nutrients TMDL specifies WLAs for POTWs and minor point sources only, not for stormwater and urban runoff from MS4 permittees.

2.2.3. Trash

The trash TMDL provides zero allowable load. The trash reduction requirements are being addressed by the County's full capture device installation program, which is in progress with a separate implementation planning and reporting process.

2.3. TMDL Implementation Schedule

The Los Angeles River TMDLs include schedules for attaining associated WLAs, which vary for each pollutant and, in some cases, for wet and dry weather conditions. This TMDL implementation plan's purpose is to outline an integrated water resources approach, taking advantage of parallel watershed planning initiatives, and providing overall responsible management of water resources affected by stormwater from the County TMDL Implementation Area.

For the metals WLAs, different implementation schedules are defined for wet and dry weather. The metals implementation schedules are based on phases expressed as the percent of total drainage area served by the MS4 that is effectively meeting the WLAs. The phases can be considered as interim goals for developing strategies to address TMDL implementation. A summary of the Los Angeles River WLAs and associated compliance schedules are in Table 6.

Table 6. WLA Implementation Schedules for Los Angeles River TMDLs

TMDL	Condition	Interim Phased Implementation	Final Compliance
Metals	Wet weather	October 29, 2012: 25% of total drainage area October 29, 2024: 50% of total drainage area	October 29, 2028: 100% of total drainage area
	Dry weather	October 29, 2012: 50%of total drainage area October 29, 2020: 75% of total drainage area	October 29, 2024: 100% of total drainage area
Nutrients	N/A	N/A	N/A
Trash[a]	N/A	September 30, 2009: 50% of baseline WLA 10% incremental reduction of baseline WLA annually thereafter	September 30, 2016: zero trash

a. Trash TMDL is addressed in a separate implementation plan.

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3. Pollutant Source Characterization and Prioritization

This section identifies the potential sources of the pollutants of concern derived from both point and nonpoint sources. The discussion is provided in several parts: modeling results, specific pollutant sources, and a source prioritization. Watershed monitoring summaries are presented for reference in Appendix B. The focus of this characterization and prioritization is primarily within the County TMDL Implementation Area. Both wet and dry conditions are discussed. The County is not responsible for alleviating or reducing pollutants resulting from many of the sources discussed in this section.

3.1. Pollutant Loading Analysis

3.1.1. Wet Weather Loading

Through a joint effort of the LARWQCB, USEPA, Southern California Coastal Water Research Project (SCCWRP), and Tetra Tech, a regional modeling approach was developed to simulate the hydrology and transport of sediment and metals. The approach is based on the Hydrologic Simulation Program–FORTRAN (HSPF) and Loading Simulation Program C++ (LSPC), a version of HSPF recoded into C++. The regional approach has been used to support metals TMDLs for Ballona Creek and the Los Angeles River.

The County is consolidating and modifying the models to support development of the BMP Decision Support System (BMPDSS). Each model of County watersheds is being converted to a single, consistent model version of LSPC to serve as a foundation for addressing watershed management needs. The LSPC watershed modeling system simulates hydrology, sediment, and general water quality on land and is combined with a stream fate and transport model. Wet weather loading estimates were developed for the unincorporated County areas using the modeled constituents including copper, zinc, lead, TN, TP, fecal coliform, and total suspended solids (TSS). The results in terms of average annual loads (based on a 10-year simulation) are provided in Table 7. Results represent runoff-based loads by unincorporated County areas. The model includes flows from all sources within the unicorporated County areas, including NPDES permitted flows, road infrastructure, atmospheric deposition, waste sites, sanitary sewers and agricultural operations.

Table 7. Wet Weather Loading by Community

Community	Total Area (acres)	Total Load (lbs/yr)							
		TN	TP	Copper	Zinc	Lead	Fecal Coliform[a]	TSS[b]	PAHs
Altadena	4,251	22,037	16,287	189	1,368.2	143.8	2.90E+14	284	22.36
Bandini Islands	30	189	103	2	20.5	1.8	6.36E+11	3.1	0.08
East Compton	527	2,297	1,822	27	220.2	23.5	3.65E+13	35.3	2.64
City Terrace – East Los Angeles	4,762	21,172	16,413	217.9	1,980.3	195.8	3.53E+14	289.2	21.27
East Pasadena - East San Gabriel	2,256	9,404	7,294	87.7	749.9	76.4	1.58E+14	119.7	10.40
Florence - Firestone	2,270	7,018	5,717	74.8	723.2	67.1	1.33E+14	100.4	7.66
Kagel Canyon	542	540	514	6.5	53.7	5.2	2.06E+13	12.9	0.39
Kinneloa Mesa	884	1,920	1,076	22	69.6	7.7	1.76E+13	56.8	0.50
La Crescenta – Montrose[c]	2,147	11184	8074	100.7	752.9	76.4	1.33E+14	188.1	21.94
Lopez Canyon	702	1,485	1,139	13.4	128.7	9.3	2.92E+13	30.4	0.96
Lynwood Island	83	420	254	3.4	37.1	2.1	2.84E+12	7.1	0.27
Oat Mountain	10,968	7,789	4,688	107.9	528.6	30.6	1.20E+14	695.8	1.86
Rancho Dominguez	968	3,749	2,491	29.4	331.9	19.5	3.26E+13	57.7	5.20
San Pasqual	164	801	621	7.5	63.8	6.8	1.07E+13	9.7	0.96
Santa Clarita Valley	1,026	1,445	828	12.1	98.7	9.1	2.90E+13	30.7	34.13
Santa Monica Mountains North Area	241	798	708	9.6	79.9	7	3.16E+13	17.1	0.62
South El Monte Island	2.6	12	16	0.2	1.9	0.2	7.87E+11	0.2	0.01
South Monrovia Islands	1,065	4,438	3,434	40.1	352.4	36.6	5.39E+13	53.2	5.67
South San Gabriel – Avocado Heights	970	3,189	2,414	20.3	186.3	18.6	5.92E+13	28	3.36
Sylmar Island	909	965	507	4.5	23	1.1	3.66E+12	29	0.15
Twin Lakes	46	114	85	1.3	7.5	0.8	1.79E+12	2.6	0.14
Universal City	301	364	187	3.7	17.1	0.7	9.27E+11	30	0.04
W. Athens - Westmont	742	2,430	1,986	25.8	244.5	24.7	3.54E+13	33	7.01
W. Rancho Dominquez - Victoria	833	1,994	1,630	20.5	193.7	19.2	3.35E+13	26.3	7.47
Walnut Park	480	1,319	1,152	14.7	136.8	14.2	2.65E+13	17.6	1.81
West Chatsworth	1,239	1,402	985	30.3	154.6	10.8	1.50E+13	187.1	1.37
Westhillls	142	310	223	2.8	21	2.1	3.19E+12	5.8	0.31
Whittier Narrows	1,612	3,166	1,884	15.4	143.1	10.6	6.40E+13	28.6	2.97
Willowbrook	1,075	3,136	2,393	32.6	314.4	30.2	4.07E+13	44	3.54
Totals	41,238	115,087	84,925	1,123	9,004	852	1.74E+15	2,423	165

a. Units are in #/year
b. Units are in tons/year
c. Includes Antelope Valley

A different method was used to develop loading estimates for chlordane, dichlorodiphenyltrichloroethanes (DDT), polychlorinated biphenyls (PCBs), selenium, cadmium, and polycyclic aromatic hydrocarbons (PAHs), because these constituents are not modeled. Total PAH loads by community were developed using surface runoff from the watershed model and event mean concentrations (EMCs) by land use developed by Stein et al. (2006). Cumulative loads for the County TMDL Implementation Areas were developed for the remaining parameters (Table 8). The loads for chlordane, DDT, and PCBs were based on the total TSS load from all County TMDL Implementation Areas in the Los Angeles River watershed with applicable sediment concentrations reported in *Watershed Model Development for Simulation of Loadings to the Los Angeles/Long Beach Harbors* (USEPA and LARWQCB 2006). The values from the Los Angeles River Estuary were selected. Cadmium and selenium loads were based on total modeled surface flow multiplied by EMC values at the mass emissions site.

Table 8. Total Wet Weather Loading Estimate

Pollutant	Pollutant Load (lb/yr)
Chlordane	4.08E-05
DDT	1.06E-03
PCBs	2.94E-03
Cadmium	25.09
Selenium	334.00

In most cases, the highest total pollutant loads are associated with larger communities: Altadena, City Terrace – East Los Angeles, East Pasadena – East San Gabriel, La Crescenta – Montrose, and Oat Mountain. Among those, Oat Mountain tends to have the lowest loads of most pollutants because of the large amount of vacant land. That community does, however, have the highest TSS total loading among all communities. The two communities with the greatest loads of nutrients, metals, and fecal coliform are Altadena and City Terrace – East Los Angeles.

Area-based loads (pollutant per acre) were also developed on the basis of the modeling results and are displayed in Figure 4 through Figure 11. In the case of nutrients, metals, and bacteria, many of the same hot spots in terms of total loading also have high per acre loads with the exception of Oat Mountain.

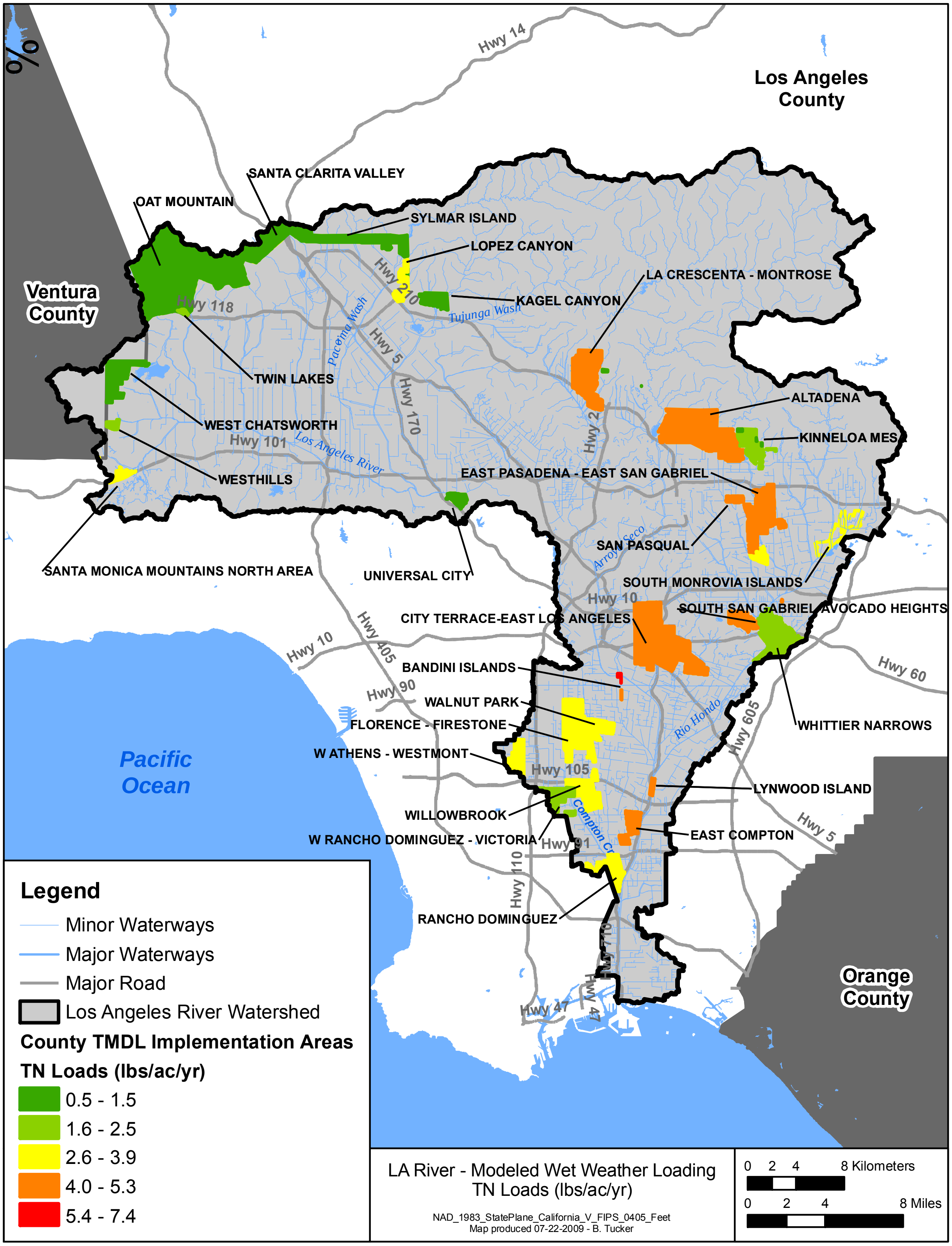

Figure 4. Wet Weather Loading—TN

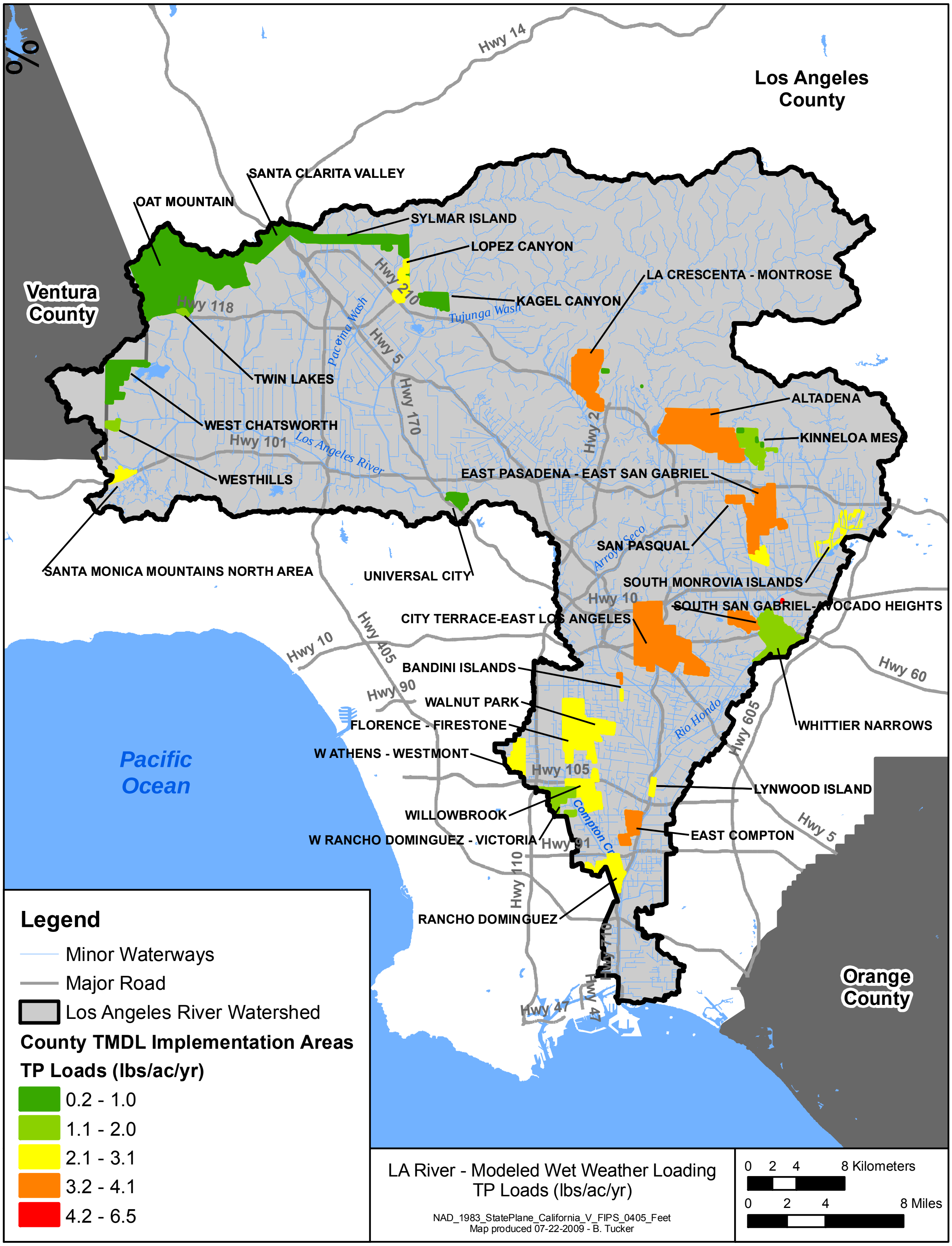

Figure 5. Wet Weather Loading—TP

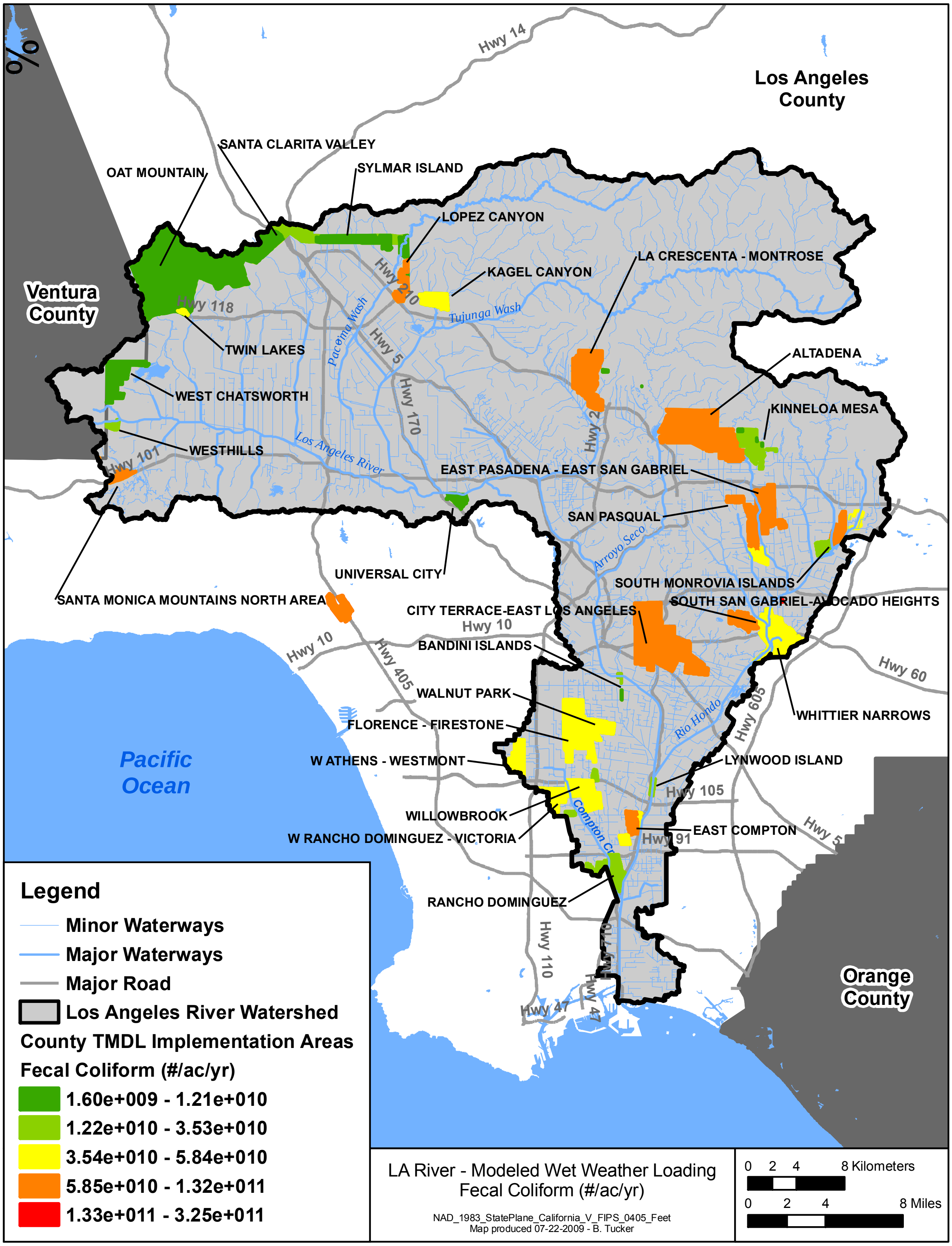

Figure 6. Wet Weather Loading—Fecal Coliform

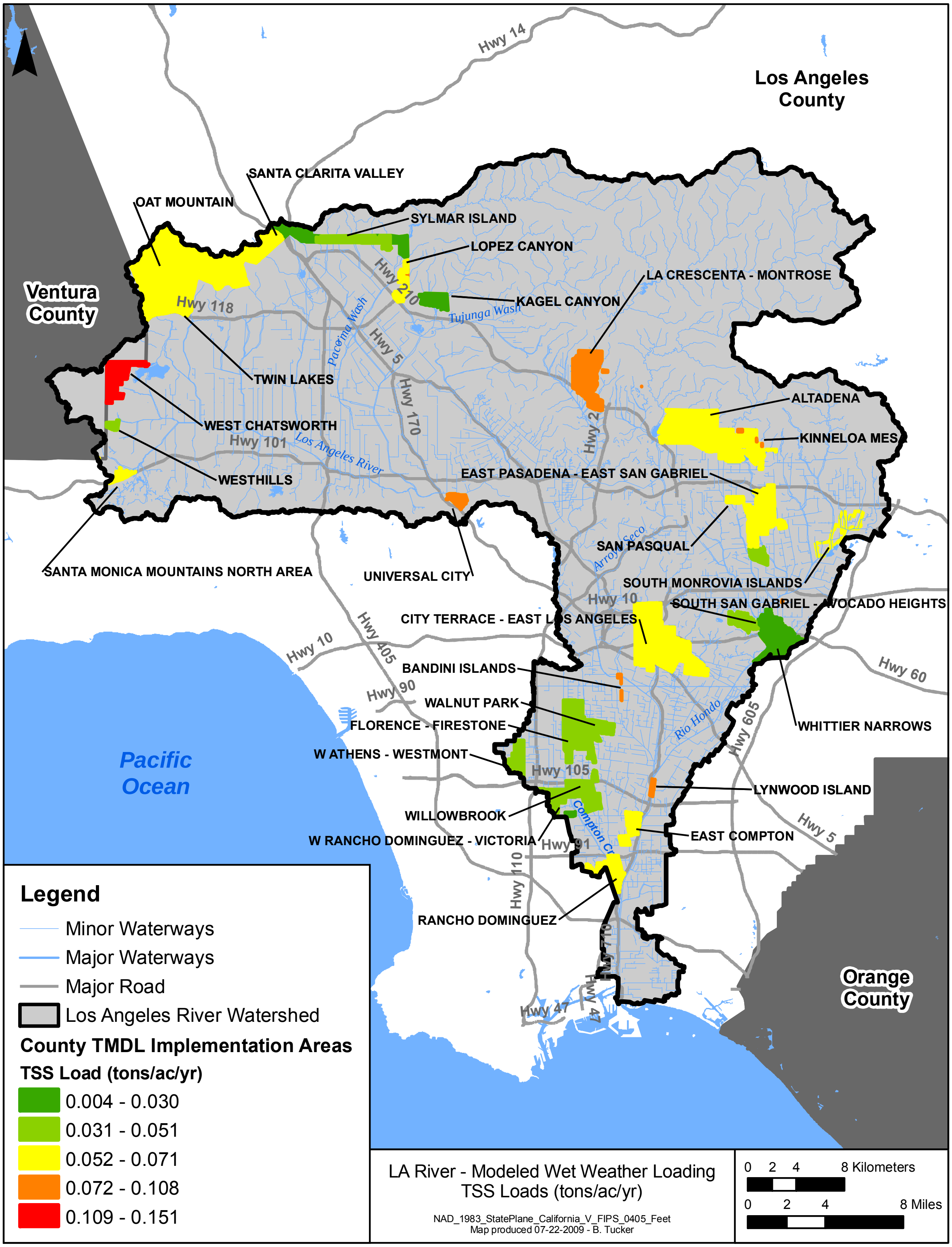

Figure 7. Wet Weather Loading—TSS

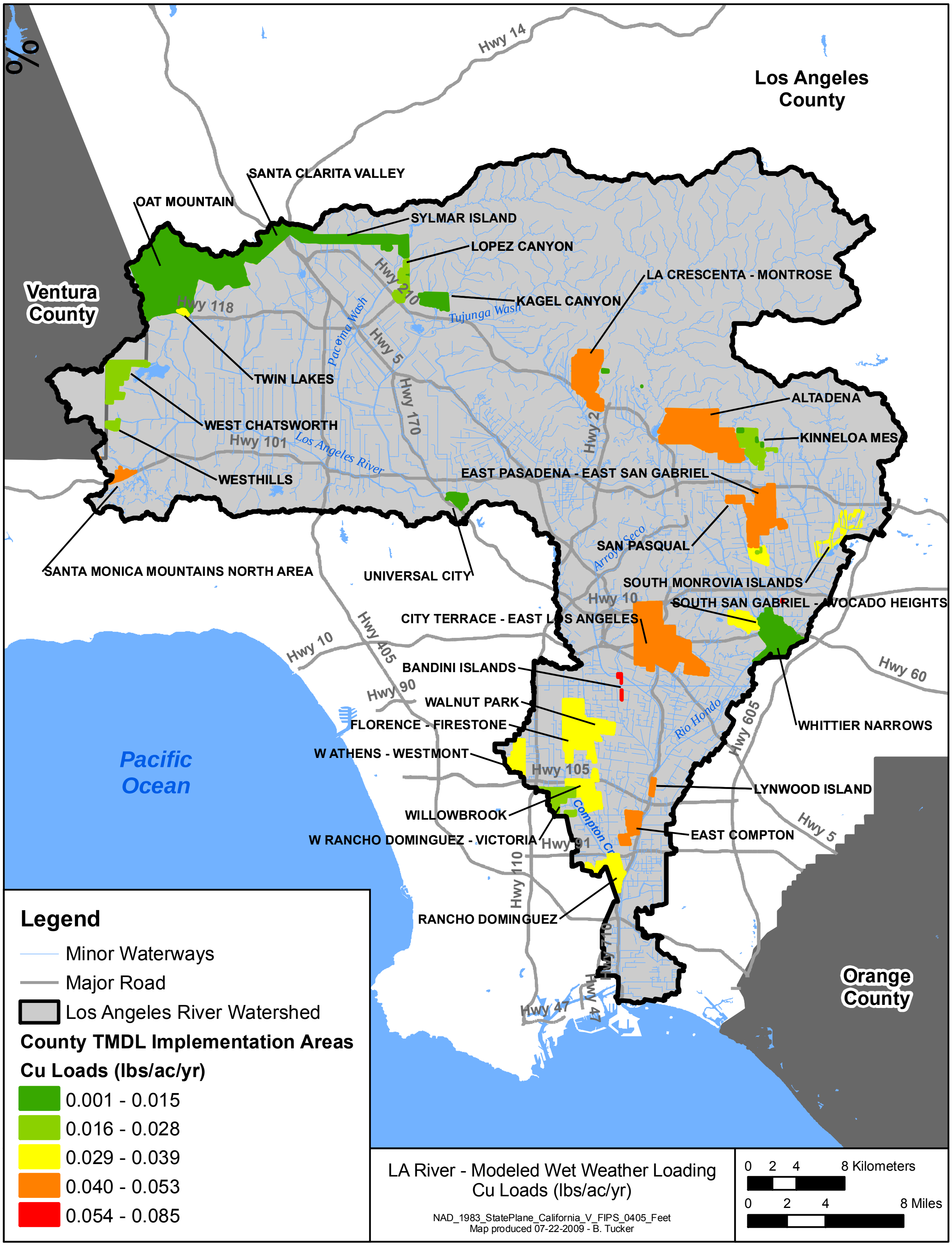

Figure 8. Wet Weather Loading—Copper

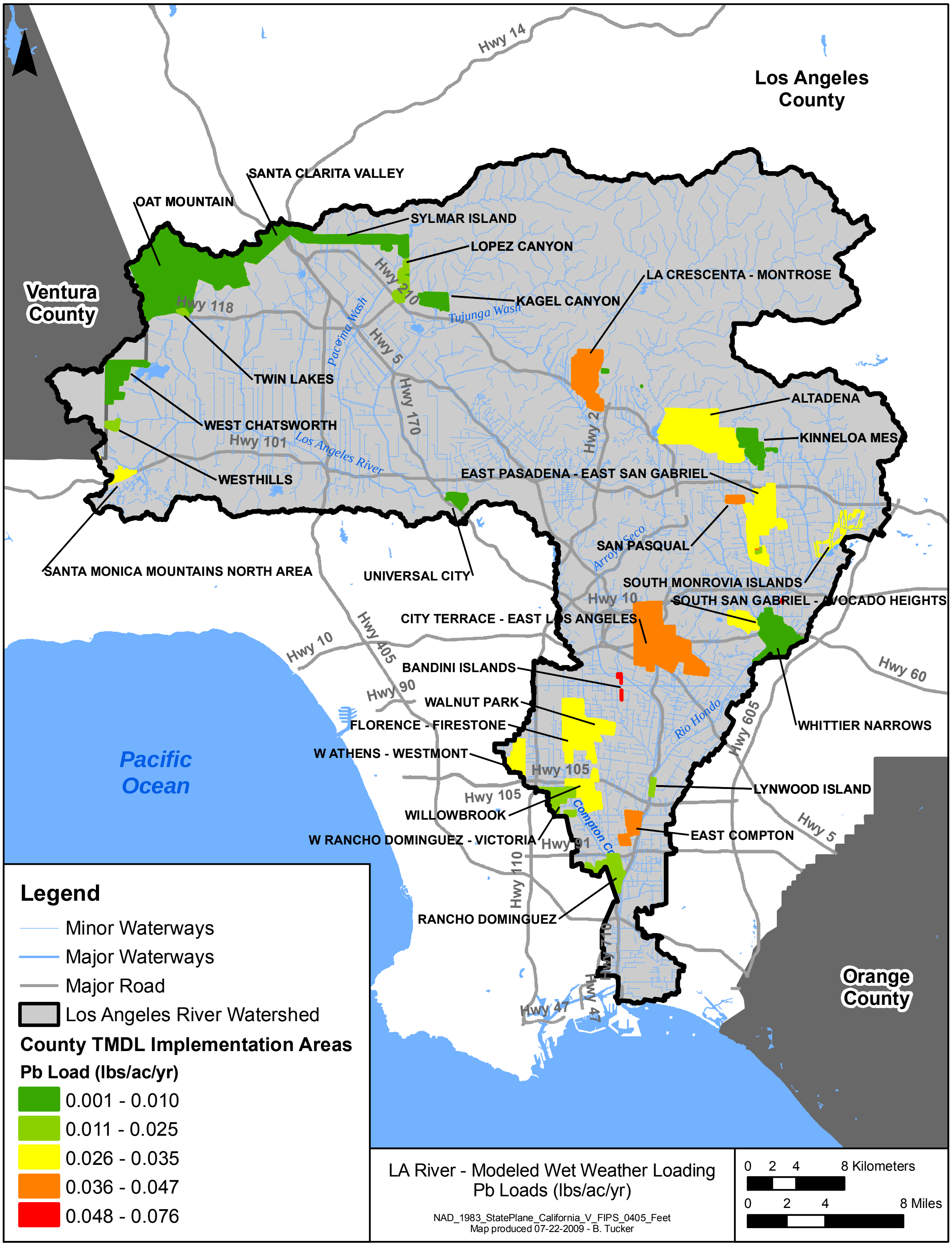

Figure 9. Wet Weather Loading—Lead

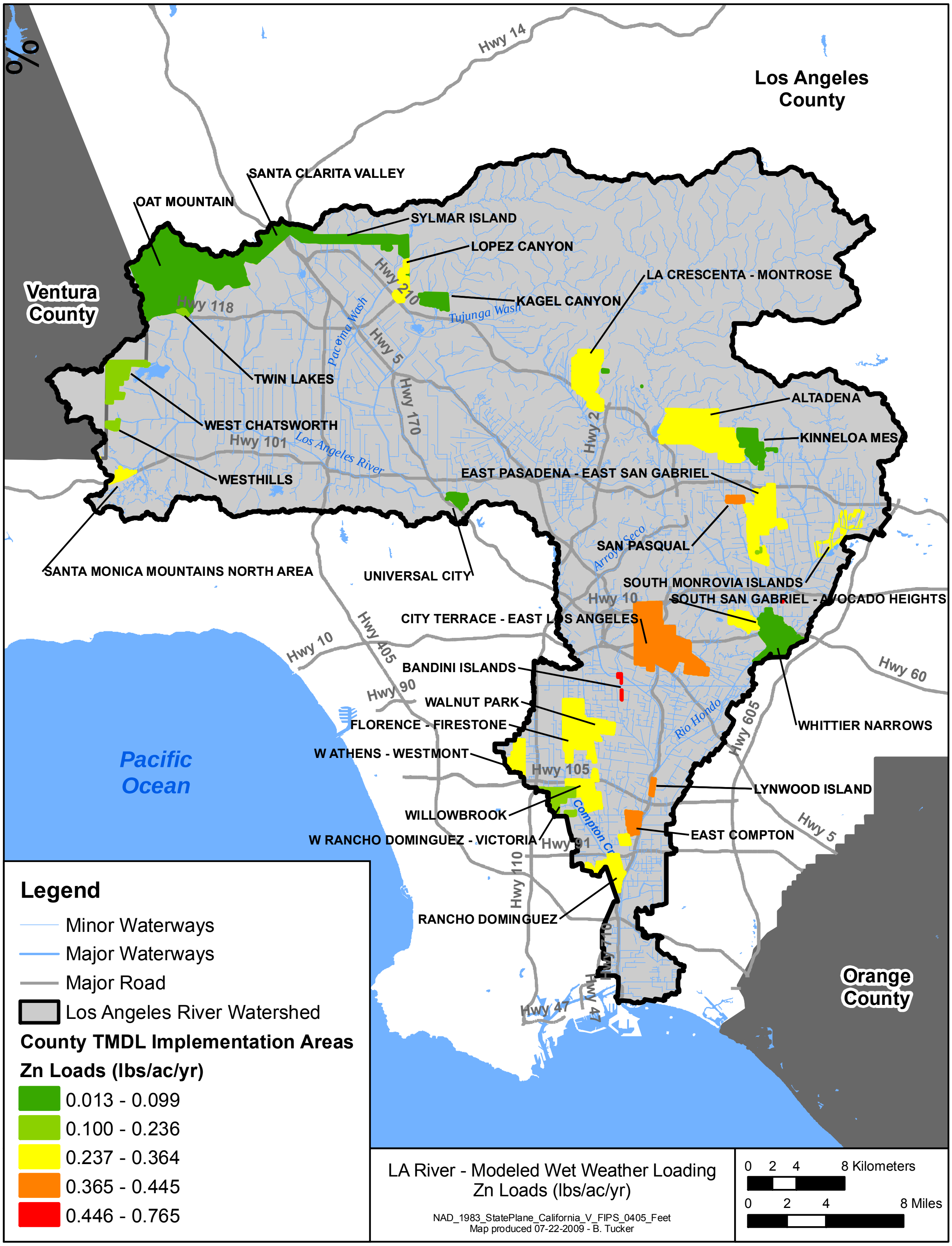

Figure 10. Wet Weather Loading—Zinc

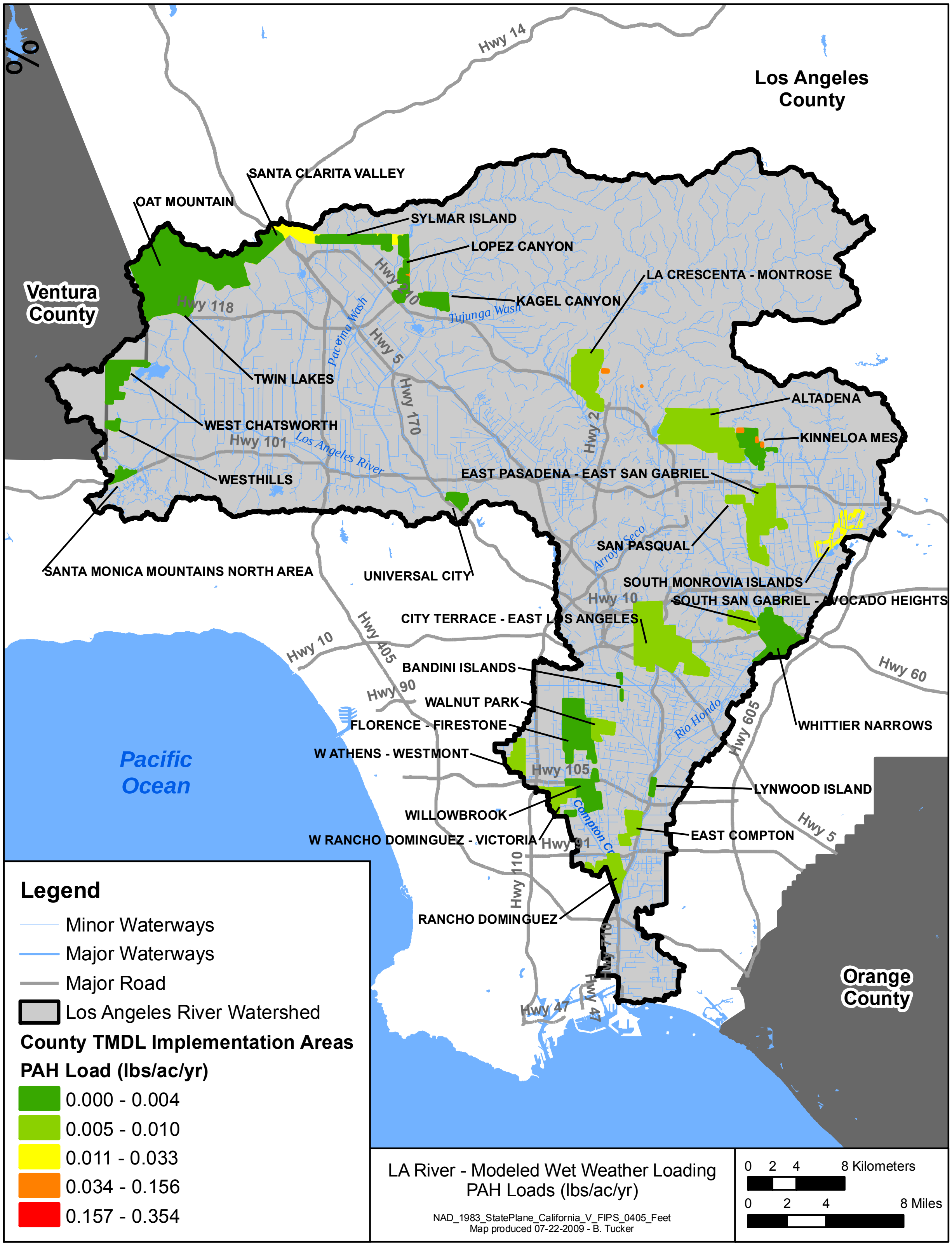

Figure 11. Wet Weather Loading—Total PAHs

3.1.2. Dry Weather Loading

Dry weather can also be a source of pollutant loading. Modeling dry weather flows has been shown to be difficult (Ackerman et al. 2005); therefore, dry weather loadings from unincorporated County areas were assessed using a combination of non-modeling techniques. Models have been developed for the Los Angeles River TMDLs for dry conditions; however, they provide an assessment of only the assimilative capacity of the waterbodies and not enough information to fully characterize dry weather pollutant sources. As part of the modeling for the Los Angeles and Long Beach Harbors (USEPA and LARWQCB 2006), a linear regression was developed that relates dry weather flows to urban land use (and excludes POTW flows but includes other sources such as NPDES permitted sources) using a regional comparison of dry weather flows by Stein and Ackerman (2007). The following equation describes this relationship.

$$Flow = 0.0024 \times (UrbanArea) \qquad \text{(equation 2)}$$

Where, *Flow* is in cubic meters per second (m^3/s) and *UrbanArea* is the sum of commercial, residential (high and low density), industrial, and mixed urban land uses in square kilometers (km^2).

Estimates of dry weather pollutant loading from urban land uses by community were based on estimated flows using equation 2 and assigned typical concentrations appropriate for the Los Angeles River watershed (Table 9). Concentrations were taken from Table 7 (Los Angeles River watershed mean storm drain concentrations) in Stein and Ackerman (2007). It should be noted that the concentrations used are not based on actual dry weather monitoring of the unincorporated County areas. The results follow similar trends as the wet weather loading estimates, but they should be understood in light of the difficulty in predicting dry weather loading.

Note that dry weather loadings of toxics and cadmium are not provided. There are typically very low or undetectable concentrations of these constituents during dry weather according to monitoring conducted to date. Therefore, loading is assumed to be zero for the purposes of this document during such periods.

Table 9. Dry Weather Annual Loading

Community Name	Area of Urban Land (acres)	Flow (m^3/s)	TSS (lbs/yr)	Copper (lbs/yr)	Lead (lbs/yr)	Zinc (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	Fecal Coliform (#/yr)
Concentrations			208 mg/L	25 µg/L	0.8 µg/L	122 µg/L	2 mg/L	0.6 mg/L	893.3 MPN/100mL
Altadena	4,090	0.0397	5.74E+05	69.0	2.2	336.9	5,523.6	1,657.1	1.12E+13
Bandini Islands	30	0.0003	4.21E+03	0.5	0.0	2.5	40.5	12.2	8.21E+10
City Terrace – East Los Angeles	4,644	0.0451	6.52E+05	78.4	2.5	382.6	6,271.7	1,881.5	1.27E+13
East Compton	523	0.0051	7.35E+04	8.8	0.3	43.1	706.3	211.9	1.43E+12
East Pasadena – East San Gabriel	2,177	0.0211	3.06E+05	36.8	1.2	179.3	2,940.0	882.0	5.96E+12
Florence – Firestone	2,224	0.0216	3.12E+05	37.5	1.2	183.2	3,003.5	901.1	6.09E+12
Kagel Canyon	114	0.0011	1.60E+04	1.9	0.1	9.4	154.0	46.2	3.12E+11
Kinneloa Mesa	550	0.0053	7.72E+04	9.3	0.3	45.3	742.8	222.8	1.50E+12
La Crescenta – Montrose	1,690	0.0164	2.37E+05	28.5	0.9	139.2	2,282.3	684.7	4.62E+12
Lopez Canyon	255	0.0025	3.58E+04	4.3	0.1	21.0	344.4	103.3	6.98E+11

Community Name	Area of Urban Land (acres)	Flow (m^3/s)	TSS (lbs/yr)	Copper (lbs/yr)	Lead (lbs/yr)	Zinc (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	Fecal Coliform (#/yr)
Lynwood Island	76	0.0007	1.07E+04	1.3	0.0	6.3	102.6	30.8	2.08E+11
Oat Mountain	1,065	0.0103	1.50E+05	18.0	0.6	87.7	1,438.3	431.5	2.91E+12
Rancho Dominguez	932	0.0091	1.31E+05	15.7	0.5	76.8	1,258.7	377.6	2.55E+12
San Pasqual	164	0.0016	2.30E+04	2.8	0.1	13.5	221.5	66.4	4.49E+11
Santa Clarita Valley	240	0.0023	3.37E+04	4.1	0.1	19.8	324.1	97.2	6.57E+11
Santa Monica Mountains North Area	151	0.0015	2.12E+04	2.5	0.1	12.4	203.9	61.2	4.13E+11
South El Monte Island	2	0.0000	2.81E+02	0.0	0.0	0.2	2.7	0.8	5.47E+09
South Monrovia Islands	1,059	0.0103	1.49E+05	17.9	0.6	87.2	1,430.2	429.1	2.90E+12
South San Gabriel – Avocado Heights	884	0.0086	1.24E+05	14.9	0.5	72.8	1,193.8	358.2	2.42E+12
Sylmar Island	101	0.0010	1.42E+04	1.7	0.1	8.3	136.4	40.9	2.76E+11
Twin Lakes	36	0.0003	5.06E+03	0.6	0.0	3.0	48.6	14.6	9.85E+10
Universal City	250	0.0024	3.51E+04	4.2	0.1	20.6	337.6	101.3	6.84E+11
W Athens – Westmont	742	0.0072	1.04E+05	12.5	0.4	61.1	1,002.1	300.6	2.03E+12
W Rancho Dominguez – Victoria	805	0.0078	1.13E+05	13.6	0.4	66.3	1,087.2	326.1	2.20E+12
Walnut Park	477	0.0046	6.70E+04	8.1	0.3	39.3	644.2	193.3	1.31E+12
West Chatsworth	208	0.0020	2.92E+04	3.5	0.1	17.1	280.9	84.3	5.69E+11
Westhills	76	0.0007	1.07E+04	1.3	0.0	6.3	102.6	30.8	2.08E+11
Whittier Narrows	1,394	0.0135	1.96E+05	23.5	0.8	114.8	1,882.6	564.8	3.81E+12
Willowbrook	1,056	0.0103	1.48E+05	17.8	0.6	87.0	1,426.1	427.8	2.89E+12
Total		0.025	3.7E+06	439	14	2,143	35,133	10,540	7.1E+13

3.2. Pollutant Source Characterization

The locations and density of pollutant sources in the watersheds are keys to understanding where BMPs and other implementation components should be focused. Typical sources for the pollutants of concern are summarized in Table 10. The following sections provide a detailed inventory and characterization of pollutant sources in the Los Angeles River watershed with a focus on the locations, densities, and areas. Summaries are provided for the following sources: land use, impervious cover, National Pollutant Discharge Elimination System (NPDES) permits, road density, Toxics Release Inventory (TRI) emissions, Resource Conservation and Recovery Act (RCRA) and Superfund sites, and sanitary sewers.

Table 10. Typical Sources of Pollutants

Parameter	Potential Sources
Indicator or coliform bacteria	Wildlife, pets, sewer leaks, sanitary sewer overflows (SSOs), wastewater discharges, humans (e.g., homeless), animal operations, illicit discharges, septic systems, land application
Lead	Lead-zinc batteries, electroplating, metallurgy, construction materials, coating and dyes, electronic equipment, plastics, veterinary meds, fuels, radiation shielding, ammunition, corrosive-liquid containers, paints, glassware, solder, piping, cable sheathing, roofing, atmospheric deposition
Zinc	Smelting, refining, wood combustion, waste incineration, iron and steel production, tire wear, atmospheric deposition
Copper	Mining, smelting, refining, copper wire mills, coal burning, iron/steel industry, copper brake pads, some algaecides and pesticides, sewage treatment plants, atmospheric deposition
Cadmium	Cadmium-nickel batteries, mining, smelting, refining, electroplating, anticorrosive metal plating, non-ferrous metal production, iron and steel industry, fossil fuel combustion, municipal solid waste combustion, sewage treatment plants, land application of sewage sludge, some phosphate fertilizers, atmospheric deposition
Nutrients	Fertilizers (residential and agricultural), atmospheric deposition, wastewater, leaking sewers, septic systems, animal operations, pets, native geology
Chlordane	Legacy pesticide—residual storage in sediment; refuse sites
DDT	Legacy pesticide—residual storage in sediment; refuse sites
PAHs	Combustion sources, transportation, atmospheric deposition, wastewater discharge, coal storage, wood treatment plants, petroleum pressing, oil
PCBs	Legacy pollutant—A variety of compounds used in dielectric fluids for transformers and capacitors, heat transfer fluids, and lubricants; refuse sites, abandoned facilities; residual storage in sediment

3.2.1. Land Use and Impervious Cover

A breakdown of the land uses (SCAG 2005) in the County TMDL Implementation Area is shown in Table 11 and mapped in Figure 12 and Figure 13. Much of these areas are high-density, single-family residential areas (38 percent) and industrial areas (21 percent). The undeveloped land is mainly in the northern part of the watershed in communities like Oat Mountain. Other land uses important to pollutant generation are also present in the watershed, including nearly 20 percent of combined industrial, commercial, and transportation uses. Industrial land use in the County TMDL Implementation Area is associated with oil and gas extraction, manufacturing, open storage, wholesaling, and warehousing (Figure 14, Figure 15, and Figure 16). The percent imperviousness estimated from this analysis is shown in the figures that follow (Figure 17 and Figure 18).

Table 11. Land Use in the County TMDL Implementation Area

Land Use	Acres	Percentage
Undeveloped Land	14,763.20	35.8%
High-Density Single-Family Residential	13,031.21	31.6%
Multi-Family/Multi-Unit	2,556.76	6.2%
Commercial and Services	2,474.28	6.0%
Developed Open Space/Recreational	2,433.04	5.9%
Industrial	2,350.57	5.7%
Transportation, Communications, Utilities	1,896.95	4.6%
Low-Density Single-Family Residential	1,195.90	2.9%
Agriculture	371.14	0.9%
Water	82.48	0.2%
Under Construction	41.24	0.1%
Rural Residential	41.24	0.1%
Mixed Commercial/Industrial	0.00	0.0%
Total	41,238	

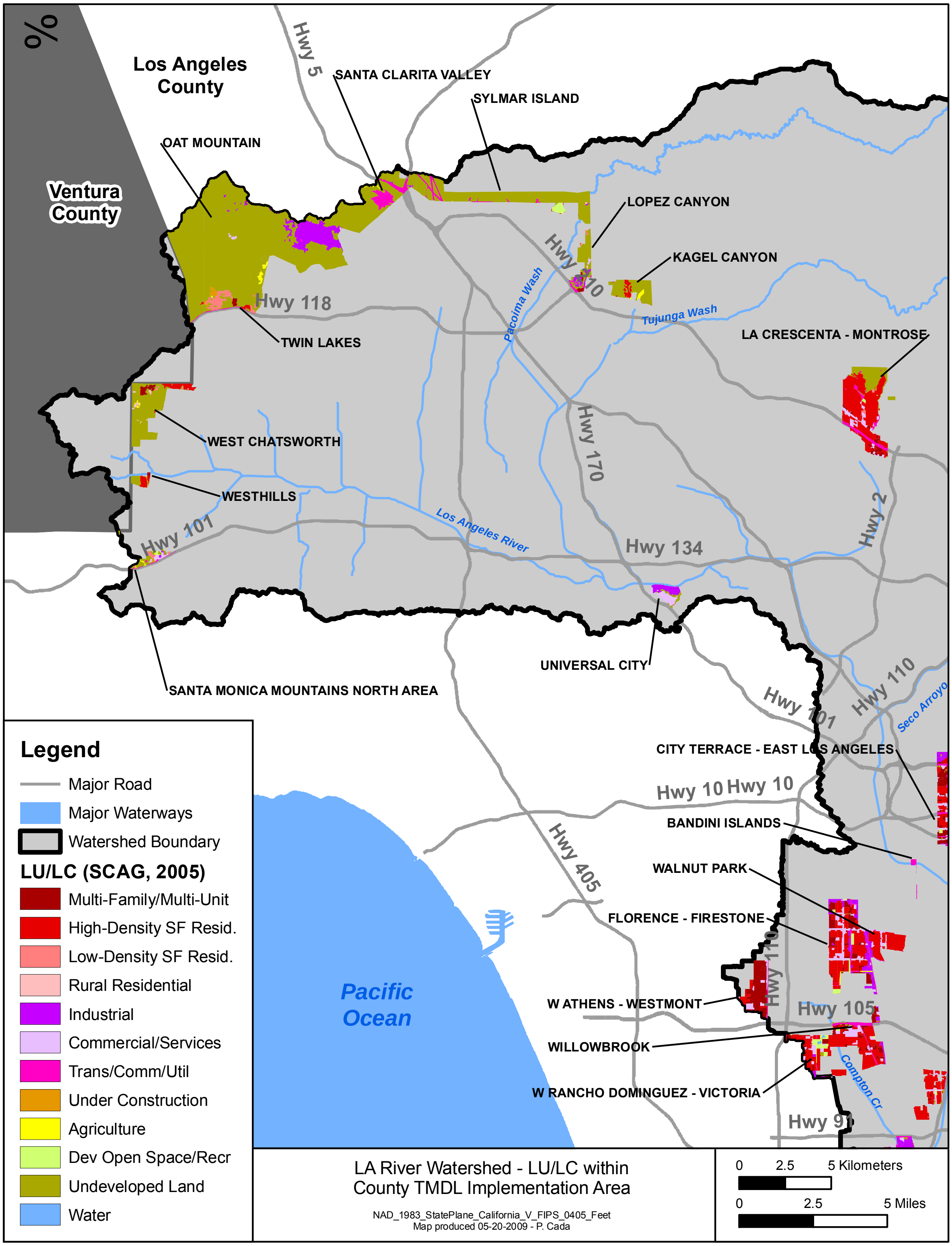

Figure 12. Land Use in the County TMDL Implementation Area (Upper Watershed)

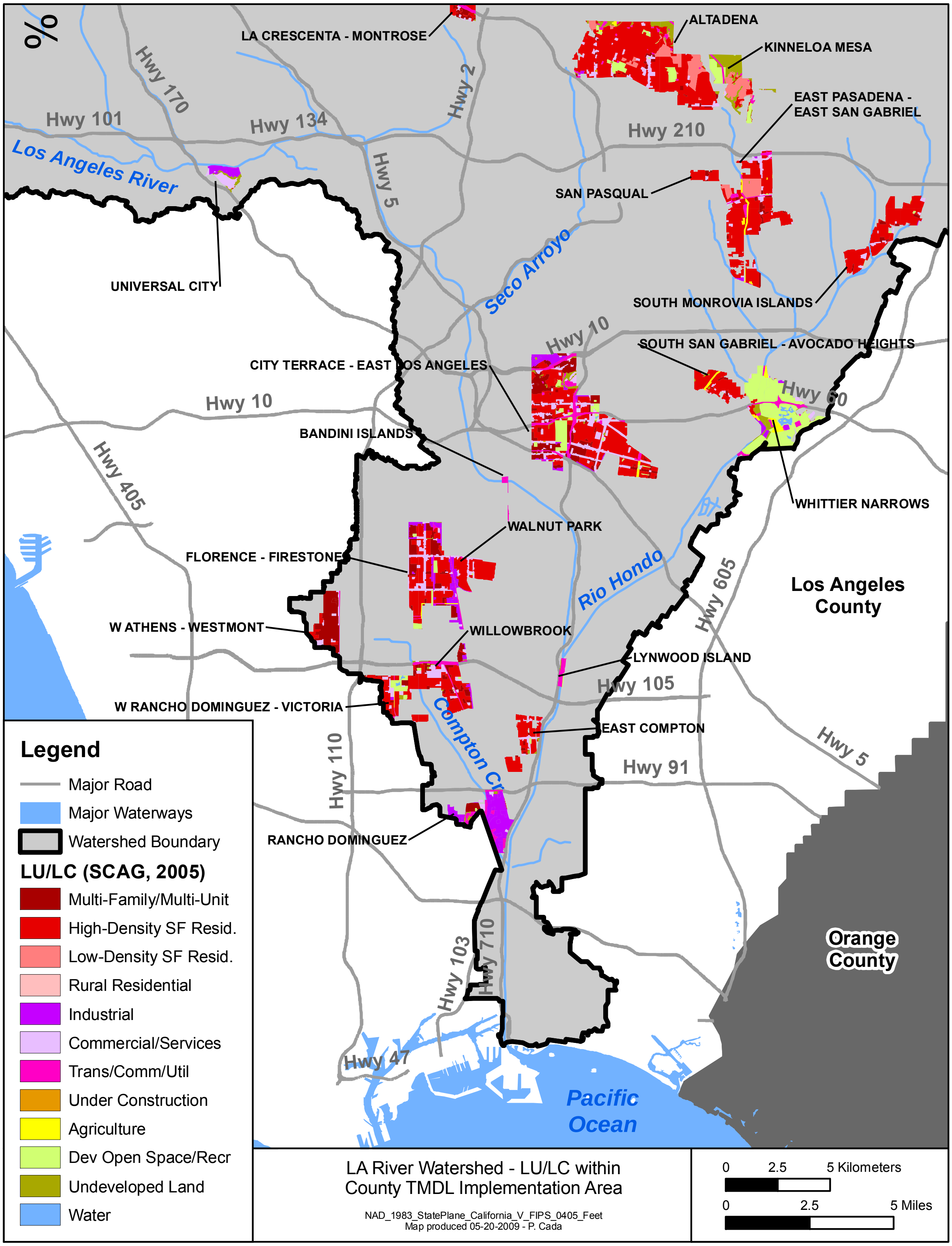

Figure 13. Land Use in the County TMDL Implementation Area (Lower Watershed)

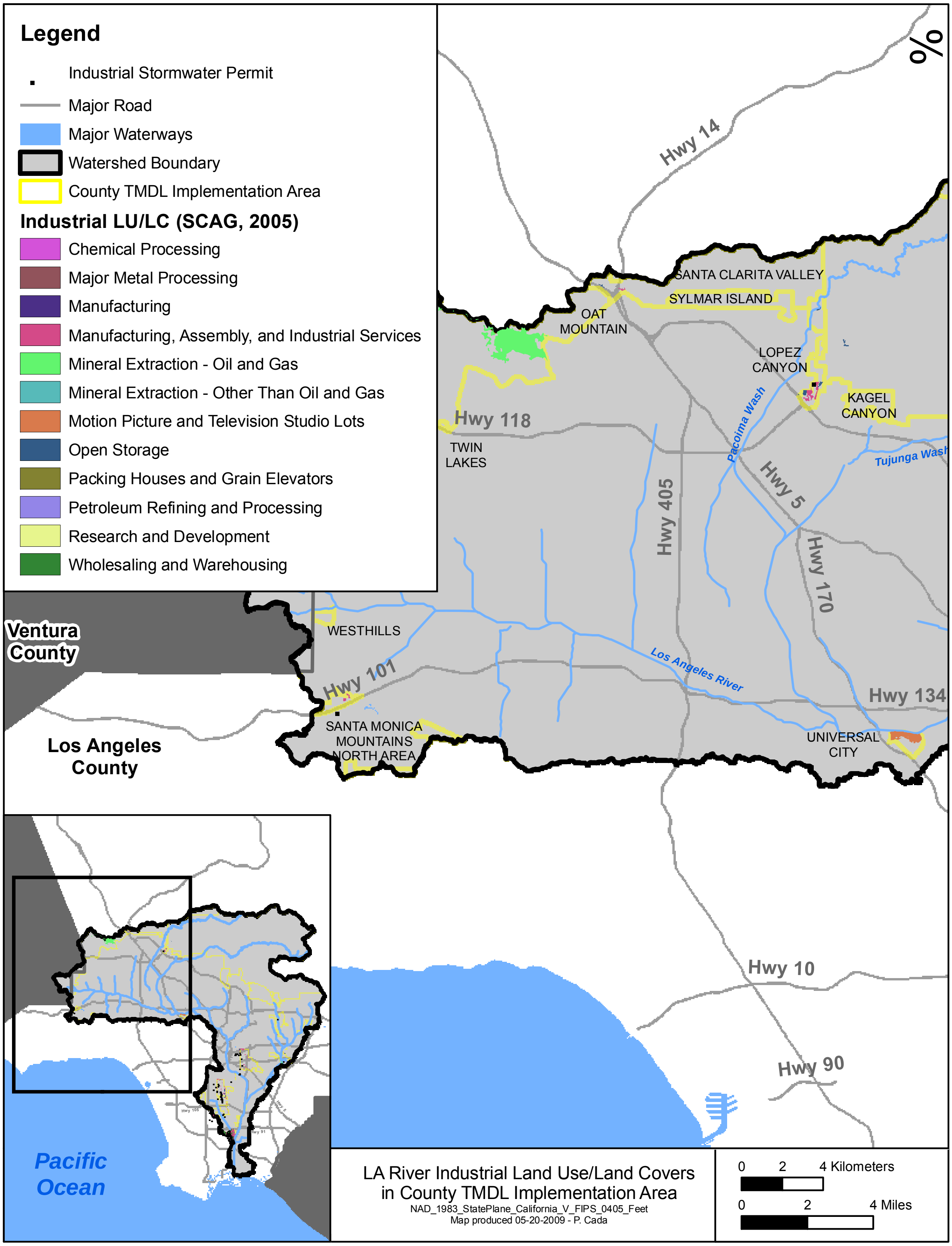

Figure 14. Industrial Land in the County TMDL Implementation Area—Map 1 of 3

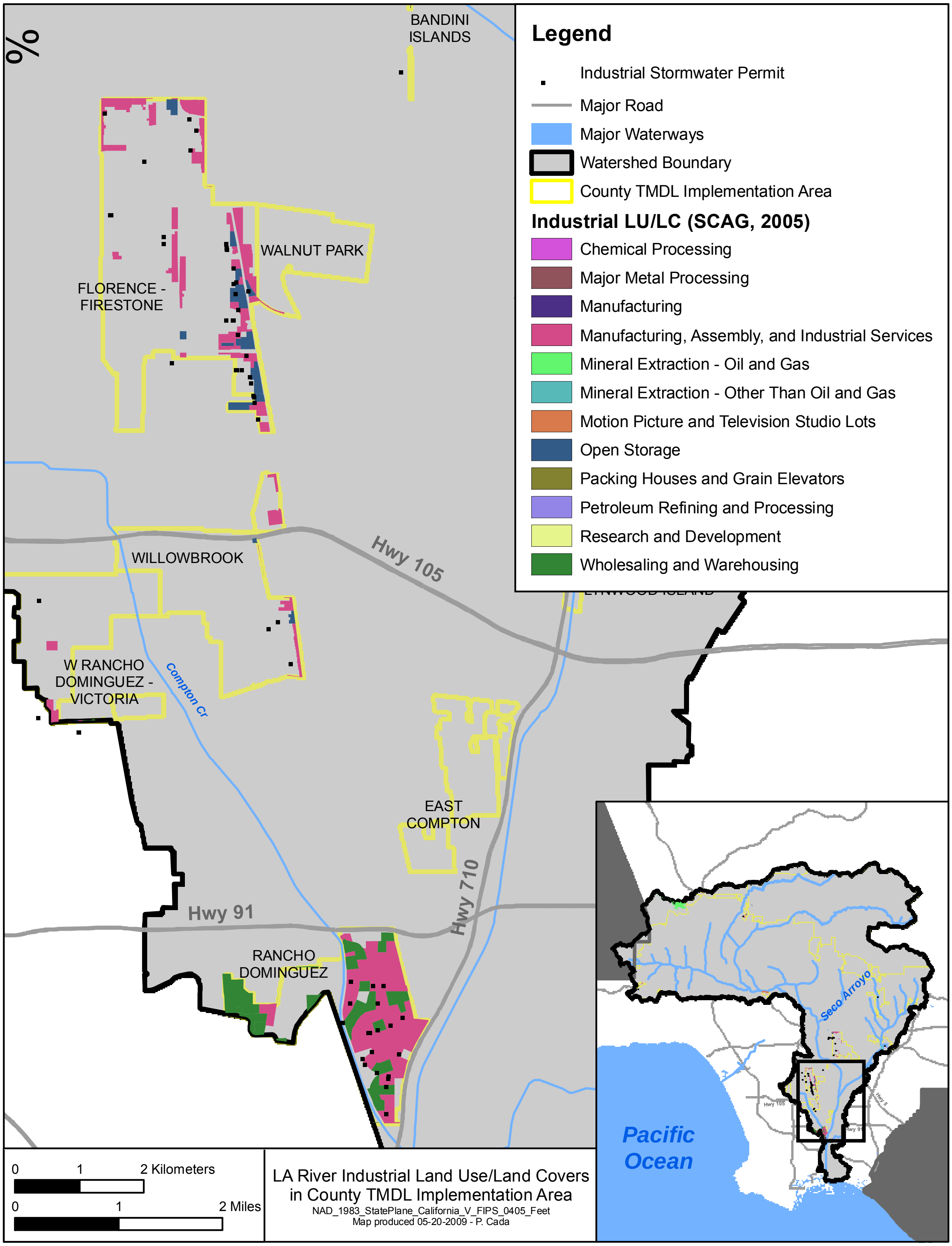

Figure 15. Industrial Land in the County TMDL Implementation Area—Map 2 of 3

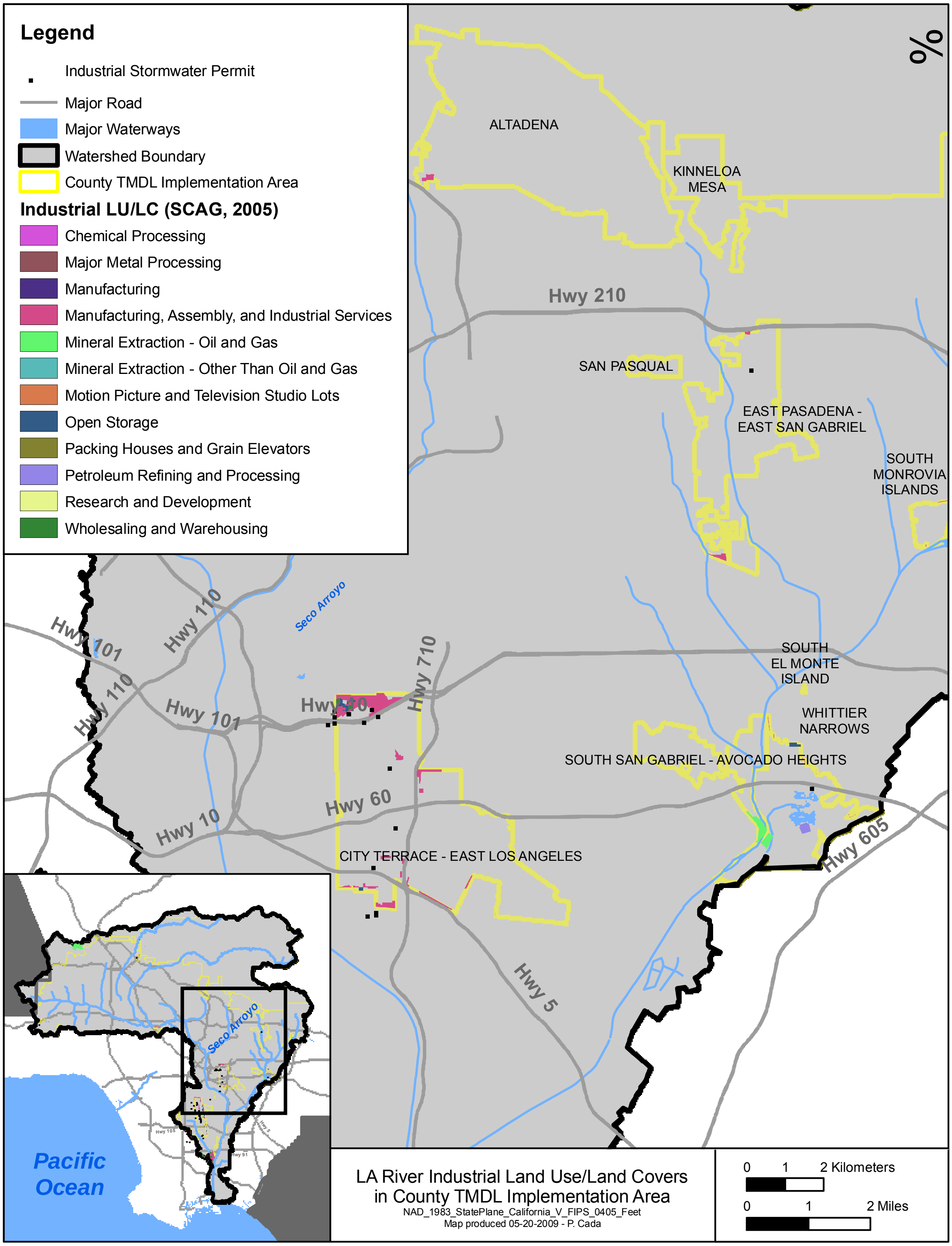

Figure 16. Industrial Land in the County TMDL Implementation Area—Map 3 of 3

As an initial indicator of the potential sources of pollutants from relevant land uses listed above, a summary of wet weather concentrations from several citations is provided. The data represent wet weather EMCs for the Los Angeles region from Stein et al. (2008), geometric mean concentrations based on studies in the Southern California Bight from Ackerman and Schiff (2003), and storm EMCs from LACDPW monitoring 1994–2000 (Table 12, Table 13, and Table 14). The data represent general observations in the Los Angeles Region, and not specific monitoring from unincorporated County areas. With the exception of runoff from open space, agriculture, and other areas that might not flow to the storm drain network, runoff from most of the other developed land uses drains to the stormwater network.

Table 12. Concentrations by Land Use

Land Use	Total Copper (µg/L)	Total Lead (µg/L)	Total Zinc (µg/L)	Total PAHs (µg/L)
High-Density Residential	26.0	28.4	207.7	4.4E+03
Low-Density Residential	29.9	6.0	87.1	1.4E+03
Commercial	38.1	20.4	362.2	1.2E+03
Industrial	70.3	24.1	599.1	1.5E+03
Recreational	38.0	16.3	131.5	4.6E+02
Transportation	9.8	3.3	92.6	4.8E+02
Open Space	7.6	1.2	23.2	1.38E+02[a]

Source: USEPA and LARWQCB 2006

a. Open space PAH is from Stein et al. 2005.

Table 13. Concentrations by Land Use

Land Use	Ammonia (mg/L)	Nitrate (mg/L)	Phosphate (mg/L)	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)	Cadmium (µg/L)	Selenium (µg/L)	DDT (µg/L)
Residential	0.42	0.08	0.57	16.2	3.98	69.7	0.20	0.15	0.0
Commercial	0.45	0.09	0.49	20.8	3.65	159	0.26	0.13	0.0
Industrial	0.34	0.06	0.37	28.4	5.86	196	0.46	0.23	0.0
Open	0.07	0.02	--	5.04	0.69	3.19	0.09	0.09	0.0

Source: Ackerman and Schiff 2003

Table 14. Concentrations by Land Use

Land Use	TN (mg/L)	TP (mg/L)	Fecal Coliform (MPN/100 mL)	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)	Cadmium (µg/L)	Pyrene (PAH) (µg/L)	Phenanthrene (PAH) (µg/L)
Mixed Residential	3.51	0.26	--	17.33	8.7	184.85	--	0.53	0.73
High-Density Residential (SF)	3.93	0.39	1.09E+06	15.3	9.59	80.35	--	1.5	--
Multifamily Residential	3.67	0.19	--	12.23	5.13	134.88	--	--	--
Retail/Commercial	4.09	0.41	1.07E+06	34.77	11.53	238.53	0.71	--	--
Education	2.33	0.31	--	21.49	4.53	123.69	--	--	--
Light Industrial	4.02	0.44	6.53E+05	31.04	14.87	565.6	--	--	--
Transportation	2.65	0.44	1.34E+06	51.86	9.08	279.45	1.05	--	--
Vacant	1.97	0.11	2.17E+03	9.12	n/m	38.81	--	--	--

Source: LACDPW monitoring 1994–2000 (LACDPW 2009a)

TN = TKN [total Kjeldahl nitrogen] plus Nitrate-N plus Nitrite-N; MPN = most probable number; n/m = not monitored

Typical dry weather concentrations for select pollutants are shown in Table 15. These were taken from Stein and Ackerman (2007) and land use-based monitoring by LACDPW (1994–2000). These concentrations represent conditions within the general Los Angeles River Watershed and not from specific areas of unincorporated Los Angeles County. Concentrations of organic toxic chemicals are typically not detected or occur at relatively low concentrations in dry weather flows.

Table 15. Typical Dry Weather Concentrations in the Los Angeles River Watershed

Pollutant	Units	Concentration
TSS	mg/L	208
Copper	µg/L	25
Lead	µg/L	0.8
Zinc	µg/L	122
TN	mg/L	2
TP	mg/L	0.6
Fecal Coliform	MPN/100 mL	893

Sources: All concentrations are from Stein and Ackerman (2007), with the exception of fecal coliform and nutrients, which were averaged from County monitoring data.

The amount of impervious cover provides an indication of the degree of urbanization and the amount of stormwater that can be conveyed directly to the MS4. The imperviousness of the County TMDL Implementation Area is shown in Figure 17 and Figure 18. The least permeable areas are the commercial land uses followed by high-density residential.

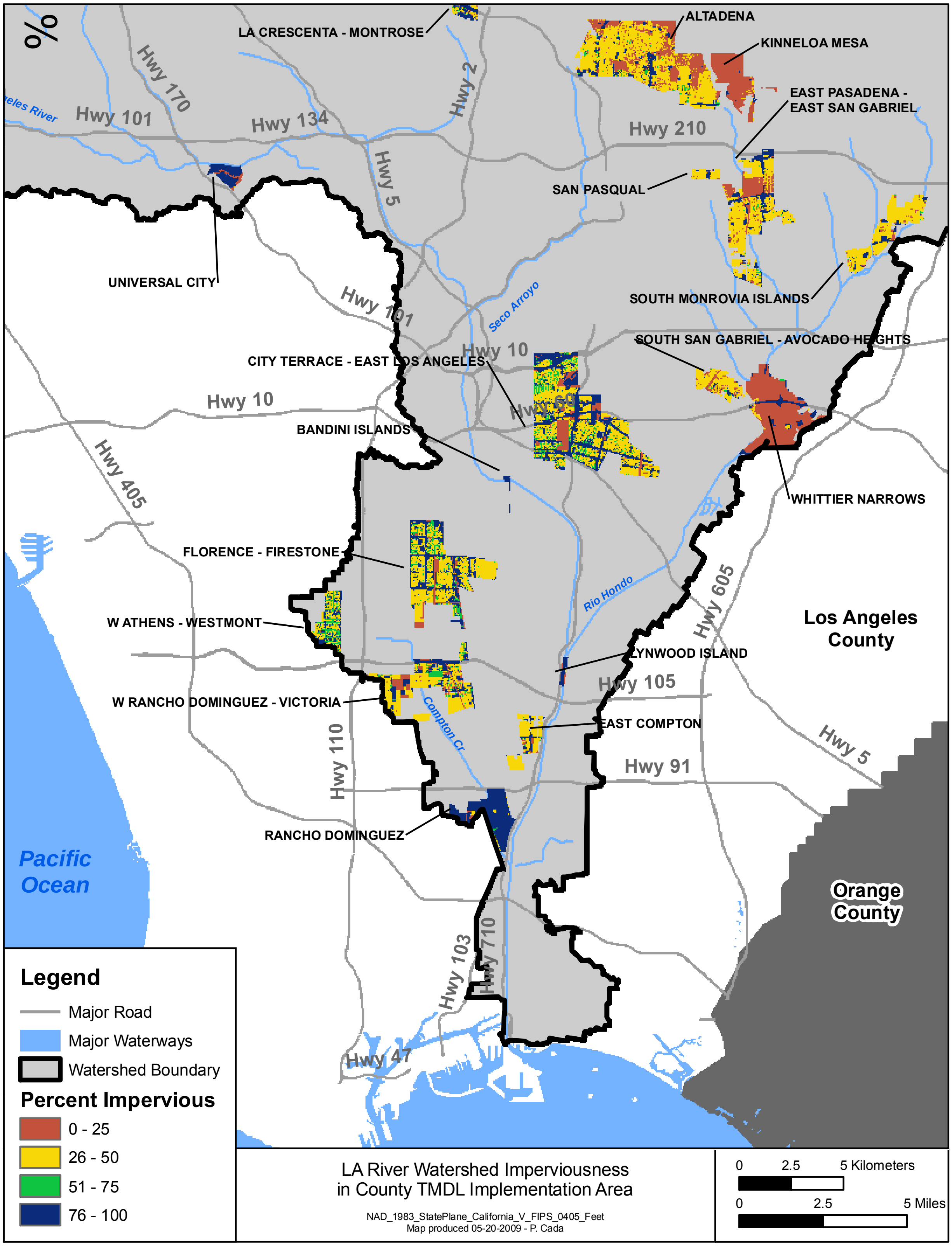

Figure 17. Imperviousness in the County TMDL Implementation Area—Lower Los Angeles River Watershed—Map 1 of 2

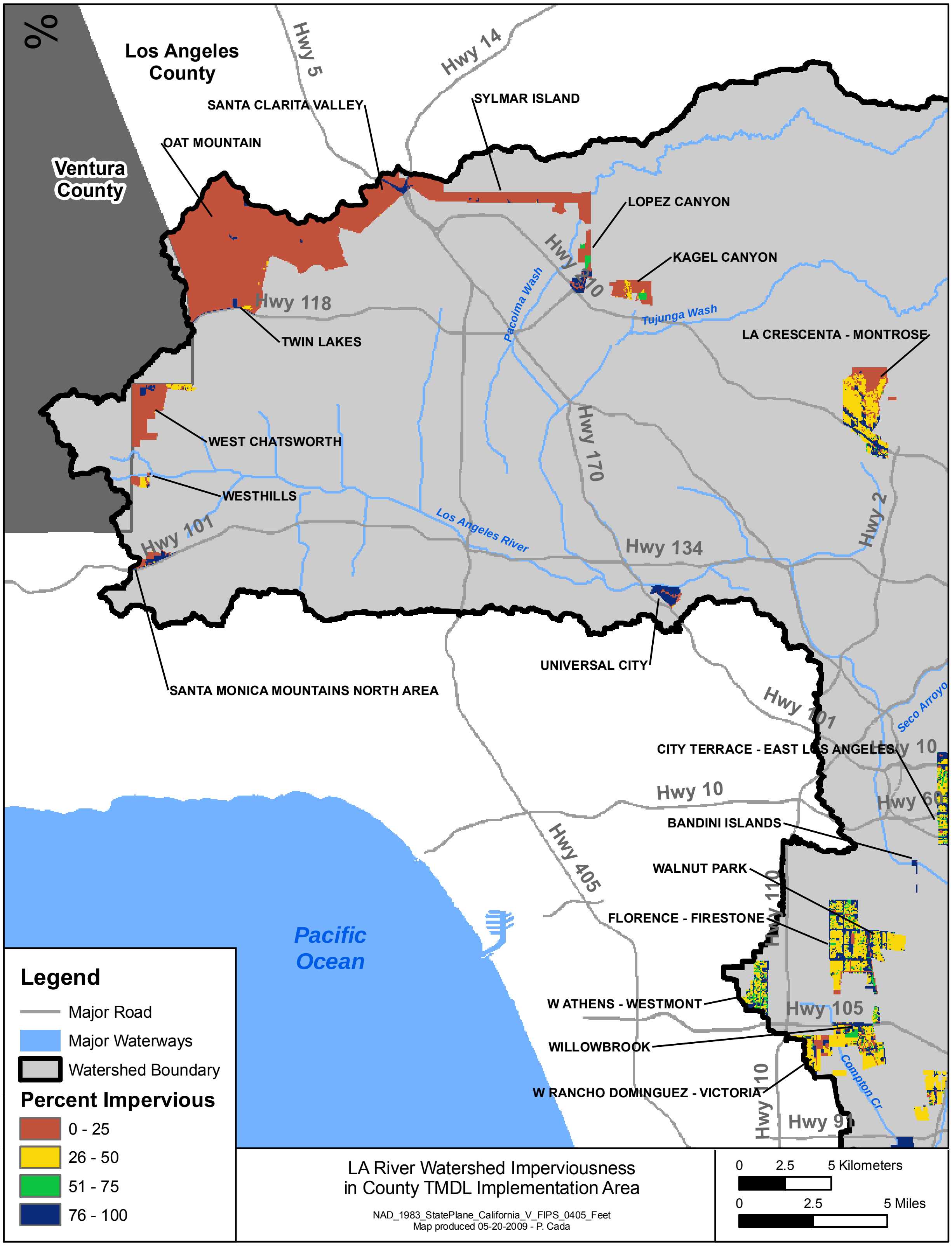

Figure 18. Imperviousness in the County TMDL Implementation Area—Upper Los Angeles River Watershed—Map 2 of 2

3.2.2. NPDES Permits

A point source, according to Title 40 of the *Code of Federal Regulations* section 122.3, is any discernible, confined, and discrete conveyance, including any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel or other floating craft from which pollutants are or can be discharged. The NPDES program, established under CWA sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. Point sources also include stormwater that is regulated through the NPDES program.

Stormwater runoff in the Los Angeles River watershed is regulated through four types of permits: an MS4 permit issued to 85 permittees, including the Unincorporated Areas of the County of Los Angeles and 84 cities; a statewide stormwater permit for Caltrans; a statewide Construction Activities Storm Water General Permit; and a statewide Industrial Activities Storm Water General Permit. Major and minor permits are mainly issued for industrial and manufacturing activities. Other minor permits are issued to residential and apartment communities, medical facilities, laboratories, and other various agencies. Table 16 summarizes the permits in the Los Angeles River watershed. Note that construction permits are temporary in nature; however, including them in this evaluation is an important component for understanding historical monitoring data (TSS for example) and serves as an indicator of the overall land disturbance that can occur in certain areas of the watershed. The permits overlap in time and space; therefore, as an aggregate, they represent a more continuous source. In addition, sediment that leaves a site can remain in the drainage system for some time.

Table 16. NPDES Permits in the Los Angeles River Watershed

Permit Type	Los Angeles River Watershed	County TMDL Implementation Area
Publicly Owned Treatment Works (POTWs)	11	0
Municipal Stormwater	3	0
Industrial Stormwater	1,365	84
Construction Stormwater	520	36
Caltrans Stormwater	1	0
Other Major NPDES Discharges	6	2
Minor NPDES Discharges	227	26
Total NPDES Discharges	2,133	148

The Caltrans statewide stormwater discharge permit authorizes stormwater discharges from Caltrans properties and facilities, such as the state highway system, park facilities, and maintenance yards. Most of those discharges eventually run to a city or Los Angeles Flood Control District storm drain. The NPDES industrial general permit regulates stormwater discharges and authorized non-stormwater discharges from several categories of industrial facilities. That permit regulates stormwater discharges and authorizes non-stormwater discharges from 10 specific categories of industrial facilities, including manufacturing facilities, oil and gas mining facilities, landfills, and transportation facilities. Covered activities specific to County watersheds include sand and gravel operations as well as oil and natural gas, metal plating, transportation, recycling, and manufacturing facilities.

In the Los Angeles River watershed there are more than 1,365 industrial permits and more than 500 construction permits, but only 84 industrial and 36 construction permits exist in the County TMDL Implementation Area. In total, 2,133 NPDES discharges are in the watershed (**Error! Reference source not found.**), and 148 of those are in the County TMDL Implementation Area, shown in **Error! Reference source not found.**. The two major NPDES dischargers are non-stormwater permits for Dominguez Hills Tank Farm (owned by Pacific Terminals, LLC) and the Whittier Narrows WRP.

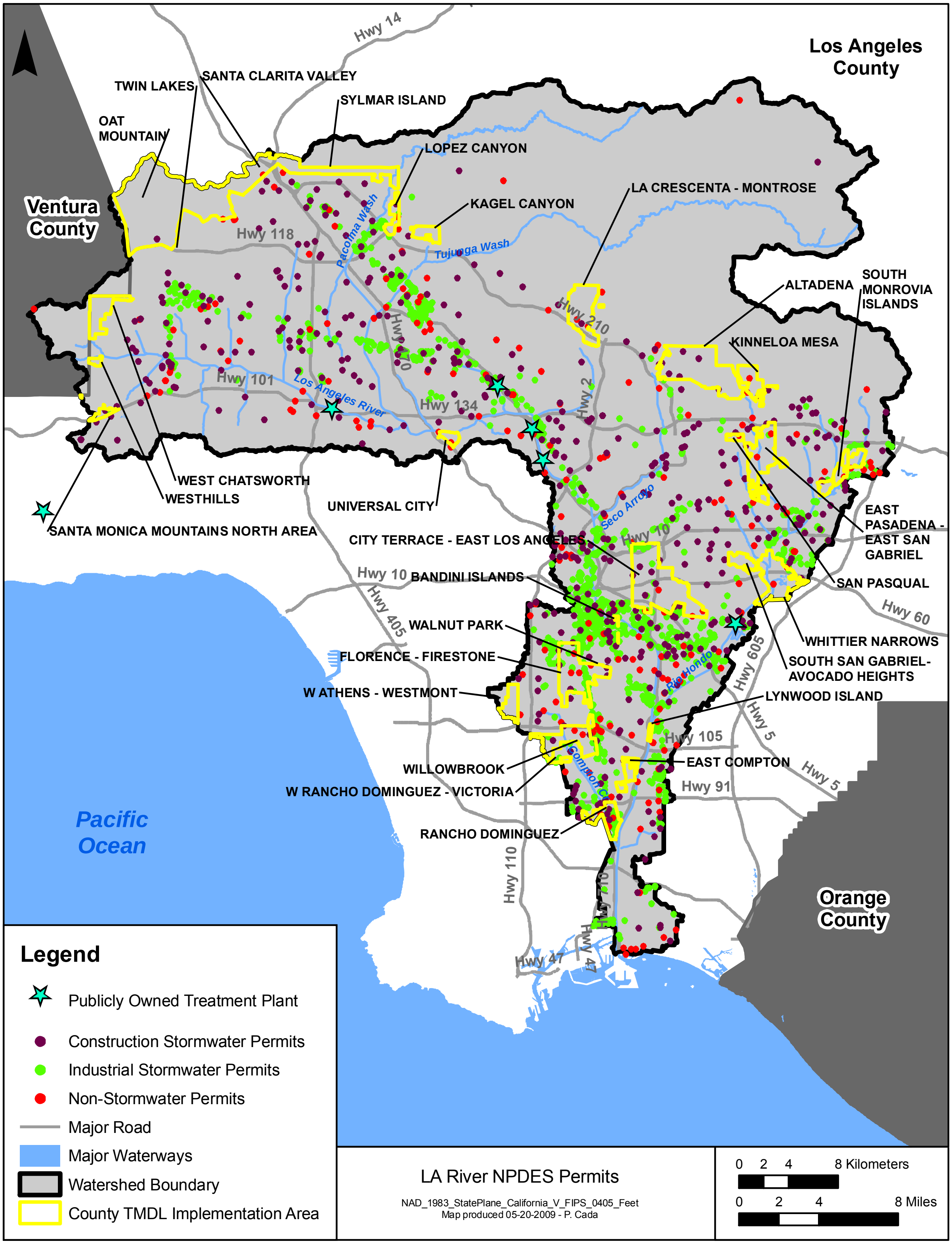

Figure 19. NPDES Permits in the Los Angeles River Watershed

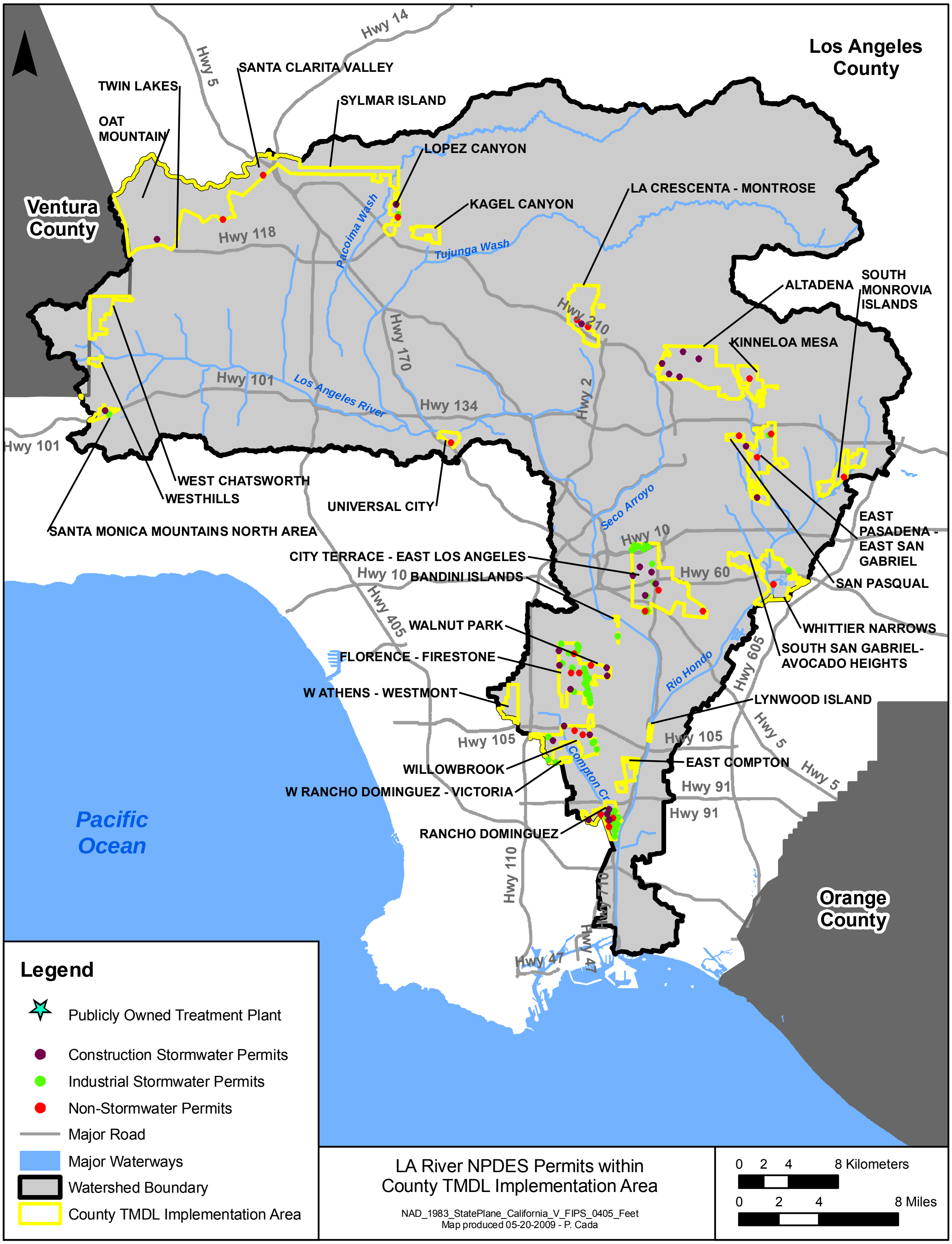

Figure 20. NPDES Permits in the County TMDL Implementation Area

The County TMDL Implementation Area has 71 outfalls, shown in Figure 21. The location and density of stormwater outfalls can provide a general indicator of the significance of stormwater-based sources in an area. However, that does not take into account the specific land-use-based sources draining to the outfalls. The drains can also be candidates for diversion of dry weather flows to sanitary sewers or alternative treatments as described in the *Dry Weather Discharge Treatment Feasibility Report* (LACDPW 2003).

Regulated stormwater can be a significant source of pollutant loads derived from residential, commercial, transportation, and industrial activities flowing to storm drains. The following provides additional discussion regarding the presence of pollutants in stormwater runoff.

Metals

The sources and delivery of metals can vary depending on weather and flow conditions. Wet weather metal loads are typically greater than dry weather loads, with wet weather stormwater runoff shown to be the dominant source of annual metals loading. Stormwater runoff during wet weather was responsible for 59 to 64 percent of the total wet weather load to the Los Angeles River in sampling from 2000 through 2005 (Tiefenthaler et al. 2008). Dry weather loads have been shown to account for 20 to 50 percent of the total load to receiving waters (Stein and Ackerman 2007). Flows during dry weather are highly variable in both time and space.

All the types of facilities covered under the industrial general permit have the potential for metal loads, especially metal plating, transportation, recycling, and manufacturing facilities (LARWQCB and USEPA 2005a; Stenstrom and Lee 2005). Stormwater runoff from industrial sites has the potential to contribute to metals loading during wet weather; although, during dry weather, the potential is low.

Discharges covered under the statewide construction general permit also have the potential to contribute metals loading from construction sites. Sediment delivered from construction sites can contain metals from construction materials and heavy equipment. Additionally, metals can leach out of building materials and construction waste exposed to stormwater (Raskin et al. 2004). During redevelopment of former industrial sites, there is a higher potential for discharge sediments to contain metals. Wet weather runoff from construction sites has the potential to contribute metals loading; however during dry weather, the potential contribution of metals loading is low because non-stormwater discharges are prohibited or controlled by the permit (LARWQCB and USEPA 2005a).

Toxic Organic Chemicals

The fertilizers used for lawn and landscape maintenance of municipal areas are also a source of metals and organic chemicals. Fertilizers, herbicides, and pesticides contain metals such as cadmium, copper, mercury, zinc, lead, iron, and manganese, which are also distributed when applying fertilizers and pesticides. Heavy metals in municipal stormwater can also come from breakdown of automotive materials (e.g., brake pads, tires), roof shingles, building materials, and plastics (Van Metre and Mahler 2003; Walch 2006; Ellis and Revitt 1982; van Breemen and Vermij 2007).

Residential fertilizers and pesticides also contain toxic chemicals such as dioxins, organophosphates, and organochlorides. Concentrations of certain pesticides, such as diazinon and chlorpyrifos, are found in higher concentrations from residential areas than agricultural areas because they are so heavily used in home applications (Katznelson and Mumley 1997; McPherson et al. 2005; Schiff and Sutula 2001).

In addition to the fertilizers and pesticides used in commercial areas, runoff from parking lots contains oil, grease, and litter. Litter loads from commercial facilities are a major source of chemicals from the breakdown of trash. Phthalate esters, which had been released from the breakdown of paper, plastic bags, and Styrofoam, were found in large concentrations in the Los Angeles region runoff (Stenstrom et al. 1998). Organic chemicals, such as phthalate esters are also associated with PVC manufacturing plants, textiles, paper mills, landfills, and incinerators (Makepeace 1995).

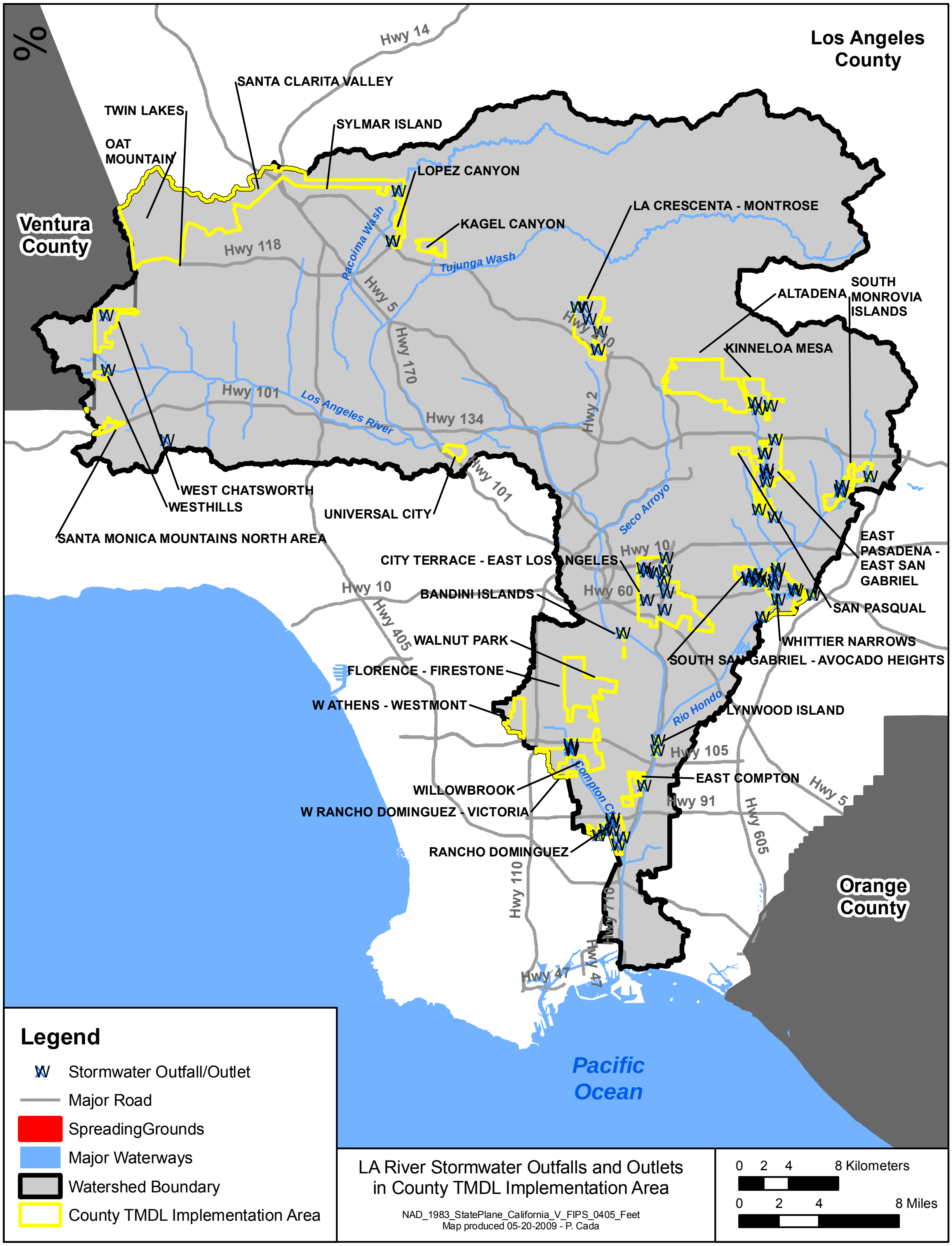

Figure 21. Stormwater Outfalls in the County TMDL Implementation Area

Commercial areas might also have toxic contaminants from dry cleaners, degreasing facilities, firing ranges, fuel terminals, car washes, car repair areas, paint stripping facilities, and others. Commercial areas with significant amounts of hazardous chemicals are reported under RCRA and discussed in later sections.

PAHs, a group of more than 200 different chemicals, are found in nature, coal, crude oil, and in emissions from fossil fuels combustion, forest fires, and volcanoes. Most PAHs entering the environment are formed during burning (coal, oil, wood, gasoline, garbage, tobacco and other organic material) or in certain industrial processes. The primary source of PAHs to the river is urban stormwater runoff. Research by Stein et al. (2006) found that the dominant source of origin was pyrogenic (combustion of organic matter) in the Los Angeles region, where PAHs are deposited through atmospheric deposition and delivered to waterbodies in stormwater runoff.

Fecal Coliform

Bacterial contamination is generated throughout the watershed and then transported through the storm drain system regulated under the MS4 permit. In the Los Angeles River watershed, bacteria concentrations found in the storm drain system are elevated during both wet and dry weather and contribute the vast majority of the bacteria loads (Ackerman et al. 2005). Storm drain system discharges can have elevated levels of bacterial indicators from sanitary sewer leaks and spills; illicit connections of sanitary lines to the storm drain system; runoff from homeless encampments; pet waste; organic debris from gardens, landscaping and parks; food waste; and illegal discharges from recreational vehicle holding tanks, among others (LARWQCB 2006). The bacteria indicators used to assess water quality are not specific to human sewage; therefore, fecal matter from animals and birds can also be a source of elevated levels of bacteria, and vegetation and food waste can be a source of elevated levels of total coliform bacteria, specifically (LARWQCB 2006).

During dry weather, non-POTW storm drain flows are attributable to nuisance flows caused by over-irrigating lawns, car washing, restaurant washout and other activities in the watershed, as well as NPDES permitted discharges. Data available through the Los Angeles County MS4 permit monitoring program and SCCWRP were evaluated as part of the Ballona Creek bacteria TMDLs to identify potential sources. The LACDPW data set for 1994–2000 (LACDPW 2009a) shows stormwater originating from the high-density, single-family residential category had the highest densities of fecal coliform indicators, followed by commercial land use. In the SCCWRP 2001–2004 data set, the highest fecal coliform levels were from the low-density, residential land use category, followed by commercial land use (LARWQCB 2006).

Illegal connections and discharges are also very likely sources of bacteria in stormwater discharge. The Los Angeles County MS4 permit requires the identification and elimination of illicit discharges and connections through a comprehensive program including identification, investigations, mapping, and public reporting of illicit activities.

Nutrients (Total Nitrogen and Total Phosphorus)

Potential nutrient sources include fertilizer used for lawns and landscaping; organic debris from gardens, landscaping, and parks; phosphorus in detergents used to wash cars or driveways; trash such as food wastes; domestic animal waste; and human waste from areas inhabited by the homeless. Those pollutants build up, particularly on impervious surfaces, and are washed into the waterways through storm drains when it rains. Such loads are typically highest during the first major storms after extended dry periods, when the pollutants have accumulated. Activities such as watering lawns and landscaping, washing cars, and washing parking lots and driveways can contribute pollutants between storms (USEPA 2003b). High nitrogen and phosphorus loadings are associated with urban wet weather runoff from residential, commercial, and industrial land uses (SCCWRP 2000; LARWQCB 2003; USEPA 2003b). Effluent irrigation from water reclamation facilities is considered a source of nitrogen and phosphorus, with higher contributions during the summer (USEPA 2003a).

Indirect atmospheric deposition is the process by which nutrients deposited on the land surface are washed off during storm events and delivered to waterbodies. Indirect atmospheric deposition of nutrients is accounted for in stormwater runoff (USEPA 2003b; LARWQCB 2008). This is discussed in more detail in Section 3.2.4.

Dry weather contributions from storm drains were quantified for the Los Angeles River watershed (SCCWRP 2000). Storm drains were shown to convey 34 percent of the nitrate load and only 2 percent of the TN load. The LARWQCB estimates that 78 percent of the nitrogen loads (wet and dry weather combined) are associated with urban runoff (LARWQCB 2003).

3.2.3. Road Infrastructure

Most of the pollutant load attributed to runoff from highways and roads are regulated under either the Caltrans or MS4 permits. Pollutants originate from cars, roadway degradation, and landscaping surrounding the highways. Most of the discharges eventually run to a city or Los Angeles Flood Control District storm drain.

The use and wear of cars is the most prevalent source of roadway pollutants. A California study found that cars are the leading source of metal loads in stormwater, producing over 50 percent of the copper, cadmium, and zinc loads (Schueler and Holland 2000). Wear from brake pads, tires, and engine parts is a significant source of metal pollutants. For example, almost 50 percent of the copper loads in roadway stormwater originates from brake pads (Davis et al. 2001), and tire wear accounts for over 50 percent of the total cadmium and zinc loads delivered to the San Francisco Bay each year (Santa Clara Valley Nonpoint Source Control Program 1992). Such conditions are likely similar for the Los Angeles region. Leaking oil, grease, and coolant also contribute metals and PAHs to the roadway loads.

PAHs are present in coolants, oil, and grease. They are also emitted from asphalt coatings and vehicle exhaust (Lau et al. 2009). Other organic chemicals, such as gasoline additives and dioxins from fertilizers are also present in roadway runoff. Table 17 shows common sources of contaminants in runoff from roads and highways.
Road density can be used to indicate the extent of traffic volume and consequential pollutant generation. Road density is defined as the total area of the impervious road pavement. A calculation of road density percentile distribution suggests that a cutoff for road density of 20 percent could delineate low and high density using a clear inflection point in the data. Therefore, the following two categories of road network density are defined:

- High Road Density: Road density is greater than 20 percent.
- Low Road Density: Road density is less than or equal to 20 percent.

Most of the County TMDL Implementation area has low road densities, shown in Figure 22. The high density areas are primarily in the communities of City Terrace – East Los Angeles and West Athens – Westmont.

Table 17. Common Sources of Roadway Pollutants

Source	Cadmium	Chromium	Copper	Iron	Nickel	Lead	Zinc	PAHs	Nutrients	Synthetic Organic Chemicals
Gasoline	•		•			•	•			
Exhaust					•	•		•		•
Motor oil and grease				•	•	•	•	•		
Antifreeze	•	•	•	•		•	•	•		
Undercoating						•	•			
Brake linings			•	•	•	•	•			
Tires	•		•			•	•	•		
Asphalt	•		•		•		•	•		
Concrete			•		•		•			
Diesel oil	•	•				•	•			•
Engine wear				•	•	•	•			
Fertilizers, pesticides, and herbicides	•		•	•	•		•		•	•

Adapted from Nixon and Saphores (2007); Lau et al. 2009; Stein 2007; Davis et al. 2001; Schueler and Holland 2000

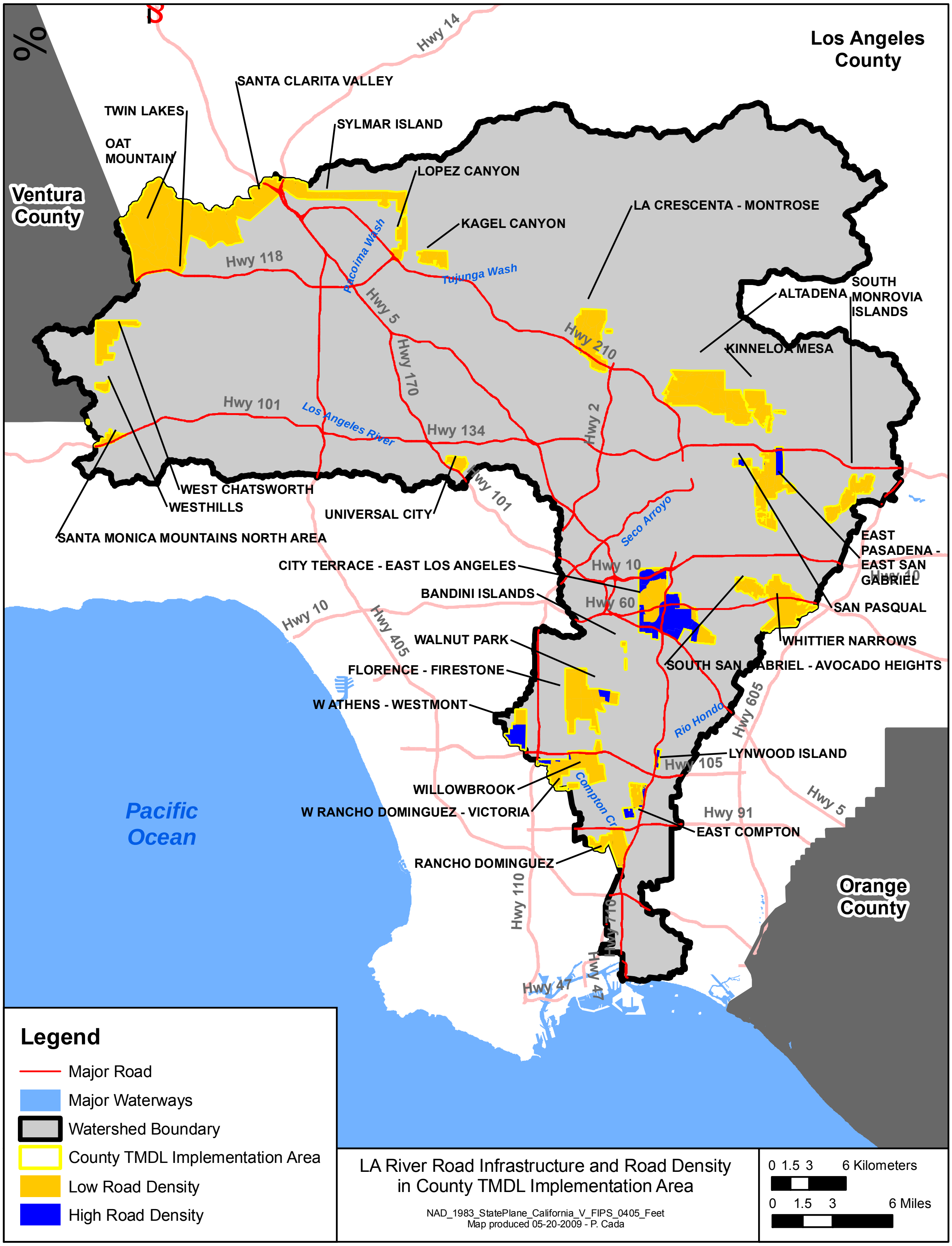

Figure 22. Road Density in the County TMDL Implementation Area

3.2.4. Atmospheric Deposition

Atmospheric deposition of pollutants—either directly to a waterbody surface or indirectly to the watershed land surface—can be a large source of contamination to surface waters near urban centers. The annual loading of nitrogen through atmospheric deposition in the Los Angeles River watershed is 5,559 tons per year (Lu et al. 2004). While this atmospheric source ultimately becomes a part of stormwater, it is important to understand the pathways from initial source (e.g., industrial facility emitting metals into the air) and transport (from air to land to water) processes. Direct dry deposition to waterbodies in the Los Angeles River watershed is not a significant factor because of the small water surface on which to receive direct deposition. Pollutants also exist in wet deposition, which occurs during rain and snowfall. In California, wet deposition is not a significant source of pollutants in comparison to dry depositions because there are so few rain events (Lu et al. 2003).

As much as 50–100 percent of trace metals in stormwater runoff in highly impervious, urban catchments of Southern California comes from dry deposition (SCCWRP 2008). Although the atmospheric deposition of lead has decreased over the past 30 years, atmospheric deposition of copper and zinc has increased along the coast near the Los Angeles Harbor (SCCWRP 2008). Recently, aerial deposition of copper, zinc, and lead were measured at Santa Monica Bay (Stolzenbach 2006). Table 18 compares the contributions of trace metals from aerial deposition, sewage treatment plants, industrial activities, and power plants.

Table 18. Comparison of Source Annual Loadings to Santa Monica Bay (metric tons/year)

Metal	Aerial Deposition	Non-Aerial Sources		
		Sewage Treatment Plants	Industrial	Power Plants
Chromium	0.5	0.6	0.02	0.14
Copper	2.8	16	0.03	0.01
Lead	2.3	< 0.01	0.02	< 0.01
Nickel	0.45	5.1	0.13	0.01
Zinc	12.1	21	0.16	2.4

Source: Stolzenbach 2006

Nutrients are also atmospherically deposited. The annual loading of nitrogen through atmospheric deposition in the Los Angeles River watershed is 5,559 tons per year, with 845 tons per year in the neighboring Ballona Creek watershed (Lu et al. 2004). Phosphorous deposition rates in Southern California have been reported in a wide range, from 0.108 to 12.4 tons/year (Anderson 2001; Anderson and Oza 2003; Jassby et al. 1994).

In addition to trace metals and nutrients, atmospheric deposition of PAHs is very common. PAHs occur naturally in oil, coal, and tar deposits. They are also created by the incomplete combustion of wood, coal, diesel, and gasoline. The occurrence of specific ratios of individual PAHs is used to identify the source of the contaminants. Studies in Southern California have determined the leading source of PAHs in the Los Angeles region comes from incomplete fuel combustion from mobile sources, such as cars and trains. This also accounts for the seemingly ubiquitous presence of PAHs (Stein et al. 2006).

The atmospheric releases based on TRI for copper, lead, zinc and PAHs in and near the Los Angeles River watershed are shown in Figure 23 through Figure 26. Though few origins of the emissions are within the Los Angeles River watershed, TRI for sites outside the watershed are also relevant because atmospheric transport occurs across watershed boundaries.

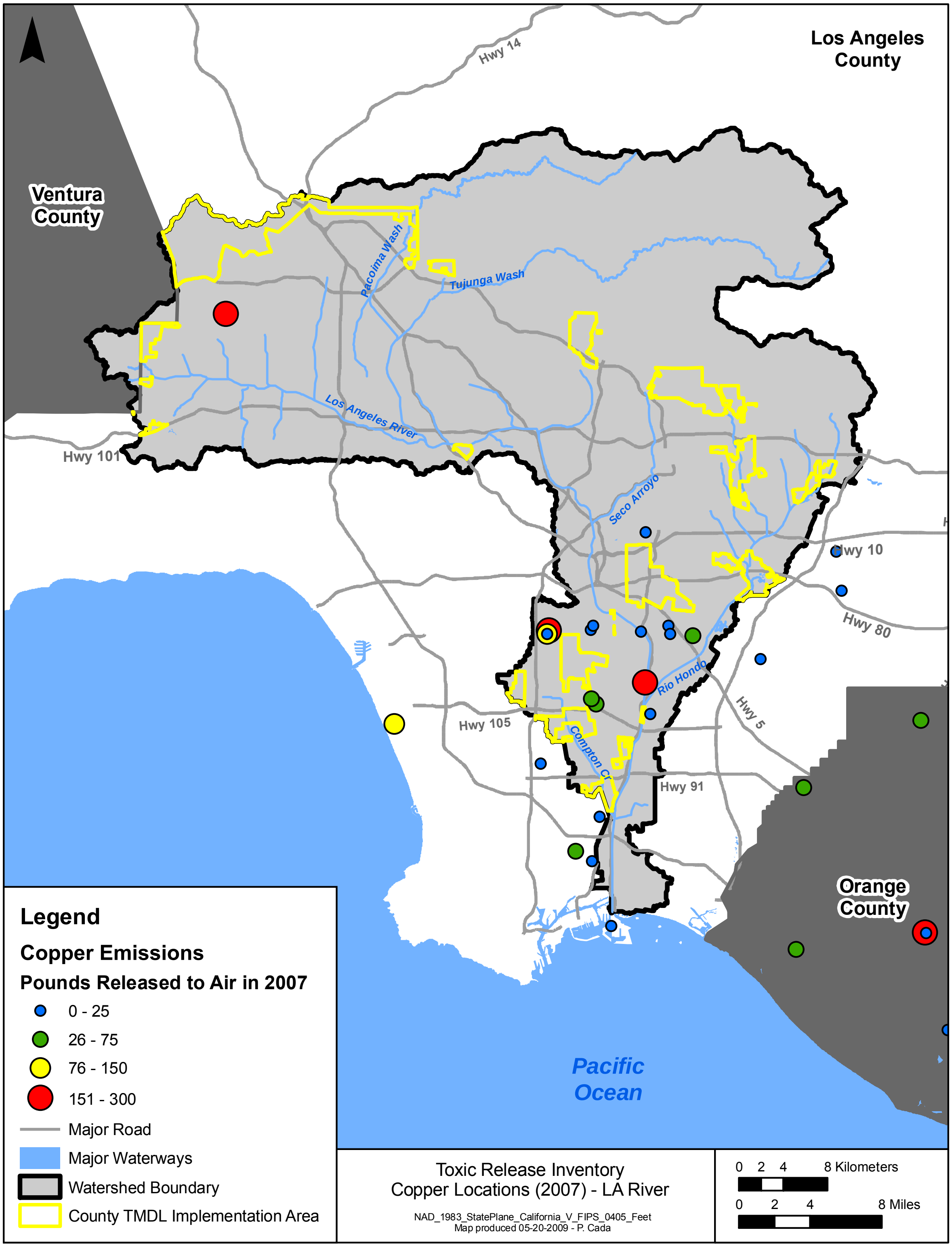

Figure 23. TRI Atmospheric Releases in the Los Angeles River Watershed—Copper

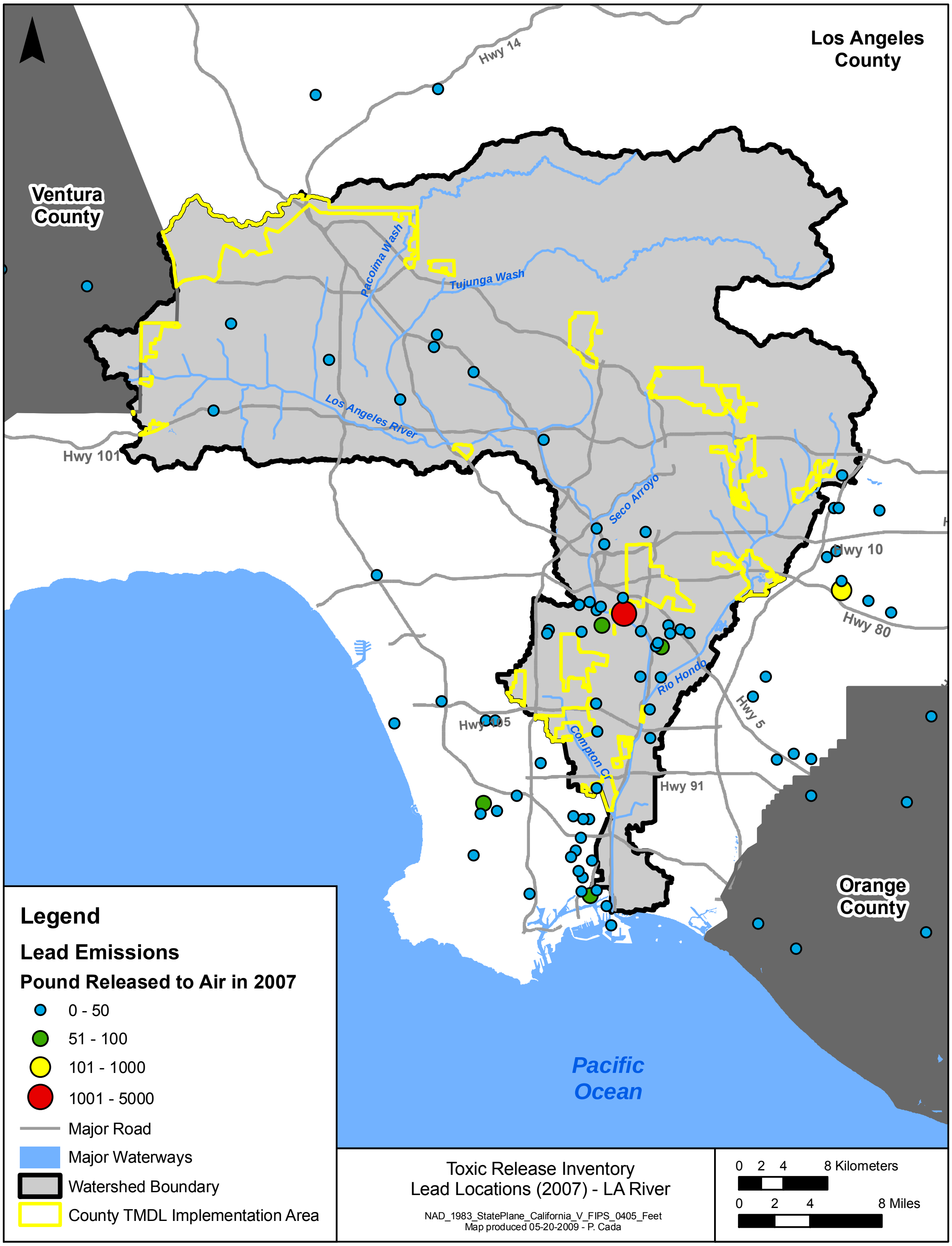

Figure 24. TRI Atmospheric Releases in the Los Angeles River Watershed—Lead

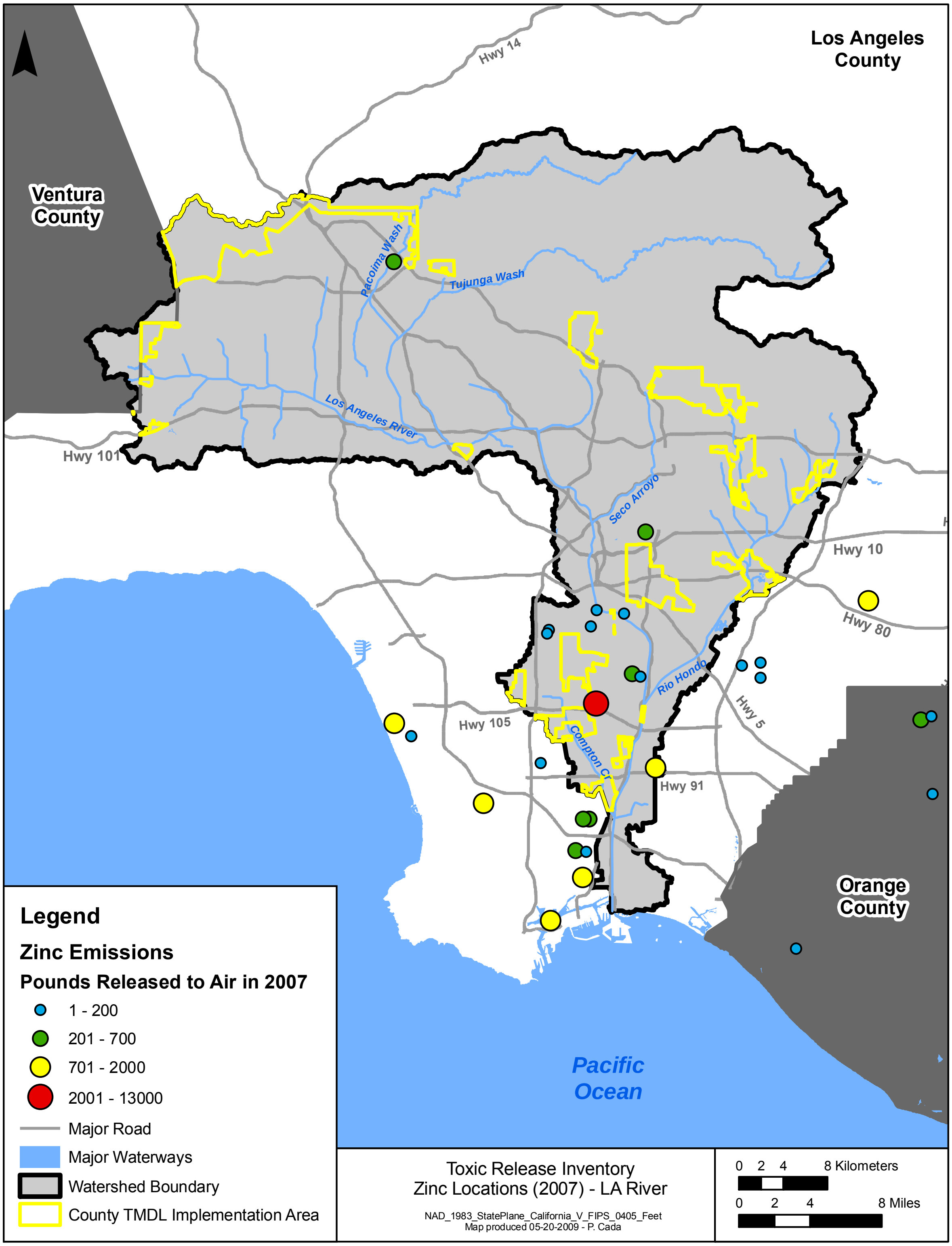

Figure 25. TRI Atmospheric Releases in the Los Angeles River Watershed—Zinc

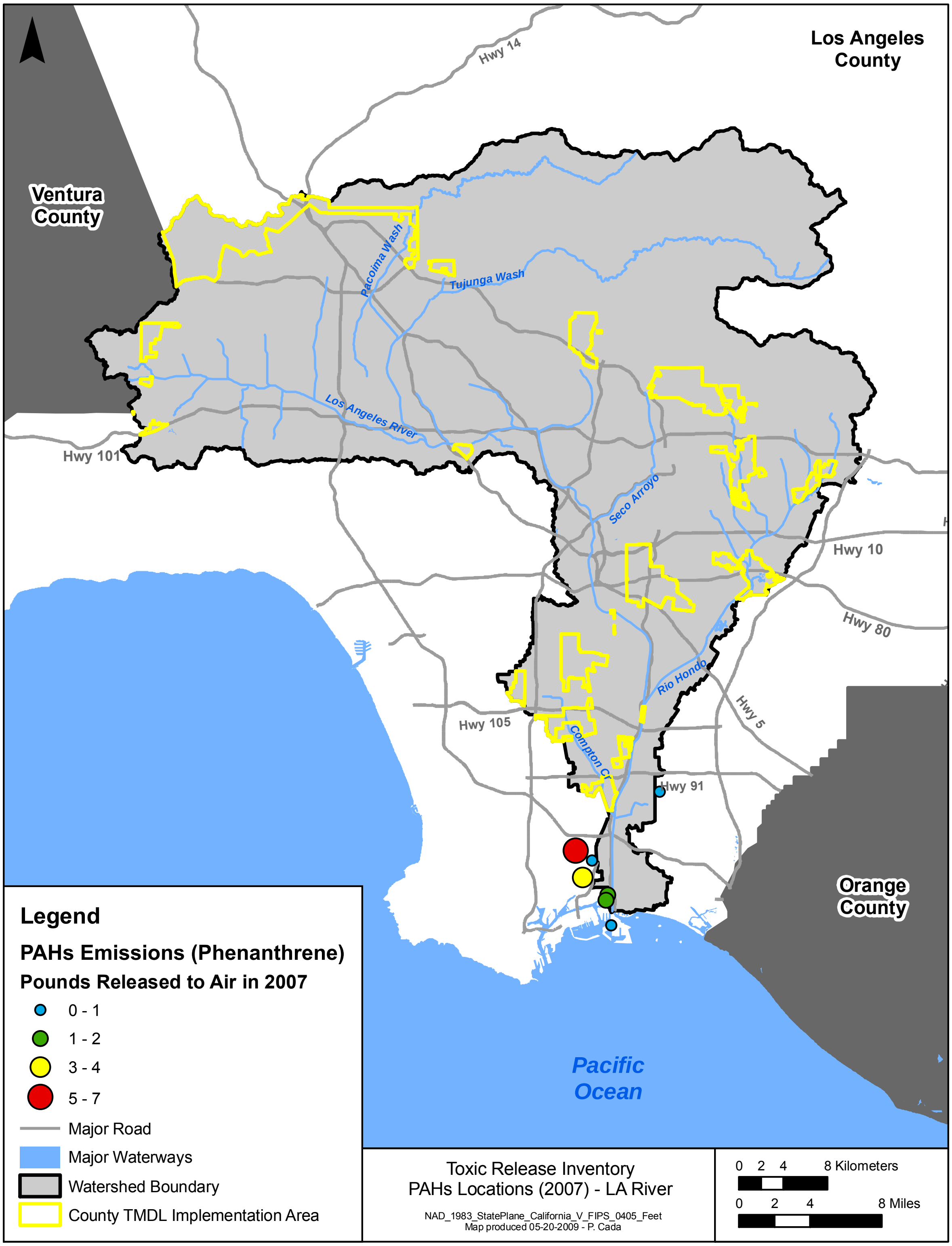

Figure 26. TRI Atmospheric Releases in the Los Angeles River Watershed—Total PAHs

In California in 2007, 81 industries released copper or copper compounds into the air. The largest emission of copper was 250 pounds. Three companies each released 250 pounds: Shultz Steel Company in Southgate, FTG Circuits in Chatsworth, and Data Electronic Surfaces in Santa Ana. Shultz and FTG are in the Los Angeles River watershed.

In 2007, 281 industries reported atmospheric emissions of lead. The largest emission was 3,434 from Exide Technologies (electronics) in Los Angeles. The next largest release was 538 pounds from Quemetco, Inc., just to the east of the Los Angeles River watershed. All other industries emitted less than 100 pounds.

Zinc was released from 66 industries in 2007. The largest emitter of zinc was Custom Alloy Sales in Los Angeles (8,787 pounds), very close to County TMDL Implementation Areas. The second largest release was 1,920 pounds from Exxon-Mobile Refinery in Torrance, south of Ballona Creek and on the southwest side of the Los Angeles River watershed.

Only eight companies reported atmospheric releases of PAHs. Phenanthrene is used as an index chemical to represent PAHs because it tends to be the most common PAH found in the Los Angeles region (Sabin et al. 2004). The largest release of phenanthrene in 2007 was seven pounds, from BP West Coast Products in Carson. All emitters of PAHs are at the most southern portion of the Los Angeles River, and the majority of emissions were from fugitive emissions (not smoke stacks).

Three companies also reported atmospheric releases of PCBs in 2007 in California (not shown). The sum of PCB releases from all the companies is less than 0.5 pound, and all these sites are farther than 100 miles away from the watersheds.

It is important to note that TRI data shows only a portion of air pollutants that could be deposited in the Los Angeles region. Many metals and chemicals are regularly deposited hundreds of miles away from their original source (Daggupaty et al. 2006; Bozó 1991). Recent studies of air pollution in Southern California have shown a large portion of the mercury, nitrates, sulfates, and other toxins in the Los Angeles region actually come from industrial practices in China. The location of the region (coastal and at the foot of a mountain range) causes the chemicals to concentrate in this terrain (Bradsher and Barboza 2006; Chea 2006).

3.2.5. Waste Sites

The RCRA was added to the Solid Waste Disposal Act (1965) in 1976 to regulate the disposal of municipal, industrial, and hazardous waste. It controls the generation, transportation, treatment, storage and disposal of hazardous and non-hazardous wastes. The term *RCRA site* generally refers to a site of waste storage or disposal. RCRA sets specific criteria for the containment at these sites; however, a site in violation has the potential to emit pollutants into the environment (USEPA 2008).

Many other waste sites (landfills, recycling areas, battery reclamation sites, incinerators, unauthorized dumping grounds) could be pollutant sources that are not listed under RCRA. Superfund sites, which are hazardous waste sites that have been inactive or abandoned, are not regulated under RCRA. Such hazardous waste areas and areas of accidental pollutant release (i.e., spills) are controlled under the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Those areas are called Superfund sites because they receive federal funding to assist with removal and cleanup processes. Only severely contaminated sites qualify for Superfund and are placed on the National Priorities List to receive funding. Many data sets are generated from the Superfund site, including data to establish the site on the National Priorities List, monitor progress of cleanup efforts, and long-term monitoring to ensure success of the cleanup.

Typical contaminants that can migrate from Superfund and RCRA sites to the environment are widespread. The top 10 pollutants on CERCLA's National Priority List include arsenic, lead, mercury, vinyl chloride, PCBs, benzene, PAHs, cadmium, benzo(A)pyrene, and benzo(B)fluoranthene. Dense and light non-aqueous phase liquids—which include chlorinated solvents, petroleum components, PCBs, and PAHs—are some of the worst contaminants found in hazardous waste sites because they can travel long distances in groundwater, are slow to degrade, and are toxic at very low concentrations.

RCRA and Superfund sites in Southern California were researched using the California EnviroStor public database. For both data sets, the facility name associated with each site is provided along with the facility address, coordinates, and permit numbers. RCRA data also describe the state of the cleanup efforts (e.g., active, completed, no action required, backlog) and the type of cleanup (voluntary, hazardous waste permit, state response, school cleanup, and such).

Twenty-three RCRA sites are in the County TMDL Implementation Area. Within the entire Los Angeles River watershed, there are 355 sites. Most sites are in an active cleanup status or have already been completed. School sites, voluntary cleanup sites, and permitted hazardous waste facilities make up the majority of RCRA listings. A complete breakdown of cleanup types and status are shown in Table 19 and Table 20. A map of RCRA sites within the County TMDL Implementation Area is shown in Figure 27.

Table 19. RCRA Sites in the Los Angeles River Watershed—Cleanup Type

Site Type	Sites in Watershed	Sites in County TMDL Implementation Area
Permitted hazardous waste facilities performing corrective actions	81	8
Federal Superfund—delisted (cleaned up) site	1	0
Federal Superfund—listed (cleanup is active or beginning)	8	0
Federal Superfund—proposed (needs cleanup, not confirmed for federal funding yet)	1	0
Permitted hazardous waste facilities currently operating	16	0
School sites (proposed and existing) being cleaned or evaluated	85	6
Confirmed release sites (generally high-priority and high potential risk)	71	4
Voluntary cleanup sites (not required by law)	92	5

Table 20. RCRA Sites in the Los Angeles River Watershed—Cleanup Status

State of Action	Sites in Watershed	Sites in County TMDL Implementation Area
Action Needed	50	5
Active	170	14
Complete	127	4
Referred	8	0

Nine Superfund sites are in the Los Angeles River watershed. None are in the County TMDL Implementation Area. The sites are shown in Figure 28. Most sites within the watershed are groundwater or soil sites (or both) contaminated with organic solvents (e.g., trichloroethylene [TCE], perchloroethylene [PCE], dichlorinated ethyelnes [DCEs], benzene, dioxane). All sites were listed in 1995 according to EnviroStor data. The site types, contaminants and areas are shown in Table 21.

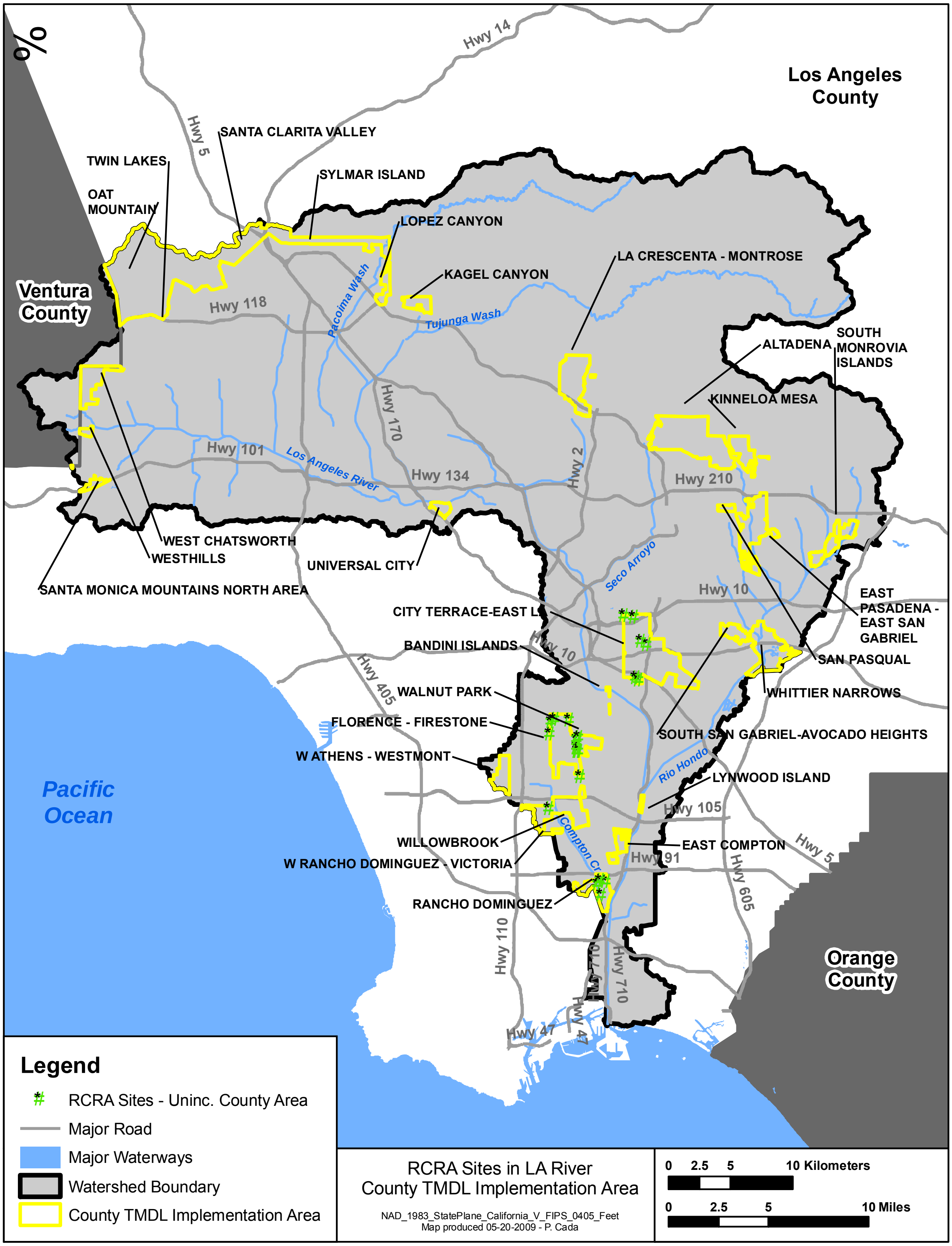

Figure 27. RCRA Sites in the County TMDL Implementation Area Only

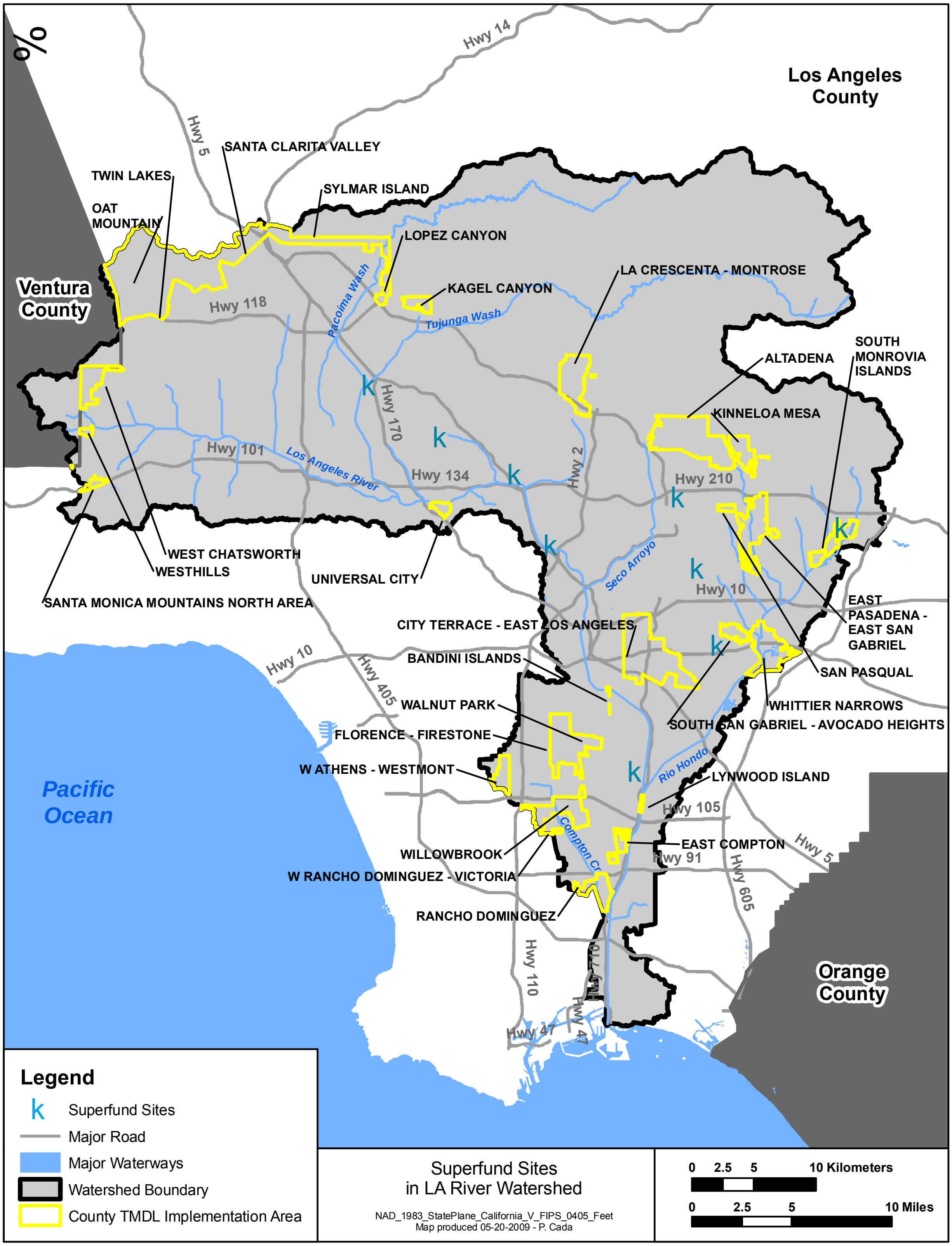

Figure 28. Superfund Sites in the Los Angeles River Watershed

Table 21. Superfund Sites in the Los Angeles River Watershed

Name	Address	Site Type	Site Size (acres)	Contaminants
Cooper Drum Co.	9316 Atlantic Ave., South Gate	Groundwater, soil, environmentally sensitive areas	3.8	Lead, PAHs, PCBs, benzene, TCE, dichloroethene, dichloroacetate
Jet Propulsion Laboratory (NASA)	4800 Oak Grove Dr., Pasadena	Groundwater	176	TCE, perchloromethane
Operating Industries, Inc., Landfill	900 N Potrero Grande Dr., Monterey Park	Groundwater, soil, air	190	landfill gas, organic and inorganic compounds
San Fernando Valley (Area 1)	North Hollywood Wellfield Area, Los Angeles	Groundwater	2,560	TCE, PCE
San Fernando Valley (Area 2)	Crystal Springs Wellfield Area, Los Angeles & Glendale	Groundwater	6,680	TCE, PCE
San Fernando Valley (Area 3)	Glorietta Wellfield Area, Glendale	Groundwater	4,400	PCE
San Fernando Valley (Area 4)	Pollock Wellfield, Los Angeles	Groundwater	5,860	TCE, PCE
San Gabriel Valley (Area 1)	Peck Rd. & Real, El Monte	Groundwater, soil	3,840	TCE, PCE
San Gabriel Valley (Area 3)	Main St. & Gafield Ave., Alhambra	Groundwater, soil	Multiple areas	TCE, PCE, perchlorates, dioxane, dimethylnitrosamine

3.2.6. Sanitary Sewer and SSOs

When sanitary sewers overflow or leak, they can release raw sewage into the environment. Many sanitary sewer networks in the United States were installed decades ago and are in need of replacement. Aging systems are a major source of sanitary sewer leakage. Severe weather, improper system operation and maintenance (O&M), clogs, and root growth can contribute to sanitary sewer leaks and overflows. Overflows can affect nearby waters and also back up into streets and basements (USEPA 2009). Raw sewage contains high concentrations of bacteria and nutrients from human and kitchen waste, as well as organic chemicals and metals.

Chemicals are present in sewage water from household use of cleaners, disinfectants, personal care products, treated swimming pools and pharmaceuticals. Personal care products and pharmaceuticals have recently been scrutinized for their potential to be harmful endocrine disrupting chemicals (Boyd et al. 2004). Chemicals from laboratory sinks are also present in raw sewage (USEPA 2009).

Los Angeles has been recognized for the severe corrosion rates occurring in its sanitary sewers caused by sulfate-reducing bacteria (Morton et al. 1991; Zhang 2008). Wastewater from corroded sewers contains several metals, including cadmium, copper, iron, lead, and nickel (Ablin and Kinshella 2004).

The sanitary sewer network for the County TMDL Implementation Area is shown below in Figure 29, Figure 30, and Figure 31. LACDPW operates a special district for sanitary sewer maintenance, the Consolidated Sewer Maintenance District, which currently covers much of the sewered Unincorporated County Areas, 40 incorporated member cities, and two contract cities. Some of the sewer network consists of city sanitary sewers and private sewers not maintained the Los Angeles County Department of Public Works.

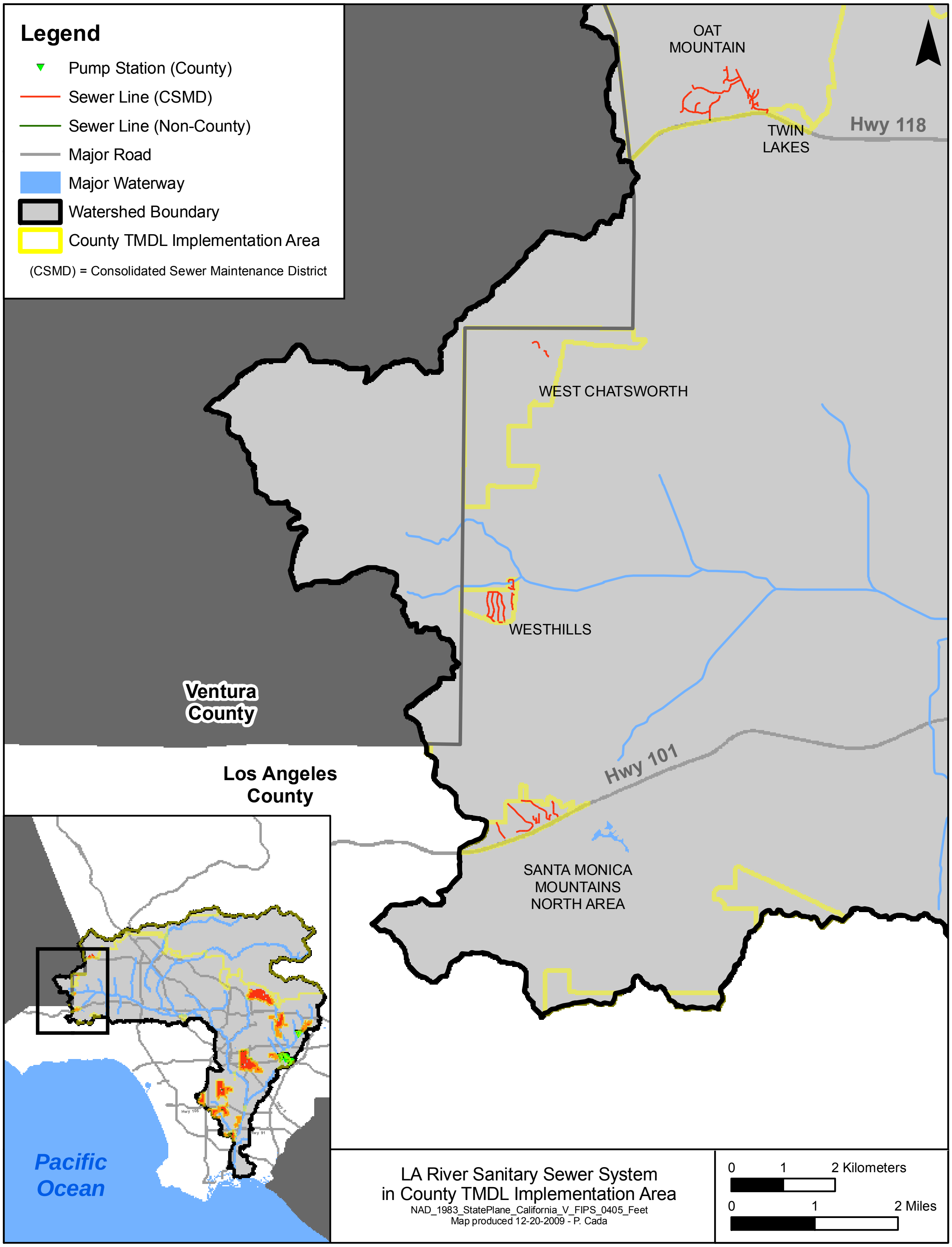

Figure 29. Sanitary Sewer Network in the Los Angeles River Watershed – County TMDL Implementation Area Only – Map 1

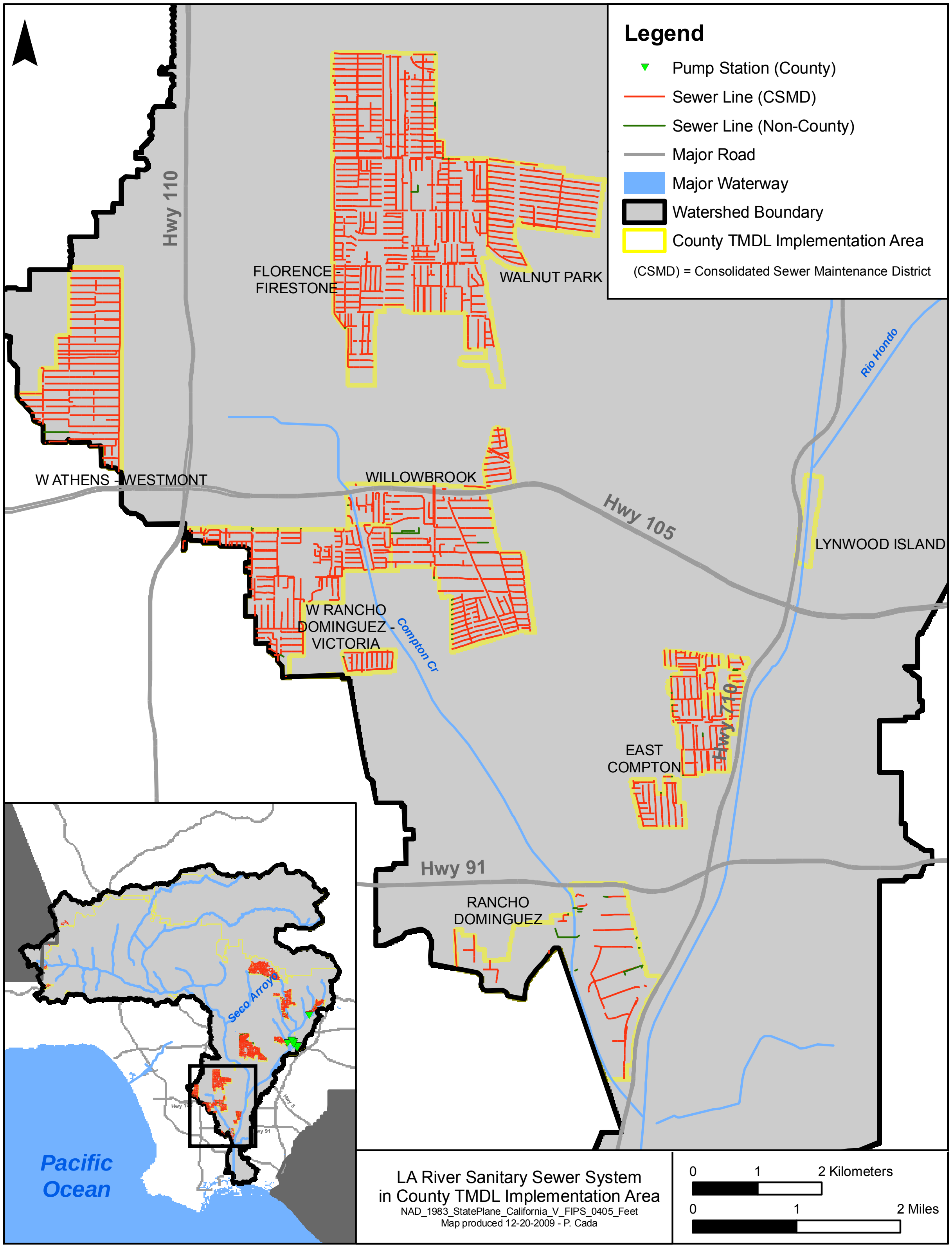

Figure 30. Sanitary Sewer Network in the Los Angeles River Watershed – County TMDL Implementation Area Only – Map 2

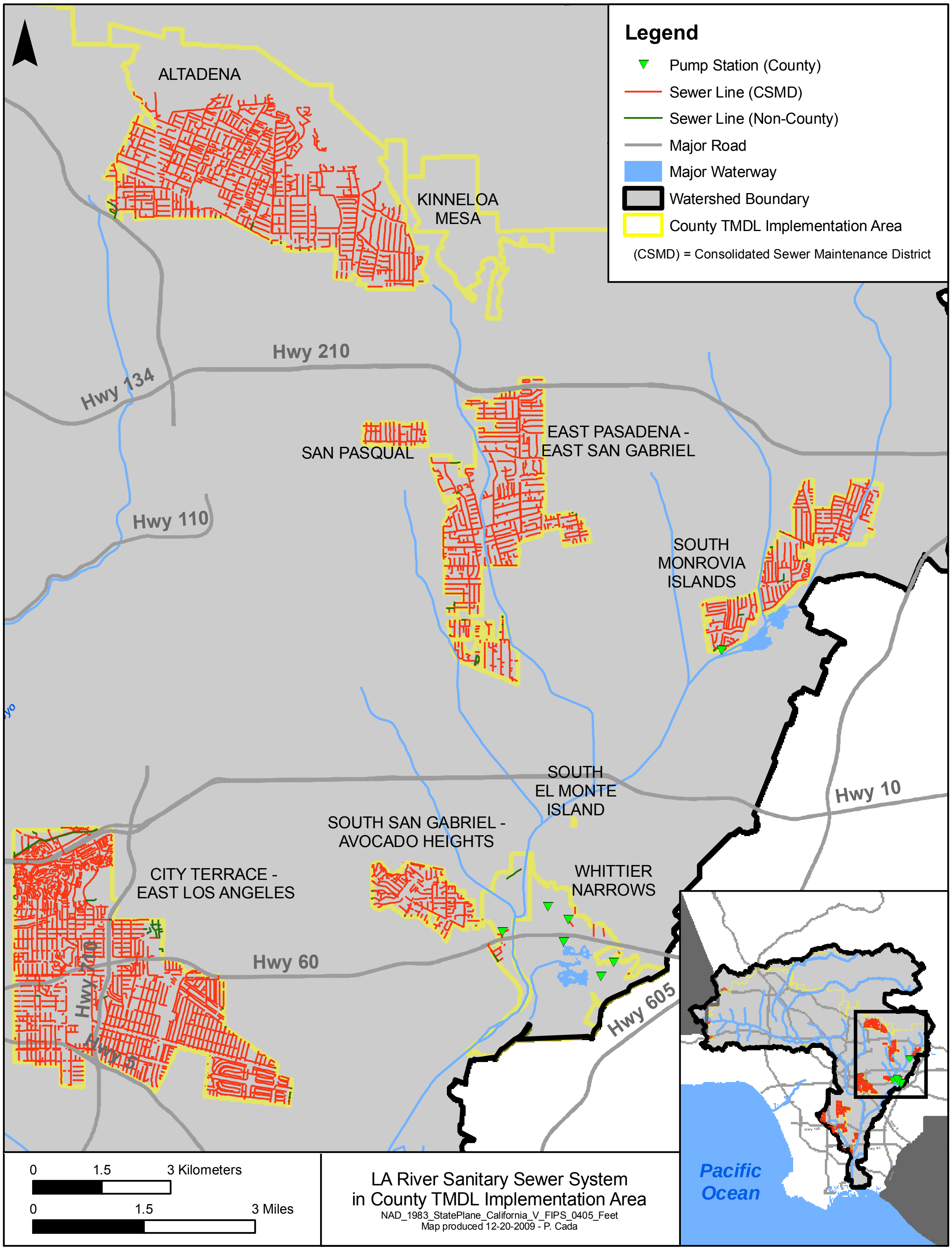

Figure 31. Sanitary Sewer Network in the Los Angeles River Watershed – County TMDL Implementation Area Only – Map 3

Table 22**Error! Reference source not found.** shows the SSOs that were recorded between November 2006 and June 2009. The range of overflow volumes was between 5 and 2,800 gallons, and the leading causes of SSOs were from root intrusions and grease deposition. In the Los Angeles River watershed, 92 SSOs were reported during that period (32 months). Approximately half of the overflows did not reach surface water, and of those that did, most flowed into the Los Angeles River.

Table 22. SSOs in the Los Angeles River Watershed TMDL Implementation Area

Cause of Spill	# of SSOs	Receiving Surface Water	# of SSOs
Debris	1	Los Angeles River	22
Flow Exceeded Capacity	1	Rio Hondo	3
Grease Deposition (FOG)	22	Compton Creek	2
Pipe Structural Problem	1	Centinela Creek	1
Root Intrusion	31	Other Surface Water	3
Vandalism	2	Did not Reach Surface Water	51
Other	24		

3.2.7. Agricultural Operations

Agricultural land use is limited in the County TMDL Implementation Area. Horse ranches near federal lands and irrigated croplands/improved pasture land exist in the northern portion of the watershed (Figure 33). Nurseries, horse ranches, and irrigated croplands/improved pasture land exist within East Pasadena-East San Gabriel, South San Gabriel – Avocado Heights, and Whittier Narrows (Figure 34).

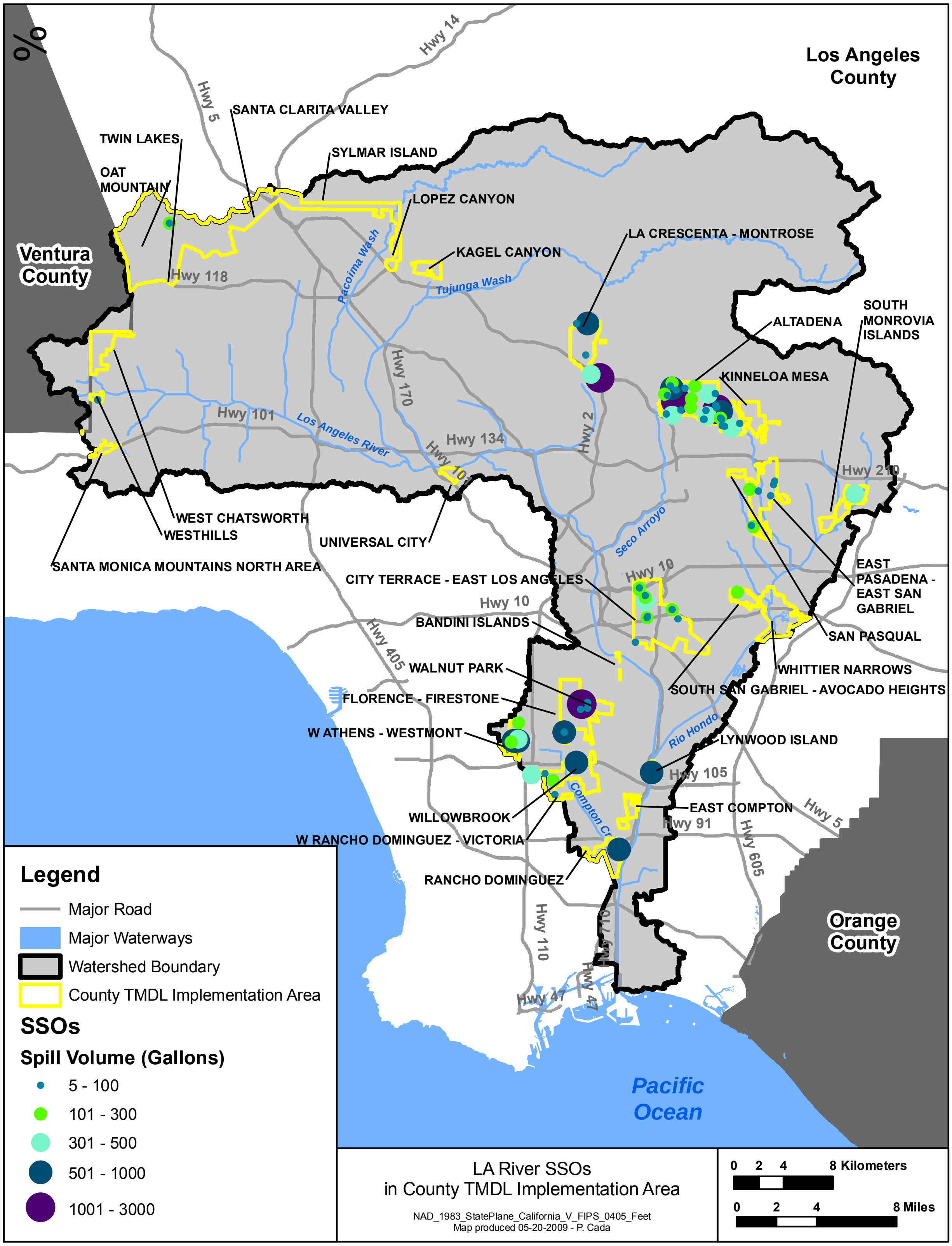

Figure 32. SSOs in the Los Angeles River Watershed – County TMDL Implementation Area Only

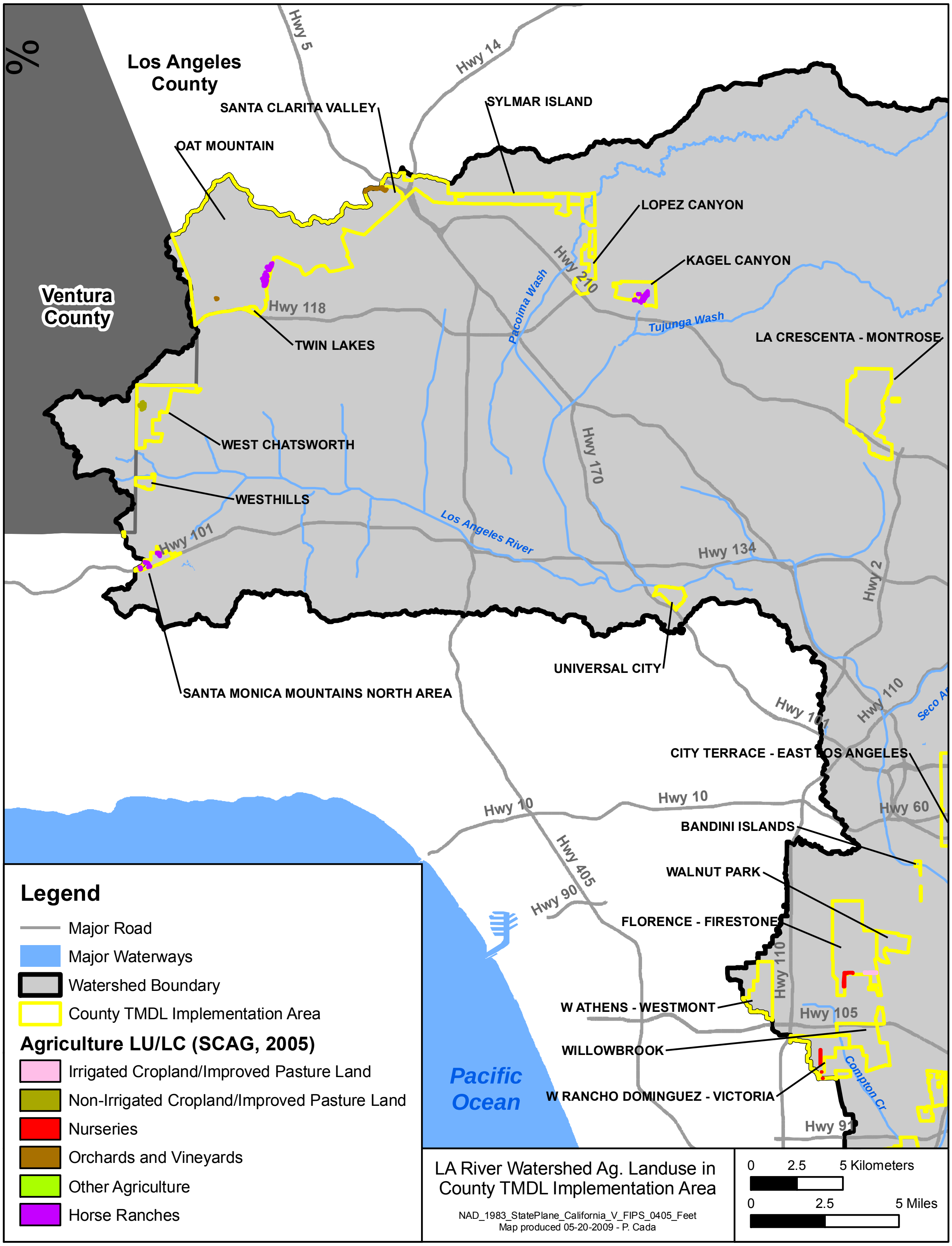

Figure 33. Agricultural Land in the Los Angeles River Watershed – County TMDL Implementation Area Only – Upper Los Angeles River Watershed

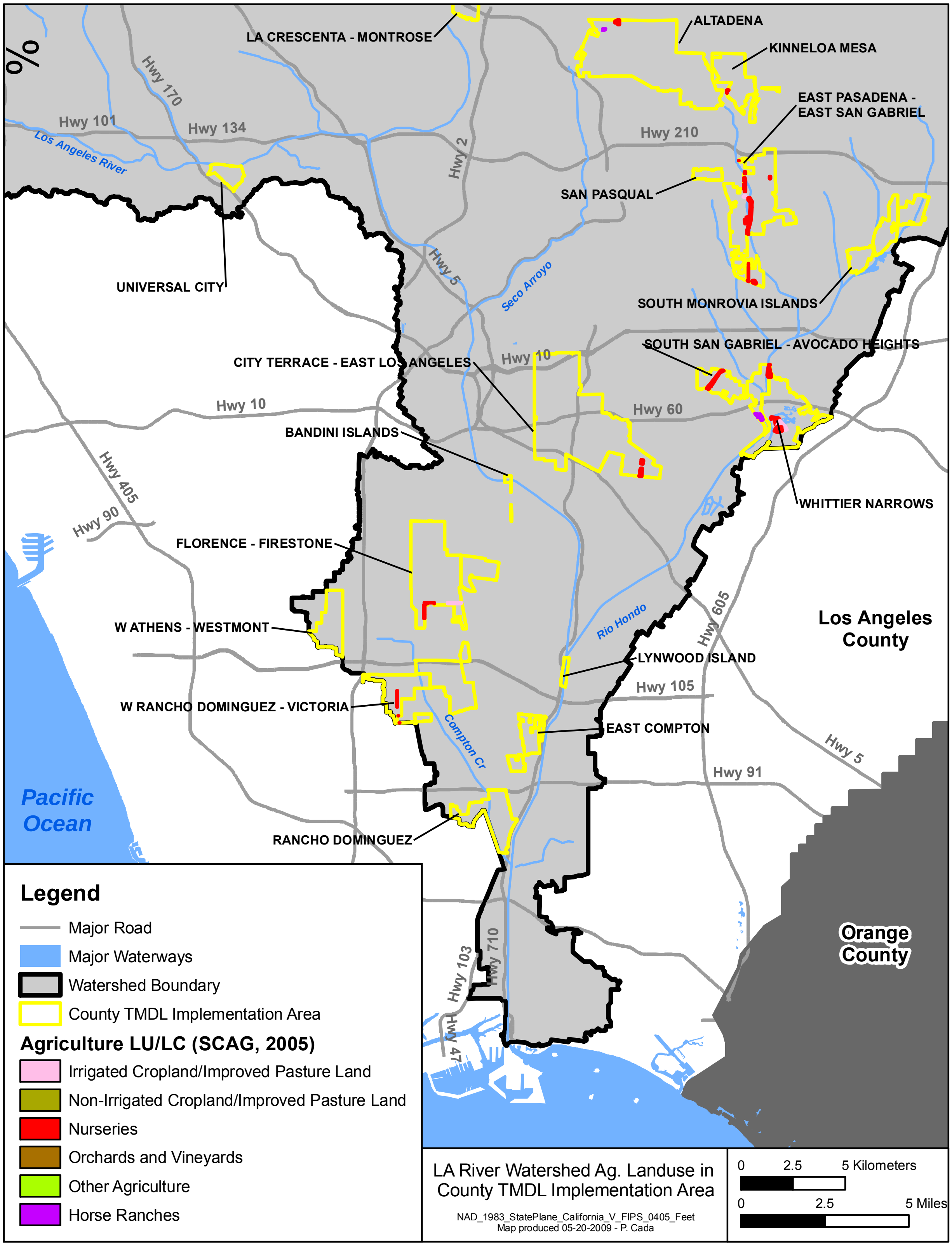

Figure 34. Agricultural Land in the Los Angeles River Watershed – County TMDL Implementation Area Only – Lower Los Angeles River Watershed

3.3. Pollutant Source Prioritization

To help develop implementation strategies, a prioritization of pollutant loading by community and potential sources was developed. The effort is concentrated on wet weather loading, with the assumption that BMPs targeted for the watershed would be designed to treat both wet and dry weather flows that drain to the BMP. Many dry weather implementation strategies would involve programs that address excessive irrigation, illicit discharges, and leaking sewer lines rather than structural BMPs.

Wet weather loads by unincorporated County community were converted to area loads (e.g., pounds per acre per year [lb/ac/yr]) for use in the pollutant source prioritization. This provides a normalized view for targeting management in that it shows where the rates are highest. Area loads for each constituent were then ranked by community. Values were assigned quartiles as follows: 1 for the lowest 25th quartile, 2 for values between the 25th and 50th quartile, 3 for values between the 50th and 75th quartile, and 4 for the highest quartile. Results for metals and bacteria were weighted slightly higher (× 1.5). PAHs are included. Cadmium and other toxics were omitted because they were not modeled, and sufficient information by land use was not available to calculate loads by community. Scores for each community were totaled and ranked. A ranking of dry weather total loading is also provided; however, because the area is a linear determinant of the load (according to the regression described earlier), the total loads rather than area-based loads are used. The final rankings are presented separately for wet and dry weather area-based loads in Table 23 and Table 24, respectively.

A tabulation of pollutant sources by community has also been prepared in Table 25. The table is sorted by the area-based, wet weather load rankings of communities. The table includes acres of industrial land use, acres of high-density residential, acres of commercial, number of TRI sites within 20 miles, number of RCRA sites, number of SSOs, percent of area that has a high road density, and acres of agricultural land. Results can be compared with load rankings in Table 23 and Table 24 to understand potential sources contributing to community loads.

Of the top 11 (there is a tie for #10) ranked communities—in terms of area-based, wet weather pollutants loads—5 also have some of the greatest number and densities of sources: City Terrace – East Los Angeles, Altadena, East Pasadena – East San Gabriel, Lynwood Island, and La Crescenta – Montrose. Major watershed areas are the Rio Hondo, headwaters of Arroyo Seco and Verdugo Wash, as well as the lower Los Angeles River. These communities have some of the most intensive land uses in the County TMDL Implementation Area. For instance, Lynwood Island, City Terrace – East Los Angeles, and East Compton have high road densities. And the communities of City Terrace – East Los Angeles, Altadena, and East Pasadena are among the top tier for commercial land use. Relative concentrations of commercial land use (i.e., commercial acres divided by total area) are highest in Universal City (37 percent), Santa Monica Mountains North Area (17 percent), and City Terrace – East Los Angeles (16 percent). Both of these land uses—roads and commercial—are important sources of copper, zinc, and fecal coliform.

The relative concentrations of high-density, single-family residential land use (i.e., high-density residential acres divided by total community land area) are among the highest in the top 11 ranked communities. San Pasqual, East Compton, and South Monrovia Islands have values above 80 percent. Altadena and East Pasadena – East San Gabriel have values above 70 percent. This land use is lower in imperviousness than transportation, commercial, and industrial. High-density, single-family residential is an important source of nutrients behind commercial in general importance. Compared to nonresidential, developed land use concentrations of copper and zinc are typically reduced.

Note that while South El Monte Island and the Bandini Islands ranked high, they are also relatively small communities in area—that is, they are a high-density source but small in area. City Terrace – East Los Angeles and Altadena have the highest number of SSOs. While these are temporary in nature, the SSOs suggest susceptibility of the areas for future problems and help to explain historical monitoring results for fecal coliform, for example.

Table 23. Wet Weather Load Ranking by Unincorporated County Community (Area Loads)

Community Name	Parameter Score								Total Score	Score Rank	Area Rank
	TN	TP	Copper	Zinc	Lead	Fecal Coliform	TSS	PAHs			
La Crescenta – Montrose	4	4	6	6	6	6	4	4	40	1	6
South El Monte Island	4	4	6	6	6	6	4	4	40	1	29
East Compton	4	4	6	6	6	6	4	3	39	3	20
San Pasqual	4	4	6	6	6	6	3	4	39	3	24
City Terrace – East Los Angeles	4	4	6	6	6	6	3	3	38	5	2
Altadena	4	4	6	4.5	4.5	6	3	3	35	6	3
Bandini Islands	4	4	6	6	6	1.5	4	2	33.5	7	28
East Pasadena – East San Gabriel	3	4	4.5	4.5	6	6	2	3	33	8	5
Lynwood Island	4	3	6	6	4.5	3	4	2	32.5	9	26
Santa Monica Mountains North Area	3	3	4.5	4.5	4.5	6	4	2	31.5	10	23
South Monrovia Islands	3	3	4.5	4.5	6	4.5	2	4	31.5	10	10
W. Athens – Westmont	3	3	4.5	4.5	4.5	4.5	2	4	30	12	17
Rancho Dominguez	3	3	4.5	6	3	3	3	4	29.5	13	12
Florence – Firestone	3	3	4.5	4.5	4.5	4.5	2	3	29	14	4
Walnut Park	2	2	4.5	3	4.5	4.5	1	3	24.5	15	21
South San Gabriel – Avocado Heights	3	3	3	3	3	4.5	1	3	23.5	16	13
Willowbrook	2	2	3	4.5	4.5	3	2	2	23	17	9
W. Rancho Dominquez – Victoria	2	2	3	3	3	4.5	1	4	22.5	18	16
Twin Lakes	2	2	3	3	3	3	3	2	21	19	27
Lopez Canyon	2	2	1.5	3	3	4.5	2	1	19	20	18
Westhillls	2	2	3	3	3	1.5	2	2	18.5	21	25
West Chatsworth	1	1	3	3	1.5	1.5	4	1	16	22	8
Kinneloa Mesa	2	2	3	1.5	1.5	1.5	3	1	15.5	23	15
Santa Clarita Valley	1	1	1.5	1.5	1.5	3	1	4	14.5	24	11
Kagel Canyon	1	1	1.5	1.5	3	3	1	1	13	25	19
Universal City	1	1	1.5	1.5	1.5	1.5	4	1	13	25	22
Whittier Narrows	1	1	1.5	1.5	1.5	3	1	2	12.5	27	7
Oat Mountain	1	1	1.5	1.5	1.5	1.5	3	1	12	28	1
Sylmar Island	1	1	1.5	1.5	1.5	1.5	1	1	10	29	14
Weighting	*1*	*1*	*1.5*	*1.5*	*1.5*	*1.5*	*1*	*1*			

Table 24. Dry Weather Load Ranking by Unincorporated County Community (Total Loads)

Community Name	Parameter Score							Total Score	Score Rank
	TN	TP	Copper	Zinc	Lead	Fecal Coliform	TSS		
Altadena	4	4	6	6	6	6	4	36	1
City Terrace – East Los Angeles	4	4	6	6	6	6	4	36	1
East Pasadena – East San Gabriel	4	4	6	6	6	6	4	36	1
Florence – Firestone	4	4	6	6	6	6	4	36	1
La Crescenta – Montrose	4	4	6	6	6	6	4	36	1
Oat Mountain	4	4	6	6	6	6	4	36	1
South Monrovia Islands	4	4	6	6	6	6	4	36	1
Whittier Narrows	4	4	6	6	6	6	4	36	1
Willowbrook	3	3	4.5	6	6	4.5	3	30	9
East Compton	3	3	4.5	4.5	4.5	4.5	3	27	10
Kinneloa Mesa	3	3	4.5	4.5	4.5	4.5	3	27	10
Rancho Dominguez	3	3	4.5	4.5	4.5	4.5	3	27	10
South San Gabriel – Avocado Heights	3	3	4.5	4.5	4.5	4.5	3	27	10
W. Athens – Westmont	3	3	4.5	4.5	4.5	4.5	3	27	10
W. Rancho Dominquez – Victoria	3	3	4.5	4.5	4.5	4.5	3	27	10
Lopez Canyon	2	2	3	3	3	3	2	18	16
San Pasqual	2	2	3	3	3	3	2	18	16
Santa Clarita Valley	2	2	3	3	3	3	2	18	16
Santa Monica Mountains North Area	2	2	3	3	3	3	2	18	16
Universal City	2	2	3	3	3	3	2	18	16
Walnut Park	2	2	3	3	3	3	2	18	16
West Chatsworth	2	2	3	3	3	3	2	18	16
Bandini Islands	1	1	1.5	1.5	1.5	1.5	1	9	23
Kagel Canyon	1	1	1.5	1.5	1.5	1.5	1	9	23
Lynwood Island	1	1	1.5	1.5	1.5	1.5	1	9	23
South El Monte Island	1	1	1.5	1.5	1.5	1.5	1	9	23
Sylmar Island	1	1	1.5	1.5	1.5	1.5	1	9	23
Twin Lakes	1	1	1.5	1.5	1.5	1.5	1	9	23
Westhillls	1	1	1.5	1.5	1.5	1.5	1	9	23
Weighting	*1*	*1*	*1.5*	*1.5*	*1.5*	*1.5*	*1*		

Table 25. Source Tabulation by Unincorporated County Community

Community Name	Total Area (acres)	Industrial Land Use (acres)	Industrial Permits (#)	High-Density Residential Land Use (acres)	Commercial Land Use (acres)	TRI (#)	RCRA (#)	SSO (#)	High Road Density (%)	Agricultural Land Use (acres)
La Crescenta – Montrose	2,146			1,277.30	146.2	159		5	1	
South El Monte Island	2					14				
East Compton	528			434.6	56.4	139			37	
San Pasqual	164			140	7.1	93			33	
City Terrace – East Los Angeles	4,763	220.3	16	2,147.90	779.8	141	7	13	63	15.9
Altadena	4,251	9.8		3,026.50	262.6	82		32		10.5
Bandini Islands	31	1.1	1			137			1	
East Pasadena – East San Gabriel	2,256	12.9	1	1,584	159.1	101		7	1	70.3
Lynwood Island	83					139		1	98	
Santa Monica Mountains North Area	240	8.2	1		40	14	1			15.5
South Monrovia Islands	1,063	1.8		942.5	65.3	91		1		
W Athens – Westmont	744			82.3	75.8	128		5	68	
Rancho Dominguez	967	626.8		1.6	46	137	4	1	1	
Florence – Firestone	2,274	353.5	35	1,050	318.5	139	11	8		20.4
Walnut Park	481	2.39		409	60.6	140			31	
South San Gabriel – Avocado Heights	967	28.8		490.2	30.1	132		1		45.23
Willowbrook	1,074	39	3	543	161.8	138		1	9	
W Rancho Dominguez – Victoria	834	16.7	1	556.9	76.2	133	1	4	12	6.2
Twin Lakes	45			22.2		16				
Lopez Canyon	703	71.1	1	0.6	8.7	19				
Westhills	143			63.7	1.9	15		1		
West Chatsworth	1,238			110.1	1.1	16				10.3
Kinneloa Mesa	886			72.2	5.7	84				0.1
Kagel Canyon	541			67.4		21				25.2
Universal City	300	134.6		1.2	109.9	80				
Whittier Narrows	1615	40.4	1	0.9	30.1	131				76.5
Oat Mountain	10,968	767.6		5.49	13.4	17		1		56.3
Sylmar Island	907			2		15				

The tabulation of RCRA sites and agricultural land is informative for targeting potential sources within some of these communities, but it does not play a large role in the prioritization at this scale. In addition, TRI sources are widely distributed across the Los Angeles River watershed and relatively ubiquitous, much like the primary source of PAHs (i.e., combustion sources like vehicles).

The high rankings for communities like Altadena, City Terrace – East Los Angeles, and East Pasadena in terms of dry weather loads is attributable to the large area of urban land, especially residential and commercial land, and associated irrigation. A comparison of rankings for dry and wet weather loads is difficult given the different methodologies: wet weather ranking uses area-based loads, and dry weather ranking uses total loads for reasons discussed earlier.

Several caveats are important in understanding this prioritization. Some areas have larger *total* pollutant loads and can be important for targeting management opportunities. In addition, the targeting and implementation of actual BMPs also depends on the availability of suitable and feasible sites. The location of and treatment by existing BMPs is an important consideration as well.

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4. Development of Nonstructural Solutions

A comprehensive program has been developed and implemented to reduce or eliminate the amount of pollutants in stormwater and urban runoff. This program meets a variety of regulatory requirements, including those of the LARWQCB adopted Order R4-2007-0042 for municipal stormwater and urban runoff discharges within the County (LARWQCB 2007b). An evaluation was conducted to identify opportunities for improvements to existing programs and new programs that would help meet TMDL WLAs and to determine the level of success in implementing these programs. Existing nonstructural BMPs are described in Section 4.1 and new nonstructural BMPs are proposed in Section 4.2. Considered holistically, these existing, improved, and new programs are expected to contribute to the reduction of TMDL pollutant loads and meet WLAs.

4.1. Existing Nonstructural BMPs

The following provides a summary of existing nonstructural BMPs that were evaluated to determine if enhancements can be made to specifically support TMDL implementation. The discussion provides an overview of relevant programs that can directly support the control of pollutants in stormwater. For those BMPs determined to be candidates for enhancements, a summary of proposed changes to the program is provided.

4.1.1. Public Information and Participation Program

The Public Information and Participation Program includes a variety of outreach campaigns and programs that address stormwater quality, including the following:

- **Stormwater/Urban Runoff Education**—a comprehensive outreach campaign that targets urban and polluted stormwater runoff. Audiences include "do-it-yourselfers," the general public, and commercial industry. It also includes a variety of formats such as public service announcements, tip cards, billboards, and movie theater advertisements.
- **Used Oil and Filter Recycling**—an outreach campaign that targets home mechanics and encourages them to recycle used oil and oil filters. The campaign includes public service announcements, brochures, and collection events. The campaign materials have been translated into English, Spanish, Chinese, Korean, Vietnamese, and Cambodian.
- **Environmental Defenders**—a 30-minute school assembly program for elementary school children. The program involves two professional children's theater actors and teaches children how to protect the environment.
- **Generation Earth**—a program presented by TreePeople for secondary school children that encourages students to make a difference in their local environment through campus and eco-projects.
- **Plan-It Earth**—a program that involves an 8-week subscription to the *Los Angeles Times* to educate sixth- to ninth-grade children on environmental issues by reading the paper. The program also involves a teacher's guide and lesson plans. Students also can write an essay or create a piece of art related to environmental issues. The winner's essay or art is published in the *Los Angeles Times*.
- **Restaurant Training**—an education program that includes restaurant BMP guidelines, a watershed model showing the potential for oil and grease to affect the watershed, a PowerPoint presentation, and collateral material for restaurant owners, including posters, buckets with BMPs printed on them, and brochures.

- **(888)Clean LA**—a waste-reduction and recycling program, which includes a Web site with information on a wide variety of topics, including recycling, household hazardous waste disposal, the Smart Gardening Program, and illegal dumping.

Each campaign or program has its own goals and objectives, unique target audiences, a variety of message packaging formats, distribution mechanisms, and evaluation methods. Although the programs are implemented countywide, each has a separate budget and contract. A detailed description of the components of the above outreach and campaigns and programs is provided in Appendix C.

Public participation events are sponsored through the Stormwater/Urban Runoff Education Program, the (888)Clean LA Program, and the Smart Gardening Program (described below). Staff attend community events to provide informational materials, collateral items, and watershed model displays.

Support is provided for the Brake Pad Partnership, a collaborative group of brake manufacturers, environmentalists, stormwater management entities, and regulators committed to reducing the amount of copper in brake pad materials. The organization's research has determined that break pads are a significant source of copper that threatens water quality.

The following sections focus on two key programs that were evaluated for enhancements to address TMDL implementation: water conservation/smart gardening and stormwater training.

Water Conservation/Smart Gardening

Two programs address overwatering and reduction of dry weather flows from landscape irrigation; the water conservation ordinance and Smart Gardening Program. In October 2008 a water conservation ordinance was passed that applies to unincorporated County areas. The ordinance prohibits various washing and watering activities that can lead to waste or runoff (a detailed list of prohibited activities is provided in Appendix I). The Smart Gardening Program educates homeowners on reducing inputs for gardening and landscaping and to encourage green waste reduction. The program consists of learning centers and workshops that cover backyard composting, worm composting, grass recycling, water conservation, and fire risk reduction topics. The program targets citizens of all ages, although most attendees are aged 50 to 80.

Most weekends, workshops are conducted at 11 learning centers, which are permanent locations for the workshops. The learning centers include a demonstration garden with educational signage, drip irrigation, and composting bins. A variety of resources were developed to complement the workshops, including

- Tip cards
- A Web site
- Billboards
- Postcards sent to residents within 5 miles of the learning centers
- Press releases
- DVDs available at libraries
- Event booths

Enhancements to Address TMDL Implementation

Expanding the reach of the Smart Gardening Program to the County TMDL Implementation Area can better address the TMDL pollutants of concern. At this time there are no Smart Gardening learning or information centers in the Los Angeles River watershed. Residents of the Los Angeles River watershed are less likely to participate because advertising for workshops and other program activities are sent to residents within five miles of learning centers. In addition, a new tip card can be developed that addresses stormwater quality and encourages water conservation and proper chemical application techniques. The tip cards can be distributed to Los Angeles

River watershed residents and can describe landscaping and gardening practices to reduce pollutants in both wet weather and dry weather discharges.

Implementing those practices or other gardening/landscaping-related programs in the watershed can benefit water quality by reducing nuisance flows and associated pollutants, including metals, bacteria, and toxics, as well as wet weather toxics and bacteria. The Smart Gardening Program promotes practices that conserve water and reduce irrigation return flow. The program also promotes pest management practices that can reduce loads of toxic chemicals in runoff. Expanding the reach of the program into the Los Angeles River watershed and enhancing the educational materials to include discussion of water quality benefits will strengthen the Smart Gardening Program as a public outreach tool to promote the goals of the TMDL Implementation Plan.

Stormwater Training

Stormwater-related training is held annually for staff members that implement portions of the stormwater management program. The training is tailored to *train the trainers*, who then take the information to their staff. The training covers stormwater pollution prevention and provides information on specific issues (e.g., case studies) that were applicable during the past year. Presentations cover such topics as construction, planning, public agency activities, and illicit connections/illicit discharges. The presentations describe various stormwater management programs, including background and regulatory information, BMPs, and tracking and reporting.

Enhancements to Address TMDL Implementation

To improve stormwater-related training to address the pollutants of concern in the Los Angeles River watershed, additional, TMDL-specific training could be implemented that focuses specifically on the requirements of the TMDLs and the County's activities under the implementation plan. Background on the TMDLs, pollutants of concern, BMPs proposed in the implementation plans, and other applicable information can be presented to staff whose work impacts stormwater pollution. Doing so would ensure that applicable staff are educated about the TMDLs and reinforce the need for diligence in implementing wet and dry weather BMPs. Effectiveness could be assessed with a survey that would gauge employees' knowledge before and after the training. The training is expected to improve the effectiveness of existing programs at reducing all the pollutants of concern in the Los Angeles River watershed.

4.1.2. Industrial/Commercial Facilities Control Program

The Los Angeles River watershed contains 1,466 of the 3,454 industrial and commercial facilities[1] in the County. Pollutant source control and structural BMPs are implemented at those industrial and commercial facilities, which are considered critical sources of pollutants in stormwater. The Industrial/Commercial Facilities Control Program tracks, inspects, and ensures compliance at those facilities.

Industrial and commercial facility data are tracked using the Hazardous Materials System database. The database includes name, location, contact information, SIC code, status, stormwater certificate data, and inspections. Facility operators are referred to the California Stormwater Quality Association (CASQA) *Stormwater BMP Handbook: Industrial and Commercial* fact sheets (CASQA 2003a) for guidance on stormwater pollution prevention BMPs. A minimum number of BMPs must be implemented at existing and new industrial and commercial facilities, as verified by inspection, including the following:

- Terminating all unauthorized non-stormwater discharges to the storm drain system
- Exercising general good housekeeping practices
- Incorporating regularly scheduled preventive maintenance into operations

[1] This value includes commercial facilities, such as restaurants, that are not covered under the General Industrial Activities Storm Water Permit.

- Maintaining spill prevention and control procedures
- Implementing soil erosion control
- Posting signage on private storm drains to indicate that they are not to receive liquid or solid wastes
- Implementing regular cleaning of the on-site private storm drain system
- Ensuring that stormwater runoff is directed away from operating, processing, fueling, cleaning and storage areas

All facilities are inspected for stormwater issues at least once a year, and facilities are re-inspected when problems are identified. If problems are identified, the facility owner is required to take action by implementing one or more recommended BMPs listed on the inspection form. If remedial action is not taken, enforcement is initiated according to the following enforcement escalation procedure:

1. The inspector withholds a signature from the certification portion of the inspection form (the permittees must obtain County certification each year).
2. A notice of noncompliance is issued.
3. The facility is referred to the RWQCB, the Los Angeles County District Attorney through the Los Angeles County Environmental Crimes Strike Force or the County Nuisance Abatement Team. For cases where criminal violations of the Clean Water Act are suspected, cases are referred to the U.S. Department of Justice and the U.S. Environmental Protection Agency.

Enhancements to Address TMDL Implementation

Additional water quality benefits, specifically for bacteria, metals, and toxics, could be achieved with a more in-depth training for inspectors and staff addressing TMDL pollutants of concern, their sources, and the use of pollutant-specific BMPs. Strengthening partnerships with enforcing agencies will also improve the enforcement escalation procedures.

4.1.3. Development Planning Program

The Development Planning program focuses on mitigating the long-term hydrologic and pollutant effects of the built environment and changes in land use. Development Planning involves establishing requirements for post-construction BMPs, reviewing plans to ensure that proposed drainage plans meet water quality and hydrologic performance standards, and ensuring long-term O&M of post-construction BMPs through a maintenance and acceptance program. Such program areas apply to both public and private development projects.

Design criteria and maintenance routines for BMPs proposed for public maintenance have been developed and adopted as part of the *Stormwater Best Management Practice Design and Maintenance Manual for Publicly Maintained Storm Drain Systems* (LACDPW 2009b). In addition, the Standard Urban Stormwater Mitigation Plan (SUSMP) manual (County of Los Angeles 2002), which developers use to design stormwater management features of their sites, has been adopted to quantify the hydrologic calculation and evaluate each plan for feasibility.

Public road and flood projects adhere to the standards outlined in the *Stormwater Best Management Practice Design and Maintenance Manual for Publicly Maintained Storm Drain Systems*, and low impact development (LID) infrastructure manual is under development. The SUSMP manual and *Low Impact Development Standards Manual* (County of Los Angeles 2009) are used to review private construction projects. Site plans are also reviewed for green building requirements and drought-tolerant landscaping requirements to the extent these requirements apply to the development. The LID, green building, and drought-tolerant landscaping requirements are described in greater detail in Appendix I.

Privately owned structural BMPs are inspected periodically, and O&M of such BMPs are performed by the property owner or homeowners association. Oversight is addressed through a covenant or agreement that is recorded indicating that the owner is aware of and agrees to operate and maintain the stormwater BMP. The covenant or agreement includes a diagram of the site indicating the location and type of each feature incorporated into the development. It is recorded before final map approval for subdivisions and before a grading permit is issued (or a building permit if no grading permit is required), for all other developments.

4.1.4. Development Construction Program

The Development Construction Program addresses runoff from both public and private construction projects. Public construction projects are of two types: linear (road, utility) and vertical (capital improvement). Stormwater pollution prevention plans (SWPPPs) are developed and reviewed for all construction projects, and all sites are inspected for stormwater compliance. Every grading project disturbing an area one acre or greater is inspected at least once per year during the rainy season. Employees involved in construction activities, including inspectors, project engineers, resident engineers, utility staff, plan checkers, and office engineers, are trained annually on regulatory requirements, construction site BMPs and their applicability, and enforcement escalation procedures.

All private construction activity relating to building drainage and grading plans is tracked using the Web-based Drainage and Grading Database. The database tracks project information such as permit number, location, disturbed area, approval/issuance dates, and assessor parcel number. It also tracks if a project was conditioned to meet the requirements of SUSMP and the County's Low Impact Development ordinance.

Public Construction Projects

All public construction sites must abide by either the *Construction Site Best Management Practices Manual* or the *Stormwater Best Management Practice Handbook: Construction* (CASQA 2003b). Both manuals describe the minimum BMPs that each construction site operator must install, including wind and water erosion control, sediment control, tracking control, non-stormwater management, and waste management/good housekeeping. Additional BMPs can be included in the project contract's special provisions if necessary. Construction site BMPs are required to be implemented year-round during construction activities, including during any temporary suspension of work. Site operators are required to regularly self-inspect and maintain the construction site BMPs before a forecast storm; after a rainstorm that causes site runoff; at 24-hour intervals during extended precipitation events; and routinely, a minimum of once every week.

Stormwater pollution prevention is specified in construction contracts for public construction projects. Provisions include compliance with NPDES permit requirements and development and implementation of a SWPPP. Plans and SWPPPs for public construction projects are reviewed for water quality and quantity concerns. Projects located in incorporated areas that connect to the County drainage system are checked to ensure appropriate drainage and pollution controls are in place.

When public construction projects do not conform to the SWPPP or other construction documents, the following enforcement escalation procedure is utilized:

- A verbal notice is provided to the contractor
- An inspection report is issued
- A notice of noncompliance is issued, which allows for retention of a percentage of pay from the contractor's monthly pay request and fines of up to $1,ooo per day per violation.

Private Construction Projects

All operators of private construction sites must abide by the *Construction Site Best Management Practices Manual* (LACDPW 2007). The manual details the minimum BMPs that each construction site operator must install as well as self-inspection requirements. Inspectors require that certain additional BMPs are installed before the rainy season. Inspectors visit each construction site and inspect for erosion and sediment controls, good housekeeping practices, and other issues. Inspection frequency is increased before and during the rainy season.

Plan submittal requirements are provided to applicants upon request for all construction projects. The plan review process includes assessment of the adequacy of erosion and sediment controls, good housekeeping practices, and verification that a Notice of Intent has been filed with the State Water Resources Control Board (SWRCB) for all projects disturbing an area of one acre or more.

The following enforcement escalation policy is used to address violations:

- The operator must stop work until the issue is addressed
- A letter is sent if the problem persists
- A notice of violation is issued and a fine of $1,000 per day per violation is levied
- The County District Attorney's office is notified

Most violations do not reach the last step. In addition, a bond is collected for sites disturbing 1,000 or more yards of soil so that the site can be stabilized if the owner fails to take responsibility.

4.1.5. Public Agency Activities Program

A broad range of infrastructure and facility operation and maintenance activities occurs daily, including maintaining buildings and maintenance facilities; stormwater, wastewater, and drinking water infrastructure; roads, bridges, flood and management structures; and parks and landscaped areas. Maintenance activities often have water quality benefits in addition to utility and aesthetic benefits. For example, street sweeping and catch basin cleaning prevents pollutants from entering the municipal storm drain system before they can enter waterways.

Sewage Systems Maintenance, Overflow, and Spill Prevention

Sewage system maintenance, overflow prevention and response, and spill prevention are addressed by the Sewer System Management Plan (SSMP). The SSMP also specifies staffing and equipment needs to carry out necessary inspection and mitigation. A Closed Circuit Television (CCTV) Program is used to detect sources of infiltration to the sewer system.Once detected, serious problems are mitigated immediately. The CCTV program also helps to identify improper and unauthorized connections to the sanitary sewer that might contribute to SSOs.

Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management

The County TMDL Implementation Area has 13 public facilities, some of which are co-located, as shown in Table 26.

Table 26. Public Agency Facilities in the County TMDL Implementation Area

Division	Facility	Address	City
Fleet	Altadena	252W Mountain View St.	Altadena
Flood	Pickens Yard	4628 Briggs Ave.	La Crescenta
Flood	Alameda St 3B Pump Plant	18900 Santa Fe Ave.	Rancho Dominguez
Flood	Alameda St Phase 3C Pump Plant	18915 Santa Fe (behind the fire station)	Rancho Dominguez
Flood	Compton Creek Pump Plant #1	19115 S. Reyes Ave.	Rancho Dominguez
Flood	Compton Creek Pump Plant #2	19115 S. Reyes Ave.	Rancho Dominguez
Flood	Pacoima Dam	15300 N. Pacoima Canyon Rd.	Sylmar
Flood	Bell Sub Yard	6850 Valley Circle Bl.	West Hills

Division	Facility	Address	City
Roads	514B	252 W. Mountain View St.	Altadena
Roads	142	4304 Eugene St.	East Los Angeles
Water	East Tank	Dexter Park	Kagel Canyon
Water	Well 21-5 Pump Station	Angeles National Forest Rd.	Lake View Terrace
Water	West Tank	Angeles National Forest Rd.	Lake View Terrace

Each facility is inspected twice annually. A database of facilities tracks location, division, facility operator/contact name and number, and inspection date, corrective action(s), and follow up. When potential problems are uncovered during inspections, findings and corrective actions are conveyed to the facility operator, and a reinspection is conducted in a few weeks.

All main vehicle maintenance and materials storage facilities have SWPPPs that include a description of the facility, the activities that occur there, potential sources of stormwater pollution, and standard operating procedures, as well as stormwater BMPs and measures to prevent or respond to spills. Several BMPs are implemented at these facilities to reduce pollutant loading. Road supplies, which have a higher likelihood to be transported in stormwater, are generally stored outdoors under cover. Chemicals are stored indoors and protected, inert materials are stored outdoors uncovered, and trash is stored in covered containers. Most facilities do not have turf grass or landscaping that would require fertilizer/pesticide use or water conservation measures. Other source control and treatment BMPs at facilities include the following:

- Susceptible drains have petroleum booms or other BMPs.
- Dirt parking lots are controlled for sediment and petroleum.
- Restrooms are established buildings, not portable toilets except temporarily for some unmanned facilities.
- Parking lots/paved areas are swept once a month or as needed.
- Power-washing of buildings occurs, but BMPs are used to contain water.
- Wash racks have clarifiers and are connected to the sanitary sewer and covered.
- Sediment control BMPs protect outlets and the perimeter of disturbed areas.

Landscape and Recreational Facilities Management

Contractors are used to perform landscape maintenance along channels and right-of-ways. Maintenance includes the application of herbicides in the right-of-way and at flood control/water conservation facilities. The contracts prohibit pollution of channels, storm drains, or gutters and, as applicable, require contractors to maintain pesticide handling licenses from the California Department of Pesticide Regulation.

Storm Drain Operation and Management

A geographic information system (GIS) database is maintained of all inlets, catch basins, outfalls, and other storm drain infrastructure, including structural stormwater controls. Maps generated from the database are used to facilitate and track maintenance activities. Storm drain pipes that are 42 inches in diameter or larger are visually inspected for illegal connections or signs of disrepair, while pipes smaller than 42 inches are monitored by video or visually inspected.

Catch basins are cleaned at a frequency determined by the amount of trash collected, with certain areas or basins targeted for more frequent cleaning on the basis of flood prevention and aesthetics. The priority levels for determining the catch basin cleaning frequency are:

- Priority A—high volume of trash generated; cleaned once during the dry season, three times during the wet season

- Priority B—moderate volume of trash generated; cleaned once during the dry season and once during the wet season
- Priority C—low volume of trash generated; cleaned once during the dry season

Most of the catch basins in the County TMDL Implementation Area are Priority C. Ninety-one catch basins are Priority A and 10 are Priority B; these higher priority catch basins are in the City Terrace – East Los Angeles and Willowbrook areas as shown in Figure 35 (Priority C catch basins in the remaining County TMDL Implementation Areas are not shown).

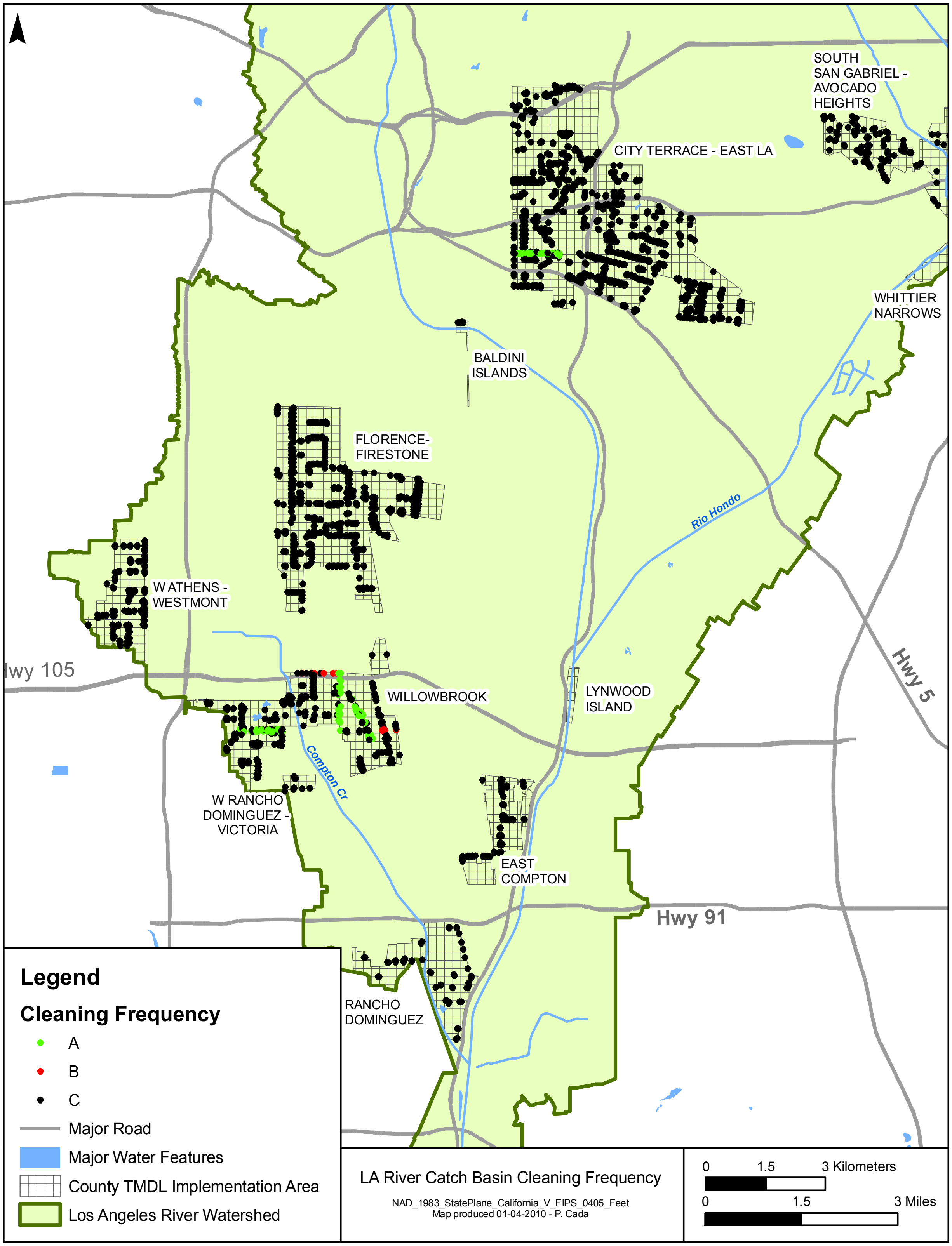

Figure 35. Catch Basins in the County TMDL Implementation Area and Associated Cleaning Frequencies

Catch basin clean out contracts contain specifications for standard operating procedures and stormwater BMPs. Complaint-based cleaning is performed as needed. Contractors generally hand-clean or vacuum (dry) catch basins. When jetting clogged lines, wash water is required to be collected. Contractors dispose of materials removed from catch basins and pipes at their own facilities. When spot-cleaning of catch basins is performed, the collected materials are dewatered at maintenance yards, and the dry material is transported to a landfill.

Streets and Road Maintenance

A combination of staff and outside contractors perform street sweeping in unincorporated County areas. Most streets are swept weekly, although that frequency could soon be reduced to twice a month because the amount of materials being collected is small relative to the cost of more frequent cleaning. If the average frequency is reduced, streets would still be swept more frequently during the fall to collect seasonal debris. Sweepers with mechanical brooms and regenerative air/vacuum sweepers are used, and swept material is transferred from broom sweepers, which have less capacity, to collection trucks. Collected material is dewatered in clarifiers at the maintenance yards, and the dry solids are disposed of in landfills.

Enhancements to Address TMDL Implementation

Regenerative air sweepers, which are designed specifically to capture fine sediments in addition to coarse sediment and other solids, achieve greater sediment and nutrient removal than do mechanical broom sweepers (Center for Watershed Protection 2006a, 2006b, and 2008). Both mechanical broom and regenerative air sweeping are used in the County TMDL Implementation Areas (86 percent and 14 percent of road length, respectively). The addition of regenerative air sweeping to locations maintained with mechanical broom sweepers can result in an improvement in treatment efficiency and pollutant removal for some of the targeted pollutants, notably metals.

Public Transportation Facility Management

A maintenance contract is in place to remove trash from trash cans at bus stops every 3 to 5 days. Bus shelters and surrounding areas are power-washed every 6 weeks; BMPs are implemented to block catch basins and vacuums are used to prevent the water from entering the storm drain system.

4.1.6. Illicit Connections/Illicit Discharge Program

Illicit Connections and Discharges

The Illicit Connections and Illicit Discharges Elimination Program aims to prevent, detect, and eliminate illicit connections and illicit discharges into the storm drain system and to document, track, and report on such incidents. If an illicit connection or evidence of past discharges is detected, an investigation is initiated within 21 days from the date it was discovered. Once confirmed, the connection is terminated within 180 days. A GIS database has been developed of all permitted connections and the locations and lengths of underground pipes 18 inches in diameter and larger. Each year the approximate locations of illicit connections and discharges are mapped to enhance the accuracy and detail of the data.

The (888)Clean LA hotline offers a means for the public or staff members to report an illicit discharge incident or an observation. Operators dispatch field crews or notify other municipalities if the incident occurs in incorporated areas. Discharges are contained, and sources and responsible parties are identified. Cleanup is performed if the responsible party is unwilling or unable to do it. Follow-up enforcement includes civil and criminal prosecution as well as reimbursement for public response and cleanup costs, if applicable.

4.2. Additional Nonstructural BMPs

In addition to the existing nonstructural BMPs, reduction of irrigation return flow is a new BMP that addresses all dry weather pollutants.

4.2.1. Reduction of Irrigation Return Flow

Irrigation return flow contributes to both wet and dry weather pollutant loading. Reduction of these nuisance flows is essential to meeting dry weather flow TMDL targets. Measures to reduce irrigation return flow in the County TMDL Implementation Area can be implemented in residential, commercial, recreational, and even industrial land use areas through incentive policies and programs. Reducing irrigation affects wet weather loads; if the antecedent soil condition is drier before a storm, the peak flow and runoff volume can also be reduced, reducing pollutant transport.

A number of steps have been taken to promote efficient water use, including the development of a drought-tolerant plant list and LID and green building requirements (described further in Appendix I). In addition to those tools, other programmatic methods can further reduce irrigation return flow. Smart irrigation controllers[2] are devices used to reduce irrigation water use by meeting the actual needs of plants using prevailing weather conditions, current and historic evapotranspiration, soil moisture levels, and other relevant factors to adapt water application. High-volume irrigators can be given the opportunity to participate in a rebate program to install smart irrigation controllers. Alternatively, implementing a xeriscape conversion incentive program could facilitate a transformation of residential lawns and gardens to low-irrigation landscapes using drought-tolerant plants and encouraging soil preparation, mulching, and zoned irrigation to reduce water use. Partnerships with local water agencies could be supported to adjust water rate structures to target large-volume irrigators with higher rates and provide additional incentives to reduce water use. Direct authority to alter rate structures to achieve demand-side management practices lies with local water agencies. Cooperation with those agencies and/or administrative support for the development of marketing and communications programs may be offered.

4.3. Summary of Nonstructural Solutions to Support TMDL Implementation

As a result of the review of existing programs that address TMDL pollutants, the following are enhancements and additional BMPs that would offer additional water quality benefits and contribute to TMDL implementation:

- **Enhancing the Smart Gardening Program** so it would extend the reach of the water conservation and pollution-prevention messages to the Los Angeles River watershed
- **Conducting TMDL-specific stormwater training** that emphasizes activities and BMPs that can cause or mitigate the TMDL pollutants of concern
- **Enhancing commercial and industrial facility inspections** to ensure that activities associated with these businesses do not become sources of pollutants
- **Improving enforcement escalation procedures** to more effectively address known sources of pollution
- **Improving street sweeping technology** to more effectively reduce sediment-bound pollutants from road surfaces
- **Reducing irrigation return flow** through a variety of water conservation initiatives

[2] Smart irrigation controllers are also referred to as ET controllers, weather-based irrigation controllers, or smart sprinkler controllers.

The remainder of the discussion and analysis pertaining to nonstructural solutions focuses on those six recommended BMPs, which are expected to contribute substantially to reductions in pollutant loads. Table 27 shows the extent to which each BMP enhancement or new BMP addresses the TMDLs. All the proposed BMPs address nutrients, metals, non-metal toxics, and bacteria; TMDL-Specific Stormwater Training addresses trash.

Table 27. Summary of Recommended Nonstructural Solutions

Nonstructural BMP	Condition		TMDL Pollutant Addressed				
	Wet Weather	Dry Weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Enhancements to Existing BMPs							
Smart Gardening Program Enhancements	✓	✓	◗	◗	◗	◗	○
TMDL-Specific Stormwater Training	✓	✓	◗	◗	◗	◗	◗
Enhancement of Commercial and Industrial Facility Inspections	✓	✓	◗	◗	◗	◗	○
Enforcement Escalation Procedures	✓	✓	◗	●	◗	◗	○
Improved Street Sweeping Technology[a]	✓		◗	◗	◗	◗	○
New BMP							
Reduction of Irrigation Return Flow	✓	✓	●	●	◗	●	○

● addresses the pollutant
◗ partially addresses the pollutant
○ does not address the pollutant

a. The scores for Improved Street Sweeping Technology represent the change in pollutant removal effectiveness compared to current street sweeping practices. Trash removal is expected to remain high but not improve.

4.4. Additional Nonstructural Options for TMDL Implementation

Other opportunities may exist for targeted BMPs that address specific pollutants. More detailed pollutant source characterizations would result in the identification of additional opportunities for the implementation of pollutant-specific BMPs. Bacterial source identification studies could pinpoint whether high fecal coliform levels are of human or wildlife origin, and site-specific management practices could be implemented to address the sources. For example, if a bacterial source identification study indicates a significant presence of bird feces upstream of a waterbody, shoreline management practices and seasonal maintenance and cleanup could be implemented to reduce fecal loads.

In addition, areas with significant dry weather flows could be targeted for detailed storm drain inspections and illicit connection/illicit discharge investigations to track down the sources of both chronic and episodic flows. Discharges from industrial and commercial areas could be addressed through existing inspection and enforcement procedures, and discharges from residential areas could be addressed through outreach, education, and, enforcement, if necessary.

In-stream, wet and dry weather monitoring data could be evaluated to identify pollution hot spots that warrant further investigation and potential site remediation or other measures. Additional long-term trend analysis could be used to identify the effects of longer-term land use changes on pollutant loads that might necessitate programmatic BMPs.

The TMDL Implementation Plan is meant to be iterative and adaptive to take advantage of these and other nonstructural BMPs determined in the future to provide the best strategy for addressing specific pollutant sources. Investigative studies may be implemented as necessary to identify these opportunities and implement the most effective approaches to address pollutant loads from the County TMDL Implementation Area. In addition, performance monitoring may be conducted to evaluate benefits from implemented nonstructural BMPs to improve future efforts towards plan implementation.

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5. Development of Structural Solutions

Although nonstructural BMPs will contribute to meeting TMDL WLAs for the County TMDL Implementation Area, structural solutions will provide the majority of the required load reductions. However, structural BMPs are also the most costly, so careful consideration was made in identifying opportunities for structural BMPs and collecting appropriate information to make cost-effective decisions regarding implementation.

Identification and assessment of opportunities for structural BMPs were focused on publicly owned land in the County TMDL Implementation Area. Both distributed and centralized structural BMPs were considered. Distributed structural BMPs refer to those practices that provide the control or treatment (or both) of stormwater runoff at the site level. Typical BMPs in this category include such features as porous pavement, grassed swales, bioretention, water harvesting systems, and other practices that can be implemented on individual parcels to store, infiltrate, and treat runoff from that parcel. Centralized BMPs refer to stormwater treatment, storage, or infiltration facilities that provide benefits on a larger scale (e.g., regional). Such projects can include neighborhood-scale or larger-scale facilities such as spreading grounds, flood control facilities, or even park space that provide treatment/infiltration of runoff from nearby areas.

The following sections describe the process used to assess opportunities for implementing structural BMPs, both distributed (Section 5.1) and centralized (Section 5.2). Section 6 describes the evaluation of BMP alternatives using an optimization process.

5.1. Assessment of Opportunities for Distributed Structural BMPs

It was not feasible within the TMDL Implementation Plan to identify and size each distributed structural BMP in the County TMDL Implementation Area. Rather, within specific classifications of land characteristics (e.g., impervious roads, land use, soil type), general assumptions were established that provide insight regarding the types and benefits of distributed BMPs that can be implemented at a larger scale. That resulted in identifying key distributed structural BMP projects that could be considered for TMDL implementation planning.

Two major categories of distributed structural BMPs were identified, which were based on site characteristics and the types of BMPs determined feasible: (1) catch basin distributed BMPs, and (2) other distributed BMPs on public land. The following provides detailed discussions for these categories and the proposed projects for TMDL implementation.

5.1.1. Catch Basin Distributed BMPs

Storm drain systems in developed areas typically begin with inlets at the street level. Stormwater inlets have a variety of names, and there are regional differences in terminology. Storm drain inlets are routinely called catch basins in California.

As discussed in Section 3, roads represent a major source of TMDL pollutant loads, and therefore treating road runoff is considered a key strategy for multi-pollutant TMDL implementation. Due to the number and spatial distribution of catch basins in the County TMDL Implementation Area, they represent an excellent opportunity for treating pollutants in addition to trash.

Full Capture Devices

Screen cover devices are being installed in catch basins to prevent trash and debris from entering the storm drain system. The screens (referred to as connector pipe screens or full capture devices) have ≤ 5 mm mesh and are installed inside the catch basin at the entrance of the collection pipe. Full capture devices, in and of themselves, do not provide for sediment capture—the 5 mm openings would allow for any suspended solids, even large sand particles, to pass through to the storm drain system. However, monitoring studies provide evidence that catch basins, even without sumps below the drain discharge point, are capable of removing sediments and sediment-size pollutants. It is likely that the accumulated trash and leaf matter provides some sorption/adsorption and filtration. Full capture devices should enhance that effect. Figure 36 through Figure 38 show the locations of catch basins and which have full capture devices installed.

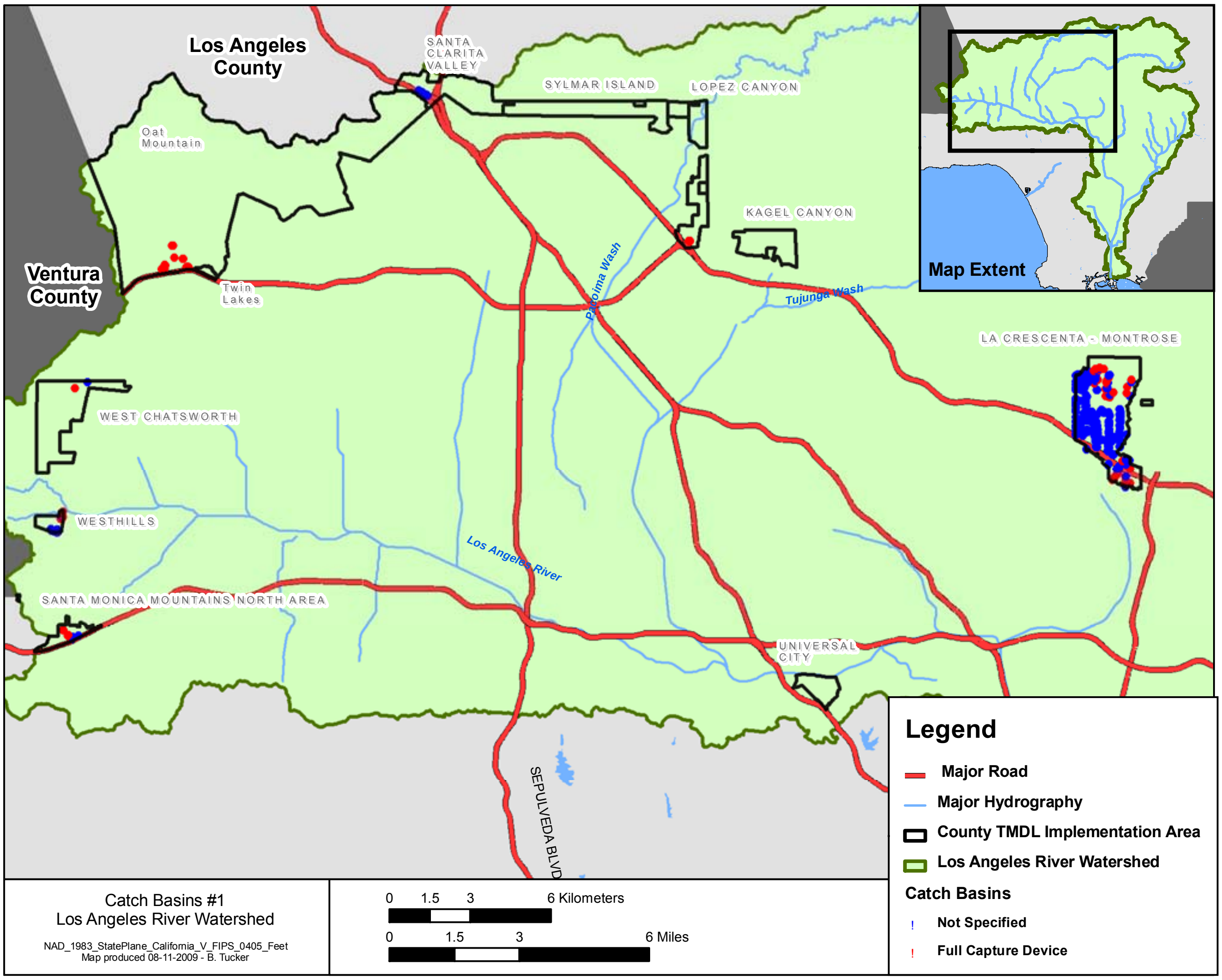

Figure 36. Catch Basins in the County TMDL Implementation Areas North

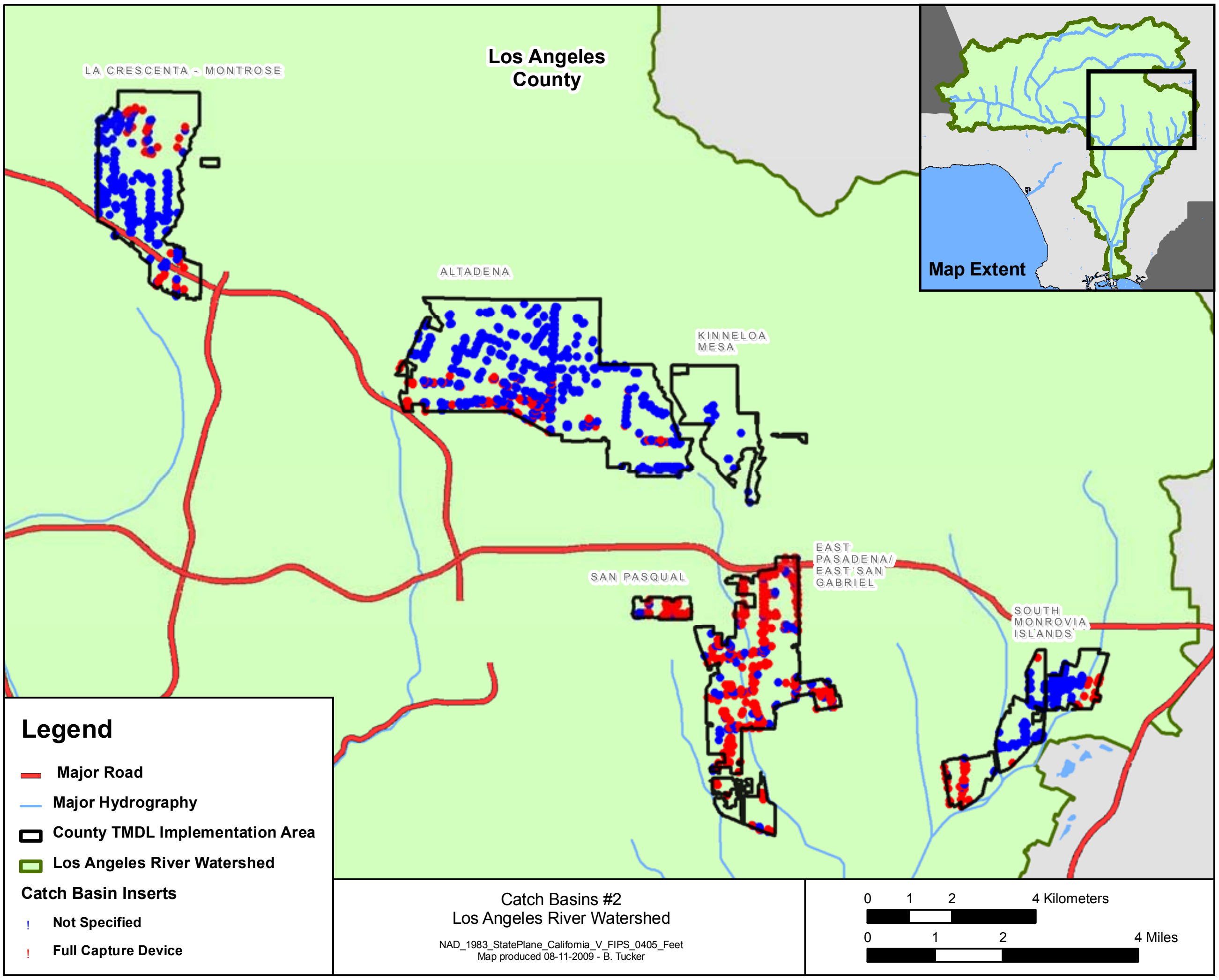

Figure 37. Catch Basins in the County TMDL Implementation Areas Central

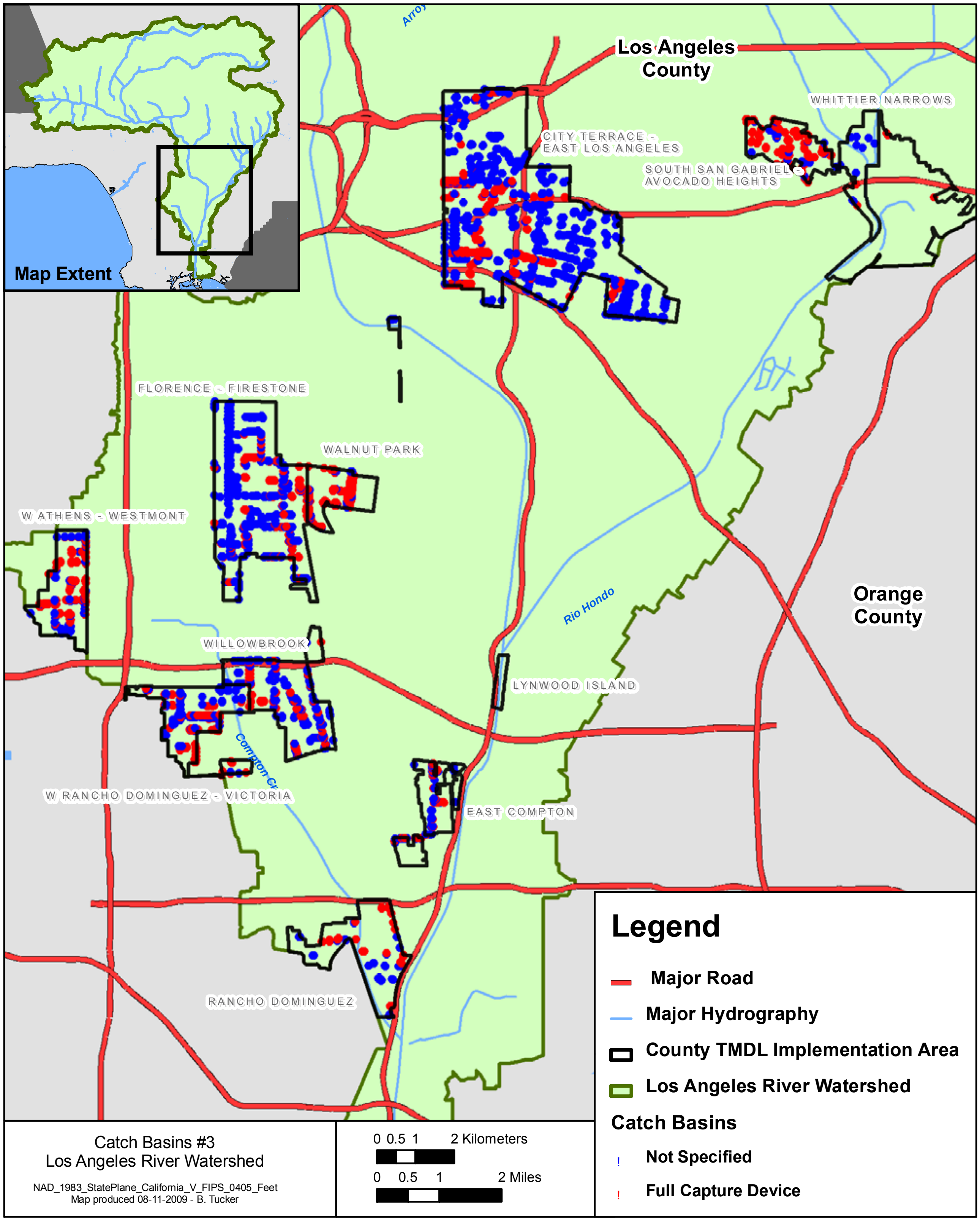

Figure 38. Catch Basin Inserts in the County TMDL Implementation Areas South

Catch Basin Inserts

Catch basin inserts (Figure 39**Error! Reference source not found.**)—which are devices designed specifically to capture trash, oil/grease, other floatables, organics, other pollutants, and sediment—can offer additional pollutant removal benefits. On the basis of a synthesis of available studies, catch basin inserts are expected to treat and remove a significant fraction of sediment (and associated metals) with treatment focused on runoff from the transportation network. The treatment efficiency of catch basin inserts for bacteria is poorly studied and unknown but is likely to be very low unless the insert has a design element targeting bacteria. Such devices tend to have a 1- to 3-year warranty and would need maintenance or replacement after that. Catch basin insert devices (such as the Abtech Smart Sponge™) can be installed in tandem with existing full capture devices.

Figure 39. Example Catch Basin Insert

Implementing catch basin inserts throughout the County TMDL Implementation Area is highly applicable because of the high density of catch basins. The County TMDL Implementation Area includes more than 4,300 catch basins, with installation of full capture devices in progress for implementing the trash TMDL. Trash TMDL Implementation Phase 3 has been completed as shown in Table 28. These numbers will increase through ongoing efforts to meet trash TMDL requirements. Implementing catch basin inserts would require retrofitting the full capture devices that have been installed. The schedule for implementing catch basin inserts in the County TMDL Implementation Area considers maximizing the operational period of installed full capture devices, thus improving the return on the investment.

Implementing catch basin inserts would involve internal planning, conducting a pilot study to gain approval from the LARWQCB for attaining the trash TMDL requirements (for cases where full capture devices are being retrofitted), installing the devices, and maintaining the sediment-removal insert as part of the existing catch basin maintenance activities.

Table 28. Implementation Progress for Catch Basin Full Capture Devices

Community	Catch Basins	Installed Full Capture Devices
Altadena	744	352
Bandini Islands	6	0
East Compton	76	36
City Terrace – East Los Angeles	987	280
East Pasadena – East San Gabriel	477	408
Florence – Firestone	491	147
Kinneloa Mesa	19	11
La Crescenta – Montrose	337	54
Lopez Canyon	4	4
Oat Mountain	**24**	**30**
Rancho Dominguez	56	49
San Pasqual	50	50
Santa Clarita Valley	6	0
Santa Monica Mountains North Area	10	8
South Monrovia Islands	250	94
South San Gabriel – Avocado Heights	119	109
W Athens – Westmont	156	124
W Rancho Dominguez – Victoria	193	122
Walnut Park	123	112
West Chatsworth	2	1
Westhills	21	21
Whittier Narrows	5	3
Willowbrook	189	82
Total	4,345	2,097

5.1.2. Other Distributed BMPs on Public Land

Before stormwater enters the storm drain systems, opportunities are available for the storage, infiltration, and treatment of runoff within publicly owned right-of-ways or parcels. Such areas include road right-of-ways or other properties owned by public agencies for various purposes (e.g., parks, schools, storage, utilities). Figure 40 shows the publicly owned parcels within the County TMDL Implementation Area. In combination with road right-of-ways, this area represents a significant opportunity for on-site stormwater treatment.

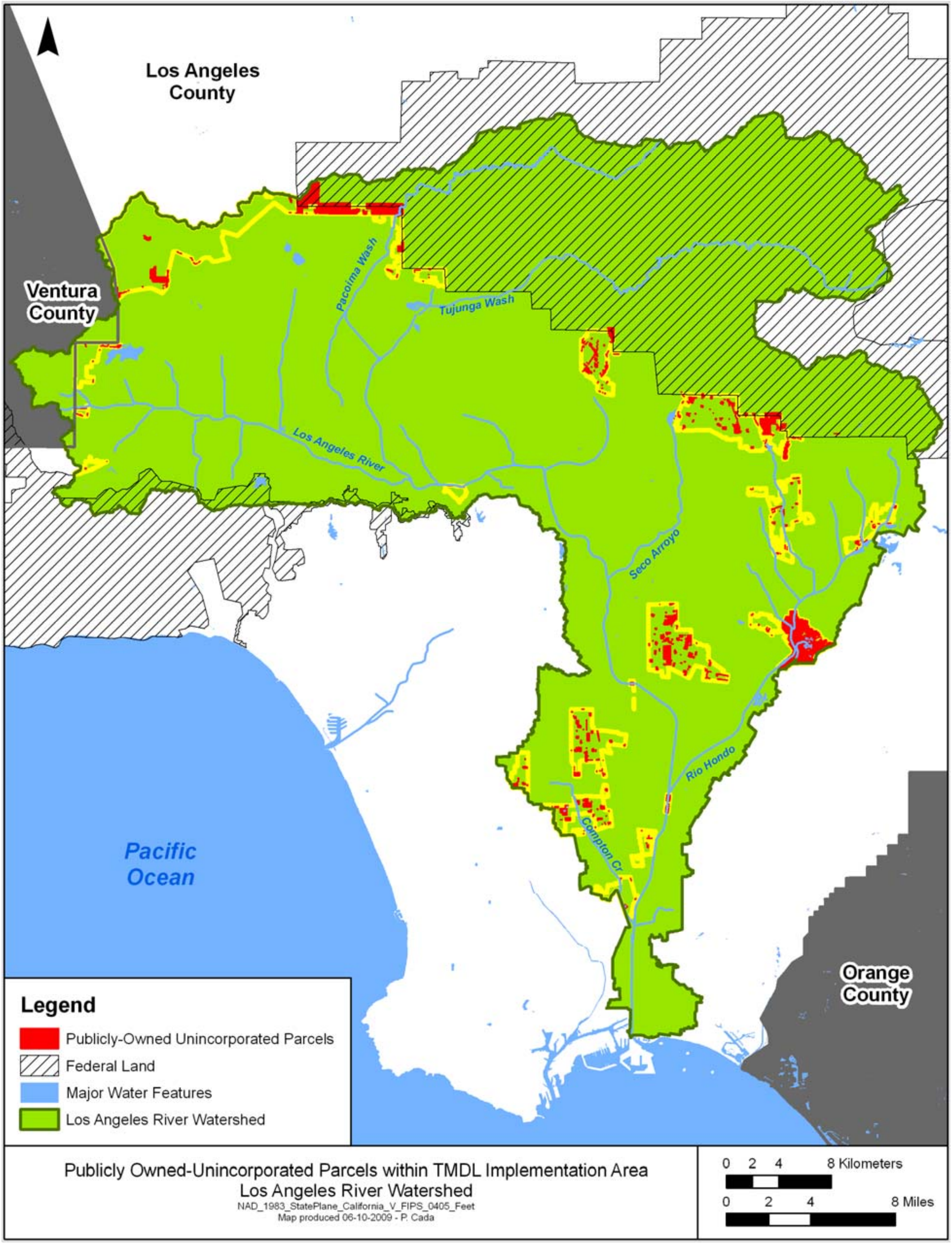

Figure 40. Publicly Owned Parcels within the County TMDL Implementation Area

Field Investigations for Distributed BMPs

Understanding the land and soil characteristics within the County TMDL Implementation Area is key to identifying the appropriate types of distributed structural BMPs that can provide meaningful benefit. Throughout the County TMDL Implementation Area, field investigations were performed to assess general land and soil characteristics that affect distributed BMP selection and performance. This information was used to establish assumptions for evaluating costs and benefits of distributed BMP implementation in Section 6.

Land characteristics were grouped into Management Categories that were assigned to distinct subwatersheds throughout Los Angeles County (LACDPW 2008b). All subwatersheds that have the same Management Category are likely to have similar opportunities and constraints for selecting and applying distributed structural BMPs. Management Categories were defined on the basis of the following selected key physiographic characteristics, which directly influence the planning, design, and construction of distributed structural BMPs: impervious cover, impervious density, land slope, and road density. When the four key characteristics that define the Management Categories were combined, they formed 16 possible combinations. Of those 16, only 9 combinations were found in the Los Angeles River watershed. Table 29 presents the definition of the nine Management Category groups and the total area of each within the County TMDL Implementation Area. Figure 41 shows the Management Categories assigned to each community.

Table 29. Definition and Total Area of Management Categories

ID	Impervious Cover	Impervious Density	Road Density	Slope	Total Area (acres)
A	Urban	Concentrated	High road density	Moderate	4,272
B	Urban	Concentrated	Low road density	Steep	3,321
C	Urban	Concentrated	Low road density	Moderate	11,312
D	Urban	Dispersed	Low road density	Steep	6,522
E	Urban	Dispersed	Low road density	Moderate	5,624
F	Non-Urban	Concentrated	Low road density	Steep	2,270
G	Non-Urban	Concentrated	Low road density	Moderate	184
H	Non-Urban	Dispersed	Low road density	Steep	7,631
I	Non-Urban	Dispersed	Low road density	Moderate	56

A GIS analysis was performed to identify 30 potential field investigation sites. Sites were identified representing a range of combinations of Management Categories and soil classifications (on the basis of the County's *Hydrology Manual*). Sites were further selected to be spatially dispersed within the County TMDL Implementation Area. The GIS analysis resulted in selecting publicly owned parcels within unincorporated County areas with moderate slope areas that contain hydrologic soil group (HSG) A-, B-, or C-type soils. Areas with such slope and HSG characteristics are typically suitable for distributed BMP implementation. For simplicity, potential investigation sites were grouped by HSG type and selected individual sites that included multiple parcels within a one-quarter-mile to one-half-mile radius that meet the selection criteria. The number of allocated HSG A-, B-, and C-type sites was proportioned on the basis of the number of HSG-type parcels among the total parcels (using location of each parcel's centroid to identify HSG type). To support a realistic implementation strategy, field investigation sites were selected from parcels outside any floodplains and 100-year floodways. That assessment yielded a total of 24 sites in the Los Angeles River watershed. Table 30 lists the potential field investigation sites and their characteristics, and Figure 42 shows the locations of the sites. Each site's HSG classification is included in the figure label.

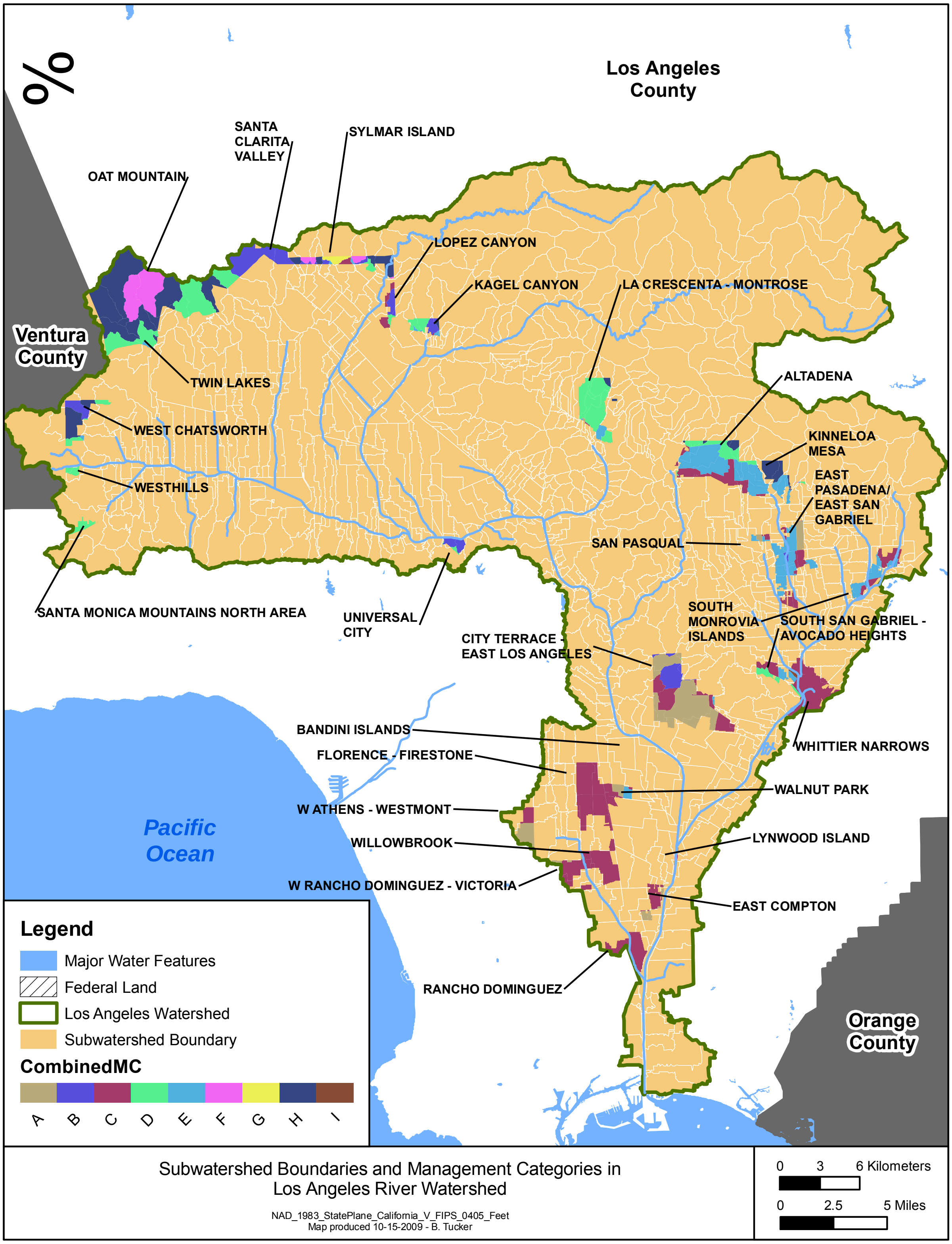

Figure 41. Management Categories in the County TMDL Implementation Area

Table 30. Potential Field Investigation Sites, Management Category, and Soil Characteristics

Site	Area	Management Category	Average Infiltration Rate (in/hr)	Within HSG Range
1A	Whittier Narrows Recreation Area	C	1.4	<
2A	Park/Open Space	C	4.8	<
3A	Mona Park	C	8.7	yes
4A	George Washington (G.W.) Carver Park	C	0.9	<
5A	Roosevelt Park	C	1.2	<
6A	Ted Watkins County Park	C	1.8	<
7A	Altadena Golf Course	E	17	yes
8A	Open Space	E	4.2	<
9A	Wilson Debris Basin	G	11.5	yes
10A	Crescent Valley High School	D	4.2	<
11A	Eaton Canyon Golf Course	E	12.8	yes
1B	Los Angeles County Fire Station	A	11.2	>
2B	Belvedere Park	A	2.7	yes
3B	Park/Open Space	C	1.3	yes
8B	Hamilton Elementary School	E	6.4	yes
9B	Carver Elementary School	E	11.8	>
10B	Magic Johnson Park	C	1.4	yes
11B	Mary Mcleod Bethune Park	C	0.4	<
12B	Fire Station 16	C	0.5	<
13B	Rio Hondo Elementary School	C/E	0.6	<
14B	Augustus F Hawkins Natural Park	C	12.6	>
15B	Open Space	C	9.6	>
2C	George Washington High School	A	0.8	yes
3C	Garfield Community Adult School	A	10.8	>

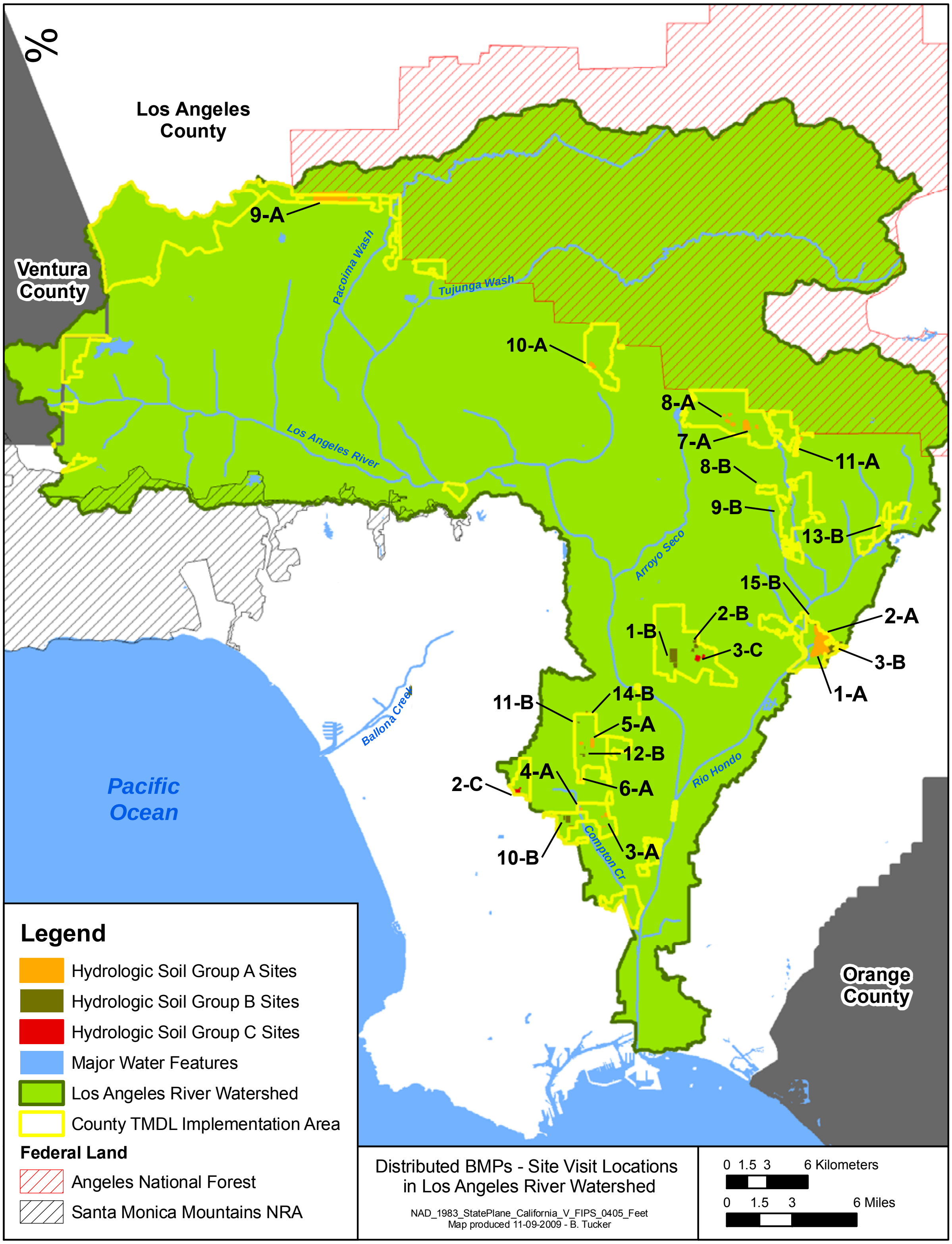

Figure 42. Field Investigation Sites for Distributed BMPs

Once the sites were identified, field investigations were conducted to verify soil conditions, particularly infiltration rates, and characterize the locations. A detailed field analysis report is presented in Appendix D. Each of the sites shows some variability in the measured surface infiltration rates. The variability at many sites could have been caused by variation in surface conditions. Many of the sites had an urban complex or mixture of soils in the top 1 to 2 feet, which affected the infiltration rate. The mixtures contained either sandier soils that cause higher than expected readings or soils with high organic content, specifically in the root zones, that would have caused lower than expected infiltration rates. Characteristic of many urban areas, most of the sites had experienced major disturbances from construction-related activities and continuing active recreation and management. Many sites had debris at the surface left over from construction, which would have caused higher than expected infiltration rates.

Each of the sites had an infiltration rate greater than the minimum infiltration rate of 0.5 inch per hour recommended by the County's *Low Impact Development Standards Manual*. In general, areas with a less concentrated impervious configuration show a greater likelihood that the measured infiltration rates are consistent with the ranges reported by the Natural Resources Conservation Service for the respective HSGs. Many times, the reported HSG in less concentrated areas were found a few feet below the surface. Areas with greater urban density are much more prone to extensive disturbance from construction, with greater levels of disturbance showing mixed HSGs. Many of the sites are suitable for infiltration BMPs, while most of the sites would be suitable for infiltration BMPs with some soils amendments near the surface.

Information gained from the field investigations was used to develop assumptions (e.g., selecting appropriate BMPs, infiltration rates) for distributed structural BMPs evaluated for public land within the County TMDL Implementation Area. The information can further support implementation of distributed structural BMPs throughout the County TMDL Implementation Area over time, as new sites are identified and benefits, in terms of infiltration capacity and pollutant load reduction, are estimated.

Distributed Structural BMP Strategies for TMDL Implementation

For this TMDL Implementation Plan, two distributed BMP strategies are planned to reduce stormwater pollutant loads from the County TMDL Implementation Area. The following discusses considerations for implementing these strategies. Distributed structural BMP options for the strategies were further evaluated, in terms of cost and benefit, during the process for evaluating nonstructural and structural solutions.

Distributed BMPs on Publicly Owned Parcels

For all publicly owned parcels shown in Figure 40, distributed structural BMPs will be implemented to treat on-site runoff. For parcels owned and operated by other public agencies, partnerships will need to be established. Implementation of BMPs will occur as funding becomes available.

The publicly owned parcels are located throughout the County TMDL Implementation Area in the unincorporated County communities of Sylmar Island, La Crescenta–Montrose, Altadena, Kinneloa Mesa, East Pasadena–East San Gabriel, San Pasqual, South Monrovia Islands, Whittier Narrows, City Terrace – East Los Angeles, Florence – Firestone, West Athens – Westmont, Willowbrook, and West Rancho Dominguez – Victoria. Of the areas where publicly owned parcels were identified, La Crescenta–Montrose and Altadena were the highest priority for wet and dry weather pollutant loading, respectively, according to the pollutant source characterization and prioritization results. South El Monte Island ranked highest for wet weather pollutant loading; however, no publicly owned parcels were identified in that area.

For planning purposes, two typical distributed structural BMPs were identified and used to represent the typical functions used by most distributed BMPs: bioretention areas and porous pavement. This allowed for developing general assumptions for cost and pollutant load reduction, which were incorporated in TMDL implementation planning and scheduling. The following describes the types of distributed BMPs considered.

Bioretention areas are vegetated, shallow depressions that provide storage, infiltration, and evapotranspiration. Bioretention areas also remove stormwater pollutants by filtration and uptake by vegetation and filtering of the stormwater through the soil matrix. The components of bioretention facilities typically include a filter strip, sand bed, ponding area, planting soil, and plants. Bioretention areas can be incorporated into a site's design as landscaping beds, landscaped islands in parking lots, and within the right-of-way along roads. An example of a bioretention area, installed in a parking lot, is shown in Figure 43.

Source: County of Los Angeles *Low impact Development Standards Manual*

Source: www.dot.ca.gov

Figure 43. Example Bioretention Areas

Porous pavement is typically used in light vehicle loading areas, such as walkways, patios, plazas, driveways, parking lots, and some portions of streets subject to compliance with building codes. Numerous products and design approaches are available including special asphalt paving; manufactured products of concrete, plastic, and gravel; paving stones; and brick. Porous pavement temporarily stores stormwater and promotes infiltration to the soil layers below. It typically consists of the driving surface, a bedding material of sand or stone, and a storage layer of structural stone—typically a washed No 57 stone. Examples of porous pavement, pervious concrete, and a site with porous pavement in a parking lot, are shown in Figure 44.

Although assessment of large-scale distributed structural BMPs for public land was limited to bioretention and porous pavement, actual site design could include a number of options for BMPs that would depend on site characteristics and other design preferences. Examples include rain barrels, vegetated swales, buffer strips, and several others. Note that many of these BMPs can be integrated into a site's landscaping and can even promote increased *green* aspects of the site that provide improved aesthetic value.

Source: County of Los Angeles *Low Impact Development Standards Manual*

Source: www.calapa.org

Figure 44. Example Porous Pavement

A secondary benefit of distributed structural BMPs on public land is the public education value. This is especially true for parks, libraries, schools, and the like, that have frequent use. As the public learns more regarding the functionality and aesthetic value of these BMPs, they can be encouraged to implement similar practices on private properties. Essentially, this education and subsequent increased use of distributed structural BMPs can help change the way the public views landscaping practices, stormwater, environmental stewardship, and how these relate and can be affected by simple changes in site design.

Pilot Distributed BMP Project for a County Road

A pilot distributed structural BMP project for a County road to store, infiltrate, and treat runoff from one acre of paved surface will be implemented. The location of the road has yet to be determined. The purpose of the project will be to demonstrate the benefits of distributed structural BMPs within road right-of-ways, and provide essential information regarding feasible designs and appropriate costs for design, construction, and maintenance. Successful implementation of this pilot project would provide political and regulatory buy-in for potential expanded implementation for other roads within the County TMDL Implementation Area. Implementation of the project will occur as funding becomes available.

For developing cost and pollutant load estimates for planning purposes, linear bioretention was assumed as the BMP to be implemented along the roadside or in the median for the road pilot project. Linear bioretention areas have the same function as bioretention areas but are narrow and are typically used to treat runoff from roads. Linear bioretention typically has a deeper storage capacity than standard bioretention areas. An example of a linear bioretention is shown in Figure 45.

Although linear bioretention was assumed for planning purposes, actual implementation and design of the BMPs for the pilot project could include other BMPs, including vegetated swales or Filterra® Bioretention Systems. Selected BMPs can be based on site characteristics or other preferences for BMPs requiring pilot testing.

Source: Los Angeles Basin Water Augmentation Study—Neighborhood Retrofit Concept Plan

Figure 45. Example Linear Bioretention Area

5.2. Assessment of Opportunities for Centralized Structural BMPs

To identify, evaluate, and ultimately select the optimal combination of centralized structural BMPs to address pollutant load reductions for the County TMDL Implementation Area, key information was required. Investigations were performed to identify and assess potential sites for placing centralized structural BMPs on public land. Priority locations of centralized structural BMPs were publicly owned properties to reduce the need for land acquisition. Additional consideration was made regarding the necessity for implementing centralized structural BMPs on private land. Results of this assessment provided information necessary to support TMDL implementation planning.

5.2.1. Centralized BMPs on Public Land

An initial analysis was conducted to identify all publicly owned parcels in the Los Angeles River watershed. That initial screening resulted in approximately 1,112 parcel groups. The 1,112 parcel groups included any publicly owned land with no analysis of the suitability for a centralized BMP. Most of the sites do not provide adequate space for a centralized BMP, are too steep, or are not within a feasible distance of a stormwater drainage system; therefore, calculation of the watershed area, management category, HSG, and slope was not performed. Additional screening was performed to further narrow potential sites for additional investigation. Additional field investigations were performed for identified locations to assess site and drainage area characteristics and identify the ideal BMP that could be constructed at the site. The following discusses the assessment's findings.

Site-Screening Methodology

A GIS analysis was performed of land ownership parcels and site characteristics to identify potential sites for centralized BMP placement on publicly owned parcels. Considerations in the analysis included the following:

- **Land cost**—Land costs were minimized by identifying publicly owned parcels.
- **Percent impervious**—Areas with higher percent imperviousness would produce more runoff during typical rain events. Higher impervious areas were targeted for greater potential volume reduction and water quality improvements.
- **Space requirements**—Sites were evaluated to determine if space is available to implement an appropriately sized BMP.
- **Watershed treatment area**—The size of the unincorporated County drainage area for each site was evaluated on the basis of available storm drain or Digital Elevation Model (DEM) data. Sites were

identified that provide sufficient space for BMPs to adequately treat/store/infiltrate runoff from their respective drainage areas.

- **Soil type**—Soil type was evaluated as an initial estimate of the infiltration rate and capacity of the soils. Sites with infiltration rates suitable for infiltration BMPs were further investigated.
- **Slope**—Slopes of sites were considered on the basis of DEM or other available topography data sets. Sites with moderate slopes (less than 10 percent for GIS purposes) were considered for centralized BMPs. Slope was verified in the field investigation, and sites where the slope is inappropriate for a centralized BMP were eliminated.
- **Multi-benefit use**—Sites were identified that could serve multiple purposes. For instance, some stormwater practices, such as infiltration basins or grassed swales, could serve a dual purpose of stormwater management and community park space. Several parks could be altered to provided stormwater treatment and storage.

Those criteria were evaluated to identify sites where centralized BMPs would be feasible. Sites that could provide enough space to effectively treat the drainage area associated with the site, that have soils suitable for infiltration, and that are publicly owned (to reduce land acquisition costs) were preferred. Sites that could provide a multi-benefit use, such as parks or parking lots where belowground storage could be used, were considered ideal. From the GIS screening analysis, a list of potential locations for centralized BMPs was developed to address stormwater runoff from the County TMDL Implementation Area.

This GIS screening and additional field investigations narrowed the potential sites to 18. Site 19, Compton Creek Wetland, was included as a potential centralized site; however, field investigation was not performed at the site because of limited access. The sites are depicted in Figure 46. Because existing site layouts and features can have an effect on where and what type of BMPs can be installed on a site, site layouts and on-site structures were photographed and documented to support evaluation of the site for centralized BMPs. The considerations included the following:

- **Effects on surrounding areas—**Any nearby structures, including storm drains and utilities, were documented. Any effects that could occur to surrounding structures because of settlement issues were noted.
- **Maintenance/accessibility—**Every BMP must be maintained at some level for the BMP to continue to function as it was designed. BMPs were considered that maximize access for maintenance purposes.
- **Research potential—**Research of stormwater BMPs is ongoing and necessary to fill existing data gaps and to continue to support the County in developing BMP standards. Monitoring protocol would be considered and incorporated into the design of each BMP that is implemented.

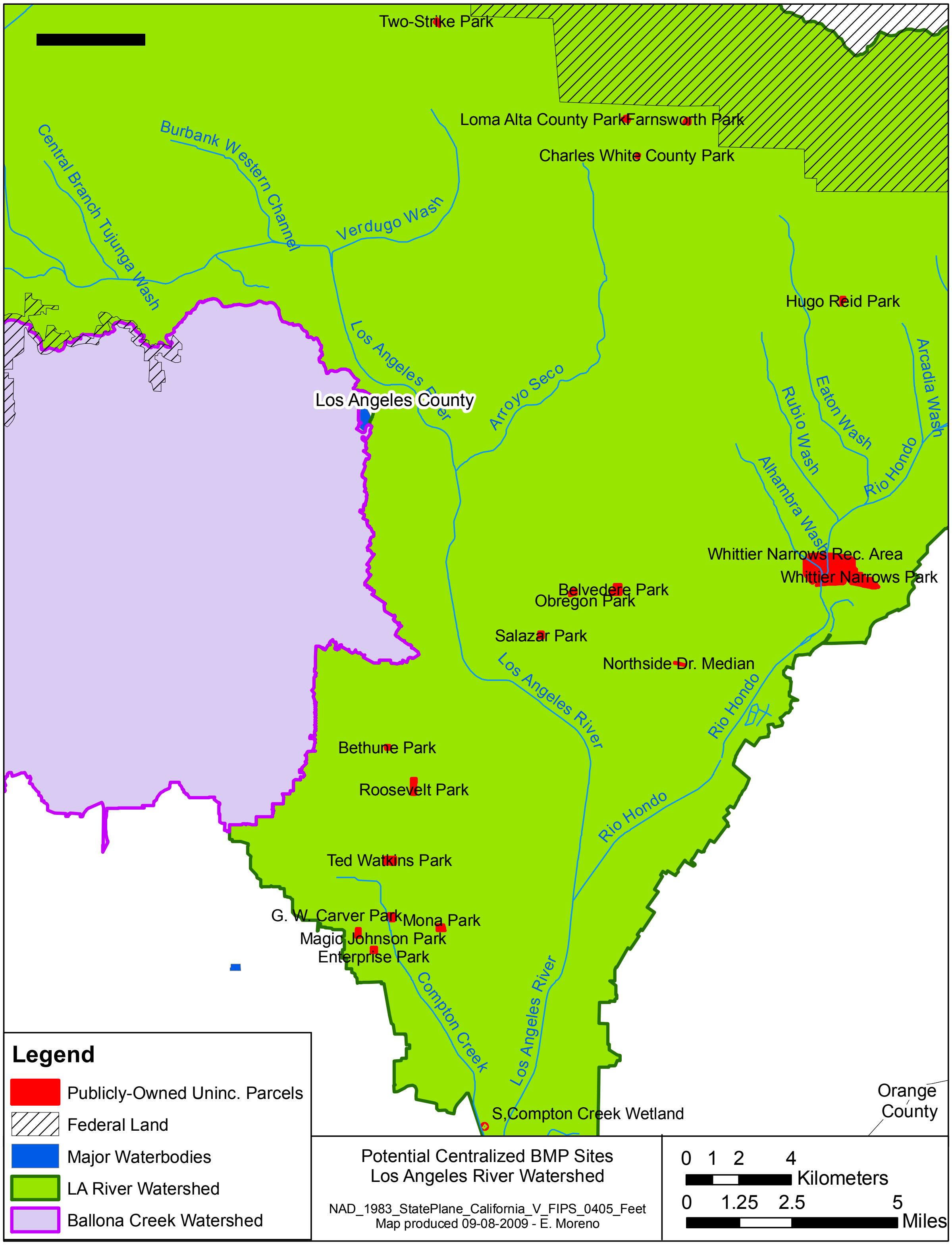

Figure 46. Selected Publicly Owned Parcels in the County TMDL Implementation Area

The individual site characteristics and summary of field investigations and BMP recommendations are described below. Appendix E includes results of field tests to evaluate infiltration rate, water table depth and soil quality; more detailed maps of potential BMP sites; and photographs of the watershed treatment area and available BMP area for each site. Centralized structural BMP options for the sites were narrowed down to specific BMP types and sizes during the process of evaluating nonstructural and structural solutions.

The watershed treatment areas for each of the 19 identified sites, unless otherwise noted, are residential with concentrated or dispersed density configurations. Residential areas are known to generate high levels of nutrients, such as nitrogen and phosphorus, typically from over fertilization and excess irrigation. Detergents used to wash cars in residential areas can contain high levels of phosphorus. Residential areas are also a source for metals and bacteria. While the largest portion of the watershed treatment areas are residential, there are also institutional and commercial areas in many of the watersheds. Institutional and commercial areas are typically a source of metals, nutrients, and PAHs. Additional pollutant source discussion is included in each site discussion where additional detail is required.

On the basis of observed conditions at all the potential BMP sites, two types of centralized BMPs could be implemented in the open space at each area: infiltration basins and extended dry detention basins. Each centralized BMP is suitable for treating nutrients, metals, and other pollutants typically delivered with suspended sediment (e.g., organic pesticides, PAHs) in stormwater. Infiltration basins are shallow surface basins that are designed to infiltrate stormwater through permeable soils. Infiltration basins require high infiltration rates and are not designed to store water for extended periods. Extended dry detention basins are basins whose outlets have been designed to detain the runoff from a water quality design storm for 36 to 48 hours to allow sediment particles and associated pollutants to settle and be removed. Extended dry detention basins are suitable in areas with HSG C soils and soils in the lower range of HSG B where infiltration is possible but could take longer. Several of the potential sites that were investigated have hard surface areas including tennis courts, basketball courts, playgrounds, skateboard parks, and parking areas. Areas that do not require a structural foundation could be used for belowground storage and treatment. Storm chambers installed below these surfaces would provide additional treatment while still allowing the areas to be used for recreation and parking. Storm chambers could be used similarly to a dry extended detention basin belowground, providing storage capacity and time for infiltration. The type and size of the BMP were determined through further optimization analysis and reported in Section 6. The BMPs are planned to infiltrate water within a few days, reducing possible public health risks from stagnant water such as mosquitoes and drowning. An infiltration basin or extended dry detention basin could still be used for recreation and open space activities between storm events and during the dry season. Belowground BMPs could have overlying space available for recreation or parking regardless of the weather.

Each of the investigated potential centralized BMP sites are used as a park or a median and have ample open space to provide access for maintenance. Observed maintenance at each potential site includes regular mowing similar to the required maintenance for an aboveground centralized BMP. To maintain infiltration functionality, sediment would need to be removed when infiltration rates are reduced twenty-five to fifty percent from the design infiltration rate. Infiltration rates can be restored by removing accumulated sediment and disking or aerating the surface. Sediment from belowground BMPs would have to be removed annually or as needed. Considering current usage, ample space would be available for construction activities at each investigated site.

While the focus of each of the potential centralized BMPs is TMDL compliance, implementing such BMPs also aligns with several integrated water resources planning objectives. In addition to the intended BMP objective of water quality improvement, a centralized BMP at each of the proposed sites, with the exception of Compton Creek, would contribute to flood protection, water conservation, groundwater replenishment, and improved aesthetics. Because they are in County parks, they would have the dual purpose of stormwater treatment while providing open space and recreational areas. The Compton Creek Wetland would provide enhanced habitat and improved aesthetics. Table 31 shows how each potential centralized BMP provides multiple water resources benefits. Additional water resources benefits could be identified during the planning phases for each BMP.

Continued discussion of how the TMDL Implementation Plan supports integrated water resources planning is in Sections 7 and 10.

Table 31. Integrated Water Resources Planning

Potential BMP Sites	Groundwater Basin	Water Quality	Water Conservation	Groundwater Replenishment	Improved Aesthetics	Open Space/Recreation	Enhanced Habitat	Flood Protection
Enterprise Park	Central Basin	✓	✓	✓	✓	✓		✓
Magic Johnson Park	Central Basin	✓	✓	✓	✓	✓		✓
Mona Park	Central Basin	✓	✓	✓	✓	✓		✓
G.W. Carver Park	Central Basin	✓	✓	✓	✓	✓		✓
Ted Watkins Park	Central Basin	✓	✓	✓	✓	✓		✓
Roosevelt Park	Central Basin	✓	✓	✓	✓	✓		✓
Bethune Park	Central Basin	✓	✓	✓	✓	✓		✓
North Side Dr. Median	Central Basin	✓	✓	✓	✓	✓		✓
Salazar Park	Central Basin	✓	✓	✓	✓	✓		✓
Obregon Park	Central Basin	✓	✓	✓	✓	✓		✓
Belvedere Park	Central Basin	✓	✓	✓	✓	✓		✓
Whittier Narrows Park	Main San Gabriel Basin	✓	✓	✓	✓	✓		✓
Whittier Narrows Recreation Area	Main San Gabriel Basin	✓	✓	✓	✓	✓		✓
Hugo Reid Park	Raymond Basin	✓	✓	✓	✓	✓		✓
Farnsworth Park	Raymond Basin	✓	✓	✓	✓	✓		✓
Loma Alta County Park	Raymond Basin	✓	✓	✓	✓	✓		✓
Two Strike Park	Verdugo Basin	✓	✓	✓	✓	✓		✓
Charles White County Park	Raymond Basin	✓	✓	✓	✓	✓		✓
Compton Creek Wetland	Central Basin	✓			✓		✓	

Enterprise Park

The watershed treatment area that could be treated in Enterprise Park is 48 percent impervious with a concentrated impervious configuration and low road density. The proposed BMP area is being used as park space with a playground, an athletic field, and a parking area. Several of the open areas and athletic fields around Enterprise Park are well maintained, suggesting the use of fertilizers that have high levels of nutrients and some metals, such as copper, adding another source of nutrients and metals to the stormwater runoff from the park.

The unincorporated County portion of the drainage area of the proposed project is in the West Rancho Dominguez–Victoria community. West Rancho Dominguez–Victoria is the 17^{th} largest unincorporated County community and is ranked 18 out of 30 for wet weather loading and is one of six communities ranked 10 out of 30 for dry weather loading. The site's drainage area is further characterized by a number of TRI sites within 3 miles, including a TRI ranging from 2,001 to 13,000 pounds for zinc, which have the potential of contributing to additional pollutant loading not represented in modeling analysis using typical land use assumptions (the basis for wet weather prioritization for the unincorporated County communities). There has also been an SSO in the area that drains to the park in the 100- to 300-gallon range. These additional sources provide further validation that a BMP would be advantageous at the site.

As shown in Figure 47, Enterprise Park is adjacent to a 44.5-acre unincorporated County watershed treatment area. Figure E-6, shows that approximately 5 acres of the park are available for the BMP. Treating the drainage from the surrounding neighborhood would require diverting flow from the existing storm drain Project No. 1227, which runs along 131st Street. A gym and a swimming pool could be affected by infiltration and should be avoided in BMP implementation. The lower measured infiltration rates, 1.1 inches per hour (in/hr), indicate that infiltration is possible but would require more time than expected for an infiltration basin. The soils in the potential BMP area are reported to be HSG B soils, indicating appropriate soils for an infiltration BMP. The soil boring indicates a layer of HSG D soils from approximately 3 to 7 feet that would have to be removed or amended to achieve the appropriate infiltration rates. Considering the depth of the clay layer, it could be removed during construction exposing the HSG B soils below with a higher infiltration rate. Soil samples taken at the site show levels of metals below the established probable effect concentrations (PEC) levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP in Enterprise Park would provide other water resources benefits. The grass in Enterprise Park indicates a regular irrigation and fertilization regimen. By routing water into the park and concentrating it in a BMP, the soils near the surface would stay moist longer, thus reducing the irrigation demand. Nutrients in the stormwater would act as natural fertilizer, again reducing the need for active fertilization and irrigation. A centralized BMP in the park would be designed to increase infiltration providing additional groundwater replenishment to the Central Basin. The area of Enterprise Park recommended for BMP implementation is being used for open space, a playground area, and a baseball field; the BMP design would provide the dual benefit of stormwater treatment and recreational facilities. Soils in the area would be amended, and the grass would be reseeded or replaced with turf, which would enhance the aesthetics of the park. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. For example, the actual BMP design could include additional vegetation that would enhance habitat area in the park.

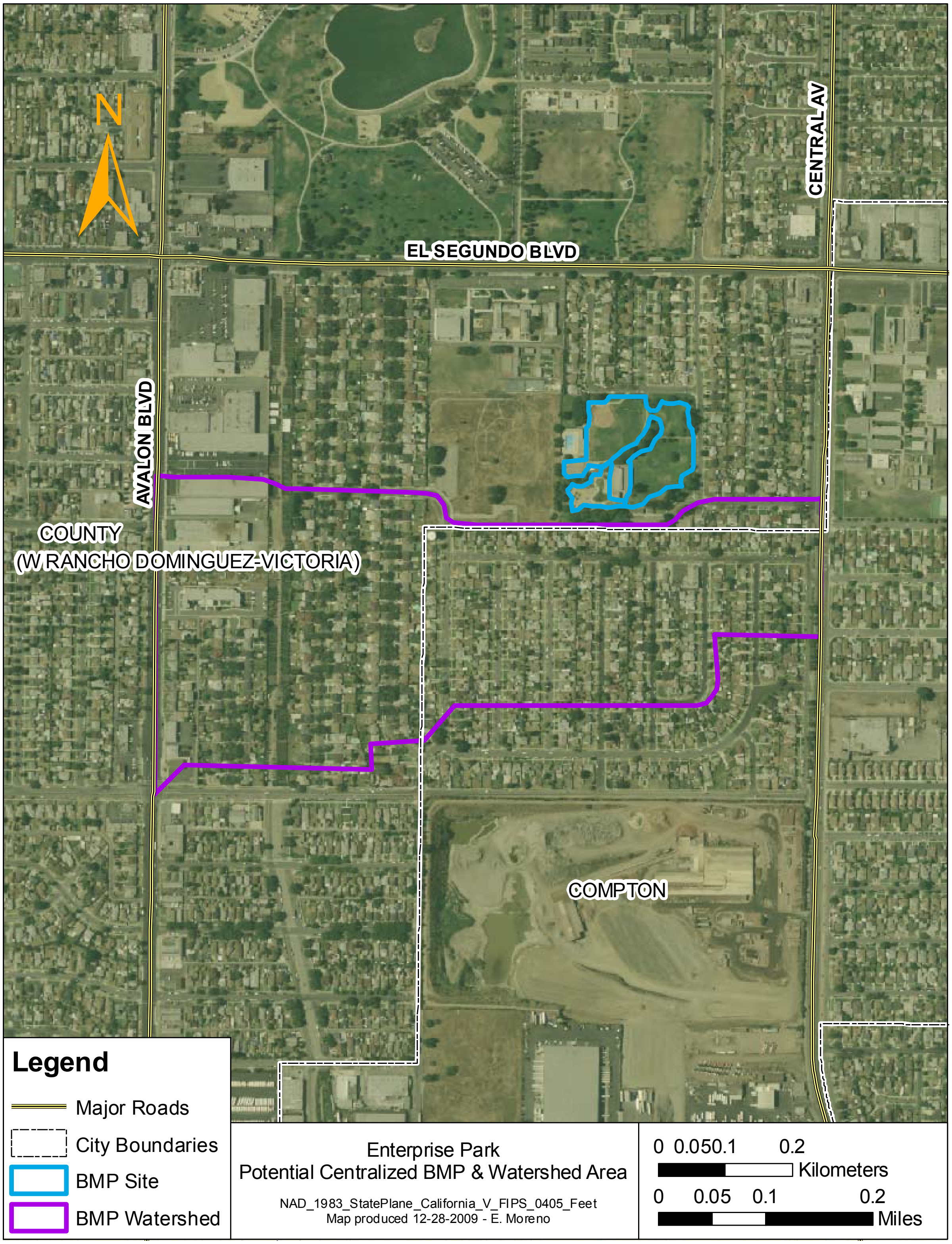

Figure 47. Enterprise Park Watershed and Potential BMP Site

Magic Johnson Park

Magic Johnson Park has a watershed treatment area similar to Enterprise Park consisting of mainly single-family residential in a concentrated impervious configuration with a low road density, and it is 38 percent impervious. The impervious percentage would be higher if the park were not included in the watershed treatment area. The park is a large facility consisting of open space areas, a large lake, and newly installed athletic fields. The park was observed to be heavily used by families and large groups of people. No drainage systems drain to either of the lakes. The lakes are known for sport fishing, but could be used for stormwater treatment; however, stormwater drains would have to be diverted to the lake. It might require fewer resources to install a new BMP in the identified BMP area. The open areas are well maintained, indicating the use of fertilizer and an aggressive irrigation schedule. The aggressive irrigation and fertilization and noticeable presence of waterfowl might lead to a degradation of water quality in the existing lakes. The newly installed athletic fields on the southeast corner of the park, nearest to East El Segundo Boulevard and Clovis Avenue, could best be used as a centralized BMP.

The unincorporated County portion of the drainage area for Magic Johnson Park is in the community of West Rancho Dominguez–Victoria and shares many of the characteristics of the watershed for Enterprise Park in terms of prioritization to address pollutant loading. Given the significant size of the watershed, the benefit of the BMP could be significant. A RCRA site is in the drainage area to the park that might need to be considered in the prioritization.

As shown in Figure 48, Magic Johnson Park is adjacent to a 254.7-acre unincorporated County watershed treatment area. Figure E-9 shows that approximately 16 acres of the park are available for the BMP. Installing the BMP in the southeast corner of Magic Johnson Park would maximize the watershed treatment area. Flows from the existing storm drain Project No. 1256, which runs along East El Segundo Blvd, would have to be diverted a short distance to route the stormwater into the park. No structures are around the available BMP area that would be affected by the infiltration. The BMP area is already partially configured to serve as a centralized BMP. Completing the berm around the athletic area could nearly make the area suitable for a BMP. The soils in the potential BMP area are reported to be HSG B with an observed infiltration rate of 1.4 in/hr, indicating soils with appropriate infiltration rates for an infiltration BMP. A layer of HSG D soils was observed closer to the surface than the anticipated base of the BMP and could be excavated during construction. Constructing a centralized BMP could expose HSG B soils with a higher infiltration rate than observed at the surface. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

A BMP implemented in Magic Johnson Park could provide many water resources benefits, including water quality, flood control, reduction in irrigation demand, increased infiltration, and groundwater replenishment for the Central Basin. Vegetation in the area of Magic Johnson Park is not well established. The open space would be enhanced by amending the soils, reseeding the grass in the area of the BMP, and by uptake of the nutrients in the stormwater. A BMP in the park would provide a dual benefit of stormwater treatment and open space or recreational areas. Finally, additional storage provided by the BMP would help alleviate flooding in the watershed treatment area.

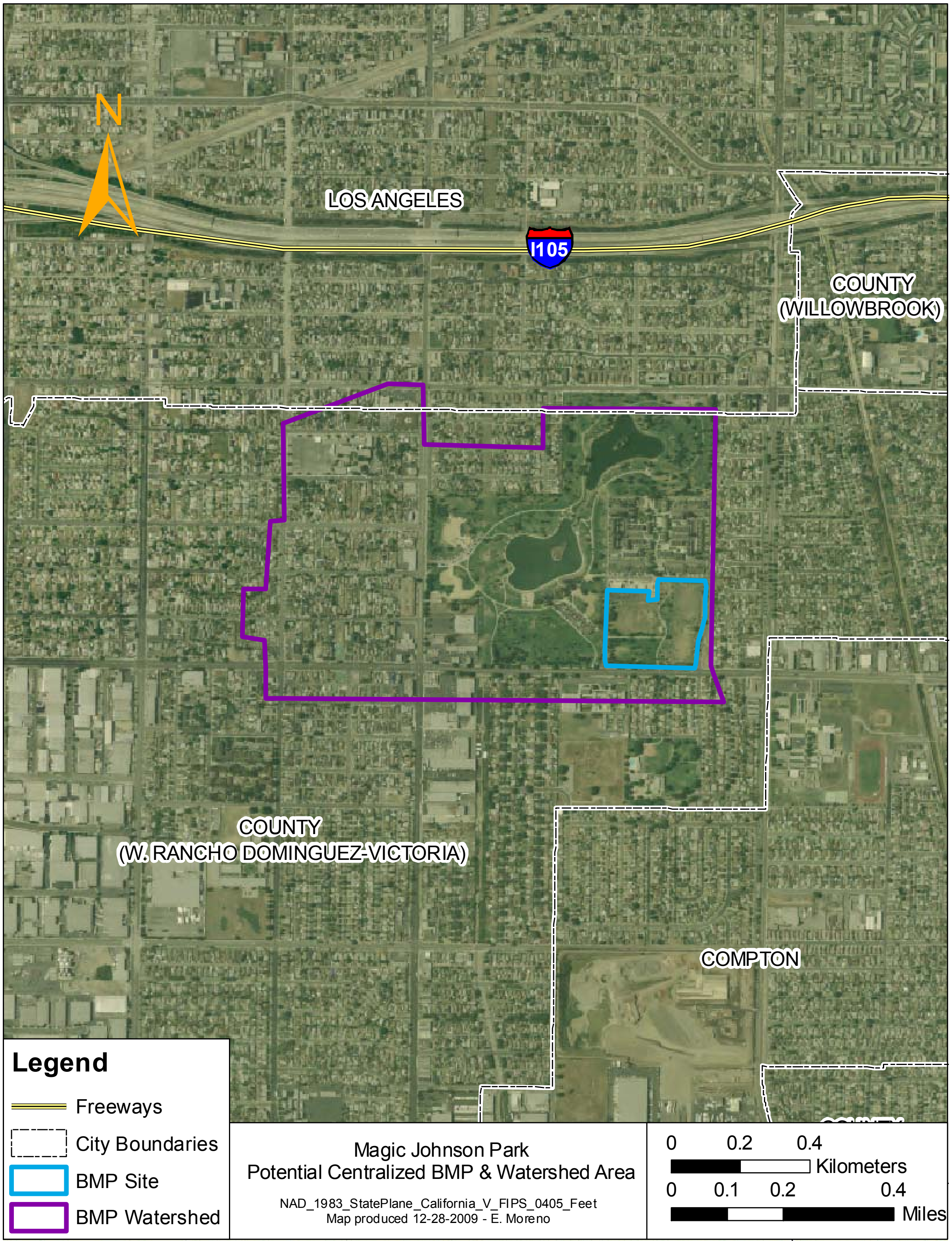

Figure 48. Magic Johnson Park Watershed and Potential BMP Site

Mona Park

The watershed area for Mona Park is 59 percent impervious, with a concentrated impervious configuration and low road density. The watershed is mainly residential but also contains some commercial and industrial land use areas. Commercial and industrial land uses are both additional sources of metals, nutrients, and PAHs. The park includes open space, a playground area, a basketball court, and athletic fields. A swimming pool and institutional areas are at the park that would be avoided when constructing an infiltration BMP. The open areas were well maintained, indicating heavy fertilization and an irrigation schedule that contribute to the source of nutrients.

The majority of the unincorporated County portion of the proposed drainage area to Mona Park is in the Florence–Firestone community, and a portion is in the Willowbrook community. The Florence–Firestone community is the 4^{th} largest and is 14 out of 30 for wet weather loads and one of eight communities ranked 1 out of 30 for dry weather loads. The Willowbrook community is the 10^{th} largest unincorporated County community and is ranked 17 out of 30 and 9 out of 30 for wet and dry weather loading, respectively. TRI sites for copper, lead, and zinc are in the Willowbrook community, and TRI sites are within a few miles of the Florence–Firestone community. SSOs have been reported in both communities with a 1,001- to 3,000-gallon spill reported in the Florence–Firestone community. Several RCRA sites are in the drainage area that could affect the pollutant loads to the site. Given the general size and the potential sources in the drainage area, Mona Park is an ideal site for a BMP.

As shown in Figure 49, Mona Park is adjacent to a 1,005-acre unincorporated County watershed treatment area. Figure E-12 shows that 5.6 acres of the park is available for the BMP. Flows from the existing Glen Avenue Drain System, which runs along Mona Boulevard, would have to be diverted into the park. Because of the size of the Glen Avenue Drain System and the position of the park relative to the confluence of the drainage system and Compton Creek, a large area drains through the stormwater network near the park. The soils in the area are reported to be HSG A soils with an observed infiltration rate of 8.7 in/hr, indicating that the soils have a high infiltration capacity. The soil boring log indicates a layer of HSG D soils between 7 and 9 feet. This layer would restrict infiltration and would need to be removed to use the maximum infiltration of the soils. It is possible that the restrictive layer is isolated and would not affect the overall infiltration of a centralized BMP. Further soils analysis is recommended before implementation. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

The basketball court and playground area at Mona Park are included in the available BMP area and could be considered for underground storage to maximize the available treatment. The pool and classrooms at the park would need to be protected from the infiltration BMP and are not included in the available BMP area.

By diverting water into a centralized BMP, excess water would be available in the surface and subsurface soils within the BMP, thereby providing an additional water source for the area and reducing the irrigation demand. Amending the soils and increasing the infiltration capacity within the BMP would promote deep percolation, enhancing groundwater replenishment in the Central Basin. Amended soils and the uptake of nutrients from the stormwater would encourage healthier vegetation and improve the aesthetics of the park. The area of Mona Park recommended for BMP implementation is used as athletic fields; in the future, the area would provide the dual benefit of stormwater treatment and recreation. While not designed with the purpose of flood control, the storage provided by a centralized BMP could reduce flooding in the watershed treatment area. Additional water resource benefits not currently quantified could be incorporated into the BMP design. While enhanced habitat is not an intended component of BMP implementation additional vegetation included in the planning and design might provide additional habitat not currently quantified.

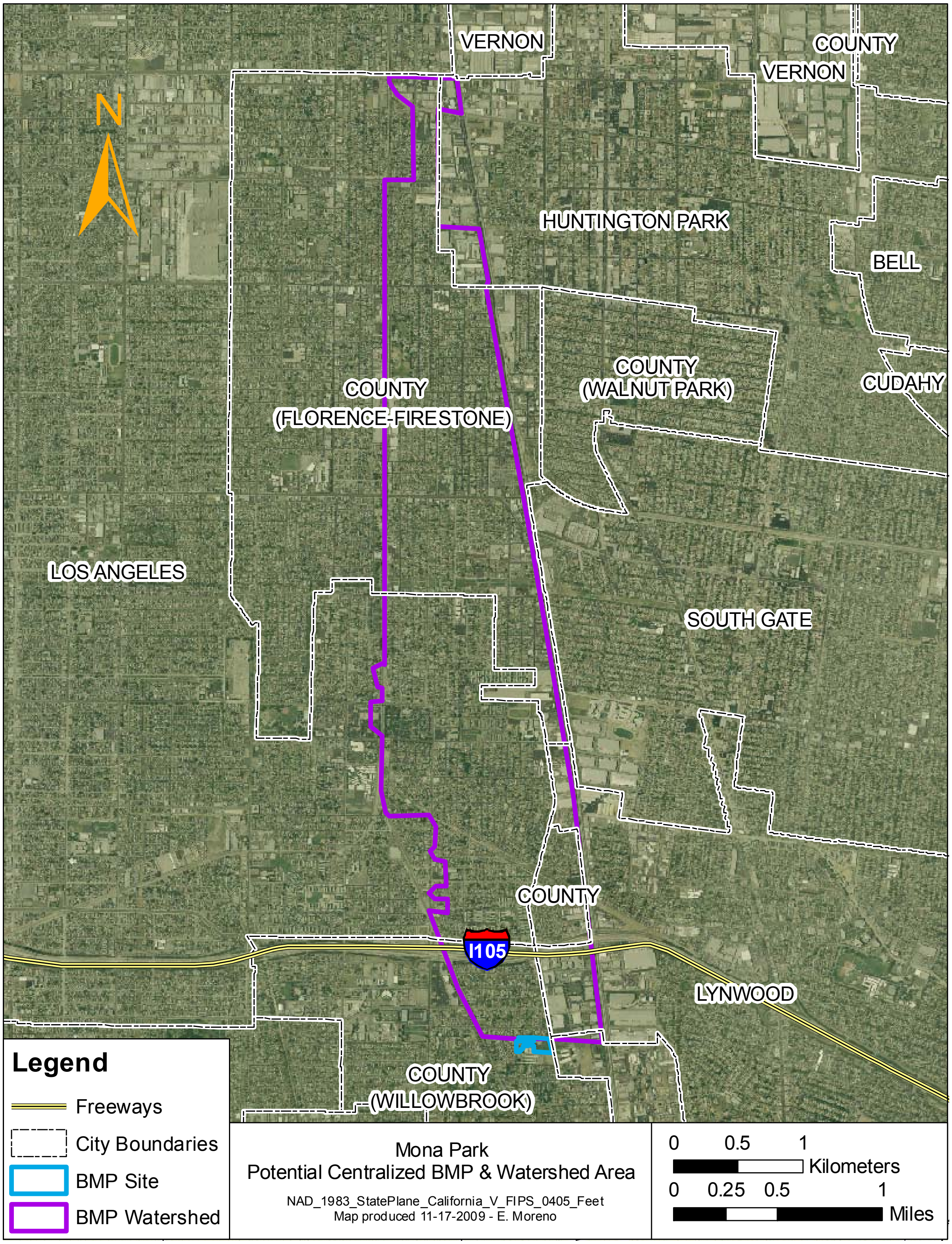

Figure 49. Mona Park Watershed and Potential BMP Site

G.W. Carver Park

The watershed treatment area for G.W. Carver Park is 50 percent impervious, with a concentrated impervious configuration. Much like Mona Park, the watershed is mainly residential with some commercial land use. The park consists of open space with an athletic field, basketball court, institutional area, parking area, and a pool. The open space and athletic fields are not as well maintained, indicating a less aggressive fertilization and irrigation schedule.

Much like the drainage area for Mona Park, the majority of the unincorporated County drainage area for G.W. Carver Park consists of the Florence–Firestone with a portion in the Willowbrook communities. A BMP would provide a benefit to the communities consistent with the discussion for Mona Park. While no TRI sites are in the portion of the Willowbrook community that drains to G.W. Carver Park, the TRI sites that are nearby could become a source for the G.W. Carver Park drainage area. Several RCRA sites are in the Florence–Firestone portion of the drainage area that could also be a source of pollutants that was not quantified in the model. Given the size of the watershed, the benefit of the BMP could be significant providing an additional indication that a BMP would be advantageous at this site.

As shown in Figure 50, the watershed treatment area that could be treated in G.W. Carver Park is approximately 1,381 acres of unincorporated County area. Flows from the existing Hooper Avenue Drain System, which runs along Success Avenue, would have to be diverted for treatment in the park. Figure E-15 of Appendix E shows that 5.25 acres are available in the park for stormwater treatment. The basketball court and parking area are included in the treatment area and could be used as underground storage. The soils in the park are reported to be HSG A, indicating a high infiltration capacity and making the park a suitable area for an infiltration BMP. Although the soils are reported to be HSG A, a low infiltration rate, 0.9 in/hr, was observed at the site. An organic layer is near the surface that might have caused the lower than expected infiltration rates. The soils below the surface were observed to be HSG B soils, indicating that infiltration rates higher than those observed at the surface are possible. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

In addition to contributing to meeting the TMDL reduction requirements by improving water quality, a centralized BMP in G.W. Carver Park would provide other benefits that would contribute to regional integrated water resources efforts. The BMP would provide water conservation by reducing irrigation demand. By routing water into the park and concentrating it in a BMP the soils near the surface would stay moist longer providing excess water for sod within the BMP reducing the irrigation demand. A centralized BMP in the park would be designed to increase infiltration providing additional groundwater replenishment to the Central Basin. The area of G.W. Carver Park recommended for BMP implementation is being used as athletic fields that would benefit from the process of BMP implementation and provide the dual benefit of stormwater treatment and recreational areas. Vegetation in the area was sparse and could be improved with the added vegetation from a BMP. Soils in the area would be amended and grass would be reseeded or replaced with turf improving and enhancing the aesthetics of the park. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. While enhanced habitat is not an intended component of BMP implementation, additional vegetation included in the planning and design might provide additional habitat not currently quantified.

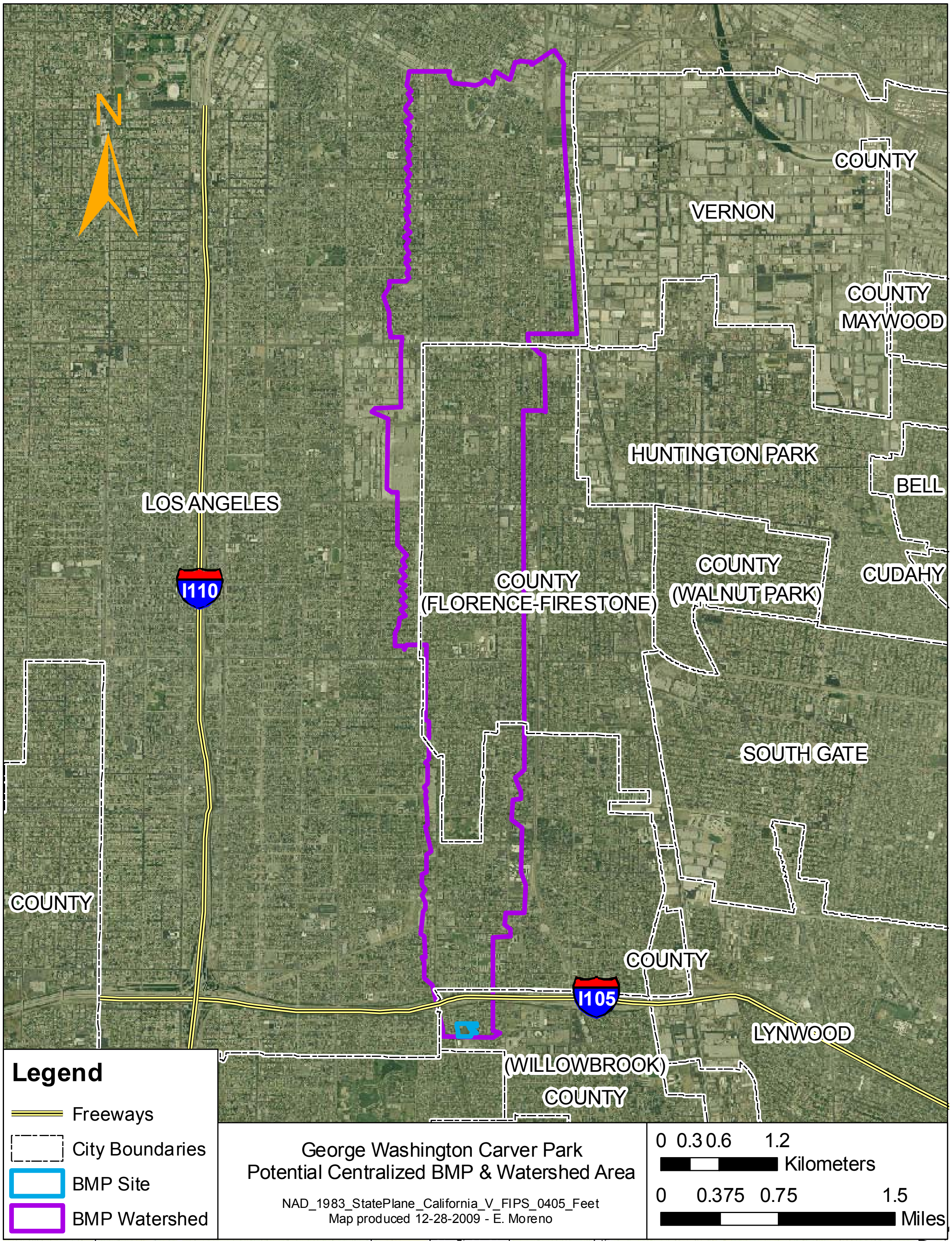

Figure 50. G.W. Carver Park Watershed and Potential BMP Site

Ted Watkins Park

The watershed treatment area for Ted Watkins Park is 52 percent impervious, with a concentrated impervious configuration and a low road density. Flows from the two existing storm drains adjacent to the park, storm drain Project No. 73, which runs along South Central Avenue, and the Hooper Avenue Drain System, which runs along Success Avenue, would have to be diverted into the park for treatment. Because two drains could be treated in the park, two separate watershed treatment areas could exist. The watershed treatment area that drains through the Hooper Avenue drain is completely within the watershed treatment area for G.W. Carver Park, causing the two watershed treatment areas to overlap. The watershed treatment area for Ted Watkins Park has the same characteristics as the watershed treatment area for G.W. Carver Park, including mostly residential with some commercial coverage. The Hooper Avenue Drain System along Success Avenue also runs adjacent to G.W. Carver Park before converging with Compton Creek. The storm drain Project No. 73 runs along South Central Avenue and converges with Compton Creek shortly after Ted Watkins Park. The park consists of mainly open space with some athletic fields, a picnic area, several tennis courts, and a skate park.

The unincorporated County portion of the drainage area of Ted Watkins Park is in the Florence–Firestone community, providing an additional opportunity for BMP implementation in the area for reasons consistent with the discussion for the Mona Park and G.W. Carver Park projects. Given the significant size of the drainage areas adjacent to Ted Watkins Park that drain to Mona Park and G.W. Carver Park, a BMP in Ted Watkins Park could provide significant additional treatment for the area.

As shown in Figure 51, Ted Watkins Park is adjacent to a 1,298-acre unincorporated County watershed treatment area. Approximately 42 acres of unincorporated County area could be treated by diverting the storm drain Project No. 73 that runs along South Central Avenue. An additional 1,256 acres could be treated by diverting the Hooper Avenue Drain System that runs along Success Avenue into the park. Figure E-18 of Appendix E shows that 14 acres are available in the park for stormwater treatment. The soils in the BMP area are reported to be HSG A, indicating a high infiltration capacity. Although the reported soil for Ted Watkins Park is HSG A, a lower infiltration rate of 1.8 in/hr was observed. The soils boring composition indicates that there is a layer of HSG D soils to approximately 4 feet with HSG B soils below. That indicates that higher levels of infiltration would be possible at the site than what was measured as the surface infiltration rate if the top 4 feet are removed. The typical centralized BMP is more than 4 feet deep, indicating that the restrictive layer would be removed if a centralized BMP is installed at the site. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater. The tennis courts and skate park area could also be used for underground storage to provide the maximum treatment area.

Additional integrated water resource benefits would be achieved by implementing a BMP in Ted Watkins Park. Most of the area recommended for BMP implementation are athletic fields or open space that is sparsely vegetated. The amended soils in the BMP and nutrient rich stormwater would provide for healthier vegetation and a more aesthetically pleasing environment. Routing the stormwater into a BMP in the park would increase the excess water available in the surface and subsurface soils, adding a water source and reducing the irrigation demand. Increased infiltration would add to groundwater replenishment in the Central Basin. By routing water into the park and concentrating it in a BMP, the soils near the surface would stay moist longer providing excess water for sod within the BMP reducing the irrigation demand. The area of Ted Watkins Park recommended for BMP implementation is being used as open space, tennis courts, and athletic fields that would benefit from the process of BMP implementation and provide the dual benefit of stormwater treatment and recreational areas. Soils in the area would be amended, and grass would be reseeded or replaced with turf improving and enhancing the aesthetics of the park. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. While enhanced habitat is not an intended component of BMP implementation, additional vegetation included in the planning and design might provide additional habitat not currently quantified.

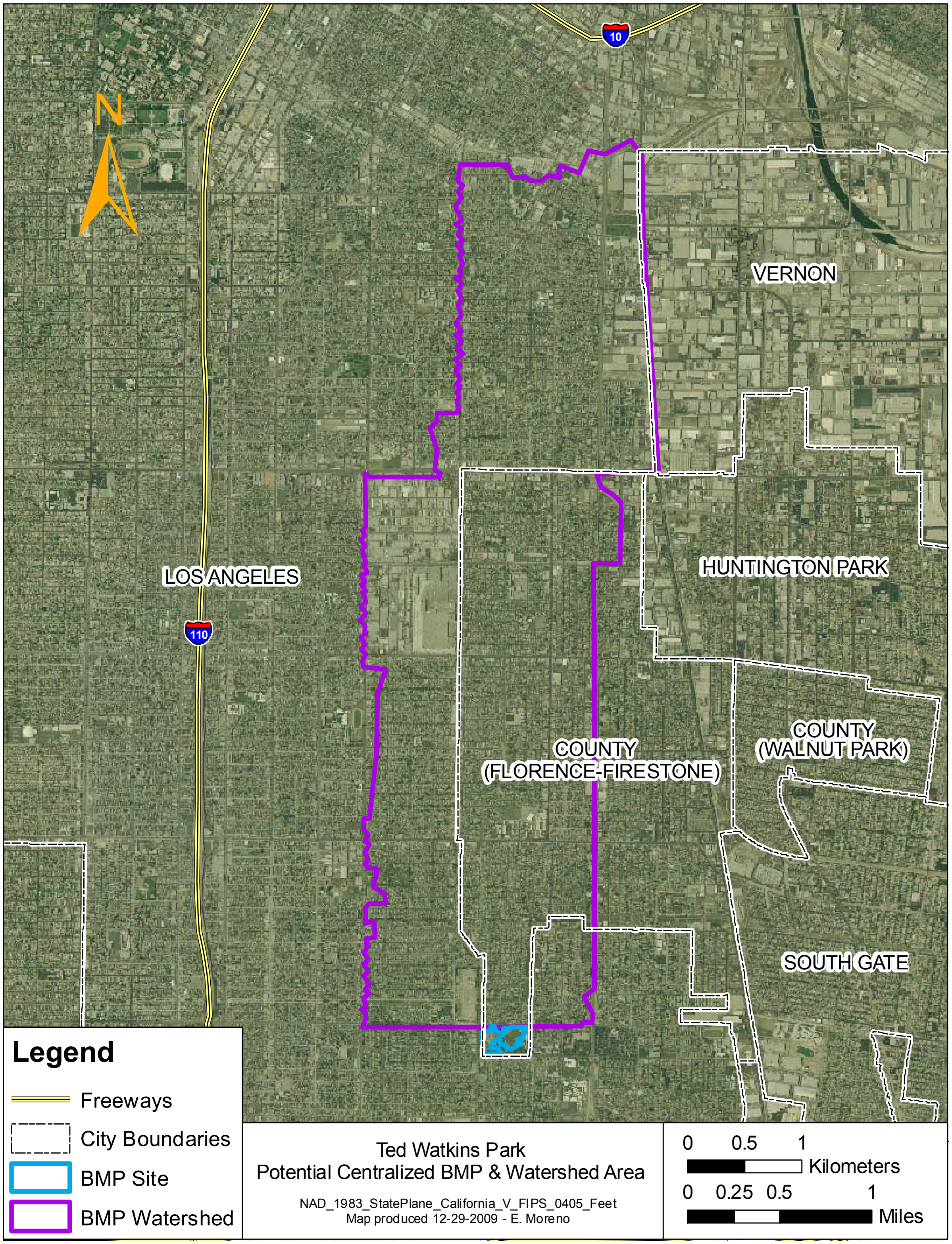

Figure 51. Ted Watkins Park Watershed and Potential BMP Site

Roosevelt Park

The watershed treatment area that could be treated in Roosevelt Park is 40 percent impervious with a concentrated impervious configuration and low road density. The treatment area is entirely residential. The park is a long, narrow space running north and south along Graham Avenue and consists of multiple uses including open space, athletic fields, a skate park, a swimming pool, and a senior center.

The drainage area for Roosevelt Park is in the same portion of the unincorporated County community of Florence–Firestone as the drainage area for Mona Park and shares the same characteristics. The drainage area also has a history of SSOs and several RCRA sites which have the potential of contributing to additional pollutant loading not represented in modeling analysis used to prioritize unincorporated County communities.

As shown in Figure 52, Roosevelt Park is adjacent to an 87.5-acre unincorporated County watershed treatment area. Figure E-21 shows that 11.5 acres are available in the park for stormwater treatment. Flows from the existing Whitsett Avenue Drainage System, which runs along Whitsett Avenue, would have to be diverted into the park. The soils in the area are reported to be HSG A soil, indicating a high infiltration capacity. Infiltration rates observed at the park were lower than expected, 1.2 in/hr, but are still acceptable for an infiltration BMP. The soil boring composition indicates HSG B soils at the surface with HSG A soils at the approximate level of the base of an infiltration basin. The soils at the surface are highly compacted, meaning that higher infiltration rates could be achieved with minor soil amendments. Constructing a typical centralized BMP would remove the upper soil layers putting the base of the BMP in the HSG A soils. The skate park was included in the BMP area and could be used as underground storage. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

The watershed treatment area that could be treated by a centralized BMP in Roosevelt Park is entirely contained in the watershed treatment area that could be treated by Mona Park. Because of the small watershed treatment area that would be treated in Roosevelt Park, priority could be given to a centralized BMP installed in Mona Park rather than a small BMP in Roosevelt Park and a large BMP in Mona Park. The most economical and effective treatment option is discussed in Section 6.

In addition to contributing to meeting the TMDL reduction requirements by improving water quality, a centralized BMP in Roosevelt Park would provide other benefits that would contribute to regional integrated water resources efforts. This BMP would provide water conservation by reducing irrigation demand. By routing water into the park and concentrating it in a BMP the soils near the surface would stay moist longer providing excess water for sod within the BMP reducing the irrigation demand. A centralized BMP in the park would be designed to increase infiltration providing additional groundwater replenishment to the Central Basin. The area of Roosevelt Park recommended for BMP implementation is being used as open space and athletic fields that would benefit from the process of BMP implementation and provide the dual benefit of stormwater treatment and recreational areas. Soils in the area would be amended and grass would be reseeded or replaced with turf, improving and enhancing the aesthetics of the park. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. While enhanced habitat is not an intended component of BMP implementation additional vegetation included in the planning and design might provide additional habitat not currently quantified.

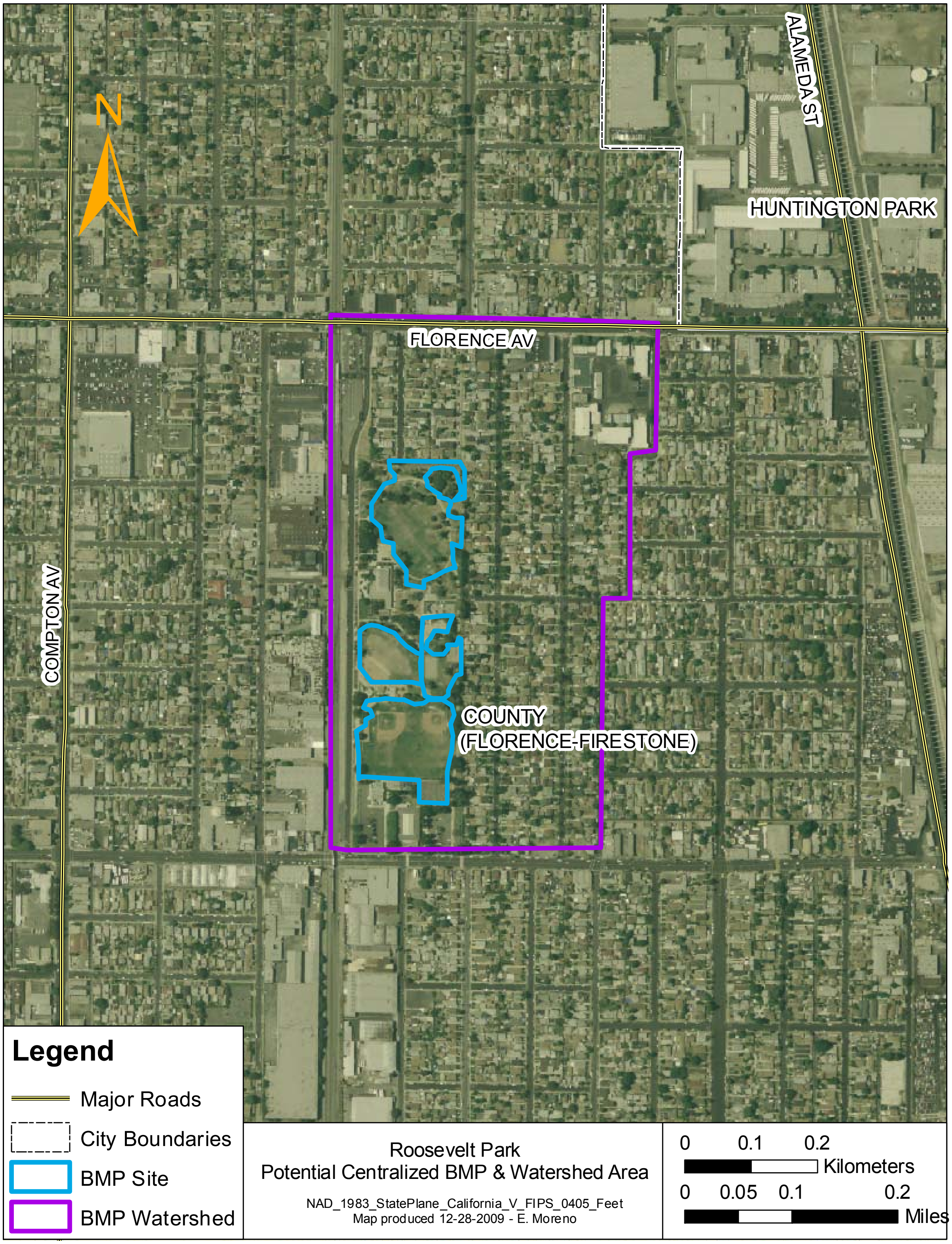

Figure 52. Roosevelt Park Watershed and Potential BMP Site

Bethune Park

The watershed treatment area that could be treated in Bethune Park is 63 percent impervious with a concentrated impervious configuration and a low road density. The watershed treatment area is mainly residential but includes commercial and institutional land uses. The park consists of an athletic field, a playground area, a swimming pool, and an institution area.

The unincorporated County portion of the drainage area for Bethune Park is in the Florence–Firestone community. The Florence–Firestone community is the 4th largest and is 14 out of 30 for wet weather loads and one of eight communities ranked 1 out of 30 for dry weather loads. Additional local pollutant sources could affect the drainage area, including: TRI sites for copper, lead, and zinc in the Willowbrook community adjacent to the Florence–Firestone community, and several others within a few miles; several RCRA sites; and several SSOs reported in Florence–Firestone community, including a 1,001- to 3,000-gallon spill.

As shown in Figure 53, Bethune Park is adjacent to a 116-acre unincorporated County watershed treatment area. Flows from the existing Glen Avenue Drainage System, which runs along Hooper Avenue, would have to be diverted into the park. Figure E-24 shows that 2.4 acres are available for stormwater treatment in the park. The soils in the BMP area are reported to be HSG B soils, indicating appropriate infiltration capacity for an infiltration BMP. Infiltration rates observed at the park were lower than expected, 0.4 in/hr, and in the HSG C range. The soils boring composition indicates that HSG B soils are at the surface with a layer of HSG D soils between 5.5 feet and 8 feet. The soils at the surface are highly organic, causing the lower than expected infiltration rates. Soils below the HSG D layer are HSG B, indicating that higher infiltration rates could be achieved below 8 feet. The restrictive layer could be removed or amended during construction. The playground area could be used for treatment by using an underground BMP. The institutional area and the swimming pool would need to be shielded from the effects of infiltration. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

In addition to contributing to meeting the TMDL reduction requirements by improving water quality, a centralized BMP in Bethune Park would provide other benefits that would contribute to regional integrated water resources efforts. This BMP would provide water conservation by reducing irrigation demand. By routing water into the park and concentrating it in a BMP the soils near the surface would stay moist longer providing excess water for sod within the BMP reducing the irrigation demand. A centralized BMP in the park would be designed to increase infiltration providing additional groundwater replenishment to the Central Basin. The area of Bethune Park recommended for BMP implementation is currently being used as athletic fields that would benefit from the process of BMP implementation and provide the dual benefit of stormwater treatment and recreational areas. Soils in the area would be amended and grass would be reseeded or replaced with turf, improving and enhancing the aesthetics of the park. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. While enhanced habitat is not an intended component of BMP implementation additional vegetation included in the planning and design might provide additional habitat not currently quantified.

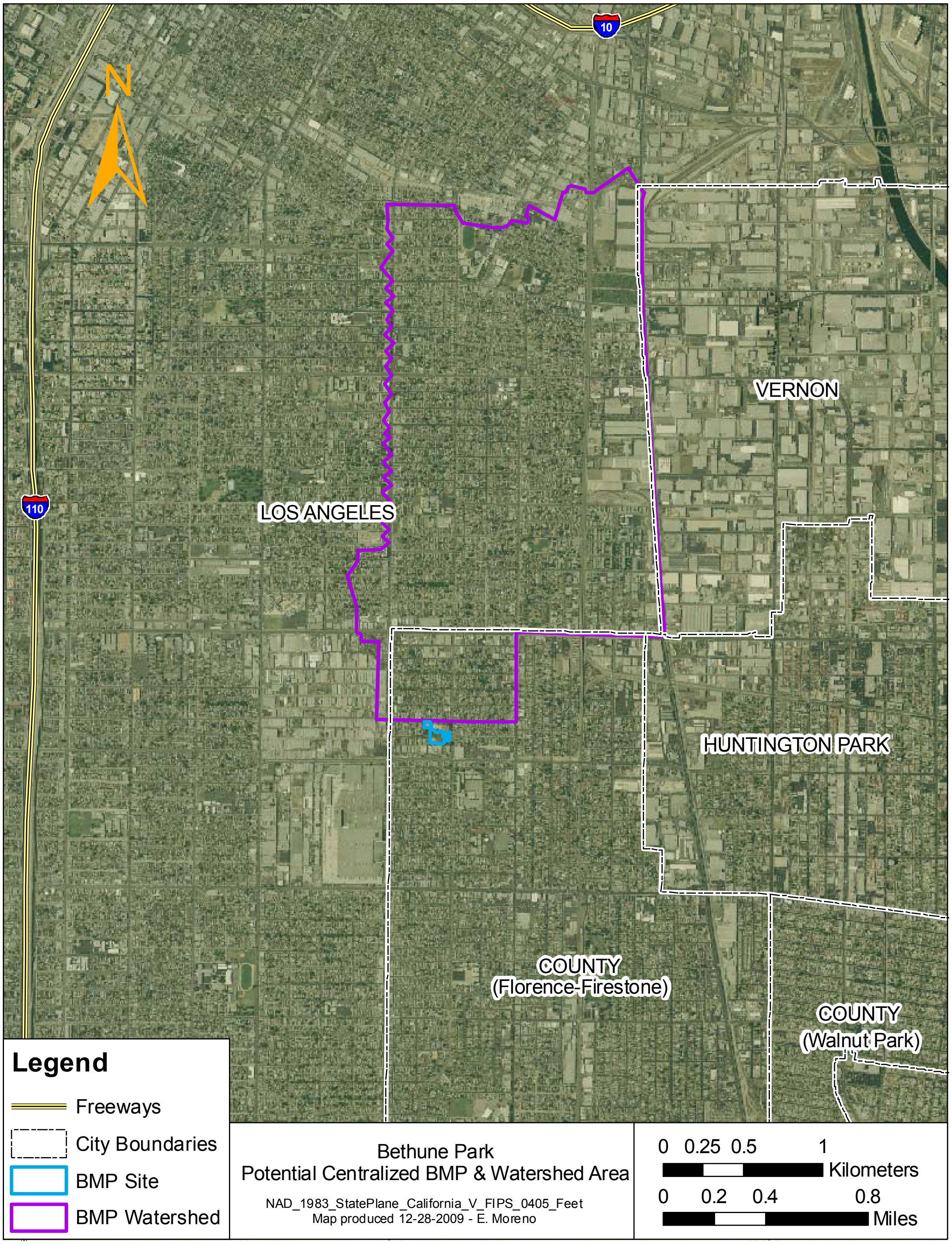

Figure 53. Bethune Park Watershed and Potential BMP Site

Northside Drive Median

The watershed treatment area that could be treated in the Northside Drive median could consist of the roadway drainage and flows that could be diverted from the existing storm drain DDI 23, which runs along Garfield Avenue. The watershed treatment area consists mainly of residential and is 58 percent imperviousness with a concentrated impervious configuration and low road density. The median is an open area dividing the travel lanes. Some mature trees are in the median that would need to be avoided while constructing a centralized BMP or removed before its construction.

A large portion of the drainage area for the Northside Drive median is in the unincorporated County community of City Terrace – East Los Angeles. City Terrace – East Los Angeles is the second largest unincorporated County community and is one of two communities ranked 4 out of 30 for wet weather loads and one of eight communities ranked 1 out of 30 for dry weather loads. TRI sites for metals are within 2 miles, and PAH sites are within 15 miles that could contribute to additional pollutant loading not represented in the modeling analysis. While no SSOs were reported in the drainage area, several were in the City Terrace – East Los Angeles community that could affect a BMP at the Northside Drive median. Those additional sources provide further validation that a BMP would be advantageous at the site.

As shown in Figure 54, the median area along Northside Drive is adjacent to a 35-acre unincorporated County watershed treatment area. Figure E-27 shows that approximately 2.7 acres are available in the median for stormwater treatment. The soils in the median are reported to be HSG B, indicating a high infiltration capacity. The observed infiltration rates at the site were high, 13.9 in/hr; however, the soils boring composition indicates HSG D soils to a depth of approximately 7 feet. The restrictive layers could be removed during construction if a centralized BMP is installed at the site, exposing soils with a higher infiltration capacity making the site suitable for an infiltration BMP. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

The Northside Drive median provides several additional benefits that would contribute to regional integrated water resources efforts. The median provides open area and green space valuable to the community. A BMP implemented in the median would incorporate integrated water resources planning by maintaining the dual purposes of open space and stormwater treatment. Diverting stormwater flows into the median area would provide a water source, thus reducing the strain on the potable water system and enhancing water conservation. Nutrients from the stormwater would add to the health and appearance of the vegetation in the BMP, increasing the aesthetics of the area, while also reducing the need for fertilization. Increased storage and infiltration at the site would provide some flood protection to the surrounding watershed treatment area, and increase the groundwater replenishment to the Central Basin. While enhanced habitat is not an intended component of BMP implementation additional vegetation included in the planning and design might provide additional habitat not currently quantified.

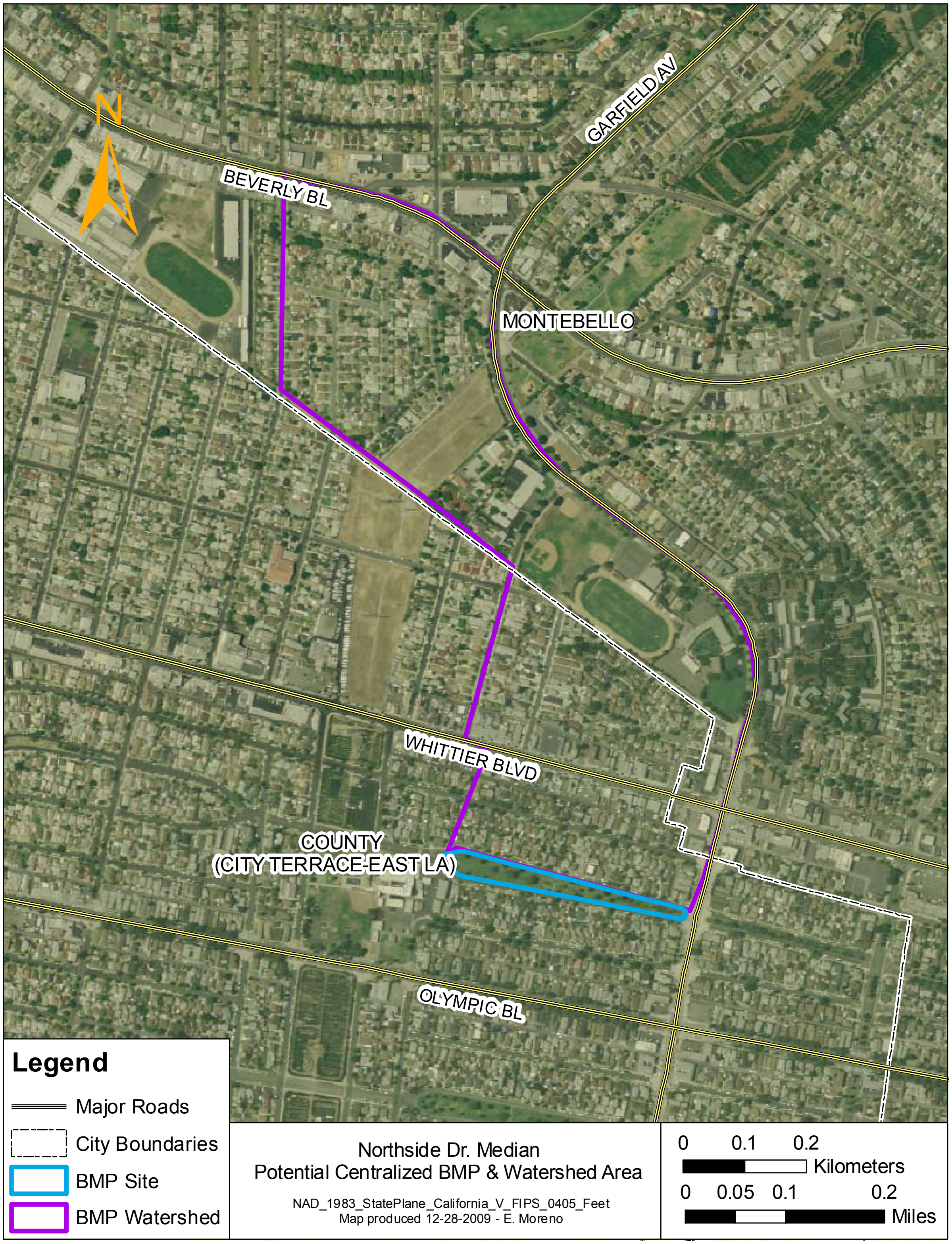

Figure 54. Northside Drive Median Watershed and Potential BMP Site

Salazar Park

The watershed treatment area that could be treated in Salazar Park is 61 percent impervious, with a concentrated impervious configuration and a high road density that is mainly residential. The park includes open space, athletic fields, several tennis courts, and parking areas.

The drainage area for Salazar Park is in the unincorporated County community of City Terrace – East Los Angeles providing an additional opportunity for BMP implementation in the area for reasons consistent with the discussion for the North Side median. Because of the high road density, the potential exists for higher metals concentrations in the area, which could be reduced by a BMP at Salazar Park providing further indication of the benefits of a BMP in the park.

As shown in Figure 55, Salazar Park is adjacent to a 105-acre unincorporated County watershed treatment area. Flows from the existing storm drain DDI 26, which runs along South Ditman Avenue, would have to be diverted into the park. Figure E-30 of Appendix E shows that approximately 5.4 acres are available in the park that could be used to treat stormwater from the watershed treatment area. The soils in the BMP area are reported to be HSG B soils, which are appropriate conditions for an infiltration BMP. Infiltration rates at the park were observed to be 6.8 in/hr, in the HSG B range. A layer of HSG D soil is near the surface that could cause lower than expected infiltration rates. The HSG D layer is below the expected base of a centralized BMP and could most likely be removed during construction to expose the HSG A soils below. The area under the tennis courts and parking areas could be used for underground storage to maximize the treatment area. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

Salazar Park is an obvious amenity to the surrounding community and appreciated for the athletic facilities and open recreation provided. The park would benefit from an integrated water resources approach by using the park for the dual purpose of stormwater treatment and open space and recreation. Storing and treating stormwater in a BMP would provide another water source reducing the load on the potable water system adding an element of water conservation. The nutrient-rich stormwater would improve the health of the vegetation in the BMP, improving the aesthetics of the park while reducing the need for fertilization. By diverting the flow from the storm drain and storing and infiltrating it in a BMP, the load on the storm drain would be reduced, providing some flood protection in the watershed treatment area while adding groundwater recharge to the Central Basin. Additional integrated water recourse elements, such as enhanced habitat, could also be incorporated into the design during the planning stages depending on the vegetation and other elements deemed appropriate for the project.

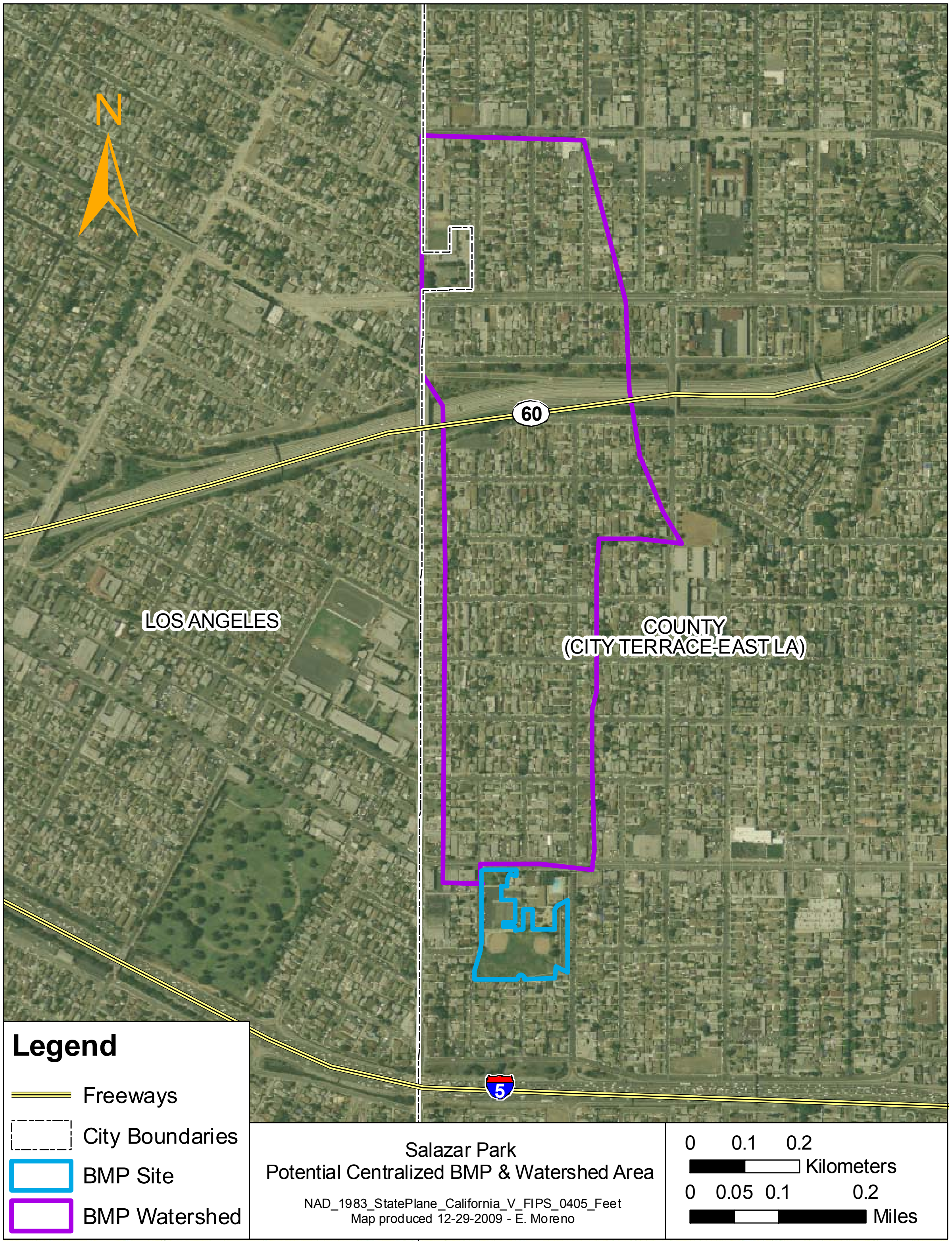

Figure 55. Salazar Park Watershed and Potential BMP Site

Obregon Park

The watershed treatment area that could be treated in Obregon Park is 60 percent imperviousness, has a concentrated impervious configuration, a low road density, and is mainly residential with a few schools. The park consists of athletic fields with some institutional areas.

Obregon Park is also in the City Terrace – East Los Angeles unincorporated County community, providing an additional opportunity for BMP implementation in this high priority area. The drainage area also has a history of SSOs and several RCRA sites, which could contribute to additional pollutant loading.

As shown in Figure 56, Obregon Park is adjacent to a 225-acre unincorporated County watershed treatment area. Flows from the existing storm drain DDI 26, which runs along North Sunol Drive. Figure E-33 of Appendix E shows that 4.6 acres are available in the park for a centralized BMP to treat the stormwater from the watershed treatment area. The area includes open space, two athletic fields, a basketball court, and a parking area. The soils in the BMP area are reported to be HSG D soils, indicating poor infiltration capacity. The observed infiltration rate at the site is higher than expected, 1.1in/hr in the HSG B range, considering the reported HSG. The soil boring log shows that the entire soil profile is HSG D, indicating that the soils might not be suitable for an infiltration BMP. Further soils analysis should be performed before implementing a centralized BMP designed for infiltration at the site. Institutional areas at the site would need to be protected from the effects of infiltration. None of the institutional areas or any structures are included in the available BMP area. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

In addition to the water quality objectives, a BMP in Obregon Park could benefit from an integrated water resources planning approach. The benefit of the park for open space and recreational facilities is clear and would benefit from the dual use for stormwater treatment. BMP implementation would require amending the soils to improve infiltration and would benefit vegetation in the facility. Diverting flows into a centralized BMP in the park would provide an additional water source, reducing the demand for potable water and therefore providing water conservation. The nutrient-rich stormwater could reduce the need for fertilization while improving the aesthetics of the park. The additional treatment by storing and infiltrating the stormwater would reduce flooding in the watershed treatment area and would increase groundwater replenishment in the Central Basin. Additional integrated water resource elements could be identified in planning and design.

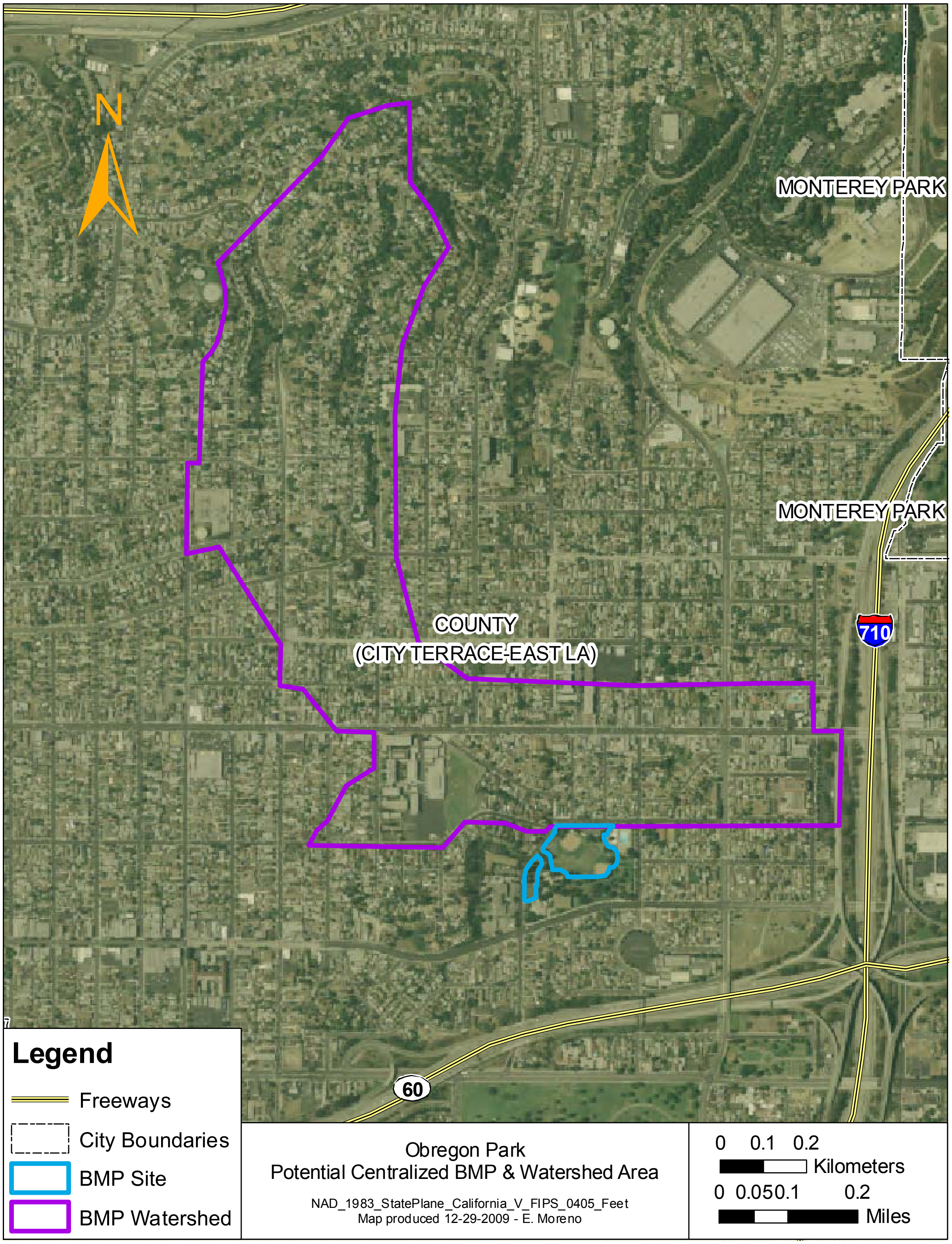

Figure 56. Obregon Park Watershed and Potential BMP Site

Belvedere Park

The watershed treatment area that could be treated in Belvedere Park is 60 percent impervious with a concentrated impervious configuration and a high road density. The area around the park is mainly residential with some commercial. The park area consists of open areas, athletic fields, tennis courts, and a skate park.

Belvedere Park is also in the City Terrace – East Los Angeles unincorporated County community, providing an additional opportunity for BMP implementation. The drainage area also has a history of SSOs as large as 300 gallons and several RCRA sites, which, like could contribute to additional pollutant loading. Because of the size of the drainage area, a BMP at Belveldere Park could be given priority over a BMP at Obregon Park.

As shown in Figure 57, Belvedere Park is adjacent to a 208-acre unincorporated County watershed treatment area. Flows from the existing storm drain RDD 296, which runs along North Kern Street, would have to be diverted into the park. Figure E-36 of Appendix E shows that approximately 21 acres are available in the park for stormwater treatment. The BMP area includes the open space, tennis courts, athletic fields, and parking lots. The BMP area is reported to be HSG B, appropriate for an infiltration BMP. As expected, the observed infiltration rate at the surface was 2.7 in/hr, in the HSG B range. The soil boring composition shows a layer of HSG D soils within 2.5 feet of the surface that could be removed during construction to put the base of a centralized BMP in HSG A soils. Infiltration rates higher than observed at the surface would be expected with a centralized BMP installed in the HSG A soils. The tennis courts and parking lots could be used for treatment using underground storage. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

The centralized BMP proposed for Belvedere Park can use an integrated water resources approach by providing open space and recreational facilities while treating stormwater to improve water quality. Diverting flows into a BMP in Belvedere Park would provide an additional water source for the vegetation in the BMP, reducing the irrigation demand and providing water conservation, while improving the aesthetics of the park. Nutrient-rich stormwater would benefit the vegetation and reduce the need for fertilizer. Providing additional storage in the park would reduce the load on the stormwater drainage system, providing flood protection while increased infiltration would enhance groundwater replenishment for the Central Basin. The integrated water resources approach might apply to other aspects of BMP implementation, such as enhanced habitat, that could be identified in planning and design.

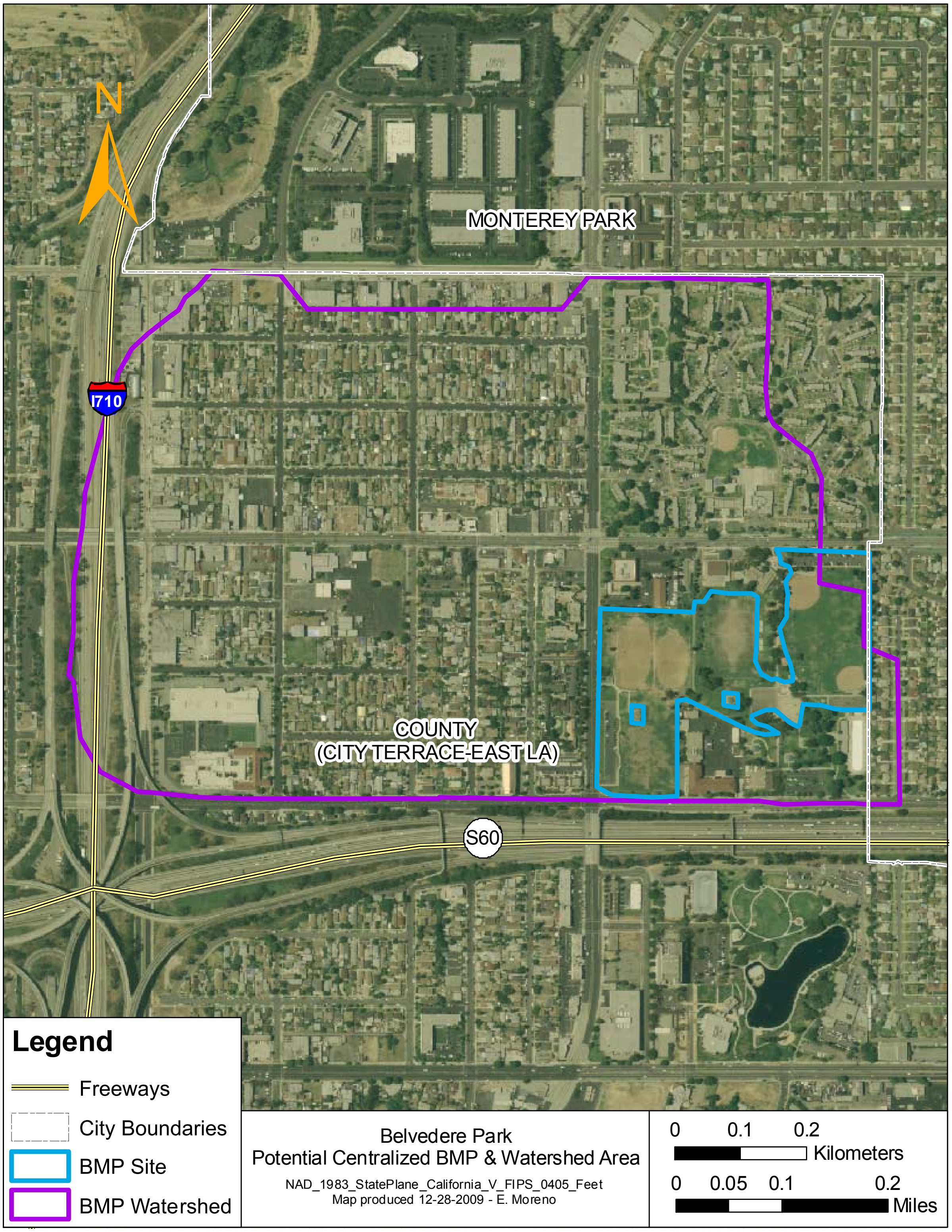

Figure 57. Belvedere Park Watershed and Potential BMP Site

Whittier Narrows Park

The watershed treatment area that could be treated by a centralized BMP in Whittier Narrows Park is 46 percent impervious with a concentrated impervious configuration and low road density. Stormwater drains into the area of Legg Lake, and additional treatment could be achieved through a centralized BMP in Whittier Narrows Park. Much of the watershed treatment area is residential with some commercial and industrial land use.

A small portion of the drainage area is in the unincorporated County community of Whittier Narrows, which is the seventh largest unincorporated County community and ranks 29 out of 30 for wet weather loads and is one of eight communities that ranks 1 out of 30 for dry weather loads. A number of TRI sites are within 20 miles, which have the potential of contributing to additional pollutant loading.

As shown in Figure 58, Whittier Narrows Park is adjacent to a 36-acre unincorporated County watershed treatment area. Flows from the existing storm drain Project No. 1213, which runs along Lema Road, would flow into the park. Figure E-39 of Appendix E shows that 42 acres are suitable for a centralized BMP consisting mainly of open space with several tennis courts. The tennis courts were included in the available BMP area and could be used for treatment with underground storage. Given the size of the watershed treatment area and the available BMP space in the park, underground storage would not be necessary. Very few structures could be affected by infiltration, and they are mostly restroom facilities. Measured infiltration rates and the soils composition at the site correspond with the reported HSG A soils, indicating high infiltration rates in the park. Observed infiltration rates were 7.2 in/hr, in the upper end of the HSG B range. The observed infiltration rates and the soil boring indicate a high capacity for infiltration and that the site will be suitable for a centralized BMP. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

A centralized BMP would be used for recreational activities and stormwater treatment. Whittier Narrows Park is a large open space area with ample opportunity for BMP implementation. Regardless of the size of the park, all existing open space is considered an amenity to the community and should be considered as green infrastructure for stormwater treatment rather than be replaced with structural stormwater BMPs. Diverting stormwater flows from the storm drain into a BMP would decrease irrigation and potable water demand. The enhanced vegetation in and around the BMP would improve the aesthetics of the park. The additional storage and increased infiltration capacity would reduce the strain on the stormwater drainage system providing some flood protection while helping to replenish groundwater in the Main San Gabriel Basin. Depending on the actual design, the BMP could provide additional water resources benefits.

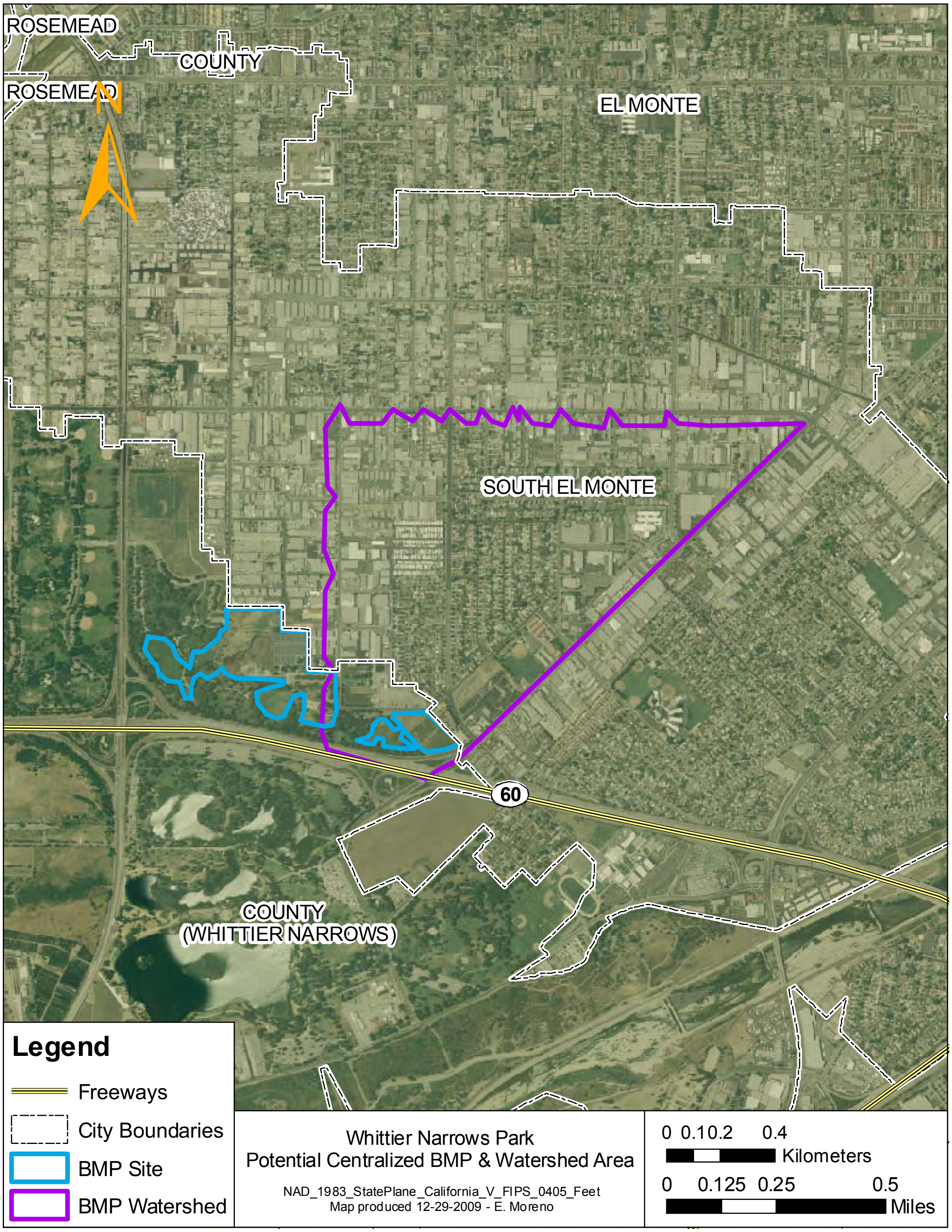

Figure 58. Whittier Narrows Park Watershed and Potential BMP Site

Whittier Narrows Recreation Area

Whittier Narrows Recreation Area is a park with multiple recreation opportunities. The park consists of a rifle range, a BMX race track, a field for remote control airplane pilots, a remote control car race track, and significant open space. The watershed treatment area is 26 percent impervious with a concentrated impervious configuration and a low road density. The unincorporated County area includes a nursery with a large amount of open space causing the area to have a low impervious percentage despite the fact that it has a concentrated impervious configuration. While the unincorporated County area has a low impervious percentage, the remainder of the watershed treatment area is 73 percent impervious.

The watershed treatment area is also in the unincorporated County community of Whittier Narrows providing an additional opportunity for BMP implementation in the area for reasons consistent with the discussion for Whittier Narrows Park.

As shown in Figure 59, Whittier Narrows Recreation Area is adjacent to a approximately 23-acre unincorporated County watershed treatment area. Flows in the existing storm drain Project No. 115, which runs along Rush Street, would have to be diverted into the Whittier Narrows Recreation Area. Figure E-42 of Appendix E shows that approximately 78 acres are available in the park for a centralized BMP, consisting mainly of open space and several athletic fields. A significant drainage system runs along Rush Street where it outfalls into the Rio Hondo Channel. Ample space should be available in the north end of the park, adjacent to Rush Street, to treat the unincorporated County watershed treatment area. The only structures on the site that would need to be avoided are restroom facilities and the facilities listed above. All structures were avoided in calculating the available BMP area requiring no underground storage. The soils at the site are reported to be HSG B, and measured infiltration rates, 1.4 in/hr, are representative of HSG B. An HSG D layer was observed near the surface that could be removed during construction of a typical centralized BMP, exposing the HSG A soils below. The HSG A soils below the surface should provide sufficient infiltration for a centralized BMP. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

Integrated water resource planning would be used when designing and implementing a centralized BMP in Whittier Narrows Recreation Area. Dual use of recreation and stormwater treatment area would be emphasized. Existing open space is an amenity of the park, not to be replaced for structural stormwater treatment, rather considered as green infrastructure. Vegetation in the BMP area of the park would be reseeded or replaced during implementation and would benefit from the nutrient rich stormwater, thus improving the appearance and aesthetics of the park. Stormwater could be used to supplement the irrigation needs in the park, enhancing water conservation. The additional storage and infiltration capacity provided by a centralized BMP would reduce the flooding potential in the watershed treatment area and help to replenish groundwater in the Main San Gabriel Basin. Additional benefits of BMP implementation could be identified in the detailed planning and design stage.

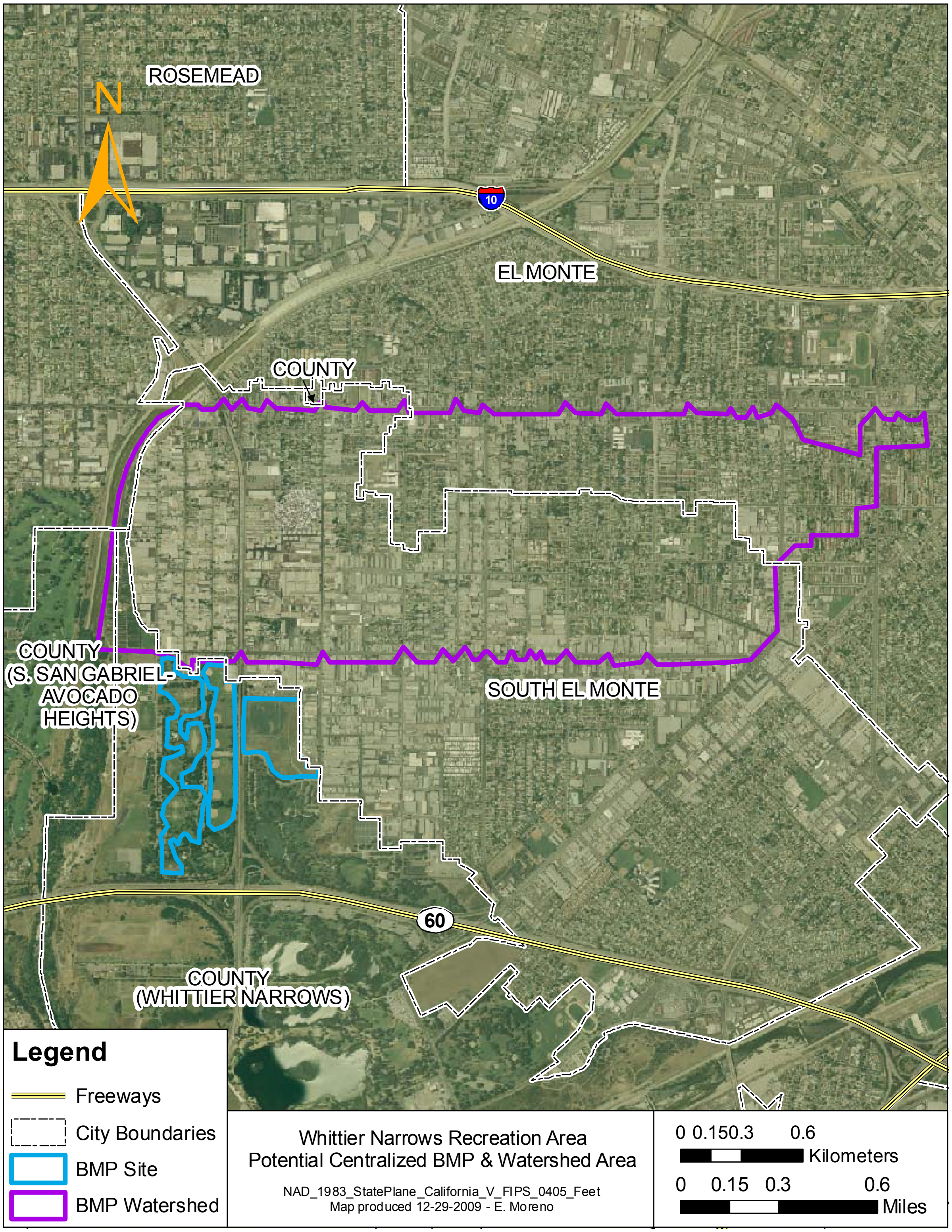

Figure 59. Whittier Narrows Recreation Area Watershed and Potential BMP Site

Hugo Reid Park

The watershed treatment area that could be treated in Hugo Reid Park is 55 percent impervious with a concentrated impervious configuration and a high road density. Much of the watershed treatment area is residential with some commercial land use. Stormwater could be treated in the athletic fields, open space, tennis courts, and parking area in the park.

The portion of the drainage area for the proposed project in the unincorporated County area is in the community of East Pasadena – East San Gabriel. East Pasadena – East San Gabriel is the fifth largest area and is ranked 8 out of 30 for wet weather loads and one of eight communities ranked 1 out of 30 for dry weather loads. No TRI sites are within the drainage area; however, numerous sites are within 20 miles of the potential site that could affect the drainage area. Also, several SSOs are in the area that could have an additional unquantified contribution that can be addressed with a BMP at the park. The majority of the unincorporated County area is high density residential and commercial with several agricultural areas that could also contribute to a potential BMP.

As shown in Figure 60, Hugo Reid Park is adjacent to a 187-acre unincorporated County watershed treatment area. Flow from the storm drain Project No. 24, which runs along Michillinda Avenue, would have to be diverted into the park for treatment. Figure E-46 of Appendix E shows that 2.8 acres are available at the park for stormwater treatment. The available BMP area is reported to have HSG A soils; however, the measured infiltration rate at the surface was 3.2 in/hr, in the HSG B range. The soils composition shows the soils to be HSG D soils. Debris at the surface prevented soils analysis below 2 feet. The surface infiltration rate was, most likely, affected by the debris in the soil causing the infiltration rates to be higher than expected. Because of the soils' HSG types, soils with infiltration capacities equal to the observed infiltration rate at the surface or higher are expected below the surface. Further soils analysis is recommended before a centralized BMP is implemented at the site. Treatment at the site could be maximized by using the tennis courts and parking area for underground storage. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

Because Hugo Reid Park is a small community park surrounded by concentrated impervious area, its open space and recreational facilities are highly valued by the surrounding community. That makes integrated water resources planning even more important. The proposed centralized BMP would provide a dual purpose of stormwater treatment and recreational facilities with aboveground treatment for the athletic fields and underground treatment for the tennis courts and parking lot. By diverting nutrient-rich stormwater into the aboveground BMPs, irrigation demand and fertilization would be reduced, and aesthetics of the park open space would be improved. Some flood protection would also be provided by the additional storage and enhanced infiltration capacity in the park. Increased infiltration would also help to replenish groundwater in the Raymond Basin.

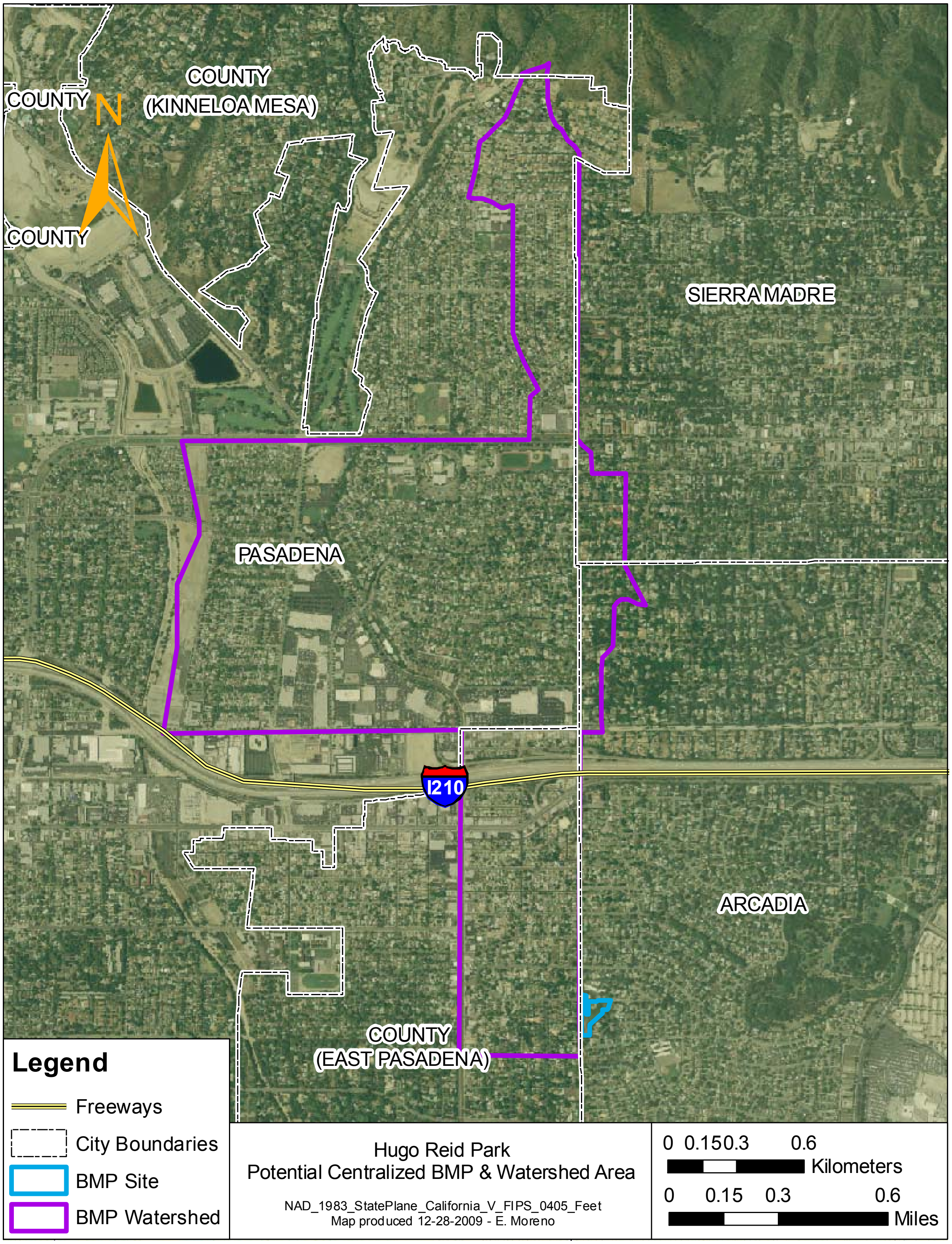

Figure 60. Hugo Reid Park Watershed and Potential BMP Site

Farnsworth Park

Farnsworth Park is in the headwaters of the Los Angeles River watershed near the base of the Angeles Mountains. The watershed treatment area is 24.5 percent impervious with a dispersed impervious configuration and a low road density. The watershed treatment area is residential with some area overlapping a park at the base of the mountains. Because the park space is open and natural, an increased sediment load could be expected. Farnsworth Park includes multiple recreational opportunities including tennis and basketball courts, a playground, athletic fields, several picnic areas, and an amphitheater.

The unincorporated County portion of the drainage area for Farnsworth Park is in the community of Altadena, which is the third largest unincorporated County community, ranked 6 out of 30 for wet weather loads, and one of eight communities ranked 1 out of 30 for dry weather loads. While no TRI sites are within Altadena, numerous sites are within 20 miles that could affect the drainage area. Altadena also had the most SSOs of any other unincorporated County community, a potential pollutant source that could be treated by a BMP in Farnsworth Park.

As shown in Figure 61, Farnsworth Park is adjacent to a 21.9-acre unincorporated County watershed treatment area. Flow from the existing storm drain Project No. 544, which runs along Lake Avenue, would have to be diverted into the park. Some of the park's 33.7 acres of total watershed treatment area are in federal lands. The portion of the drainage area that is in unincorporated County area was calculated using the most recent data available. Figure E-49 of Appendix E shows that approximately 4.25 acres are available in the park for stormwater treatment. Soils in the BMP area are reported to be HSG A, and the observed infiltration rate of 9.0 in/hr corresponds. The soils composition shows HSG B soils to a depth of 7 feet. The soil boring was not able to go deeper than 7 feet because of debris, being so close to the mountains. Because of the HSG of the soils and the observed infiltration rate at the surface, the infiltration rate would be expected to be appropriate for an infiltration BMP at depths below 7 feet. The basketball courts, tennis courts, and playground could be used as underground storage to maximize the available BMP area in the park. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

The integrated water resources planning approach would be applied to a centralized BMP implemented in Farnsworth Park. Incorporating stormwater treatment into the open space and recreational aspects of the park would be critical. Open space and athletic fields would be used for aboveground storage while belowground storage would be used for the tennis and basketball courts and the playground areas. Aboveground centralized BMPs would benefit from nutrient-rich stormwater diverted into the park, which would reduce the irrigation demand, decrease fertilization needs, and improve the aesthetics of the park. Areas with sparse vegetation would benefit from reseeding or turf replacement that would occur with BMP implementation. Additional storage and increased infiltration capacity from a BMP in the park would provide additional flood protection and help to replenish groundwater in the Raymond Basin.

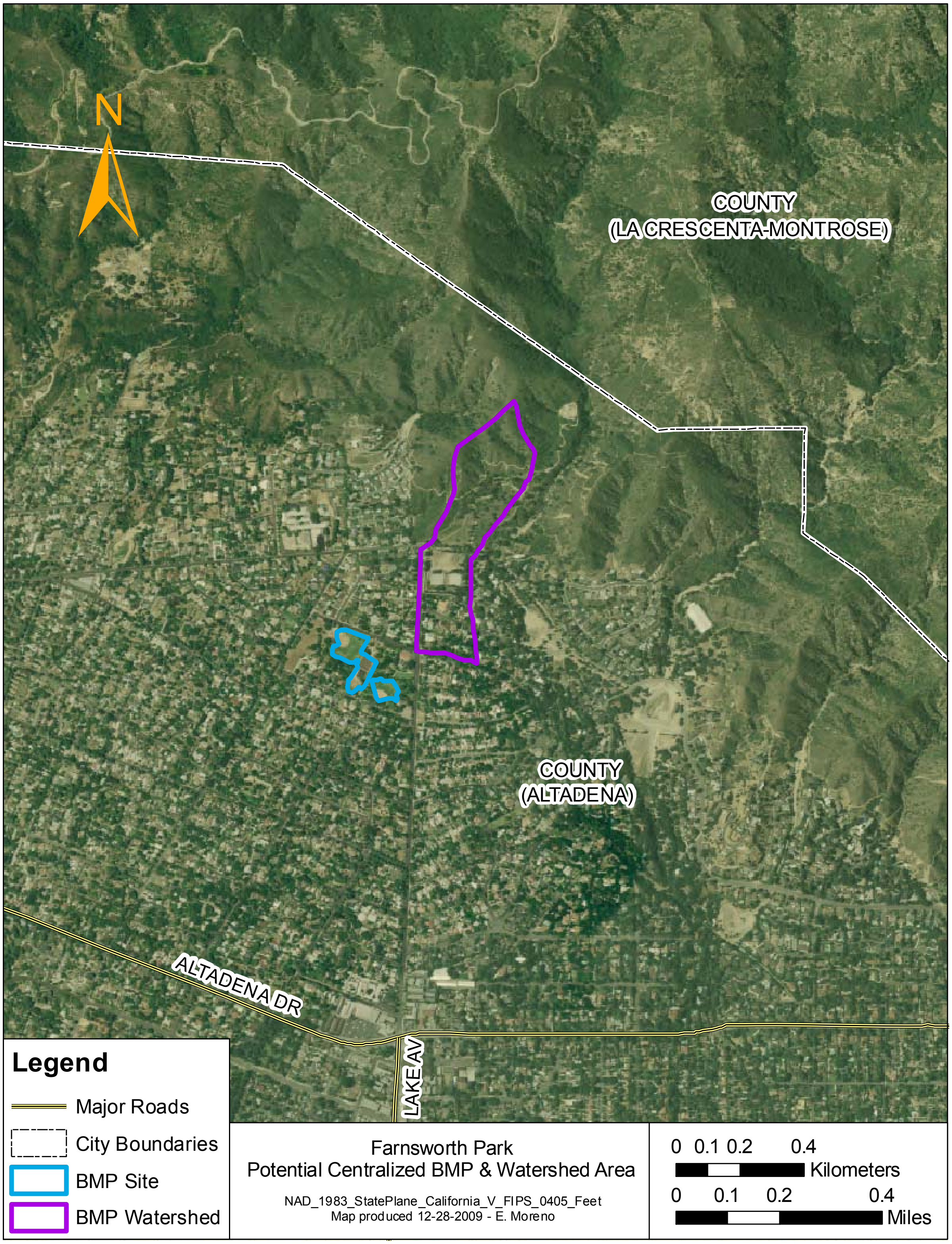

Figure 61. Farnsworth Park Watershed and Potential BMP Site

Loma Alta Park

Loma Alta Park is at the base of the Angeles Mountains near the headwaters of the Los Angeles River. The watershed treatment area is 32 percent impervious with a dispersed impervious configuration and low road density. Much of the watershed treatment area is undeveloped and has a low impervious percentage, and the remainder is residential. The park consists of mainly open space with restroom facilities and several tennis courts. An equestrian area is adjacent to the park—used by the Los Angeles County Sheriffs Department—that was not included in the available BMP area. Several flood control areas are along West Loma Alta Drive that overflow into the Altadena Drainage System along West Loma Drive, The Lincoln, West Ravine, and Rubio Debris Basins provide pretreatment and peak flow control for the drainage from the mountains. A centralized BMP would not affect the debris basins and would benefit from some pretreatment.

Loma Alta Park is also in the Altadena unincorporated County community providing an additional opportunity for BMP implementation in the area for reasons consistent with the discussion for the Farnsworth Park project. Several significant SSOs occurred in the drainage area, further justifying a BMP's usefulness in the park.

As shown in Figure 62, Loma Alta Park is adjacent to a 203-acre unincorporated County watershed treatment area. The remaining portion of the 941-acre watershed is in federal land. The portion of the watershed treatment area that is unincorporated County area was calculated with the most recent data available. Flows from the existing Altadena Drainage System, which runs along West Loma Alta Drive, would have to be diverted into the park for treatment. Figure E-52 shows that approximately 4.25 acres are available in the park for stormwater treatment. The open space, tennis courts, and parking area could be used as underground storage for additional stormwater treatment. The BMP area is reported to be HSG A, and measured infiltration rates reflect that with an infiltration rate of 29.7 in/hr. The soil boring also indicates HSG A soils with a thin layer of HSG D soils at a depth of around 8 feet. That layer could impede infiltration and could be amended or removed during construction. A centralized BMP in Loma Alta Park would provide additional treatment for nutrients, metals, and pathogens not provided by the debris basins. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

Loma Alta Park incorporates several uses that complement integrated water resources planning and provide multiple water resources benefits. The tennis courts, parking lot, and open space areas would be used for stormwater treatment. The open spaces that would be used for aboveground treatment would benefit from centralized BMP implementation. Vegetation would be reseeded or replaced during implementation and would have a healthier environment with the diversion and uptake of nutrient-rich stormwater. That would also improve the overall aesthetics of the park and provide an additional water source to supplement irrigation demand. Some flood control and protection would be provided by the additional storage and enhanced infiltration capacity resulting from BMP implementation. The added infiltration would help replenish groundwater in the Raymond Basin.

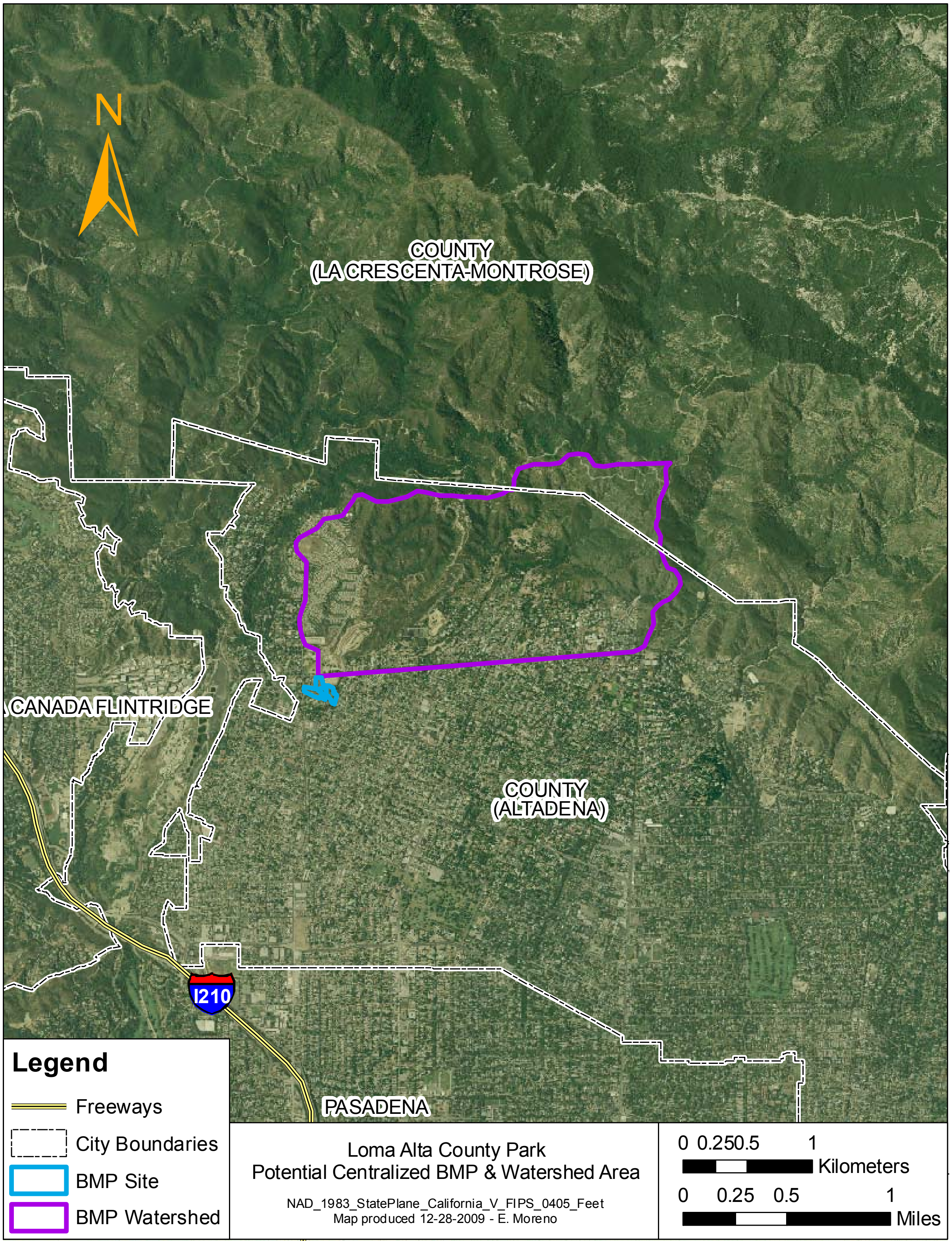

Figure 62. Loma Alta Park Watershed and Potential BMP Site

Two Strike Park

The watershed treatment area is 17 percent impervious with a dispersed impervious configuration. A large portion of the watershed is in an undeveloped area at the base of the mountains and has a low impervious percentage. The area of the watershed that is developed is residential. The park consists of athletic fields, open space, a playground, and a restroom facility. Eagle Debris Basin adjacent to the park could be used to divert flow from Eagle Canyon Channel and Goss Canyon Chanel and provide some pretreatment and peak flow control.

The majority of the drainage area of this proposed project is in the unincorporated County community of La Crescenta – Montrose, which is the sixth largest unincorporated County community, one of two communities ranked 2 out of 30 for wet weather loads, and one of eight communities ranked 1 out of 30 for dry weather loads. No TRI sites are within La Crescenta – Montrose, but the numerous sites within 20 miles could still have an effect on the drainage area. Several SSOs occurred within the drainage area, including one of 501 to 1,000 gallons.

As shown in Figure 63, Two Strike Park is adjacent to a 469-acre unincorporated County watershed treatment area. Flows in the existing Eagle Canyon Channel, which flows adjacent to Two Strike Park, would have to be diverted into the park. Figure E-55 shows that, in the park, 2.65 acres are available for stormwater treatment. The BMP area is reported to be in HSG A soils, and a measured infiltration rate of 17.2 in/hr is in the HSG A range. However, the soils composition indicates that soils are in the HSG B range. Debris and rock prevented a soils analysis below 2.5 feet. Because of the surface infiltration rates and the observed soil boring, infiltration rates equivalent to the surface rates would be expected at depths appropriate for an infiltration BMP. The athletic field at the park, where some treatment could be provided, is elevated above the open space. The athletic field and the open space could be used for infiltration by allowing the athletic field to overflow into the open space below. Soil samples taken at the site show levels of metals below the established PEC levels, indicating that infiltration through the existing soils would not cause any addition of metals into the stormwater.

All areas of Two Strike Park recommended for BMP implementation are open space areas or athletic fields that would provide multiple water resources benefits, including stormwater treatment, enhanced open space and recreational spaces, water conservation, flood protection, and groundwater replenishment of the Verdugo Basin.

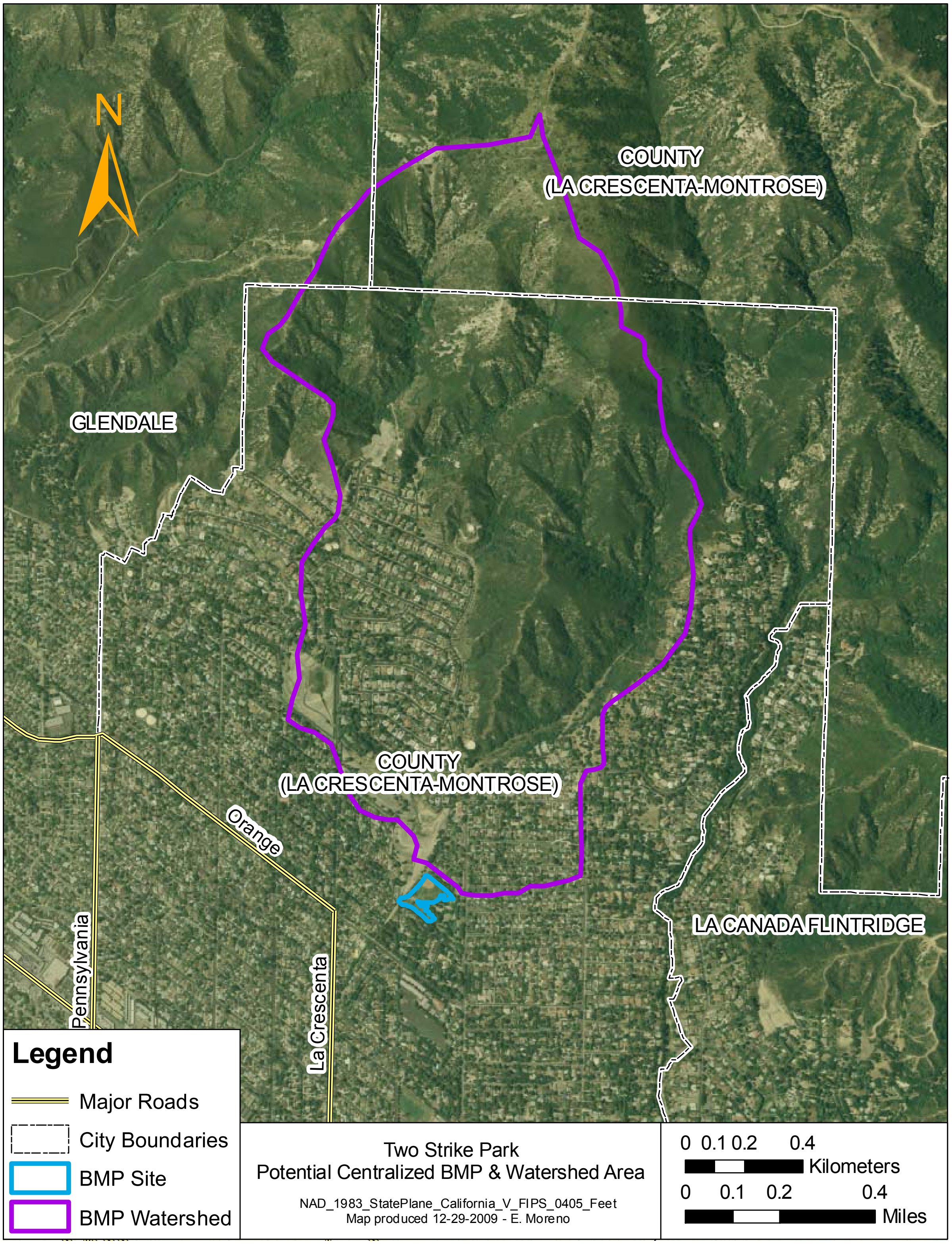

Figure 63. Two Strike Park Watershed and Potential BMP Site

Charles White Park

The watershed treatment area that could be treated in Charles White Park is 40 percent impervious with a dispersed impervious configuration and low road density. The watershed treatment area is mainly residential with some commercial. The athletic field in the park could be retrofitted as an infiltration BMP because it slopes down from the road. Excavation at the site could be minimized by installing a berm to increase water storage and promote infiltration.

Charles White Park is also in the Altadena unincorporated County community providing an additional opportunity for BMP implementation in the high priority area for pollutant loading. Several significant SSOs occurred in the drainage area, adding an unquantified benefit for a BMP in the park. Given the significant size of the watershed, the benefit of this BMP could be significant.

As shown in Figure 64, Charles White Park is adjacent to a 696-acre unincorporated County watershed treatment area. Flows from the existing West Altadena Drainage System, which runs along West Ventura Street, would have to be diverted into the park. The park is mainly open space and athletic fields with a playground and restroom facilities, including approximately 3.9 acres available for stormwater treatment, as shown in Figure E-58. The entire available BMP area is open space that would not require any underground storage. The BMP area is reported to be HSG A soils, but the observed infiltration rate is 0.6 in/hr, in the upper HSG C range. The soils composition indicates that the soils at the site are HSG B soils. The soil boring indicates that the site would provide infiltration sufficient for a centralized BMP.

Charles White Park is heavily used and is an obvious amenity to the community, making an integrated water resources approach imperative. Open space is key, and recreational areas can serve the dual purpose of stormwater treatment without affecting their existing use. Sparsely vegetated areas could benefit from the vegetation added or replaced during BMP implementation and the soil amendments incorporated to increase infiltration. The BMP would reduce the irrigation demand and the strain on the potable water system. The additional storage provided by a BMP in the park would reduce the volume transported through the storm drain, and provide some flood protection in the watershed treatment area. Increasing the infiltration in the park would also increase the groundwater replenishment in the Raymond Basin. Additional water resource benefits might be identified during the planning and design phase of the project.

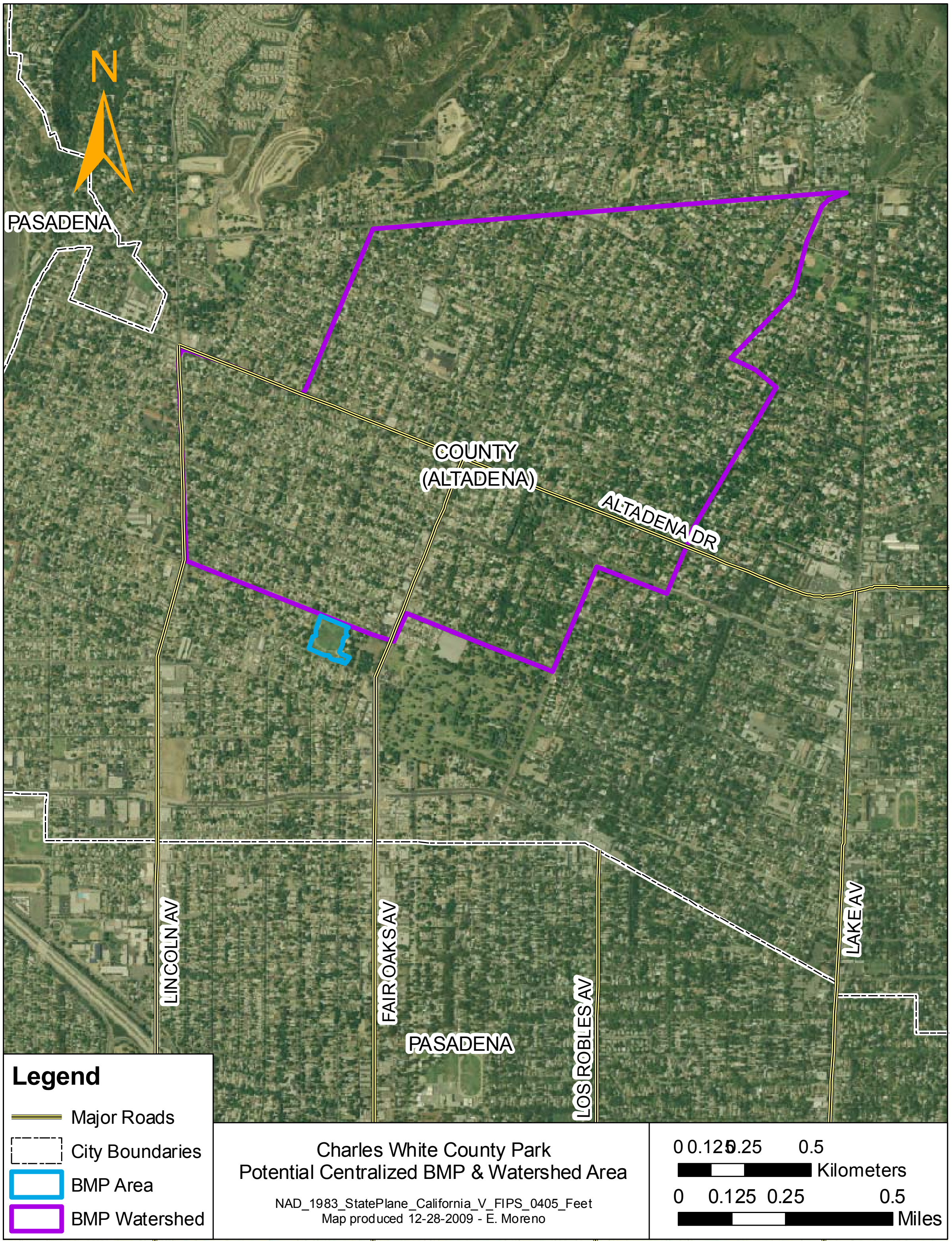

Figure 64. Charles White Park Watershed and Potential BMP Site

Compton Creek Wetland

The Compton Creek Wetland is in the design phase and will be installed in the summer of 2011. The wetland is designed to treat stormwater routed from Compton Creek and is adjacent to a 6,253-acre unincorporated County watershed treatment area. The wetland will be at the confluence of Compton Creek and the Los Angeles River, indicating that as much of the unincorporated County area that could be treated from the Compton Creek drainage area could be routed to the wetland. The watershed treatment area is 59 percent impervious with a concentrated impervious configuration and a low road density.

The Compton Creek Wetland drainage area includes the unincorporated County communities of Rancho – Dominguez, West Rancho Dominguez – Victoria, West Athens – Westmont, Willowbrook, and Florence – Firestone and a portion of East Compton and Walnut Park. These communities represent a range of priorities for dry and wet weather loads. In addition, a TRI site for lead is in the unincorporated County community of Willowbrook. The drainage area also has TRI sites within 20 miles that could contribute additional pollutant loads. Multiple SSOs were reported in each of the communities, adding pollutant loads to the drainage areas. In addition to the TRI sites and SSOs, RCRA sites are in the unincorporated County communities of Rancho Dominguez, Florence–Firestone, Willowbrook, and West Rancho Dominguez–Victoria that could also contribute to the pollutant loads in the drainage area.

The area available for stormwater treatment is approximately 5.5 acres, as shown in Figure 65. The BMP area is reported to be HSG B soils. Field investigations were not performed at the site because of limited access. Infiltration is assumed to be limited because the selected BMP is a stormwater wetland rather than an infiltration BMP.

In addition to improving water quality, a stormwater wetland near the confluence of Compton Creek and the Los Angeles River would provide other water resources benefits After initial establishment, the wetland should not require any additional irrigation because it would be fully sustained by low flows from Compton Creek. The wetland would also enhance habitat and improve aesthetics in the park.

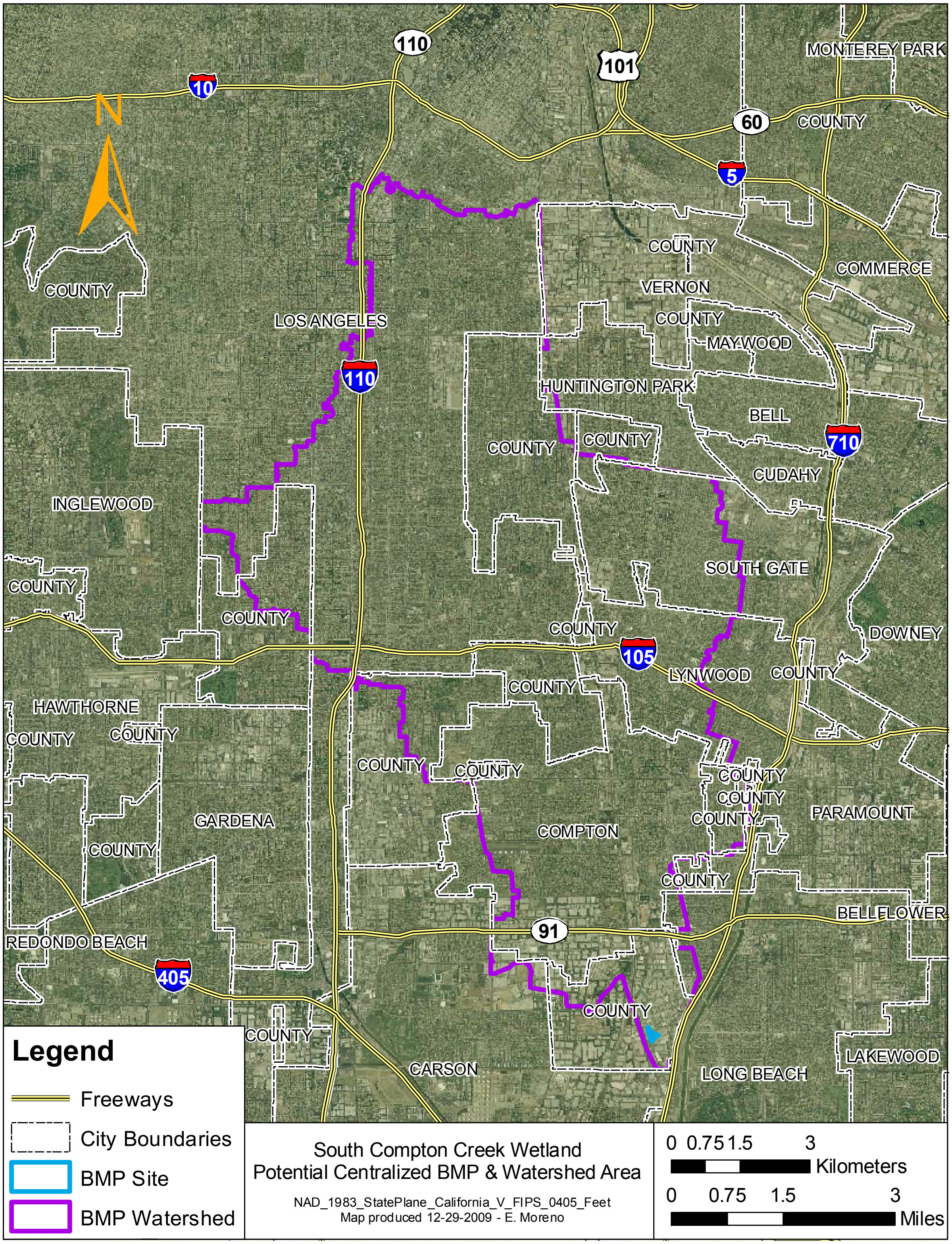

Figure 65. Compton Creek Wetland Potential BMP Site

Additional Considerations for Mona, G.W. Carver, Ted Watkins, Roosevelt, and Bethune Parks

In South Los Angeles, several of the potential sites are in close proximity to each other. In addition, extensive drainage networks are near Compton Creek resulting in large watershed treatment areas. As a result, several watershed treatment areas overlap (Figure 66). The watershed treatment area for G.W. Carver Park is 3,104 acres and encompasses the entire watershed treatment areas for Bethune Park and Ted Watkins Park. The watershed treatment area that could be treated at Bethune Park could also be treated with a centralized BMP at G.W. Carver Park. A similar situation exists for Roosevelt Park. The entire watershed treatment area for Roosevelt Park is within the watershed treatment area for Mona Park (Figure 66).

As a result, special consideration is required for BMP evaluation and optimization of the most cost-effective strategy. Some of those BMPs can work in conjunction through design in series, or in some cases one BMP option could be selected over another. Section 6 provides a discussion of the optimization results and the ultimate BMPs planned for each site.

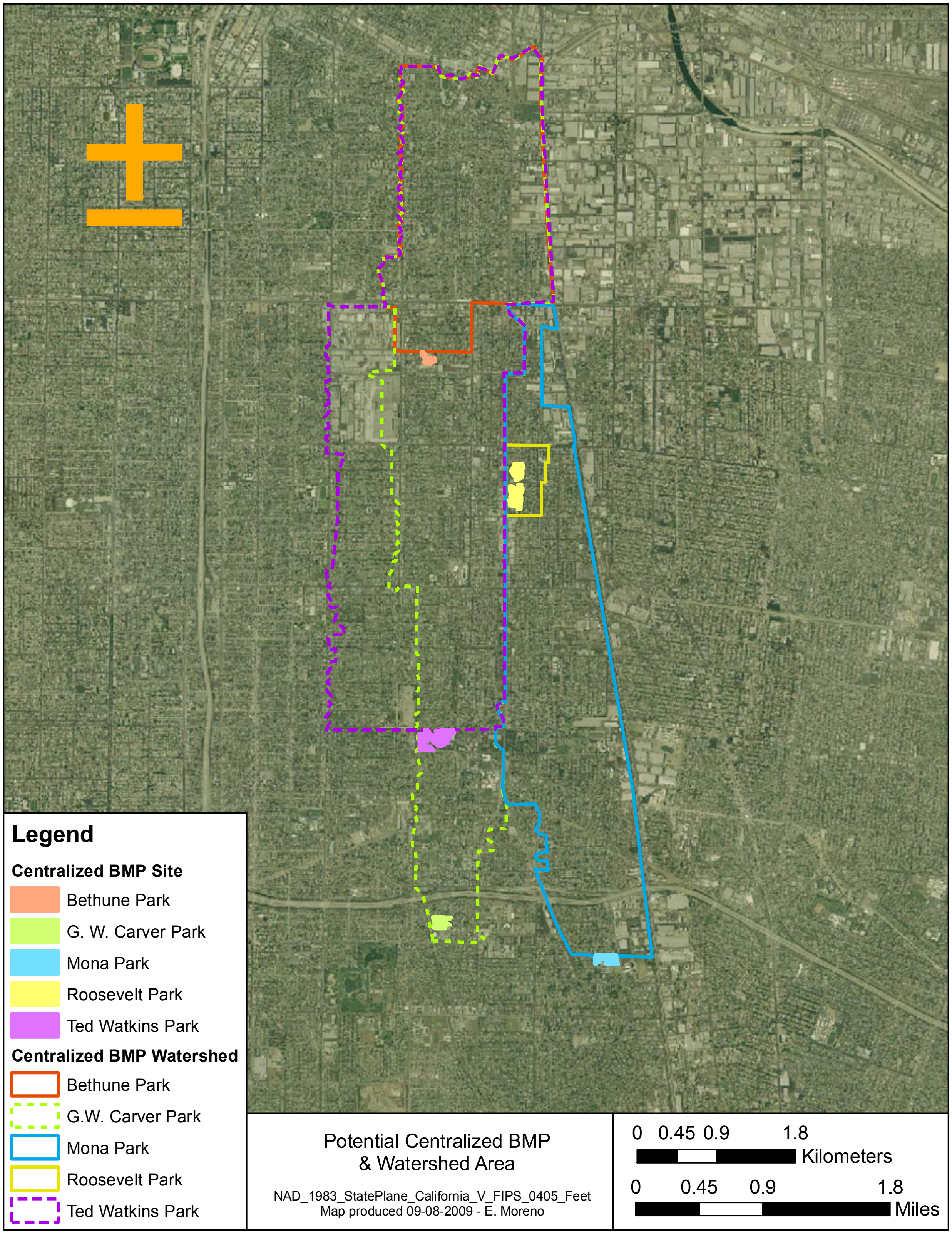

Figure 66. Mona, G.W. Carver, Ted Watkins, Roosevelt, and Bethune Parks Watershed Treatment Areas

5.2.2. Centralized Structural BMPs on Private Land

It is recognized that the centralized BMP projects identified for public land will not likely provide the full pollutant load reductions necessary to meet the WLAs for the entire County TMDL Implementation Area. Essentially, not enough suitable public land is available to build centralized BMPs to treat the drainage area required. As a result, strategic acquisition of private land will be necessary to provide the space needed to site the BMPs. It is not the focus of this TMDL Implementation Plan to identify those privately owned parcels that should be targeted for acquisition. However, through the process of evaluating structural and nonstructural BMPs, the necessary capacity of centralized BMPs on private land was determined. Knowing the necessary space requirements to build centralized BMPs will assist in developing a strategic land acquisition program that can be implemented throughout the TMDL implementation schedule to ensure that phased load reductions to meet WLAs are achieved. These lands will be acquired as private parcels become available and as funding becomes available for purchasing.

For the purpose of projecting the necessary capacity of centralized structural BMPs on private land within the County TMDL Implementation Area and estimating associated pollutant load reductions and cost, BMPs were assumed to represent a combination of multiple infiltration basins and dry detention basins. Descriptions of treatment processes for infiltration basins and dry detention basins were provided in the discussions for the centralized BMPs.

5.3. Summary of Structural Solutions to Support TMDL Implementation

Table 32 lists the proposed distributed and centralized BMP projects to support TMDL implementation. The table also lists the dry or wet weather runoff that can be treated or infiltrated, as well as the TMDL pollutants that can be addressed.

Table 32. Summary of Structural Solutions

Structural BMP	Condition		TMDL Pollutant Addressed				
	Wet weather	Dry weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Catch Basin Distributed BMPs							
Full Capture Devices	✓		○	○	○	○	●
Catch Basin Inserts	✓		○	●	◗	●	●
Other Distributed BMPs on Public Land							
Distributed BMPs on Public Land	✓	✓	●	●	●	●	●
Pilot Distributed BMP Project for a County Road	✓	✓	●	●	●	●	●
Centralized BMPs on Public Land							
Enterprise Park	✓	✓	●	●	●	●	●
Magic Johnson Park	✓	✓	●	●	●	●	●
Mona Park	✓	✓	●	●	●	●	●
G.W. Carver Park	✓	✓	●	●	●	●	●
Ted Watkins Park	✓	✓	●	●	●	●	●
Roosevelt Park	✓	✓	●	●	●	●	●

Structural BMP	Condition		TMDL Pollutant Addressed				
	Wet weather	Dry weather	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Bethune Park	✓	✓	●	●	●	●	●
Northside Drive Median	✓	✓	●	●	●	●	●
Salazar Park	✓	✓	●	●	●	●	●
Obregon Park	✓	✓	●	●	●	●	●
Belvedere Park	✓	✓	●	●	●	●	●
Whittier Narrows Park	✓	✓	●	●	●	●	●
Whittier Narrows Recreation Area	✓	✓	●	●	●	●	●
Hugo Reid Park	✓	✓	●	●	●	●	●
Farnsworth Park	✓	✓	●	●	●	●	●
Loma Alta County Park	✓	✓	●	●	●	●	●
Charles White County Park	✓	✓	●	●	●	●	●
Two Strike Park	✓	✓	●	●	●	●	●
Compton Creek Wetland	✓	✓	●	●	●	●	◗
Centralized BMPs on Private Land							
Infiltration Basins	✓	✓	●	●	●	●	●
Dry Detention Basins	✓	✓	●	●	●	●	●

● addresses the pollutant
◗ partially addresses the pollutant
○ does not address the pollutant

5.4. Additional Structural Options for TMDL Implementation

Through additional monitoring, pollutant source characterizations, and site investigations throughout the duration of the TMDL implementation schedule, additional options for structural BMPs could be identified that can enhance or replace those BMPs identified in this plan. This is especially true for dry weather, when flows are highly variable throughout the storm drain system, and specific areas could require special methods treating storm drain flows before they discharge to receiving waters. For storm drains with particularly high dry weather flows and associated pollutant loads where other nonstructural or structural BMPs are not providing a remedy, specific mechanical BMPs can be implemented. Such BMPs could include diversions to wastewater treatment plants or on-site treatment facilities that provide ultraviolet disinfection or other forms of treatment.

Likewise for wet weather, certain mechanical BMPs can be installed in problem storm drains where other nonstructural and structural BMPs are not providing a solution. Several stormwater BMPs are available for this purpose, which are based on a range of technologies that continue to evolve through continued research and development.

The TMDL Implementation Plan is meant to be iterative and adaptive to allow for modifications and improvements informed by on-going study of the drainage system, extensive diagnosis of problem sources, and emergence of new technologies and methodologies for dry and wet weather treatment. In addition, performance monitoring may be conducted to evaluate benefits from implemented structural BMPs to improve future efforts towards plan implementation and BMP design.

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6. Evaluation of Nonstructural and Structural Solutions

As shown in the previous sections, a number of nonstructural and structural BMP options were identified that can support TMDL implementation. An evaluation of those practices was performed, including optimizing the most cost-effective combination of BMPs to support meeting WLAs for the County TMDL Implementation Area. That process required both qualitative and quantitative evaluation techniques to support selection and sequencing of BMPs throughout the TMDL implementation period to meet phased WLAs. This section provides a summary of those evaluations.

6.1. Nonstructural BMP Evaluation

For most nonstructural BMPs, quantification of benefits in terms of pollutant load reductions are challenging and often require extensive survey and monitoring information to gauge performance. For the purposes of this plan, a qualitative approach was used to evaluate the effectiveness and feasibility of the nonstructural BMPs identified in Section 4. Most of the BMPs focus on increased training/education and improved pollutant source control. However, the Reduction of Irrigation Return Flow and Improved Street Sweeping Technology BMPs will have quantitative effects on dry- and wet weather flows, respectively, and reduction of associated pollutant loads. For that reason, a modeling approach was used to provide additional quantitative evaluation of the BMPs.

Results of the quantitative evaluation of nonstructural BMPs are reported for each unincorporated County community in the County TMDL Implementation Area. Variability among each community can be attributed to the extent to which current management practices need to change (e.g., some communities already use the more advanced street sweeping technology).

6.1.1. Qualitative Evaluation of Nonstructural BMPs

The nonstructural BMPs were evaluated for several factors that contribute to their success and effectiveness. A customized scoring system was developed to compare benefits across many quantitative and qualitative factors. The scoring framework and methods are described below. The scoring was based on factors relevant to successfully achieving pollutant reduction benefits from nonstructural BMPs, which include inherent effectiveness, source contribution, and feasibility. Compliance resources were also considered as a factor for BMPs involving voluntary public participation, but none of the BMPs differ significantly for that factor. It was assumed that the materials or facilities needed for voluntary compliance would be available either through the programs or at local retailers.

The nonstructural BMPs were scored using a three-point scale, with fractional values allowed to account for more subtle differences between BMPs. Generally, three points indicate a high benefit for a factor, two points indicate a moderate benefit, and one point indicates a low or nonexistent benefit. The scores are defined differently for each factor but represent those general definitions. Guidelines were developed for each factor to ensure that the BMPs are scored consistently, as shown in Table 33.

Table 33. Factor-Specific Guidelines Used when Scoring the Nonstructural BMPs

Factor	Score		
	3 Points	2 Points	1 Point
Effectiveness	Highly effective (pollutant removal likely about 25 percent reduction at an individual site)	Moderately effective (all training/education, practices that are likely to reduce load on an individual site by less than 25 percent)	Not significantly effective or does not address pollutant
Source Contribution	Addresses a highly significant portion of the load	Addresses a moderately significant portion of the load	Does not address a significant portion of the load
Administrative Feasibility	Low effort and quick time frame; little or no constraints	Moderate effort and time frame; some moderate constraints	Requires considerable effort, and startup process could take a long time; potential exists for significant administrative roadblocks and hurdles
Political Feasibility and Public Interest	No objection from public or politicians expected	Public or politicians might have some objections	Public or politicians would object strongly

Effectiveness, for the purposes of the scoring, is defined as the relative pollutant removal provided per unit of the BMP. The BMPs received a score for each parameter of concern (bacteria, metals, non-metal toxics, nutrients, and trash). A 25 percent threshold is used to distinguish between scores of two and three points for effectiveness. This threshold is selected because the most effective nonstructural BMPs would be expected to provide at least this percent reduction. This designation is supported by the fact that Reduction in Irrigation Return Flow is expected to provide at least a 25 percent reduction in dry weather copper loading (the simulated load reduction was 37 percent; see Section 6.1.2). Most nonstructural BMPs, especially those related to education and outreach, are likely to provide much less than 25 percent load reduction. This threshold provided a means of distinguishing between the high-performing and moderate-performing nonstructural BMPs with reasonable confidence.

The source contribution factor considers how much of the total pollutant load a nonstructural BMP would address in the County TMDL Implementation Area. For example, Smart Gardening Program Enhancements target pollutant loading from all residential areas in the watershed, which is only a small portion of the implementation area.

The Administrative Feasibility factor considers how difficult a BMP would be to implement and the likelihood that it would be implemented in a reasonable time frame. For example, Enhancement of Industrial and Commercial Facility Inspections is expected to have high administrative feasibility because the enhanced inspections would occur within current County operations and require minimal changes to the administrative structure. On the other hand, changes to Enforcement Escalation Procedures could present administrative hurdles because multiple County departments would need to be involved. Administrative Feasibility is related to cost, but the scoring is based less on cost and more on the degree of difficulty and the potential for implementation delays. Some BMPs might have a promising feasibility score even though they present a relatively high cost.

The factors Political Feasibility and Public Interest were combined because they tend to be correlated, and for each BMP, an assessment was made as to whether strong opposition is anticipated, either from politicians or the public. For example, strong political and public opposition is expected for Reduction of Irrigation Return Flow because it involves changing the water supply rate structure, whereas little opposition is expected for the Smart Gardening Program Enhancements because they provide a public service without mandates.

Table 34 summarizes the individual parameter scores for the four factors described above. The two BMPs that have the highest benefit scores are TMDL-Specific Stormwater Training and Enhancement of Commercial and Industrial Facility Inspections. Those BMPs balance high feasibility with moderate effectiveness and source contribution scores. The advantages of those BMPs are that they would be fairly easy to implement and have the potential to provide some pollutant removal toward meeting TMDL requirements.

Independent of Source Contribution and Feasibility, Improved Street Sweeping Technology and Reduction of Irrigation Return Flow offer the highest pollutant-removal effectiveness. Both BMPs have moderate source contributions. Reduction of Irrigation Return Flow has low feasibility scores, which leads to its relatively low overall benefit score. The major feasibility constraint is the need to adjust water supply rate structures, which has implications for both administrative and political feasibility. Improved Street Sweeping Technology has moderate feasibility scores because of the capital outlay needed to purchase sweepers. To achieve TMDL pollutant load reductions, the County might want to consider these BMPs as promising opportunities if the feasibility constraints can be addressed.

Table 34. Nonstructural BMP Scores

Nonstructural BMP	BMP Effectiveness				
	Bacteria	Metals	Non-Metal Toxics	Nutrients	Trash
Smart Gardening Program Enhancements	2	2	2	2	1
TMDL-Specific Stormwater Training	1.5	1.5	1.5	1.5	1.5
Enhancement of Commercial and Industrial Facility Inspections	2	2	2	2	1
Enforcement Escalation Procedures	2	3	2	2	1
Improved Street Sweeping Technology[a]	2	2	2	2	1
Reduction of Irrigation Return Flow	3	3	2	3	1
Nonstructural BMP	**Source Contribution**				
	Bacteria	**Metals**	**Non-Metal Toxics**	**Nutrients**	**Trash**
Smart Gardening Program Enhancements	2	2	2	2	1
TMDL-Specific Stormwater Training	2	2	2	2	2
Enforcement Escalation Procedures	2	2	2	2	2
Enhancement of Commercial and Industrial Facility Inspections	2	2	2	2	2
Improved Street Sweeping Technology	2	3	2	2	3
Reduction of Irrigation Return Flow	2	2	1	2	1
Nonstructural BMP	**Administrative Feasibility**	**Political Feasibility and Public Interest**			
Smart Gardening Program Enhancements	2	3			
TMDL-Specific Stormwater Training	3	3			
Enforcement Escalation Procedures	2	3			
Enhancement of Commercial and Industrial Facility Inspections	3	3			
Improved Street Sweeping Technology	2	3			
Reduction of Irrigation Return Flow	1	1			

a. The scores for Improved Street Sweeping Technology represent a change in pollutant removal effectiveness compared to current street sweeping practices. Trash removal is expected to remain high but not improve.

Other promising BMPs with moderate pollutant reduction and high feasibility are the Smart Gardening Program Enhancements and Enforcement Escalation Procedures. The major constraint with the Smart Gardening Program Enhancements is building additional learning centers or information centers convenient to or within the County TMDL Implementation Areas. If additional centers could be built or if residents could be reached through other methods, this BMP provides another opportunity to contribute to TMDL requirements while using existing County resources. Some uncertainty exists regarding the exact nature of new Enforcement Escalation Procedures, but significant environmental improvements could be achieved if arrangements can be made to strengthen legal actions against polluters.

6.1.2. Quantitative Evaluation of Reduction of Irrigation Return Flow

Irrigation return flow can be significantly reduced via aggressive programs, including educational programs, rebates for irrigation water saving devices, tiered rate structures, xeriscaping, and other measures. Quantification of benefits of reduction of irrigation return flow assumes that irrigation water demand is reduced by 25 percent; Gleick et al. (2003) indicate that California could reduce outdoor residential water use by 25 to 40 percent through improved landscape management practices and better application of available technology. An assumption of 25 percent reduction reflects a conservative estimate of what is achievable.

A modeling approach was used to quantify benefits of Reduction of Irrigation Return Flow, using the LSPC model configured for the County TMDL Implementation Area (Appendix B). The LSPC model has an irrigation module that allows for representation of landscape irrigation that is sensitive to soil moisture content and irrigation efficiency. The model was calibrated to represent dry weather flows by comparing simulated to observed flow during dry periods. In the model, as in the watershed, dry weather flows are dominated by irrigation return flow as the primary source. The model was further calibrated to represent pollutant concentrations and loads by applying fixed pollutant concentrations to groundwater/irrigation return flow inputs, and calibrating to observed low flow pollutant data. To estimate the impact of Reduction of Irrigation Return Flow, the LSPC model was configured to represent a 25 percent reduction in irrigation water use, which resulted in a reduction in modeled low flows and associated pollutant loads.

Pollutant load reductions are shown in Table 35 for each of the County TMDL Implementation Areas for dry weather runoff. The pollutant loads reductions are significant, reflecting an average dry weather flow and load reduction of 37 percent. Much of the water applied to landscaping evaporates or is taken up and transpired by the vegetation, so a 25 percent reduction in total irrigation water use has a much larger influence on dry weather flow.

Table 35. Dry Weather TMDL Pollutant Load Reductions Resulting from Reduction of Irrigation Return Flow

Community	Area (acres)	Annual Total Copper Load (lbs/year)		
			Reduction of Irrigation Return Flow	
		Baseline Load	Load	% Red.
Altadena	4,251	71.94	45.02	37%
Bandini Islands	30	0.04	0.02	33%
East Compton	527	4.62	3.11	33%
City Terrace – East Los Angeles	4,762	30.88	20.80	33%
East Pasadena – East San Gabriel	2,256	28.62	16.25	43%
Florence – Firestone	2,270	15.43	10.39	33%
Kagel Canyon	542	1.71	1.07	37%
Kinneloa Mesa	884	10.53	6.59	37%
La Crescenta – Montrose	2,147	26.42	16.54	37%
Lopez Canyon	702	1.19	0.68	43%
Lynwood Island	83	0.12	0.08	33%
Oat Mountain	10,968	25.22	14.32	43%
Rancho Dominguez	968	1.92	1.29	33%
San Pasqual	164	2.18	1.24	43%
Santa Clarita Valley	1,026	3.94	2.24	43%
Santa Monica Mountains North Area	241	0.81	0.54	33%
South El Monte Island	2.6	0.01	0.00	33%
South Monrovia Islands	1,065	14.44	8.20	43%
South San Gabriel – Avocado Heights	970	9.12	6.14	33%
Sylmar Island	909	1.35	0.77	43%
Twin Lakes	46	0.53	0.30	43%
Universal City	301	0.94	0.53	43%
W Athens – Westmont	742	4.67	3.15	33%
W Rancho Dominguez – Victoria	833	7.13	4.80	33%
Walnut Park	480	4.06	2.74	33%
West Chatsworth	1,239	1.77	1.19	33%
Westhills	142	0.81	0.54	33%
Whittier Narrows	1,612	13.25	8.92	33%
Willowbrook	1,075	8.13	5.48	33%
Total	41,238	291.78	182.95	37%

Community	Area (acres)	Annual Total Zinc Load (lbs/year)		
		Baseline Load	Reduction of Irrigation Return Flow	
			Load	% Red.
Altadena	4,251	263.78	165.08	37%
Bandini Islands	30	0.13	0.09	33%
East Compton	527	16.95	11.41	33%
City Terrace – East Los Angeles	4,762	113.23	76.26	33%
East Pasadena – East San Gabriel	2,256	104.94	59.58	43%
Florence – Firestone	2,270	56.57	38.10	33%
Kagel Canyon	542	6.27	3.93	37%
Kinneloa Mesa	884	38.60	24.15	37%
La Crescenta – Montrose	2,147	96.90	60.64	37%
Lopez Canyon	702	4.37	2.48	43%
Lynwood Island	83	0.42	0.28	33%
Oat Mountain	10,968	92.46	52.50	43%
Rancho Dominguez	968	7.02	4.73	33%
San Pasqual	164	8.01	4.55	43%
Santa Clarita Valley	1,026	14.44	8.20	43%
Santa Monica Mountains North Area	241	2.96	2.00	33%
South El Monte Island	2.6	0.02	0.02	33%
South Monrovia Islands	1,065	52.96	30.06	43%
South San Gabriel – Avocado Heights	970	33.45	22.53	33%
Sylmar Island	909	4.94	2.81	43%
Twin Lakes	46	1.94	1.10	43%
Universal City	301	3.44	1.95	43%
W Athens – Westmont	742	17.13	11.54	33%
W Rancho Dominguez – Victoria	833	26.15	17.62	33%
Walnut Park	480	14.89	10.03	33%
West Chatsworth	1,239	6.49	4.37	33%
Westhills	142	2.97	2.00	33%
Whittier Narrows	1,612	48.59	32.72	33%
Willowbrook	1,075	29.81	20.08	33%
Total	41,238	1,069.85	670.81	37%

Community	Area (acres)	Annual Total Lead Load (lbs/year)		
			Reduction of Irrigation Return Flow	
		Baseline Load	Load	% Red.
Altadena	4,251	47.96	30.02	37%
Bandini Islands	30	0.02	0.02	33%
East Compton	527	3.08	2.08	33%
City Terrace – East Los Angeles	4,762	20.59	13.87	33%
East Pasadena – East San Gabriel	2,256	19.08	10.83	43%
Florence – Firestone	2,270	10.29	6.93	33%
Kagel Canyon	542	1.14	0.71	37%
Kinneloa Mesa	884	7.02	4.39	37%
La Crescenta – Montrose	2,147	17.62	11.02	37%
Lopez Canyon	702	0.79	0.45	43%
Lynwood Island	83	0.08	0.05	33%
Oat Mountain	10,968	16.81	9.54	43%
Rancho Dominguez	968	1.28	0.86	33%
San Pasqual	164	1.46	0.83	43%
Santa Clarita Valley	1,026	2.63	1.49	43%
Santa Monica Mountains North Area	241	0.54	0.36	33%
South El Monte Island	2.6	0.00	0.00	33%
South Monrovia Islands	1,065	9.63	5.47	43%
South San Gabriel – Avocado Heights	970	6.08	4.10	33%
Sylmar Island	909	0.90	0.51	43%
Twin Lakes	46	0.35	0.20	43%
Universal City	301	0.63	0.35	43%
W Athens – Westmont	742	3.11	2.10	33%
W Rancho Dominguez – Victoria	833	4.76	3.20	33%
Walnut Park	480	2.71	1.82	33%
West Chatsworth	1,239	1.18	0.79	33%
Westhills	142	0.54	0.36	33%
Whittier Narrows	1,612	8.83	5.95	33%
Willowbrook	1,075	5.42	3.65	33%
Total	41,238	194.52	121.97	37%

Community	Area (acres)	Annual Fecal Coliform Load (#/year)		
		Baseline Load	Reduction of Irrigation Return Flow	
			Load	% Red.
Altadena	4,251	7.61E+13	4.77E+13	37%
Bandini Islands	30	3.89E+10	2.62E+10	33%
East Compton	527	4.89E+12	3.29E+12	33%
City Terrace – East Los Angeles	4,762	3.27E+13	2.20E+13	33%
East Pasadena – East San Gabriel	2,256	3.03E+13	1.72E+13	43%
Florence – Firestone	2,270	1.63E+13	1.10E+13	33%
Kagel Canyon	542	1.81E+12	1.13E+12	37%
Kinneloa Mesa	884	1.11E+13	6.97E+12	37%
La Crescenta – Montrose	2,147	2.80E+13	1.75E+13	37%
Lopez Canyon	702	1.26E+12	7.16E+11	43%
Lynwood Island	83	1.22E+11	8.21E+10	33%
Oat Mountain	10,968	2.67E+13	1.52E+13	43%
Rancho Dominguez	968	2.03E+12	1.37E+12	33%
San Pasqual	164	2.31E+12	1.31E+12	43%
Santa Clarita Valley	1,026	4.17E+12	2.37E+12	43%
Santa Monica Mountains North Area	241	8.55E+11	5.76E+11	33%
South El Monte Island	2.6	7.15E+09	4.82E+09	33%
South Monrovia Islands	1,065	1.53E+13	8.68E+12	43%
South San Gabriel – Avocado Heights	970	9.66E+12	6.50E+12	33%
Sylmar Island	909	1.43E+12	8.10E+11	43%
Twin Lakes	46	5.61E+11	3.19E+11	43%
Universal City	301	9.92E+11	5.63E+11	43%
W Athens – Westmont	742	4.95E+12	3.33E+12	33%
W Rancho Dominguez – Victoria	833	7.55E+12	5.08E+12	33%
Walnut Park	480	4.30E+12	2.89E+12	33%
West Chatsworth	1,239	1.87E+12	1.26E+12	33%
Westhills	142	8.56E+11	5.77E+11	33%
Whittier Narrows	1,612	1.40E+13	9.45E+12	33%
Willowbrook	1,075	8.60E+12	5.80E+12	33%
Total	41,238	3.09E+14	1.94E+14	37%

6.1.3. Quantitative Evaluation of Improved Street Sweeping Technology

Motorized street sweeping has been a part of urban sanitation for almost a century, but only recently have the benefits of street sweeping been considered for addressing stormwater quality. Performance of street sweeping is mainly dependent on two factors—the type of equipment used and the frequency of sweeping—and to a lesser extent on other factors, such as street condition, presence of parked vehicles, and the physical/chemical properties of street particulate matter. The types of equipment most frequently cited in performance studies are mechanical broom sweepers and regenerative air/vacuum sweepers, and the sweeping frequencies reported by municipalities typically range from monthly to weekly.

In a study of street sweeping and catch basin effectiveness, the Center for Watershed Protection (CWP) provides an extensive literature review, results of a field study, and a conceptual model for estimating the effectiveness of the practices (CWP 2008, 2006a, 2006b). Because of difficulties encountered with monitoring during the field study, less weight was placed on its field study results. A conceptual model was developed to estimate the effectiveness of street sweeping for total solids (TS) for two equipment types and two sweeping frequencies. Inputs to the model were developed using the results of an extensive literature review of street sweeping studies. The model accounts for pollutant sources (e.g., pollutants washed onto street surfaces from adjacent non-street areas, atmospheric deposition, sanding), the portion of the load available for pickup (which accounts for dust loss during sweeping, washoff during storms between sweeping passes, unswept areas, street cracks, and the like), and sweeper effectiveness. Regenerative air sweepers, which are designed specifically to capture fine sediments in addition to coarse sediment and other solids, perform better across the board for sediment and nutrient removal than do mechanical broom sweepers. A summary of their results for total solids is shown in Table 36.

Table 36. Sediment Removal from Street Sweeping for Total Solids

Frequency	Technology	TS
Monthly	Mechanical broom	9%
	Regenerative air/vacuum	22%
Weekly	Mechanical broom	13%
	Regenerative air/vacuum	31%

Source: CWP 2008

Because street sweeping has been an ongoing activity for some time in the watershed, the influence of street sweeping practices is already tied to the watershed-scale pollutant load generation. In other words, street sweeping has been reducing pollutant loads since inception of the practice, and it is not appropriate to assume removal credit for a practice already in place. However, increasing the frequency of sweeping or upgrading equipment type or both could result in an increase in pollutant load removal. Sweeping already occurs weekly, so there is no opportunity to increase sweeping frequency to improve pollutant removal performance. If the frequency is reduced to semi-monthly (a plan under consideration for cost savings), the relatively long return interval on rainfall events in the Los Angeles region will tend to exceed the sweeping frequency, so reducing sweeping frequency is likely to have little effect. However, mechanical broom sweeping is used throughout the majority of the County TMDL Implementation Area, and implementing regenerative air sweeping in those communities could improve pollutant removal performance. With an assumption that sediment removal is equivalent to total solids removal, upgrading from weekly mechanical broom sweeping to weekly regenerative air sweeping results in an 18 percent increase in pollutant removal, as shown in Table 36.

To model the influence of converting sweeping equipment from mechanical broom to regenerative air in the LSPC model, the 18 percent annual sediment removal rate was applied to surface runoff from the impervious secondary road transportation network, which is represented explicitly in the model. Because metals are modeled as sediment-associated, sediment removal was modeled directly, and LSPC performed internal calculations of metals removal. The reductions were applied only to communities that have roads maintained with mechanical broom sweepers; there was no reduction potential for communities already served by regenerative air sweepers. As shown in Table 37, the overall reduction in metals load ranges from 3.0 percent to 3.7 percent. The metals reduction is relatively low because the transportation network is not dense in many of the communities, and the practice targets road runoff only. Also, some communities are already served by regenerative air/vacuum sweepers, so no improvement is achievable. The influence of Improved Street Sweeping Technology was applied to the wet weather LSPC model only. While street sweeping occurs mainly during dry weather; the runoff that carries other pollutants and sediment to Los Angeles River streams happens during wet weather events. In other words, street sweeping acts to reduce wet weather pollutant loads by reducing them at their source—the street surface. Dry weather flow on street surfaces is not expected to transport pollutants targeted by street sweeping.

Bacteria were not modeled for this practice because performance is not well known, though it is likely that street sweeping reduces bacteria loads from street surfaces. For that reason, bacteria are addressed in the qualitative evaluation, in addition to toxics, trash, and nutrients.

Table 37. Wet Weather TMDL Pollutant Load Reductions Resulting from Improved Street Sweeping Technology

Community	Area (acres)	Annual Total Copper Load (lbs/year)		
			Improved Street Sweeping Technology	
		Baseline Load	Load	% Red.
Altadena	4,251	188.66	180.99	4.1%
Bandini Islands	30	2.93	2.92	0.3%
East Compton	527	29.46	27.73	5.9%
City Terrace – East Los Angeles	4,762	313.75	298.93	4.7%
East Pasadena – East San Gabriel	2,256	152.21	152.21	0.0%
Florence – Firestone	2,270	142.60	135.50	5.0%
Kagel Canyon	542	4.90	4.90	0.0%
Kinneloa Mesa	884	6.64	6.54	1.5%
La Crescenta – Montrose	2,147	97.10	93.45	3.8%
Lopez Canyon	702	14.49	14.39	0.7%
Lynwood Island	83	5.03	5.03	0.0%
Oat Mountain	10,968	84.55	84.49	0.1%
Rancho Dominguez	968	64.90	63.20	2.6%
San Pasqual	164	10.56	10.12	4.2%
Santa Clarita Valley	1,026	14.99	14.98	0.1%
Santa Monica Mountains North Area	241	10.04	9.93	1.1%
South El Monte Island	2.6	0.34	0.34	0.0%
South Monrovia Islands	1,065	65.45	65.45	0.0%
South San Gabriel – Avocado Heights	970	31.96	31.96	0.0%
Sylmar Island	909	10.47	10.47	0.0%
Twin Lakes	46	2.50	2.50	0.0%
Universal City	301	22.35	22.35	0.0%
W Athens – Westmont	742	51.28	49.07	4.3%
W Rancho Dominguez – Victoria	833	40.47	38.55	4.8%
Walnut Park	480	28.25	26.95	4.6%
West Chatsworth	1,239	11.39	11.31	0.7%
Westhills	142	2.83	2.69	5.0%
Whittier Narrows	1,612	30.39	30.20	0.6%
Willowbrook	1,075	63.16	60.75	3.8%
Total	41,238	1,503.66	1,457.91	3.0%

Community	Area (acres)	Annual Total Zinc Load (lbs/year)		
		Baseline Load	Improved Street Sweeping Technology	
			Load	% Red.
Altadena	4,251	1,720.21	1,648.32	4.2%
Bandini Islands	30	29.33	29.26	0.2%
East Compton	527	267.16	250.87	6.1%
City Terrace – East Los Angeles	4,762	2,908.56	2,769.71	4.8%
East Pasadena – East San Gabriel	2,256	1,036.31	1,036.31	0.0%
Florence – Firestone	2,270	1,346.35	1,279.75	4.9%
Kagel Canyon	542	43.69	43.69	0.0%
Kinneloa Mesa	884	38.01	37.06	2.5%
La Crescenta – Montrose	2,147	908.78	874.50	3.8%
Lopez Canyon	702	116.71	115.77	0.8%
Lynwood Island	83	56.78	56.78	0.0%
Oat Mountain	10,968	374.41	373.84	0.2%
Rancho Dominguez	968	723.22	707.35	2.2%
San Pasqual	164	76.10	71.98	5.4%
Santa Clarita Valley	1,026	101.22	101.12	0.1%
Santa Monica Mountains North Area	241	92.65	91.64	1.1%
South El Monte Island	2.6	3.08	3.08	0.0%
South Monrovia Islands	1,065	467.07	467.07	0.0%
South San Gabriel – Avocado Heights	970	267.33	267.33	0.0%
Sylmar Island	909	36.92	36.92	0.0%
Twin Lakes	46	11.39	11.39	0.0%
Universal City	301	215.60	215.60	0.0%
W Athens – Westmont	742	475.96	455.27	4.3%
W Rancho Dominguez – Victoria	833	366.77	348.74	4.9%
Walnut Park	480	256.77	244.58	4.7%
West Chatsworth	1,239	97.64	96.90	0.8%
Westhills	142	25.26	23.93	5.3%
Whittier Narrows	1,612	210.17	208.34	0.9%
Willowbrook	1,075	594.16	571.58	3.8%
Total	41,238	12,867.58	12,438.66	3.3%

Community	Area (acres)	Annual Total Lead Load (lbs/year)		
			Improved Street Sweeping Technology	
		Baseline Load	Load	% Red.
Altadena	4,251	174.55	166.88	4.4%
Bandini Islands	30	2.61	2.60	0.3%
East Compton	527	28.00	26.26	6.2%
City Terrace – East Los Angeles	4,762	286.35	271.54	5.2%
East Pasadena – East San Gabriel	2,256	108.25	108.25	0.0%
Florence – Firestone	2,270	125.68	118.58	5.7%
Kagel Canyon	542	4.47	4.47	0.0%
Kinneloa Mesa	884	3.49	3.38	2.9%
La Crescenta – Montrose	2,147	91.28	87.63	4.0%
Lopez Canyon	702	9.52	9.42	1.1%
Lynwood Island	83	3.13	3.13	0.0%
Oat Mountain	10,968	27.15	27.09	0.2%
Rancho Dominguez	968	43.34	41.65	3.9%
San Pasqual	164	8.40	7.96	5.2%
Santa Clarita Valley	1,026	10.75	10.74	0.1%
Santa Monica Mountains North Area	241	8.26	8.15	1.3%
South El Monte Island	2.6	0.31	0.31	0.0%
South Monrovia Islands	1,065	50.41	50.41	0.0%
South San Gabriel – Avocado Heights	970	27.34	27.34	0.0%
Sylmar Island	909	3.15	3.15	0.0%
Twin Lakes	46	1.40	1.40	0.0%
Universal City	301	16.37	16.37	0.0%
W Athens – Westmont	742	48.44	46.23	4.6%
W Rancho Dominguez – Victoria	833	36.72	34.79	5.2%
Walnut Park	480	26.66	25.36	4.9%
West Chatsworth	1,239	10.21	10.13	0.8%
Westhills	142	2.64	2.50	5.4%
Whittier Narrows	1,612	17.20	17.01	1.1%
Willowbrook	1,075	57.59	55.18	4.2%
Total	41,238	1,233.65	1,187.90	3.7%

6.1.4. Summary of Qualitative and Quantitative Analysis Results and Recommendations

Final recommendations for nonstructural BMPs were based on the following decision criteria:

- Which nonstructural BMPs are likely to provide the greatest success at achieving TMDL implementation requirements?
- Which nonstructural BMPs provide significant dry weather pollutant load reduction?
- Which nonstructural BMPs are most cost-effective?
- Which nonstructural BMPs are the most feasible considering the County's current programs and resources?
- Which nonstructural BMPs present the least uncertainty, or greatest risk, regarding successful implementation and minimizing negative impacts?

Using the available information, the nonstructural BMPs that best achieve TMDL implementation requirements are those that are likely to achieve significant pollutant load reduction. The qualitative analysis indicated that Enforcement Escalation Procedures, Enhancement of Commercial and Industrial Facility Inspections, Smart Gardening Program Enhancements, and TMDL-Specific Stormwater Training could provide some pollutant reduction with relative ease of implementation. In addition, Reduction of Irrigation Return Flow is likely to provide relatively significant pollutant reduction in the watershed if feasibility issues can be overcome.

The cost analysis (Section 9) indicated that the BMPs that build on existing programs (Smart Gardening Program Enhancements, TMDL-Specific Stormwater Training, and Enhancement of Commercial and Industrial Facility Inspections) are the most cost-effective options. The high cost of Improved Street Sweeping Technology stems from high labor and equipment costs, and the incentives associated with Reduction of Irrigation Return Flow could result in high costs, thereby reducing overall cost-effectiveness. Enforcement Escalation Procedures, though not requiring a significant capital outlay, could significantly increase staffing and administrative costs.

To summarize the results of this evaluation, Table 38 indicates which BMPs best meet the decision criteria, indicated by a checkmark (✓). The BMPs that best meet multiple decision criteria are the Smart Gardening Program Enhancements, TMDL-Specific Stormwater Training, Enhancement of Commercial and Industrial Facility Inspections, and Reduction of Irrigation Return Flow.

Table 38. Nonstructural BMPs Meeting Multiple Decision Criteria

Criterion	Overall TMDL Implementation Requirements	Dry Weather Pollutant Load Reduction	Cost-Effectiveness	Feasibility	Certainty
Smart Gardening Program Enhancements	✓	✓	✓		
TMDL-Specific Stormwater Training	✓		✓	✓	
Enforcement Escalation Procedures	✓				
Enhancement of Commercial and Industrial Facility Inspections	✓		✓	✓	
Improved Street Sweeping Technology	✓				✓
Reduction of Irrigation Return Flow	✓	✓			✓

6.2. Evaluation of Structural Solutions

Given the number of BMP implementation options to be considered, there are many different ways to achieve the targeted TMDL objectives. Each potential alternative has a range of individual nonstructural and structural BMP considerations and associated costs. Structural BMPs (either distributed or centralized) can alter hydrology and provide benefit from either the hydromodification process itself or in conjunction with additional water quality treatment. Nonstructural BMPs can provide a pollutant load reduction benefit that either operates in tandem with structural BMPs or in lieu of them. For phased implementation planning, it is often advantageous to consider multiple control objectives for different levels of management in terms of pollutant reduction goals or flow volume/peak control.

With all those considerations in place, the number of alternatives is expansive. At the same time, prescriptive BMP selection, even when based on the success of past implementation activities, faces the risk of adopting an inferior solution or one that might not be congruous with long-term, phased implementation objectives. Recognizing the nonlinear response of the watershed and associated hydrology, water quality, and benefits of BMPs, using an optimization search technique can provide meaningful insights and direction. Optimization can be used to identify near-optimum benefits at each cost interval within the search space of alternatives. In addition, on the basis of how the constraints are established, each successive solution could be additive of the previously identified solutions, producing a prioritization order and sequence of BMP implementation, which is also valuable for phased implementation and planning. An optimization can assist in navigating the choices of alternatives, understanding cause-effect relationships of different actions, and identifying cost-effective and actionable strategies for addressing the water quality concerns.

The Los Angeles County BMPDSS and LSPC were used to evaluate the benefits, in terms of pollutant load reductions, and costs of alternative combinations structural BMPs implemented in the County TMDL Implementation Area. This approach was focused on wet weather TMDL implementation, which represented the most critical condition for investment in structural BMPs. A background summary of LSPC and BMPDSS is provided in Appendix G.

To model structural BMPs for optimizing the most cost-effective combination for TMDL implementation, the following steps were taken.

- **Quantitative Evaluation of Catch Basin Distributed BMPs**—Catch basin distributed BMPs, including full capture devices and catch basin inserts, were evaluated to determine what pollutant load reductions could be achieved if implemented. They were modeled in LSPC independent of other structural BMPs because of special considerations needed for representing treatment processes and determining pollutant load reductions, which do not rely on traditional storage or infiltration.
- **Development of Baseline Scenario**—A baseline runoff and pollutant load scenario was developed using LSPC. The baseline assumes that catch basin inserts, Reduction of Irrigation Return Flows, and Improved Street Sweeping Technology were implemented. The baseline scenario provides the starting point for determining additional structural BMPs necessary for TMDL implementation. Considering catch basin inserts, Reduction of Irrigation Return Flows, and Improved Street Sweeping Technology within the baseline scenario ensures that associated load reductions were considered in combination with all other structural BMPs within the optimization.
- **Determination of TMDL Reduction Objectives—**Although specific WLAs have been assigned for each TMDL for Los Angeles River, some interpretation of the WLAs was necessary to provide meaningful objectives for BMP optimization.
- **Optimization Analysis**—Using the baseline scenario, BMPDSS was used to determine the most cost-effective combination of structural BMPs necessary to meet WLAs. This optimization considered conceptual costs as well as pollutant load reductions achieved by the BMPs, and also provided guicance

for determining sizes and treatment capacities required for the BMPs. This information was used to refine the cost estimates for the TMDL Implementation Plan.

6.2.1. Quantitative Evaluation of Catch Basin Distributed BMPs

Quantitative evaluation was performed for both full capture devices and catch basin inserts for relative comparison of benefits.

Full Capture Devices

The original LSPC watershed model was calibrated to conditions in the watershed before full capture device installation, so the model needed adjustment to account for the influence of the full capture devices. To represent full capture devices in the model, annual pollutant removal rates were applied to surface runoff from the impervious secondary road transportation network, which was represented explicitly in the model.

Pollutant removal performance of full capture devices was estimated from a synthesis of monitoring studies. The CWP (2006a) developed a conceptual model that defined the removal rates for catch basins and inlets. The street dirt load entering the catch basins and inlets included such inputs as run-on (stormwater that flows onto street surfaces from adjacent areas), atmospheric deposition, vehicle emissions, littering, sanding, street breakup, and organic matter. The trapping efficiency was dependent on the type of inlet, the capacity of the inlet, and the clean-out frequency. Using conditions representative of catch basins in the Chesapeake Bay watershed, it was estimated that annual cleanouts would result in urban watershed-scale reductions of 18 percent for TS, while semiannual cleaning would result in reductions of 35 percent for TS. The model assumed catch basins had sumps below the drain discharge point. Catch basins without sumps have significantly less storage capacity. For instance, Pitt (1985) reports catch basins without sumps as having about half the accumulation rates as catch basins with sumps.

The annual percentage removal rate used to represent the effect of full capture devices on storm event runoff loads originating from the transportation network was 5 percent sediment and attached metals removal. Bacteria removal was not modeled. A conservative sediment removal rate was used to account for the lack of sumps below the drain discharge point, and to account for a lower available sediment yield because of advanced street sweeping practices used by the County. No information was available in monitoring studies to characterize bacteria removal, so it was not included.

Catch Basin Inserts

The pollutant removal efficiency of catch basins can be improved, in certain circumstances, by using inserts and other removal media. However, independent studies of catch basin and catch basin insert performance are uncommon. Morgan et al. (2005) found that catch basin inserts yielded an average total suspended solids (TSS) removal efficiency of 10 to 42 percent and an average total petroleum hydrocarbons removal efficiency of 10 to 19 percent. During the testing of the inserts, water flowed out of the bypasses of the inserts; therefore, sediment was removed from solution via settling because much of the inflow did not pass through the screens or over the absorbent material. The Stormwater Manager's Resource Center (http://www.stormwatercenter.net) cites two studies for catch basin inserts with sufficient data, one from 1997 showing 32 percent TSS removal, and another from 1982 with TSS removal ranging from 10 to 25 percent. Edwards et al. (2004) tested four catch basin inserts with synthetic runoff (TSS 225 mg/L) and reported sediment removal from 11 to 42 percent. Sufficient information was not available from monitoring studies to characterize bacteria removal from catch basin inserts, so bacteria removal was not included.

The full capture device and catch basin insert removal rates are not additive; the inserts would provide direct sediment filtration and pollutant capture before runoff would reach the full capture devices (assuming dual installation of inserts and full capture devices is feasible). On the basis of a synthesis of available studies with best professional judgment, the removal rate used for catch basin inserts was 30 percent sediment and attached metals removal. Bacteria removal was not modeled.

Results of Quantitative Evaluation of Catch Basin Distributed BMPs

Wet weather pollutant load reductions are shown in Table 39 for each of the unincorporated County communities within the County TMDL Implementation Areas. Full capture devices have little influence on pollutant loads but are important to consider because full capture devices have already been installed in some locations in the County TMDL Implementation Area. Catch basin inserts performed considerably better. Percent reductions vary on the basis of the relative land area of the transportation network within the various unincorporated County areas. Fecal coliform is not shown because no reduction was assumed for the scenarios. The influence of catch basin distributed BMP scenarios were applied to the wet weather LSPC model only. Dry weather flow on street surfaces is not expected to transport pollutants captured by catch basin practices.

Table 39. Full Capture Device and Catch Basin Insert Load Reductions

Community	Area (acres)	Annual Total Copper Load (lbs/year)				
		Baseline Load	Full Capture Devices		Catch Basin Inserts	
			Load	% Red.	Load	% Red.
Altadena	4,251	188.66	188.35	0.2%	176.98	6.2%
Bandini Islands	30	2.93	2.93	0.0%	2.93	0.0%
East Compton	527	29.46	29.37	0.3%	27.85	5.5%
City Terrace – East Los Angeles	4,762	313.75	312.87	0.3%	289.33	7.8%
East Pasadena – East San Gabriel	2,256	152.21	151.38	0.5%	145.96	4.1%
Florence – Firestone	2,270	142.60	142.19	0.3%	130.86	8.2%
Kagel Canyon	542	4.90	4.90	0.0%	4.90	0.0%
Kinneloa Mesa	884	6.64	6.64	0.0%	6.56	1.2%
La Crescenta – Montrose	2,147	97.10	96.97	0.1%	91.44	5.8%
Lopez Canyon	702	14.49	14.49	0.0%	14.49	0.1%
Lynwood Island	83	5.03	5.03	0.0%	5.03	0.0%
Oat Mountain	10,968	84.55	84.55	0.0%	84.53	0.0%
Rancho Dominguez	968	64.90	64.67	0.3%	62.08	4.3%
San Pasqual	164	10.56	10.47	0.9%	9.87	6.5%
Santa Clarita Valley	1,026	14.99	14.99	0.0%	14.98	0.0%
Santa Monica Mountains North Area	241	10.04	10.03	0.1%	9.92	1.2%
South El Monte Island	2.6	0.34	0.34	0.0%	0.34	0.0%
South Monrovia Islands	1,065	65.45	65.31	0.2%	61.81	5.6%
South San Gabriel – Avocado Heights	970	31.96	31.71	0.8%	29.99	6.2%
Sylmar Island	909	10.47	10.47	0.0%	10.47	0.0%
Twin Lakes	46	2.50	2.50	0.0%	2.50	0.0%
Universal City	301	22.35	22.35	0.0%	22.35	0.0%
W Athens – Westmont	742	51.28	51.02	0.5%	48.70	5.0%
W Rancho Dominguez – Victoria	833	40.47	40.25	0.6%	37.51	7.3%
Walnut Park	480	28.25	28.04	0.7%	26.75	5.3%
West Chatsworth	1,239	11.39	11.39	0.0%	11.38	0.0%
Westhills	142	2.83	2.82	0.6%	2.62	7.7%
Whittier Narrows	1,612	30.39	30.38	0.0%	30.35	0.1%
Willowbrook	1,075	63.16	62.97	0.3%	59.68	5.5%
Total	41,238	1,503.66	1,499.38	0.3%	1,422.15	5.4%

Community	Area (acres)	Annual Total Zinc Load (lbs/year)				
		Baseline Load	Full Capture Devices		Catch Basin Inserts	
			Load	% Red.	Load	% Red.
Altadena	4,251	1,720.21	1,717.33	0.2%	1,610.65	6.4%
Bandini Islands	30	29.33	29.33	0.0%	29.32	0.0%
East Compton	527	267.16	266.24	0.3%	252.07	5.6%
City Terrace – East Los Angeles	4,762	2,908.56	2,900.33	0.3%	2,679.67	7.9%
East Pasadena – East San Gabriel	2,256	1,036.31	1,028.48	0.8%	977.71	5.7%
Florence – Firestone	2,270	1,346.35	1,342.51	0.3%	1,236.26	8.2%
Kagel Canyon	542	43.69	43.69	0.0%	43.69	0.0%
Kinneloa Mesa	884	38.01	38.01	0.0%	37.24	2.0%
La Crescenta – Montrose	2,147	908.78	907.50	0.1%	855.71	5.8%
Lopez Canyon	702	116.71	116.70	0.0%	116.63	0.1%
Lynwood Island	83	56.78	56.78	0.0%	56.78	0.0%
Oat Mountain	10,968	374.41	374.38	0.0%	374.22	0.0%
Rancho Dominguez	968	723.22	721.10	0.3%	696.77	3.7%
San Pasqual	164	76.10	75.25	1.1%	69.64	8.5%
Santa Clarita Valley	1,026	101.22	101.22	0.0%	101.19	0.0%
Santa Monica Mountains North Area	241	92.65	92.56	0.1%	91.54	1.2%
South El Monte Island	2.6	3.08	3.08	0.0%	3.08	0.0%
South Monrovia Islands	1,065	467.07	465.78	0.3%	432.96	7.3%
South San Gabriel – Avocado Heights	970	267.33	265.03	0.9%	248.83	6.9%
Sylmar Island	909	36.92	36.92	0.0%	36.92	0.0%
Twin Lakes	46	11.39	11.39	0.0%	11.39	0.0%
Universal City	301	215.60	215.60	0.0%	215.60	0.0%
W Athens – Westmont	742	475.96	473.52	0.5%	451.75	5.1%
W Rancho Dominguez – Victoria	833	366.77	364.63	0.6%	338.94	7.6%
Walnut Park	480	256.77	254.83	0.8%	242.77	5.5%
West Chatsworth	1,239	97.64	97.63	0.0%	97.60	0.0%
Westhills	142	25.26	25.11	0.6%	23.22	8.1%
Whittier Narrows	1,612	210.17	210.10	0.0%	209.76	0.2%
Willowbrook	1,075	594.16	592.43	0.3%	561.59	5.5%
Total	41,238	12,867.58	12,827.45	0.3%	12,103.49	5.9%

Community	Area (acres)	Annual Total Lead Load (lbs/year)				
		Baseline Load	Full Capture Devices		Catch Basin Inserts	
			Load	% Red.	Load	% Red.
Altadena	4,251	174.55	174.24	0.2%	162.86	6.7%
Bandini Islands	30	2.61	2.61	0.0%	2.61	0.0%
East Compton	527	28.00	27.90	0.3%	26.39	5.7%
City Terrace – East Los Angeles	4,762	286.35	285.47	0.3%	261.93	8.5%
East Pasadena – East San Gabriel	2,256	108.25	107.41	0.8%	102.00	5.8%
Florence – Firestone	2,270	125.68	125.27	0.3%	113.94	9.3%
Kagel Canyon	542	4.47	4.47	0.0%	4.47	0.0%
Kinneloa Mesa	884	3.49	3.49	0.0%	3.40	2.3%
La Crescenta – Montrose	2,147	91.28	91.15	0.1%	85.62	6.2%
Lopez Canyon	702	9.52	9.52	0.0%	9.51	0.1%
Lynwood Island	83	3.13	3.13	0.0%	3.13	0.0%
Oat Mountain	10,968	27.15	27.14	0.0%	27.13	0.1%
Rancho Dominguez	968	43.34	43.12	0.5%	40.52	6.5%
San Pasqual	164	8.40	8.31	1.1%	7.71	8.2%
Santa Clarita Valley	1,026	10.75	10.75	0.0%	10.75	0.0%
Santa Monica Mountains North Area	241	8.26	8.25	0.1%	8.14	1.4%
South El Monte Island	2.6	0.31	0.31	0.0%	0.31	0.0%
South Monrovia Islands	1,065	50.41	50.27	0.3%	46.77	7.2%
South San Gabriel – Avocado Heights	970	27.34	27.09	0.9%	25.36	7.2%
Sylmar Island	909	3.15	3.15	0.0%	3.15	0.0%
Twin Lakes	46	1.40	1.40	0.0%	1.40	0.0%
Universal City	301	16.37	16.37	0.0%	16.37	0.0%
W Athens – Westmont	742	48.44	48.18	0.5%	45.85	5.3%
W Rancho Dominguez – Victoria	833	36.72	36.49	0.6%	33.75	8.1%
Walnut Park	480	26.66	26.45	0.8%	25.17	5.6%
West Chatsworth	1,239	10.21	10.21	0.0%	10.21	0.0%
Westhills	142	2.64	2.63	0.6%	2.43	8.2%
Whittier Narrows	1,612	17.20	17.20	0.0%	17.16	0.3%
Willowbrook	1,075	57.59	57.41	0.3%	54.12	6.0%
Total	41,238	1,233.65	1,229.37	0.3%	1,152.15	6.6%

6.2.2. Development of Baseline Scenario

The baseline scenario represented the starting point for optimizing cost-effective BMPs to achieve WLAs for the County TMDL Implementation Area. Because existing BMPs were included in the baseline condition, their benefits were included prior to consideration of additional structural BMPs. The following provides discussion of key BMPs included in the baseline scenario.

Nonstructural BMPs

The nonstructural BMP modeling scenario for Reduction of Irrigation Return Flows and Improved Street Sweeping Technology, reported earlier in this section, was represented in the baseline scenario for structural BMP implementation. Reduction of Irrigation Return Flow was modeled in all the County communities, though the degree of influence depended on the amount of developed land. Reduction of Irrigation Return Flow is a BMP focused on dry weather; however, there are small benefits for wet weather conditions as well. Reduction of irrigation to urban lawns results in less soil saturation, which provides additional soil storage for a rain event, and hence a reduction of stormwater runoff.

Improved Street Sweeping Technology was available to communities currently served by mechanical broom sweepers (representing about 86 percent of the public road miles). Table 40 shows the proportion of public road area assumed to benefit from Improved Street Sweeping Technology. Zero percent improvement indicates that the community is already served by regenerative air/vacuum sweepers, and no improvement is available. Wet weather load reductions attributed to each unincorporated County community resulting from improved technology were reported in
Table 37.

Catch Basin Inserts

As shown in the previous section, catch basin inserts provide a significant overall load reduction for the County TMDL Implementation Area. Catch basin inserts focus on treating road runoff, which is a significant source of metals and represents a large portion of impervious area that drains directly to the storm drain system. Catch basins under County control capture runoff from about 80 percent of the public road area. (Some communities with low development density do not have catch basins, while some streets on community edges drain to incorporated areas.) Table 40 shows the proportion of public road area within each unincorporated County community that drain to County catch basins. Runoff from those areas can be treated with catch basin inserts.

With inclusion in the baseline scenario, this BMP is assumed for TMDL implementation. As a result, the remaining discussion regarding optimizing distributed structural BMPs does not include catch basin inserts, but rather additional structural BMPs required to meet the TMDL WLAs.

Table 40. Percent Road Area Treated by Improved Street Sweeping Technology and Catch Basin Inserts

Community	Percent Transportation Area Treated	
	Improved Street Sweeping Technology	Catch Basin Inserts
Altadena	100%	91%
Bandini Islands	100%	6%
East Compton	100%	56%
City Terrace – East Los Angeles	100%	99%
East Pasadena – East San Gabriel	0%	94%
Florence – Firestone	100%	99%
Kagel Canyon	100%	0%
Kinneloa Mesa	100%	48%
La Crescenta – Montrose	100%	93%
Lopez Canyon	100%	5%
Lynwood Island	0%	0%
Oat Mountain	100%	20%
Rancho Dominguez	100%	100%
San Pasqual	100%	94%
Santa Clarita Valley	100%	19%
Santa Monica Mountains North Area	100%	66%
South El Monte Island	0%	0%
South Monrovia Islands	0%	96%
South San Gabriel – Avocado Heights	0%	93%
Sylmar Island	100%	0%
Twin Lakes	100%	0%
Universal City	0%	0%
W Athens – Westmont	100%	70%
W Rancho Dominguez – Victoria	100%	93%
Walnut Park	100%	69%
West Chatsworth	100%	3%
Westhills	100%	92%
Whittier Narrows	100%	13%
Willowbrook	100%	87%

6.2.3. Determination of TMDL Reduction Objectives

The metals TMDL targets for Los Angeles River watershed were converted to numerical percent reduction values for easy comparison and analysis with model results. The percent reduction required to meet the WLA was first determined by estimating the existing loads provided by the model. Table 41 presents the reduction percentage targets for the County TMDL Implementation Area. They were calculated on the basis of the existing and TMDL target values. Table 41 presents the copper, lead, zinc, and cadmium existing and TMDL annual load targets. The existing values for copper, lead, zinc, and fecal coliform were estimated on the basis of continuous model simulation for hydrologic year (HY) 2003. Appendix G describes how that year was selected for analysis. Cadmium was not included in the model; however, the existing load for cadmium was estimated based on the model-predicted annual volume multiplied by the median EMC value reported at the mass emissions site (Appendix B). The TMDL pollutant (copper, lead, zinc, and cadmium) annual loading target values are derived using the target concentration multiplied by annual total flow volume. Note that bacteria TMDLs are not approved for the Los Angeles River watershed, therefore no TMDL targets are included in the table.

Table 41. TMDL Reduction Targets for the County TMDL Implementation Area

Pollutants	Existing Loading	TMDL Target Loading	TMDL Reduction Target (%)
Copper (lb/yr)	1,502.5	1,051.8	30%
Lead (lb/yr)	1,231.9	3,836.1	0%
Zinc (lb/yr)	12,853.8	9,837.8	23%
Cadmium (lb/yr)	37.1	191.8	0%
Fecal Coliform (counts/yr)	1.88E+15	n/a	n/a

It is important to note that the terms *percent reduction* and *percent reduction targets* were derived from summarizing time series of multiple storms throughout the model simulation period. They do *not* represent flat reductions applied uniformly to all flows and all loads. Treatment efficiency and BMP effluent concentrations vary for individual storms during the simulation period. Those targets are based on long-term evaluation of allowable load and critical conditions associated with both metals and bacteria TMDLs. Of the metals, copper has the highest required reduction to meet the TMDL target, as shown in Table 41. For that reason, copper is the limiting pollutant for metals TMDL compliance in the County TMDL Implementation Area (i.e., controlling copper tends to ensure that other metals TMDL targets are met); therefore, copper load reduction was used as the control target for the optimization runs. Benefits of structural BMPs to address fecal coliform, nutrients, and TSS were also assessed.

6.2.4. Optimization Analysis

Considering the large number of alternatives for combinations of structural BMPs, the BMP optimization scenarios required careful formulation to take into account the physical constraints (such as available land, land ownership, and soil properties), as well as political constraints (such as order preference and prioritization of actions). The BMP optimization scenarios were constructed to reflect management considerations for BMP implementation as follows:

- BMPs on public land are preferred over the BMPs on private land.
- For BMPs on private land, centralized BMPs are the only options.

With the above considerations, four optimization scenarios were formulated. They are summarized in matrix form as Table 42. The first scenario (1) used the baseline model run as the initial condition and considered only centralized BMPs on public land. Scenario 2 was built on the maximum optimal solution derived from Scenario 1 and added distributed BMPs on public land. Scenario 3 was built on the maximum optimal solution derived from

Scenario 2 but added centralized BMPs on private land in addition to considering distributed BMPs on public land. Scenario 4 was also built on the maximum optimal solution derived from Scenario 1 but added centralized BMPs on private land without considering distributed BMPs on public land.

Table 42. Optimization Scenario Matrix

Scenario	Baseline Scenario (Nonstructural BMPs + Catch Basin Inserts)	Structural BMPs		
		Public Centralized	Public Distributed	Private Centralized
1	Fixed	Variable		
2	Fixed	Fixed (Optimal solution derived in 1	Variable	
3	Fixed	Fixed (Optimal solution derived in 1	Fixed (Optimal solution derived in 2)	Variable
4	Fixed	Fixed (Optimal solution derived in 1		Variable

Fixed: Corresponding BMPs are included as a fixed condition.
Variable: Corresponding BMPs are included as decision variables to be optimized for cost-effectiveness.

BMP Cost Functions

Cost estimation was a critical component in the optimization process because the optimization process was dependent on evaluating and comparing the cost-effectiveness of various BMP alternatives. Detailed BMP cost functions are discussed in Appendix K. The functions consider BMP construction, maintenance, and land acquisition for BMP implementation. However, it is important to note that resulting cost estimates are meaningful only for relative comparison of BMP implementation alternatives and should not be used directly for BMP planning.

BMP Drainage Zone Classification

The County TMDL Implementation Areas are scattered throughout the entire Los Angeles River watershed, and precipitation and background soil infiltration potential vary dramatically. To support assessment of opportunities for centralized BMPs on private land, the BMP drainage areas required classification based on precipitation characteristics and infiltration potential to ensure accurate representation. The potential areas for BMP implementation on private land include County TMDL Implementation Areas that are not within drainage areas of centralized or distributed BMPs proposed for public land (except Compton Creek Wetland). These areas were classified into eight BMP Drainage Zones (Table 43) which take into account historic rainfall characteristics, background soil infiltration potential, and whether they are within the Compton Creek Wetland drainage area. The classifications included the following considerations:

- **Compton Creek Wetland Drainage Area**—The Compton Creek Wetland is one of the centralized BMPs identified on public land, however unlike other centralized BMPs, the wetland size (4.3 acres) is small relative to the drainage area (2,184 acres). This means that during large storms, the relatively small wetland is more likely to overflow and result in less stormwater treatment. Therefore, for optimization analysis it was determined necessary to consider centralized BMPs on private land as options to provide additional treatment or flow attenuation upstream of the wetland to meet the target reduction for that drainage area.

- **Weather Zone**—Rainfall characteristics were categorized into weather zones representative of high, mid-range (mid), and low rainfall intensity and volume. Further discussion on the identification of weather zones is provided in Appendix G.

- **Infiltration Potential**—*High* infiltration rates were classified as areas composed primarily of HSG A- or B-type soils; whereas, *Low* infiltration rates are areas composed primarily of HSG C- or D-type soils.

- **Potential BMP Type**—Potential BMPs types and size ranges were assigned to each group. Infiltration basins were assigned to areas with high infiltration potential soils, while extended detention basins were assigned to areas with low infiltration potential soils.

Resulting BMP Drainage Zones are shown in Figure 67.

Table 43. BMP Drainage Zones

BMP Drainage Zone	Drainage Area Description	Weather Zone	Infiltration Potential	Potential BMP Type
1	Within Compton Creek Wetland drainage area	Low	High	Infiltration Basin
2	Within Compton Creek Wetland drainage area	Low	Low	Extended Detention Basin
3	Outside of drainage areas for centralized and distributed BMPs on public land	High	High	Infiltration Basin
4	Outside of drainage areas for centralized and distributed BMPs on public land	High	Low	Extended Detention Basin
5	Outside of drainage areas for centralized and distributed BMPs on public land	Low	High	Infiltration Basin
6	Outside of drainage areas for centralized and distributed BMPs on public land	Low	Low	Extended Detention Basin
7	Outside of drainage areas for centralized and distributed BMPs on public land	Mid	High	Infiltration Basin
8	Outside of drainage areas for centralized and distributed BMPs on public land	Mid	Low	Extended Detention Basin

An additional consideration in evaluation of benefits of BMPs within the BMP Drainage Zones was the land characteristics that contribute to pollutant loading. Appendix G summarizes the land characteristics within each BMP Drainage Zone. During optimization analysis, the LSPC model provided estimates of pollutant loads within each BMP Drainage Zone as a function of these land characteristics, which supported assessment of the appropriate BMPs required to meet WLAs.

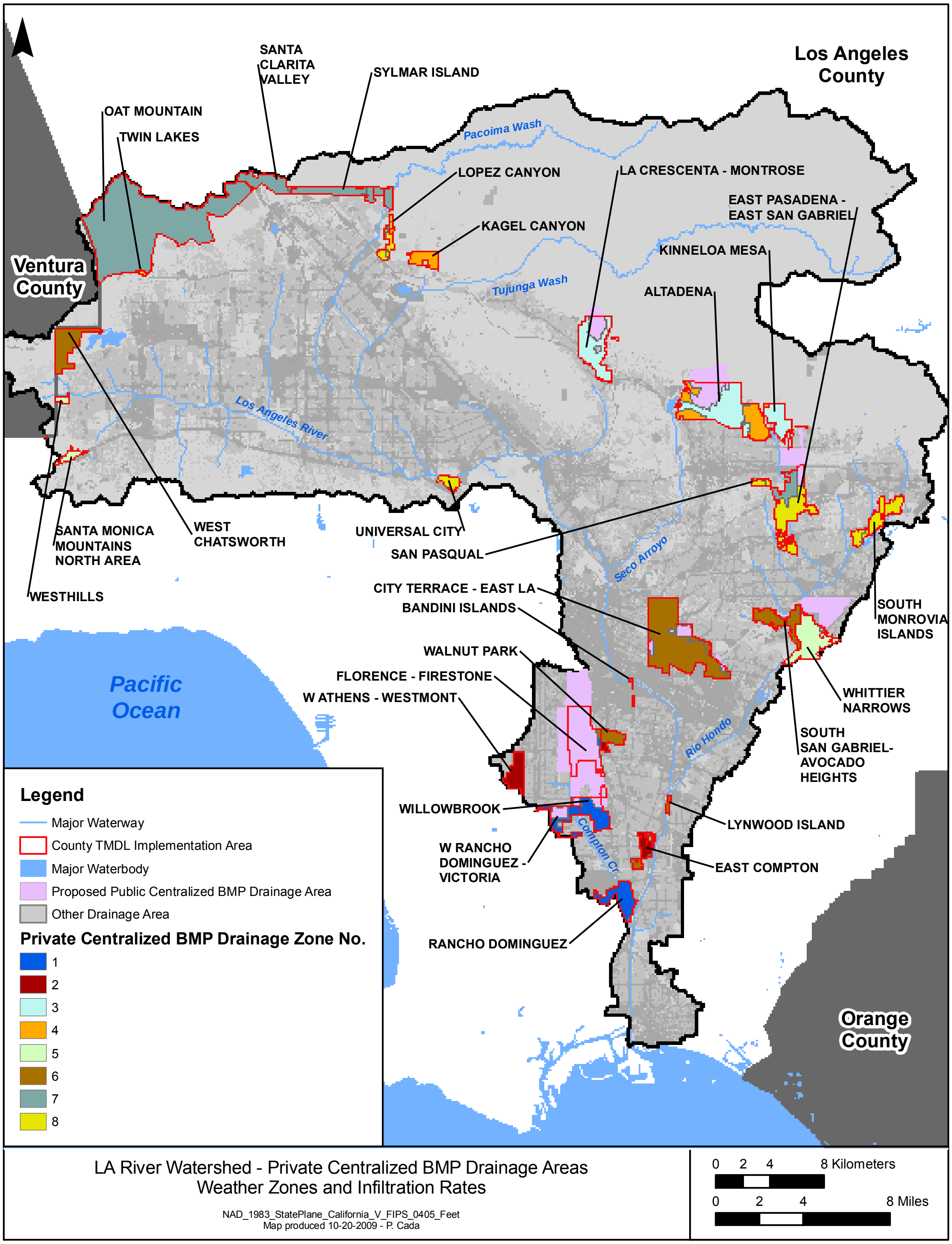

Figure 67. BMP Drainage Zones

Optimization Results

The cost-effective BMP solutions derived from the four optimization runs were distilled to produce Figure 68. Because copper was determined to be the limiting pollutant, cost-effectiveness curves are presented for copper only; however, the associated reductions for other pollutants of concern are also tabulated in Table 44. Figure 68 shows the copper load reduction percentages and associated minimum cost that can be achieved at various BMP implementation levels.

Figure 68 presents three curve segments:

- Curve A-C contains the cost-effective solutions that are derived from the optimization scenarios considering only structural BMPs on public land, both centralized and distributed (Scenarios 1 and 2). Notice that point A seemingly represents a 7.5 percent reduction at no cost. That is because no cost estimate was specified for the baseline scenario (nonstructural BMPs and catch basin inserts) on which it was developed. Therefore, all costs for all scenarios should be interpreted as cost above the baseline scenario cost. Point B indicates the cost and benefit of the solution including only centralized structural BMPs on public land (Scenario 1). Point C represents the solution that achieves the maximum water quality benefits while applying centralized and distributed BMPs on public land (Scenario 2).
- Curve C-F is built on point C (maximum optimal solution from Scenario 2) and contains the cost-effective solutions that were derived from the optimization scenarios considering centralized BMPs on private land (Scenario 3). Point D indicates the solution that meets the copper TMDL reduction target (30 percent). Points E and F are two solutions that achieve higher reductions, i.e., 50 percent and 70 percent, respectively. It is important to note the percent reductions of Points D, E, and F are based on the assumption that 100 percent of the impervious drainage areas within the selected BMP Drainage Zones are treated with centralized BMPs on private land. For example, for Point D, 100 percent of BMP Drainage Zones 3, 5, and 7 are treated; for Point E, 100 percent of zones 1, 3, 5, 6, and 7 are treated; for Point F, 100 percent of all the zones are treated.
- The cost-effective solutions derived from Scenario 4 (private centralized BMPs in addition to public centralized BMPs) were also plotted for comparison purpose. It shows that implementing public distributed BMPs results in a cost saving of approximately $1 million at the reduction level of 18.4 percent (Point C). Scenario 4 was not considered in the subsequent analysis because (1) Scenario 3 provides a marginal savings at Point C, and (2) beyond Points D, E, and F, the two cost curves representing centralized BMPs on private land are virtually indistinguishable.

All six solutions (A, B, C, D, E, and F) were evaluated to estimate the removal effectiveness of other pollutants resulting from optimizing copper reductions. The evaluation results are summarized in Table 44. Note that the metals TMDL reduction target (indicated as 30 percent reduction in copper annual load) can be met by implementing private centralized BMPs in addition to the maximum public BMPs

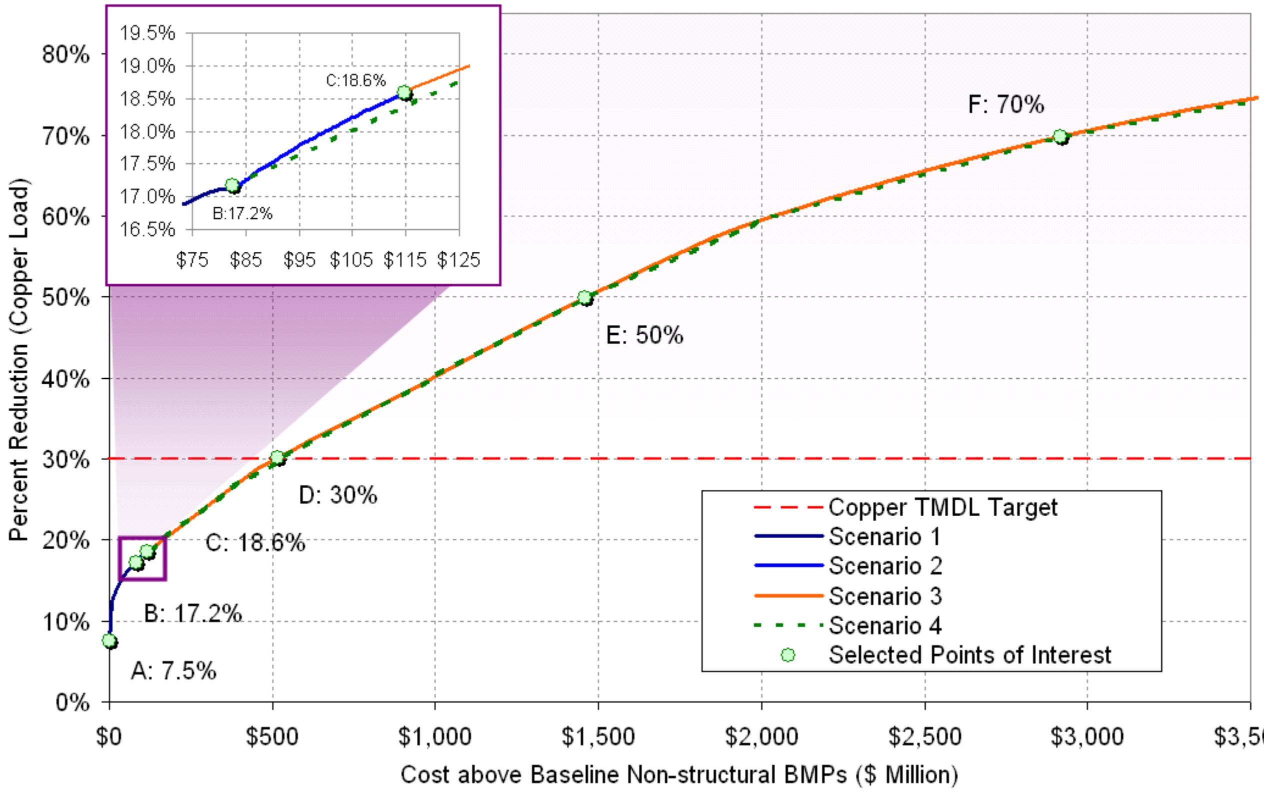

Figure 68. Pollutant Reduction vs. Minimum Cost Relationship Derived from Scenarios 1, 2, and 3

Table 44. Costs and Pollutants Reduction of the Selected Solutions Corresponding to Figure 68

Pollutants	Existing Load	TMDL Reduction Target (%)	A: Nonstructural + Inserts	Scenario 1	Scenario 2	Scenario 3		
				B: Public Central	C: Public Ctrl + Dist	D: Metal TMDL	E	F
Flow Volume (ft^3/yr)	991,014,657	--	1.6%	9%	11%	23%	44%	62%
TSS (lb/yr)	10,518,165	--	2.7%	6%	8%	15%	24%	33%
Copper (lb/yr)	1,502	30%	7.5%	17.2%	18.6%	30%	50%	70%
Lead (lb/yr)	1,232	0%	9.1%	19%	20%	33%	56%	77%
Zinc (lb/yr)	12,854	23%	8.1%	19%	21%	32%	57%	78%
Cadmium (lb/yr)	37.1	0%	1.6%	9%	11%	23%	44%	62%
Fecal Coliform (#/yr)	1.85E+15	--	0.8%	12%	13%	26%	46%	67%
Cost ($million)				$82.4	$114.8	$564.0	$1,458.7	$2,915.5

Table 45 summarizes the costs and BMP compositions of all solutions of interest. The BMP details of the selected solutions (points B to F) are summarized and analyzed in Appendix G. The details include a breakdown of the level of application for each BMP type within each subarea and selected scenario point. Information provided in Appendix G includes BMP-specific pollutant load estimates as well as sizing information used to develop more detailed cost estimates reported in Section 9.

Table 45. Optimal Treatment Levels Considering Public Centralized and Distributed BMPs, and Private Centralized BMPs

Zinc Annual Load Reduction (%)			7.5% (Point A)	17.2% (Point B)	18.6% (Point C)	30% (Point D)	50% (Point E)	70% (Point F)
Total Cost ($million)			n/a	$82.4	$ 114.8	$ 564.0	$1,458.7	$ 2,915.5
Cost per lb load reduction ($/lb)			n/a	295,093	389,304	1,132,834	1,924,696	2,777,822
Public	Centralized	Cost ($ million)		$82.4	$82.4	$82.4	$82.4	$82.4
		Storage (AF)		144	144	144	144	144
		Surface Area (acre)		28.1	28.1	28.1	28.1	28.1
	Distributed	Cost ($ million)			$32.40	$32.40	$32.40	$32.40
		Storage (AF)			54.6	54.6	54.6	54.6
		Surface area (acre)			32.1	32.1	32.1	32.1
Private	Centralized	Cost ($ million)				$401.14	$1,343.90	$2,800.70
		Storage (AF)				250	711	1,448
		Surface area (acre)				46	151	328

Optimal Considerations for BMP Implementation Planning

Using the optimal solutions identified, this section discusses the prioritization order and phased sequence for BMP implementation to meet phased TMDL implementation requirements. The previous optimization assumed 100 percent of selected BMP Drainage Zones were treated. For example, Solution D meets the TMDL reduction targets by treating 100 percent of BMP Drainage Zones 3, 5, and 7. However, there might not be enough opportunity in zones 3, 5, and 7 to treat 100 percent of the drainage area. For that reason, alternatives treating less area within selected BMP Drainage Zones with high-end BMP design (as specified in Point E and F solutions) were developed, even though they are less cost-effective, to allow less percentage area of treatment. The hypothesis is to treat less drainage area with larger BMPs to achieve the same load reductions. Given the hypothetical nature of the private centralized BMP analysis, the intention here is not to identify the exact solutions. Rather, it is to show the examples of alternative solutions for meeting TMDL targets.

Another alternative solution that meets the copper TMDL target was derived by assuming 100 percent of the drainage area in all the BMP Drainage Zones are treated. This solution is shown as Point G in Figure 69 relative to the other alternative solutions. In order to better associate the level of treatment with the unincorporated County communities within the County TMDL Implementation Area, community boundaries were intersected with the boundaries for the BMP Drainage Zones. The modeling results were then reaggregated by community according to the respective impervious area distributions. As previously described, while Point D treated 100 percent of areas in BMP Drainage Zones 3, 5, and 7, Point G treated all impervious area in all zones. Table 46 shows the communities affected by the treatment associated with the Points D and G solutions, in addition to distributed and centralized BMPs on public land identified for these communities and discussed in Section 5 (with optimization results for each BMP reported in Appendix G). The private centralized BMP details for each community are summarized in Table 47 (Point D) and Table 48 (Point G). The total costs, flow, and pollutant reductions are summarized in Table 49.

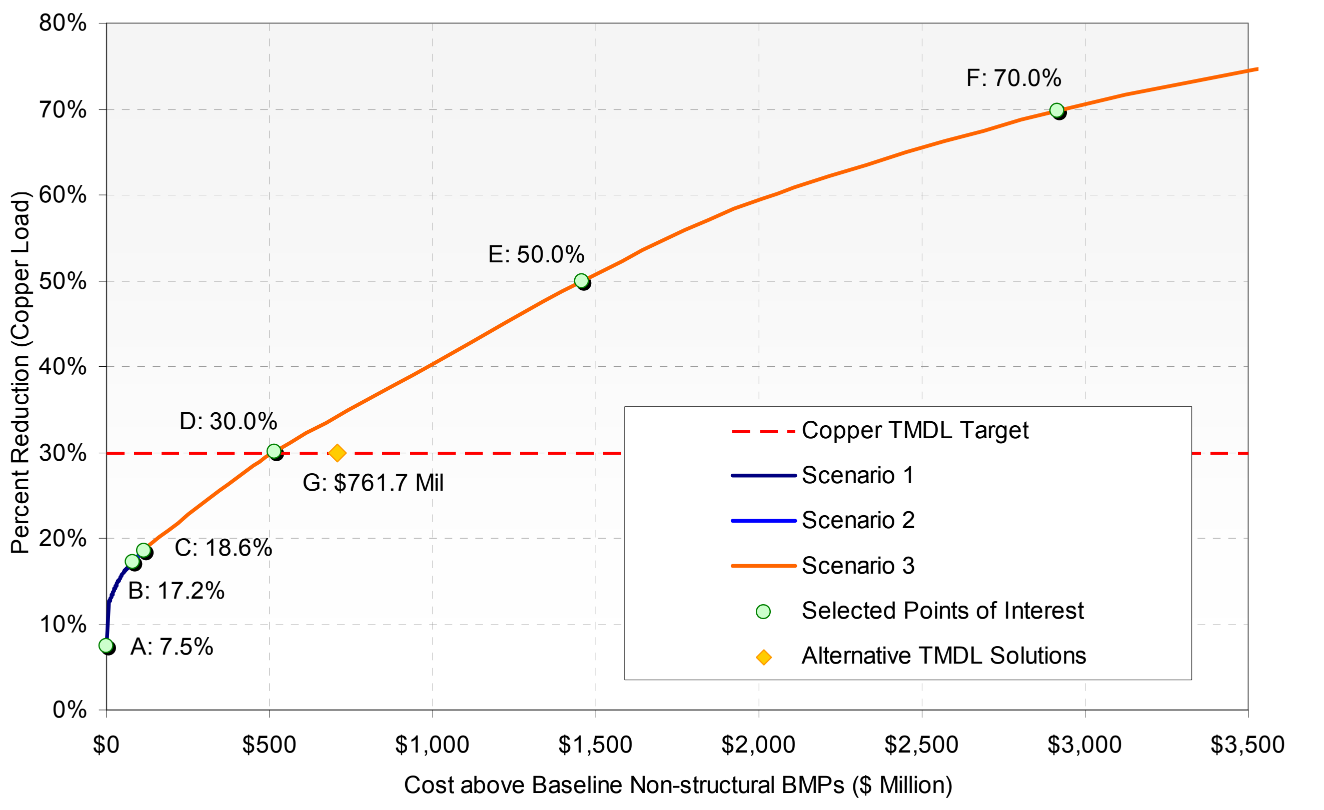

Figure 69. TMDL Alternative Solutions for Meeting the Copper TMDL Target.

Table 46. Treated Areas Associated with Points D and G by Community

Community	Public Distributed BMPs	Public Centralized BMPs	Private Centralized BMP (Point D Solution)	Private Centralized BMP (Point G Solution)
Altadena	✓	✓	✓	✓
Bandini Islands	✓			✓
East Compton		✓		✓
City Terrace – East Los Angeles	✓	✓		✓
East Pasadena – East San Gabriel	✓	✓	✓	✓
Florence – Firestone		✓		✓
Kagel Canyon				✓
Kinneloa Mesa	✓		✓	✓
La Crescenta – Montrose	✓	✓	✓	✓
Lopez Canyon	✓			✓
Lynwood Island				✓
Oat Mountain	✓		✓	✓
Rancho Dominguez	✓	✓		✓
San Pasqual				✓
Santa Clarita Valley			✓	✓

Community	Public Distributed BMPs	Public Centralized BMPs	Private Centralized BMP (Point D Solution)	Private Centralized BMP (Point G Solution)
Santa Monica Mountains North Area	✓		✓	✓
South El Monte Island				✓
South San Gabriel – Avocado Heights				✓
Sylmar Island	✓		✓	✓
Twin Lakes				✓
Universal City	✓			✓
W Athens – Westmont		✓		✓
W Rancho Dominguez – Victoria		✓		✓
Walnut Park	✓	✓		✓
West Chatsworth				✓
Westhills			✓	✓
Whittier Narrows	✓	✓	✓	✓
Willowbrook	✓	✓		✓

Table 47. Private Centralized BMPs Cost and Configurations (Point D)

Community	BMP Drainage Zone	BMP Type[a]	Total Area (acres)	Impervious Drainage Area (acres)	Impervious Drainage Area Treated by BMPs (acres)	BMP Surface Area	BMP Storage Capacity (AF)	Copper Load Reduction (lb/yr)
Altadena	3	IB	1,872.4	656.6	626.9	16.1	87.0	56.1
Kinneloa Mesa	3	IB	553.5	46.0	33.2	0.9	4.6	3.0
La Crescenta – Montrose	3	IB	1,558.4	725.4	680.4	17.5	94.4	60.9
Santa Monica Mountains North Area	5	IB	239.1	75.1	69.7	1.8	9.5	7.3
Westhills	5	IB	1,164.3	24.2	22.9	0.6	3.1	2.4
Whittier Narrows	5	IB	299.4	183.3	99.0	2.5	13.4	10.3
East Pasadena – East San Gabriel	7	IB	2,087.0	204.6	201.4	3.1	16.5	15.0
Oat Mountain	7	IB	195.9	181.0	167.7	2.6	13.8	12.5
Santa Clarita Valley	7	IB	1,023.1	78.0	77.5	1.2	6.4	5.8
Sylmar Island	7	IB	720.7	16.5	16.4	0.3	1.3	1.2

a. IB = infiltration basin, Ex-DB = extended detention basin

Table 48. Private Centralized BMPs Cost and Configurations (Point G)

Community	BMP Drainage Zone	BMP Type[a]	Total Area (acres)	Impervious Drainage Area (acres)	Impervious Drainage Area Treated by BMPs (acres)	BMP Surface Area	BMP Storage Capacity (AF)	Copper Load Reduction (lb/yr)
Altadena	3	IB	1,872.4	656.6	613.4	3.8	20.3	11.4
	4	Ex-DB	1,448.9	537.8	527.2	7.5	30.1	11.0
Bandini Islands	6	Ex-DB	28.1	28.1	19.9	0.1	0.5	0.3
East Compton	2	Ex-DB	338.7	167.8	167.8	1.8	7.0	2.9
	6	Ex-DB	186.4	82.4	82.4	0.5	2.0	1.3
City Terrace – East Los Angeles	6	Ex-DB	4363.4	2,481.0	2,316.8	14.0	55.9	36.2
East Pasadena – East San Gabriel	7	IB	618.0	204.6	202.7	2.3	12.4	11.0
	8	Ex-DB	1,445.5	632.2	611.6	6.3	25.2	13.7
Florence - Firestone	1	IB	69.8	36.2	36.2	0.2	1.0	0.5
	6	Ex-DB	57.5	35.7	35.7	0.2	0.9	0.6
Kagel Canyon	4	Ex-DB	540.3	32.8	32.8	0.5	1.9	0.7
Kinneloa Mesa	3	IB	878.9	46.0	32.5	0.2	1.1	0.6
La Crescenta – Montrose	3	IB	1,600.6	725.4	665.7	4.1	22.0	12.4
Lopez Canyon	8	Ex-DB	696.7	113.0	110.1	1.1	4.5	2.5
Lynwood Island	6	Ex-DB	81.2	66.2	45.1	0.3	1.1	0.7
Oat Mountain	7	IB	10,965.5	181.0	168.8	1.9	10.3	9.2
Rancho Dominguez	1	IB	957.2	823.5	770.6	3.9	21.3	10.5
	6	Ex-DB	6.5	6.5	6.5	0.0	0.2	0.1
San Pasqual	8	Ex-DB	161.8	72.1	72.1	0.7	3.0	1.6
Santa Clarita Valley	7	IB	1,023.1	78.0	78.0	0.9	4.8	4.2
Santa Monica Mountains North Area	5	IB	239.1	75.1	73.8	0.4	2.3	0.9
South El Monte Island	6	Ex-DB	1.6	1.6	1.6	0.0	0.0	0.0
	8	Ex-DB	1,061.4	465.7	449.6	4.6	18.5	10.1
South San Gabriel – Avocado Heights	6	Ex-DB	959.3	255.2	255.2	1.5	6.2	4.0
Sylmar Island	7	IB	905.1	16.5	0.0	0.0	0.0	0.0
Twin Lakes	8	Ex-DB	45.2	10.9	10.9	0.1	0.4	0.2
Universal City	8	Ex-DB	298.6	211.9	207.9	2.1	8.6	4.7
W Athens – Westmont	2	Ex-DB	741.1	449.4	421.6	4.4	17.6	7.2
W Rancho Dominguez – Victoria	1	IB	529.9	239.0	239.0	1.2	6.6	3.2
Walnut Park	2	Ex-DB	88.1	43.2	43.2	0.5	1.8	0.7
	6	Ex-DB	387.4	194.9	191.3	1.2	4.6	3.0

Community	BMP Drainage Zone	BMP Type[a]	Total Area (acres)	Impervious Drainage Area (acres)	Impervious Drainage Area Treated by BMPs (acres)	BMP Surface Area	BMP Storage Capacity (AF)	Copper Load Reduction (lb/yr)
West Chatsworth	6	Ex-DB	1,235.3	95.2	95.2	0.6	2.3	1.5
Westhills	5	IB	140.3	24.2	24.2	0.1	0.7	0.3
Whittier Narrows	5	IB	1,556.5	183.3	104.8	0.6	3.2	1.2
Willowbrook	1	IB	787.1	413.9	348.6	1.8	9.6	4.7

a. IB = infiltration basin, Ex-DB = extended detention basin

Table 49. Pollutant Reductions Achieved by Optimal Maximum Centralized BMPs Size on Private Land

TMDL Alternative		Point D	Point G
Total Cost (Million $)		$508,8	$761.7
Flow Volume	Flow Reduction (ft^3/yr)	225,114,296	290,111,462
	Reduction (% of total)	23%	29%
Copper	Load Reduction (lb/yr)	449.3	448.0
	Reduction (% of total)	30%	30%
Zinc	Load Reduction (lb/yr)	4,176.90	4,224.3
	Reduction (% of total)	32%	33%
Lead	Load Reduction (lb/yr)	407.07	411.1
	Reduction (% of total)	33%	33%
Cadmium	Load Reduction (lb/yr)	8.533	10.9
	Reduction (% of total)	23%	29%
TSS	Load Reduction (lb/yr)	1,559,518	1,294,151
	Reduction (% of total)	15%	12%
Fecal Coliform	Load Reduction (counts/yr)	4.88E+14	7.13E+14
	Reduction (% of total)	26%	39%

Table 50 further summaries BMP size, load reduction, and life cycle cost components by BMP type or land use. Life cycle cost represents the annualized total cost to design, construct, and maintain a BMP from conception to replacement. Three options are included for implementing centralized BMPs on private land, with different percentages of the drainage area treated. For distributed BMPs, porous pavement and bioretention components are disaggregated to show the relative load reduction and cost associated with each; however, the two BMPs act as one unit because porous pavement is selected whenever supplemental storage is needed, mainly to enhance bioretention performance (see the BMP implementation by land use group discussed in Appendix F).

The following describes the sequence of events for prioritizing and developing a phased implementation plan of action:

1. Cost-effectiveness for BMP implementation was computed by land use and BMP type using the life cycle cost and pollutant removal benefits presented in Table 50.

2. BMPs and land uses were ranked by cost-effectiveness (lowest to highest cost/lb of copper removed).
3. Cumulative percent of target load reduction, percent of total cost, and percent of drainage area treated were computed according to the ranked order of cost-effectiveness as shown in Figure 70.
4. The phased, wet weather implementation schedule for metals (Table 51) was compared against the cost-effectiveness and cumulative progress benchmarks to determine a strategic order of management actions, with the catch basin inserts and Reduction of Irrigation Return Flows (baseline scenario) schedule determined on the basis of constraints identified by the County.

Table 50. BMP Size, Load Reduction, and Life Cycle Cost Associated with the Copper TMDL Target Reduction

BMP Type and Location		BMP Drainage Area, Treatment		Load Reduction		Life Cycle Cost ($1,000)
		(acres)	(% treated)	(lb copper/yr)	(% total)	
Baseline Scenario		--	--	112	7.5%	--
Centralized BMPs on Public Land	20 sites	4,493.8	100%	141	9.4%	$82,638
Pilot Distributed BMP Project for a County Road	Bioretention	1.0	100%	0.1	0.01%	$93
Distributed on Public Land -High Infiltration Soil	Porous Pavement	225.8	97%	8.3	0.6%	$13,478
	Bioretention	111.2	54%	1.2	0.1%	$4,403
Distributed on Public Land – Low infiltration Soil	Porous Pavement	183.6	72%	9.1	0.6%	$9,534
	Bioretention	111.5	44%	3.5	0.2%	$3,773
Centralized BMPs on Private Land Option 1: Point D	Infiltration Basin	3,423.7	58%	174.4	11.6%	$401,139
	Ex-Detention Pond	5,803.1	0%	0.0	0.0%	$0
Centralized BMPs on Private Land Option 2: Point G	Infiltration Basin	3,423.7	100%	70.1	4.7%	$185,665
	Ex-Detention Pond	5,803.1	100%	103.0	6.9%	$385,689

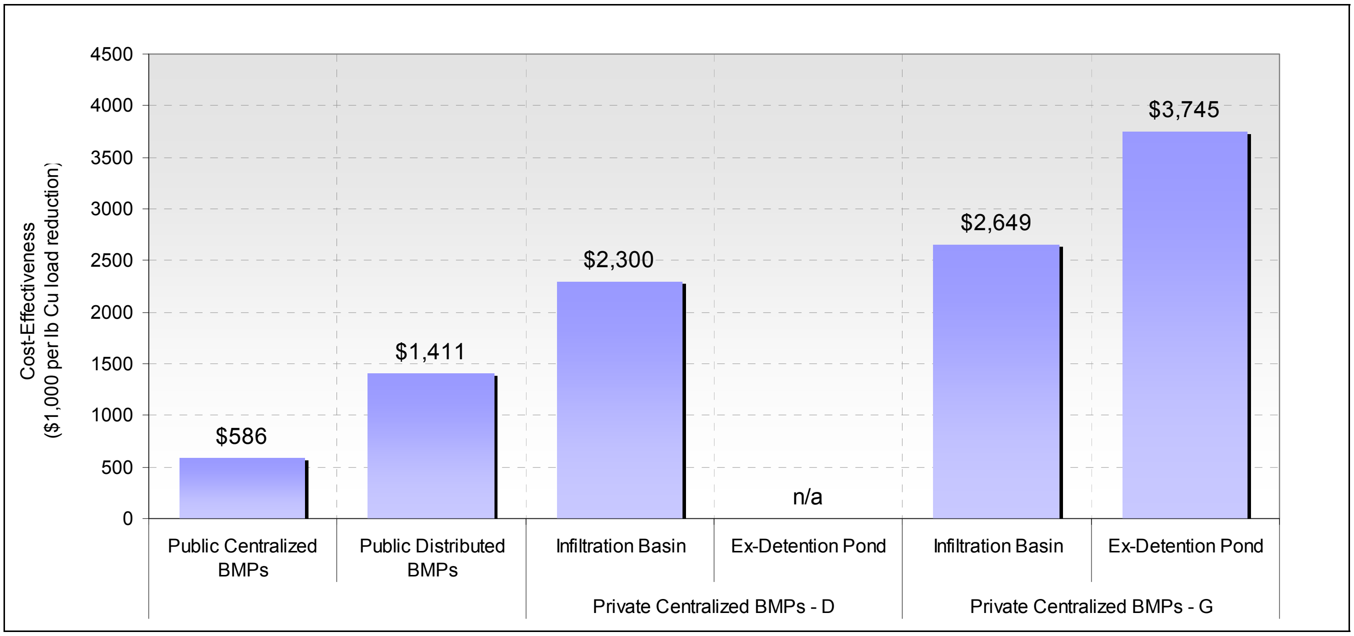

Figure 70. Incremental BMP Components for Phased Implementation Planning

Table 51 summarizes a proposed wet weather implementation action plan with projected outcomes. Table 51 also shows that by the time 100 percent of the TMDL target reduction for copper (30 percent) has been achieved under Options 1 or 2, about 50 percent or 100 percent of the total drainage area has been treated. That suggests that using the percent of total drainage area as an implementation benchmark might not be the most meaningful and practical course of action. Instead, percent of progress toward achieving the TMDL target is a more reliable and measurable interpretation of the TMDL requirement. Therefore considering cost-effectiveness, Option 1 was selected for strategizing the TMDL implementation plan.

In Table 41 attainment of the copper TMDL target (30 percent load reduction) is normalized to 100 percent of progress achieved by 2028. As discussed, copper is the limiting metals TMDL. Given the proposed schedule presented above, it is anticipated that the zinc TMDL (23 percent) can be achieved earlier than the copper TMDL.

Table 51. Proposed Phased, Wet Weather Implementation Action Plan and Projected Outcomes

Plan Components	Schedule, Actions, and Projected Outcomes		
Date	1/11/2012	1/11/2024	1/11/2028
Target Interpretation	25% of TMDL target	50% of TMDL target	100% of TMDL target
Proposed Actions	• Centralized BMPs on public land at the following sites: – G.W. Carver Park – Infiltration Basin – Mona Park – Infiltration Basin – Compton Creek Wetland – Ted Watkins Park Right – Infiltration – Bethune Park – Infiltration Basin – Roosevelt Park – Infiltration Basin – Ted Watkins Park Left – Infiltration Basin – Farnsworth Park – Infiltration Basin – Hugo Reid Park – Infiltration Basin – Northside Drive Median – Belvedere Park – Infiltration Basin – Charles White County Park – Infiltration Basin – Salazar Park – Infiltration Basin	• Centralized BMPs on public land at the following sites: – Magic Johnson Park – Two Strike Park – Infiltration Basin – Whittier Narrows Park – Infiltration Basin – Whittier Narrows Recreation Area – Infiltration Basin • Implement the Pilot Distributed BMP Project for a County Road • 66% of catch basin inserts • Improved Street Sweeping Technology • Reduction of Irrigation Return Flow	• Remaining centralized BMPs on public land at the following sites: – Enterprise Park – Loma Alta County Park – Infiltration Basin – Obregon Park – Ex-Detention Pond • Remaining 34% of catch basin inserts. • Implement 100% of distributed BMPs on public industrial and institutional land • Centralized BMPs on private land: Option 1: Implement private centralized BMPs to treat 100% of impervious areas in zones 3, 5, and 7 (see Table 47) Option 2: Implement private centralized BMPs to treat 100% of impervious areas in all zones (see Table 48)
Actual Progress (% of Zinc TMDL Target)	25%	51%	100%
Actual Progress (% of Impervious Area Treated)	29%	35%	Option 1: 50% Option 2: 100%
Incremental Cost ($ Million)	$42.46	$21.20	Option 1: $451.4 Option 2: $698.0

6.2.5. Summary

Optimization scenarios (Table 52) were constructed to reflect management considerations on BMP implementation preference. BMP selection on public land (Figure 71) was prioritized over BMP selection on private land. The optimization scenarios generated valuable BMP implementation insights and recommendations. Some of the highlights are presented below:

- Nonstructural BMPs and catch basin inserts are effective at reducing pollutant loads before or as they enter the storm drain system and are recommended for TMDL implementation.
- Implementing structural BMPs solely on public land does not result in meeting the metals TMDL reduction target. Therefore, implementing BMPs on private land is necessary.
- Public centralized BMPs are the most cost-effective options; therefore, they should be implemented first. Public distributed BMPs are the second cost-effective options; however, given the limited public distributed BMP opportunities, it will still be necessary to implement centralized BMPs on private land to achieve TMDL reduction targets.
- Recommendations for private centralized BMPs vary by factors such as infiltration potential and typical rainfall intensity. Those factors were grouped into BMP Drainage Zones of similar characteristics.
- The optimization results showed that treating the impervious area in BMP Drainage Zones 3, 5, and 7 was the most cost-effective solution (Point D). Another higher-cost alternative, Point G, was determined assuming that 100 percent of all the BMP Drainage Zones can be treated. Details of individual private centralized BMPs will need to be further refined during implementation as opportunities for land acquisition and BMP design are presented over time within each zone.

Table 52. BMPs and Associated Load Reductions

BMP Type and Location		Load Reduction (lb copper/yr)	Load Reduction (% total)
Baseline Scenario (Reduction of Irrigation Return Flows, Improved Street Sweeping Technology, and Catch Basin Inserts)		112	7.5%
Centralized BMPs on Public Land	20 sites	141	9.4%
Pilot Distributed BMP Project for a County Road	Bioretention	0.1	0.01%
Distributed on Public Land -High Infiltration Soil	Porous Pavement	8.3	0.6%
	Bioretention	1.2	0.1%
Distributed on Public Land – Low infiltration Soil	Porous Pavement	9.1	0.6%
	Bioretention	3.5	0.2%
Centralized BMPs on Private Land Option 1: Point D	Infiltration Basin	174.4	11.6%
	Ex-Detention Pond	0.0	0.0%
Centralized BMPs on Private Land Option 2: Point G	Infiltration Basin	70.1	4.7%
	Ex-Detention Pond	103.0	6.9%

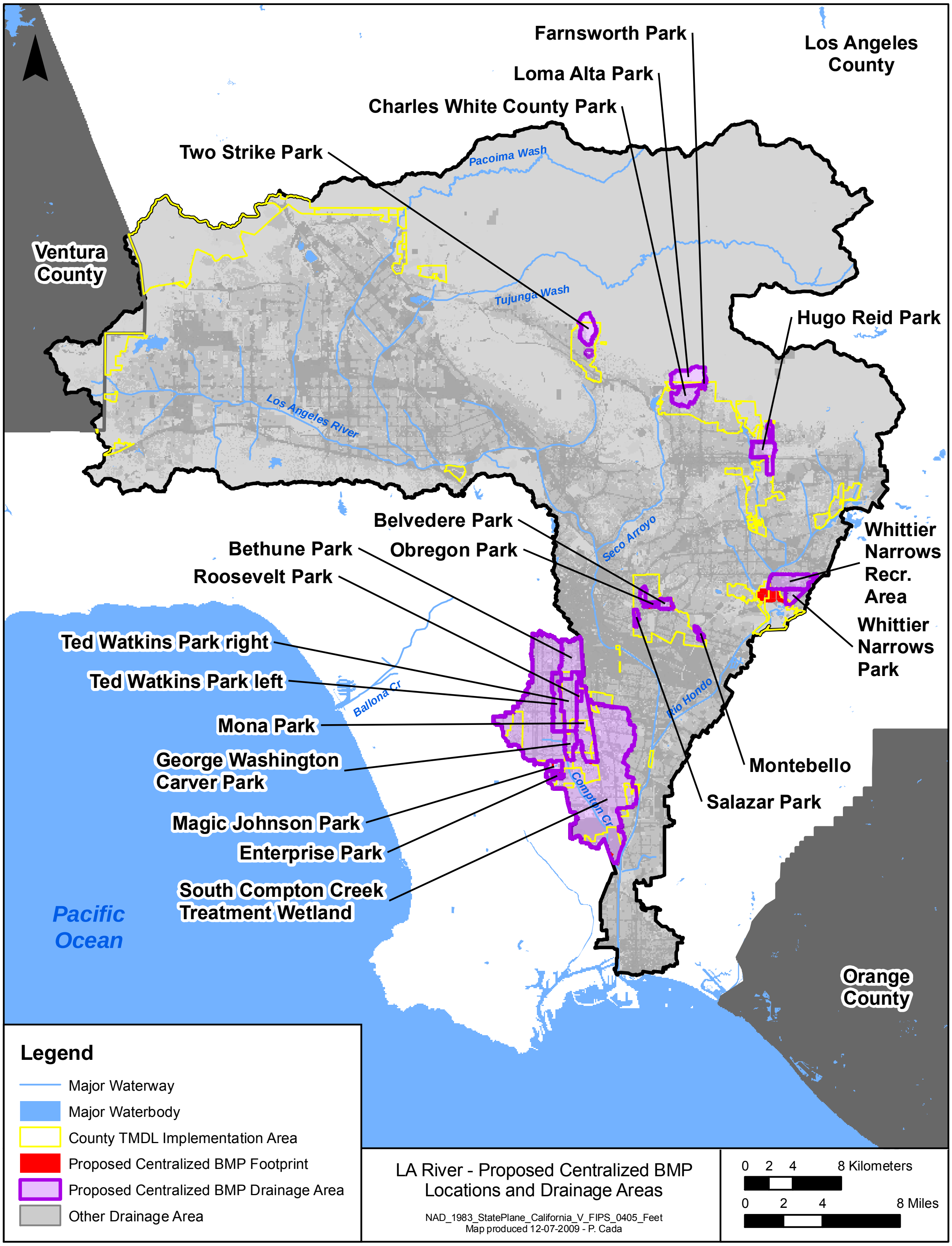

Figure 71. Locations and Drainage Areas of Centralized BMPs on Public Lands

7. Identification of Water Resources and Other Opportunities

Water is one of the most precious of natural resources to the arid and highly urbanized Los Angeles region. Agencies work together to manage this resource and recognize the importance of an integrated approach to developing regional strategies for its optimization. Storage and reuse of stormwater runoff is a major component of an integrated water resources approach. This section includes an examination of the region's water supply, current management considerations, and plans for maintaining and enhancing those resources. Planned water resource projects are identified that could provide an opportunity to contribute to TMDL implementation including additional opportunities for distributed and centralized structural BMPs.

7.1. Hydrogeology and Groundwater Aquifer Characteristics

Before the region was developed, rain collected in the existing waterbodies and washed down to the broad alluvial plain where the soil absorbed it. The Los Angeles River was once free flowing with a course that naturally shifted across the coastal plain. Since the early 20th century, however, the river has been channelized and concrete lined to control runoff and protect the region from damaging floods. The concrete channels that facilitate flood management, however, have the negative effect of impeding groundwater recharge, which is of special concern because the groundwater basins in the watershed have been historically over-pumped and in need of replenishment.

Groundwater represents a significant portion of local supplies and is an important resource for storage. The key to groundwater basin management is to provide for sustainable, long-term operation of the groundwater basin. This requires a balance between production and long-term recharge. Natural recharge in the region is mostly insufficient for maintaining both the groundwater levels in the basin and current pumping levels. This is primarily because of the extent of impervious surfaces in the highly developed region. Many managing agencies rely on artificial recharge of the groundwater basins, including diverting local runoff to spreading grounds. Recharge of captured runoff is, by far, the largest component of active recharge.

Captured local surface water is considered an important resource. Its benefits include flood protection, but it also can support direct use and groundwater recharge. Most surface runoff results from precipitation, but dry urban runoff is also a contributing source. The infrastructure that is in place for managing storm flows in the Los Angeles River watershed includes the riverbed's channelization; five dams that U.S. Army Corps of Engineers (USACE) manages—Hansen, Lopez, Santa Fe, Sepulveda, and Whittier Narrows; and several dams and surface water storage facilities that LACDPW manages. These include the Big Tujunga and Pacoima dams, which further improve flood protection and store runoff for subsequent diversion to the County's 27 groundwater spreading grounds.

The major groundwater basins in the Los Angeles River watershed are shown in Figure 72. The basins that underlie the watershed are the San Fernando Valley Basin, the Central and West Coast Basins in the Los Angeles County Coastal Plain Basin, the Raymond Basin, and a portion of the San Gabriel Valley Basin. The San Fernando Valley Basin, Raymond Basin, and a portion of the San Gabriel Valley Basin are the northernmost basins underlying the Los Angeles River watershed and benefit from recharge through the percolation of both precipitation and stream flows from the San Gabriel Mountains to the north. The San Fernando Valley Basin, Raymond Basin, San Gabriel Valley Basin, and the Central Basin underlie the majority of County TMDL Implementation Area and are further described in the following sections. A detailed description of the groundwater basin characterstics is provided in Appendix H, including a summary of the groundwater storage and recharge capacities managed for the basins. The basins represent a major source of water supply for the region, with recharge of stormwater via spreading grounds practiced extensively for water resource management.

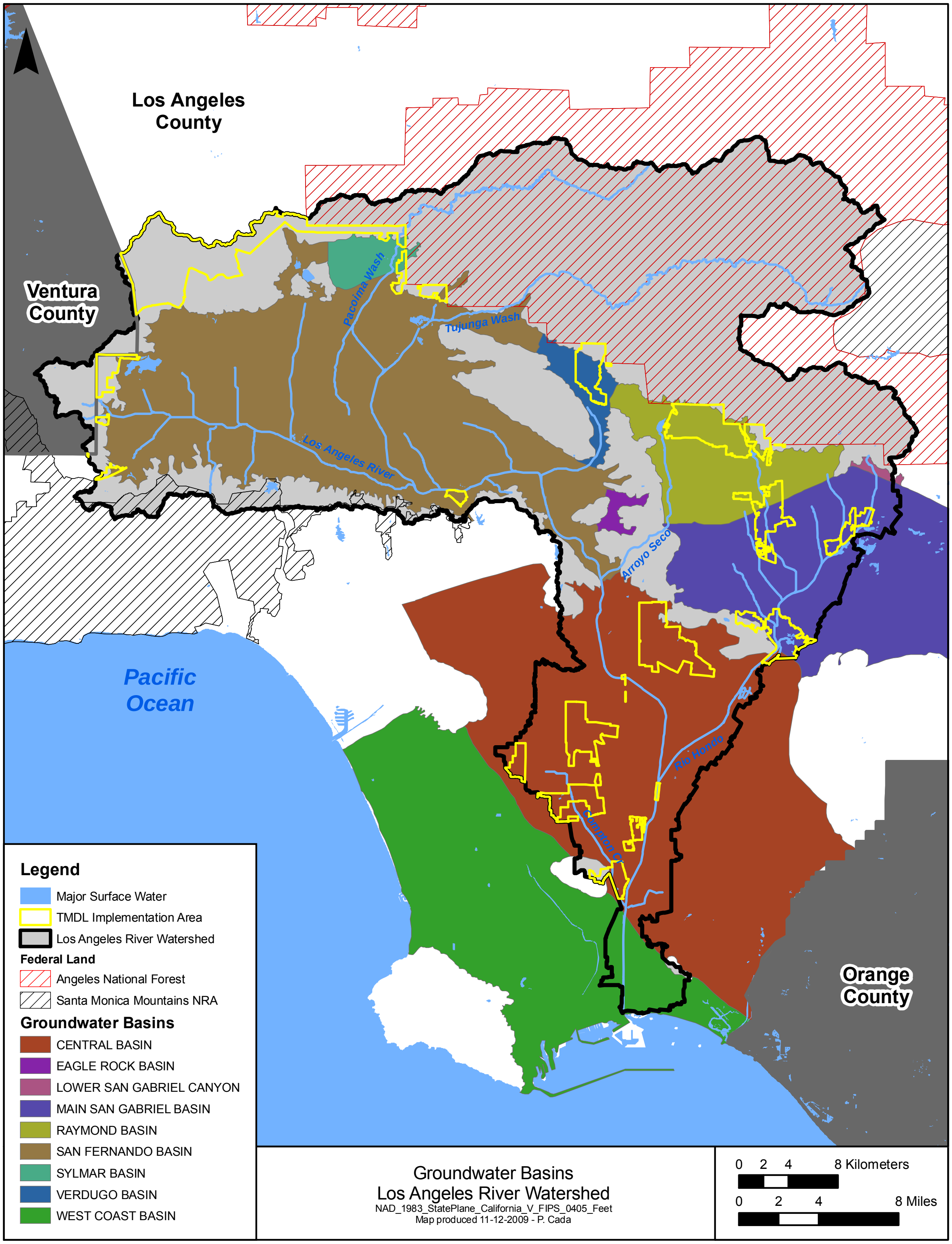

Figure 72. Groundwater Basins and TMDL Implementation Areas in the Los Angeles River Watershed

7.2. Merging Integrated Water Resources Planning Objectives with TMDL Implementation

Various strategic planning efforts are underway in the region that can be merged to ensure that integrated water resources plans are in line with TMDL implementation objectives, and vice versa. This TMDL Implementation Plan seeks to acknowledge those efforts and take advantage of planned projects as opportunities for additional benefit in terms of BMP implementation in the County TMDL Implementation Area. Likewise, additional BMPs recommended in this plan can provide benefit to water resources in the watershed, which should be quantified so that future parallel integrated water resources plans can be consolidated with TMDL implementation efforts. Consideration of both aspects within this plan provides a comprehensive perspective for overall responsible management of water resources and improved water quality, resulting in an integrated watershed management framework for the County TMDL Implementation Area.

Managers are focused on optimizing water resources through developing strategic, regional, and multi-beneficial water quality and water supply projects. The project objectives are often interrelated, where targeting a primary goal could result in many secondary benefits. The goal for meeting TMDL requirements, for example, is potentially in alignment with several integrated water resources planning objectives outlined in the Integrated Regional Watershed Management Plan (IRWMP), including the following:

- Improved water supply
  - Increase water supply reliability
  - Diversify water supply sources
  - Balance groundwater management
  - Promote water use efficiency
- Improved water quality
  - Protect and improve water quality
- Enhanced habitat
  - Protect and restore wildlife habitats/ecosystems
- Sustained infrastructure for local communities
  - Flood management and protection

Diversifying water supplies and, specifically, reducing reliance on imported supplies are primary goals of water management for the region. As a result, developing local supplies is of special importance. Groundwater already represents a significant portion of local supplies for the region. In the Los Angeles River watershed, many agencies rely on artificial recharge of the aquifers to support groundwater production. As noted previously, local runoff, including both dry and wet weather flow, is the primary source for active recharge in the area.

The vast network of flood control infrastructure that includes channels, dams, and reservoirs also provides the means for replenishing local groundwater supplies. Therefore, planned enhancements to structures that increase the ability to capture, store, and manage local runoff often target both flood protection as well as water conservation and result in increased water available for recharge. Recharge is further enhanced by improvements to spreading grounds. It results in increased supplies because of the additional available storage capacity that has been identified for the underlying groundwater basins.

Goals for water conservation and groundwater recharge are in sync with goals toward TMDL compliance. Capturing runoff results in less water discharged to the Los Angeles River, and consequently, reduces the transport and discharge of pollutants. The water quality benefits include removal of bacteria, nutrients, metals, toxics, and trash, which would otherwise be transported to the Los Angeles River and the Pacific Ocean.

Projects identified in this TMDL implementation plan have a primary focus on water quality improvement to achieve TMDL compliance. Some of the projects would have additional benefits for regional water resources. Such projects include the following:

- Reduction of Irrigation Return Flow provides a significant conservation of water supplies through improved water use efficiency.
- All centralized and distributed structural BMPs that provide on-site storage could also support rainwater capture, opportunities for diversifying water supply sources, enhanced wildlife habitat/ecosystems, and recreational opportunities.

7.3. Consideration of Currently Planned Water Resources Projects

Several projects planned for the Los Angeles River watershed were reviewed and identified to have additional benefit of improving water quality in the watershed. A number of documents were reviewed for this task, but the IRWMP was the largest source of project-specific information. Once identified, the projects were screened to develop a priority list of projects for consideration in the TMDL implementation plan. The criteria for selecting projects are presented in Figure 73.

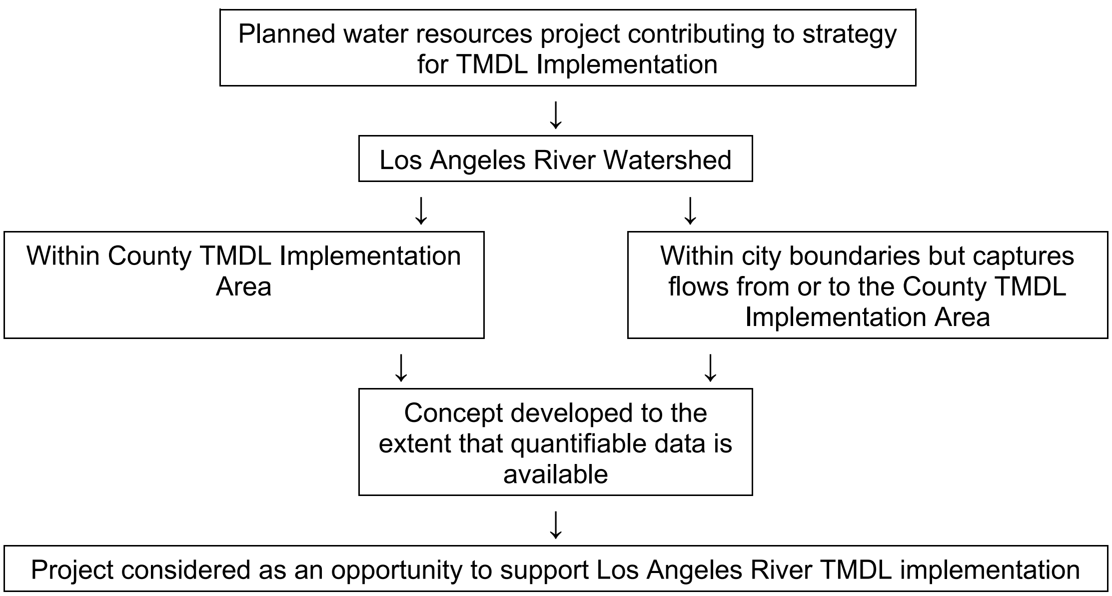

Figure 73. Criteria for Selecting Projects for Consideration in the TMDL Implementation Plan

Several of the identified projects for the Los Angeles River watershed are focused on improving water quality. The projects target TMDL compliance and have other benefits such as habitat restoration and recreational opportunities. Table 53 documents the identified planned or proposed projects in the Los Angeles River watershed that meet the above criteria. Figure 74 shows the location of those projects and their proximity to the County TMDL Implementation Area. For the projects planned for Charles White County Park, Obregon County Park TMDL/LID Improvements, and Compton Creek Wetland, the sites are consistent with the centralized BMP projects (Charles White County Park, Obregon Park, and Compton Creek Wetland) included in this TMDL implementation plan.

Table 53. Identified Los Angeles River Watershed Area Project Summaries

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Big Tujunga Dam Seismic Rehabilitation and Spillway Modification Project					
LACDPW	809 Big Tujunga Canyon Road, above city of Sunland, in the Angeles National Forest along the Big Tujunga River	Plans, environmental documentation, and funding are complete	Reinforce the existing dam, modify the spillway, dam crest and other structural appurtenances, and install a new control system to restore the dam's original operational capacity of 5,960 AF	Increase storage capacity by 4,500 AF for stormwater runoff and water conservation.	Downstream flood protection and habitat enhancement, increase local water supply reliability, recharge groundwater to the San Fernando Basin; capital cost of $88.5 million; in construction with a completion date of 5/01/2010.
Big Tujunga Dam Spillway					
LACDPW	Big Tujunga Dam is about 10 miles northeast of Sunland in Big Tujunga Canyon near the San Gabriel Mountains	Concept plans not yet developed	Construct a rubber dam in the existing spillway to allow for increased storage capacity behind the dam	Increase storage capacity by 700 AF for stormwater runoff and water conservation.	Increased storage will allow for greater water conservation activities at downstream spreading grounds; estimated cost is $2 million; future project with no date given.
Charles White County Park					
LACDPW	In the unincorporated community of Altadena at the 6-acre Charles White County Park	Project Concept Report. The project will likely be categorically exempt with no environmental permits anticipated.	Intercept dry weather and low storm flows from the adjacent West Altadena Drainage System and convey to a low-flow stream course through the park. The stream course will be planted with native vegetation and promote infiltration. Flows not infiltrated will be collected by a second drain that ties into the Altadena Drainage System that discharges to Arroyo Seco. A trash removal device is also proposed.	Soils have moderate to high infiltration rates.	Improve water quality and enhance water conservation, aesthetically enhance existing park, capture flow from approximately 223 acres; estimated costs are $812,000 for construction; construction is planned for FY 2009–2010.
Crescenta Valley County Park Multiuse Project					
Crescenta Valley Water District	Crescenta Valley County Park South of Honolulu Avenue between New York Avenue and Lauderdale Avenue in La Crescenta	Preliminary Design	Installation and maintenance of underground infiltration galleries underneath portions of the existing park. Includes restoration of existing park with native and heritage landscaping garden. Existing parking lot to be redesigned to incorporate native landscaping surrounding parking area to achieve 0% runoff.	Annual yield of water supply 3,300 AF/year. Recharges the Verdugo Basin.	Stormwater capture in infiltration basins will be used for reduction of surface water pollution, groundwater recharge, water conservation education, and recreational multi-use. Estimated design and capital cost 3.2 million. Estimated O &M costs $35,000/year. Final design by 12/2010. Construction 2/2011-10/2011.

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Eaton Wash Spreading Grounds					
LACDPW	Altadena, adjacent to Eaton Wash in the upper Rio Hondo watershed	Concept has been approved, although issues have arisen regarding facilities planned for the site	Combine and enlarge existing basins	Increase storage to 575 AF. Increase conveyance by 85 cfs from 40 to 125 cfs. Recharges the Raymond Basin.	Increased flood protection and additional water for recharge to the Raymond Basin increasing the local water supplies; estimated cost is $2 to $5 million; construction is tentatively scheduled from 10/1/2010 to 1/1/2011.
Hansen Spreading Grounds Basin Improvements					
LACDPW	Sun Valley area of the city of Los Angeles, adjacent to Tujunga Wash in the upper Los Angeles River watershed	In construction, to be completed by 1/10/2010	Increase storage capacity by reconfiguring and deepening the existing spreading basins.	156-acre parcel is adjacent to the Tujunga Wash Channel downstream from the Hansen Dam. Recharges the San Fernando Basin.	The additional storage will provide more flood protection of approximately 150 cfs, increase recharge, and enhance water quality with a silting basin; estimated capital costs are $8 to $14 million; basin modifications are in the construction stage.
Obregon County Park TMDL/LID Improvements					
LACDPW	4021 East First Street in East Los Angeles	Project concept in development	Includes developing a stormwater pretreatment unit and infiltration basins with LID elements (native landscaping, porous pavement, green roofs, bioretention) used throughout the park. Bioretention swales will be placed along the street frontage and planter boxes near buildings.	Infiltration areas will treat water to reduce pollutants for TMDL compliance.	Water quality and water conservation improvements with infiltration areas designed to treat water to reduce pollutants for TMDL compliance and increase recharge; estimated costs are $25 to $40 million; construction is planned from 6/1/2010 to 5/31/2011.
Pacoima Dam Sediment Removal Project					
LACDPW	Pacoima Reservoir is in the Angeles National Forest, above the Sylmar area of the city of Los Angeles, in Pacoima Canyon	Conceptual plans complete	The reservoir has more than 5,000,000 cubic yards of sediment accumulated in it, resulting in a loss of almost 2,800 AF of water storage capacity. The project will excavate approximately 1.5 to 5 million cubic yards of accumulated sediment.	Will provide an additional 930 to 2,800 AF of additional reservoir storage for flood control and recharge for the recharge the San Fernando Basin.	Increased flood control and water conservation for groundwater recharge; estimated cost of $10 to $50 million; phase I of the proposed construction is from 7/1/2011 to 12/31/2012. Phase II is unscheduled.

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Pacoima Spreading Grounds Improvements					
LACDPW	The Pacoima Spreading Grounds facility is in the Sun Valley area of the city of Los Angeles, adjacent to Pacoima Diversion Wash	Concept is scheduled to be finalized by August 2009	Replacing existing Pacoima Diversion Channel radial gate with a rubber dam, installing telemetry, installing trash rack and updated flow measurement instrumentation at intake works, relocating headworks, removing sediment and clay lens, installing vertical drains to enhance percolation, combine basins to simplify operation, and enhance landscaping around the perimeter of the facility.	The rubber dam and new intake system will improve water conservation. Removing sediment and the clay lens will increase percolation from 100 cfs to about 200 cfs. Relocating the intake will improve intake operations and provide more open space.	Enhanced water quality, recharge, water quantity control, increased open space for future public use; estimated capital costs are $12 to $15 million; proposed construction scheduled from 1/1/2011 to 3/30/2012.
Santa Anita Dam Buttress					
LACDPW	Santa Anita Dam is along Santa Anita Wash, approximately 4 miles north of the city of Arcadia, in the San Gabriel Mountains	Conceptual plans approved	Upgrade Santa Anita Dam to comply with Division of Safety of Dams design requirements for seismic stability and spillway adequacy. Two concepts developed for rehabilitation are (1) a full rehabilitation consisting of a full concrete buttress on the downstream face, to an elevation of 1,300 feet, and (2) a partial rehabilitation consisting of a partial concrete buttress on the downstream face, to an elevation of 1,270 feet.	The operating guidelines for the dam will be modified for maximum water conservation benefits.	The ability to hold a larger reservoir pool and capture more stormwater runoff for recharge downstream; estimated costs are $40 to $100 million (depending on concept accepted); proposed schedule has construction from 2013 to 2014.
Santa Anita Debris Basin Seismic Upgrade					
LACDPW	Santa Anita Debris Dam is along Santa Anita Wash, near the mouth of Santa Anita Canyon in Arcadia	Conceptual plans in progress	Seismically modify dam spillway walls, spillway invert, outlet tower and embankment to meet state seismic requirements and restore ability to hold reservoir for water conservation purposes.	Rehabilitation of Santa Anita Debris Dam will mitigate seismic deficiencies and allow for additional flexibility in operating guidelines for the debris dam.	Increased water conservation and recharge benefits in the East Raymond Basin, some water quality improvements are also expected; estimated capital costs are $10 million; proposed construction for 2013 or 2014.

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Santa Anita Spreading Grounds Improvements					
LACDPW	Santa Anita Spreading Grounds is in the Arcadia, adjacent to Santa Anita Wash, in the Rio Hondo watershed	Concept plans are in development	Reconfigure and deepen the spreading basins for more efficient operation and storage. Construct interbasin structures and motorized interbasin drain gates.	The estimated annual yield of supply is 300 acre-feet per year (AFY). Current storage is 25 AF with a proposal to increase storage to 61 AF.	Increased groundwater conservation and recharge in the Raymond Basin; estimated capital costs are $1 to $3 million; proposed construction is scheduled for 12/1/2010 to 12/1/2011.
Compton Creek Wetland					
LACDPW	Unincorporated County community of Rancho Dominguez, near detention basin for the Compton Creek Pump Plant	Project Concept Report complete. Will require environmental documentation like a Negative Declaration before proceeding with design.	Develop a treatment wetland in the basin to treat a portion of dry weather and small stormwater flows from Compton Creek. The detention basin is used to store runoff before it is pumped out to the creek. A treatment wetland would remove pollutants from the runoff before discharge. Water from the creek would also be diverted through the wetland to maintain constant water levels for habitat when runoff is insufficient.	Treatment of dry weather and small stormwater flows before discharge to creek.	Improved water quality and help meet TMDL requirements for the subwatershed, provide wetland habitat, maintain flood protection, and aesthetically improve community; estimated project costs are $4 million; proposed construction is scheduled from 1/1/2009 to 5/1/2010.
Tujunga Wash Greenway and Stream Restoration, Phase 2, and Phase 3					
LACDPW	Tujunga Wash. Phase 1 between Oxnard Street and Vanowen Street. Phase 2 between Vanowen Street and Sherman Way. Phase 3 to be determined (TBD)—north of Sherman Way	Phase 1 is in operation, Phase 2 construction is scheduled for summer 2010, Phase 3 construction is potentially planned for 2012	Use the County's right-of-way along the Wash for a 1-mile stream course where dry weather flows are diverted from the flood control channel to the stream for percolation into the underlying San Fernando Valley Groundwater Basin. Phase 2 will extend the project another one-half mile to the north. The Phase 3 location is yet TBD.	Diverts 0.5 cfs from the channel to the stream for percolation to the groundwater basin.	Improved groundwater recharge, water quantity control, and presumably some water quality benefits; Phase 1 project costs are $7 million, Phase 2 is estimated at $5 million, Phase 3 estimated at $5 to $10 million; Phase 1 was completed in November 2007, Phase 2 is scheduled for construction in summer of 2010, and Phase 3 is planned for 2012.

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Tujunga—Sun Valley Tujunga Wash Diversion Project (Sheldon Pit)					
LACDPW	Sun Valley subwatershed at Glenoaks and Sheldon	Conceptual plans have been completed	Diverting water from Tujunga Wash into Sheldon Pit for groundwater recharge. Acquiring this 138-acre pit provides multiple benefits such as habitat enhancement and both active and passive recreational amenities to enhance the quality of life for the residents living in the community.	Take in storm flows from Tujunga Wash and recharge the Upper Los Angeles River Basin.	Increased water conservation and supply, flood protection, pollution control, TMDL compliance, and opportunities to develop open space for recreation and wildlife; estimated project costs are $22 to $30 million; proposed project schedule is 1/1/2014 to 1/1/2019.
Boulevard Pit					
City of Los Angeles, Department of Water and Power	Privately owned, 140-acre, active gravel mining pit at the intersection of San Fernando Road and Branford Street	Conceptual plans are in progress	Acquire and develop Boulevard Pit into a multiuse retention and recharge facility to enhance stormwater conservation.	Recharge the San Fernando Valley Groundwater Basin with approximately 16,000 AF on average, per year, for storage and later pumping.	Groundwater recharge, water quality improvements, increased stormwater conveyance downstream, creation of native habitat, wetlands, and recreational opportunities; cost of $21 to $28 million; construction tentatively scheduled from 1/1/2012 to 1/1/2014.
Browns Canyon Wash at Route 118 and Rinaldi					
Mountains Recreation and Conservation Authority	Southwest corner of the 118 Freeway and DeSoto Avenue	Conceptual plans and environmental documentation complete	Widen Browns Canyon channel with terracing resulting in increased stormwater capacity and reduced flood risks. Construction of detention areas and swales are designed into the project to improve water quality from stormwater and runoff. Re-creating native riparian and upland habitats will increase habitat value.	Modifying the channel by terracing will increase capacity by 197,000 cu. ft. Construction of detention areas and swales will increase capacity by 572,000 cu. ft.	Water quality enhancements by filtering pollutants, recharging groundwater supplies, reducing flood risks, and restoring open space; $4 million capital cost; schedule is TBD.
Browns Canyon Wash at Plummer and Variel					
Mountains Recreation and Conservation Authority	San Fernando Valley	Conceptual plans complete and land acquisition in progress	Create a greenway that would capture and filter stormwater and urban runoff, enhance habitat for birds, and provide a recreational area for the surrounding neighborhood	TBD	Improving water quality, create a new water supply, habitat enhancement for wildlife, and beneficial public use; $15 million capital cost; schedule TBD.

Agency	Location	Current phase	Project description	Characteristics	Benefits; estimated costs; schedule
Santa Susana Creek at Topanga Canyon and Plummer					
Mountains Recreation and Conservation Authority	San Fernando Valley	Conceptual plans have been completed	Increase water retention capacity by building three detention areas and three swales, improve water quality from urban runoff and stormwater, and create recreational space and expand habitat for nearby wildlife corridor.	Add detention capacity of 3.9 AF, swale capacity of approximately 33,840 cu. ft. to filter pollutants and recharge groundwater supplies. Nine planned cisterns with a capacity of 1,178 gallons each to store rainwater.	Improve water quality, create a new water supply, habitat enhancement for wildlife, and beneficial public use; costs TBD: schedule TBD.
Rogers Park Watershed Runoff Treatment Reuse and Infiltration					
City of Los Angeles, Department of Water and Power	Sun Valley area of the city of Los Angeles, adjacent to Tujunga Wash; recharges the San Fernando Basin	Final design initiated 7/21/09	Regrade and increase the capacity of the spreading basins; abandon the existing Tujunga Wash intake and rubber dam and relocate to Basin 1; add an intake and rubber dam near Basin 12 to capture additional flows from Tujunga Wash and Pacoima Diversion Channel, and install a telemetry system.	Increase intake from 250 cfs to 450 cfs and storage capacity from 100 to 944 AF, and the added diversion of Pacoima Wash flows will allow recharge of approximately 4,200 AF per year.	Increase water conservation thereby reducing the demand on imported water; estimated cost of $12 million in capital costs; proposed construction scheduled for 7/1/2010 to 7/1/2011.

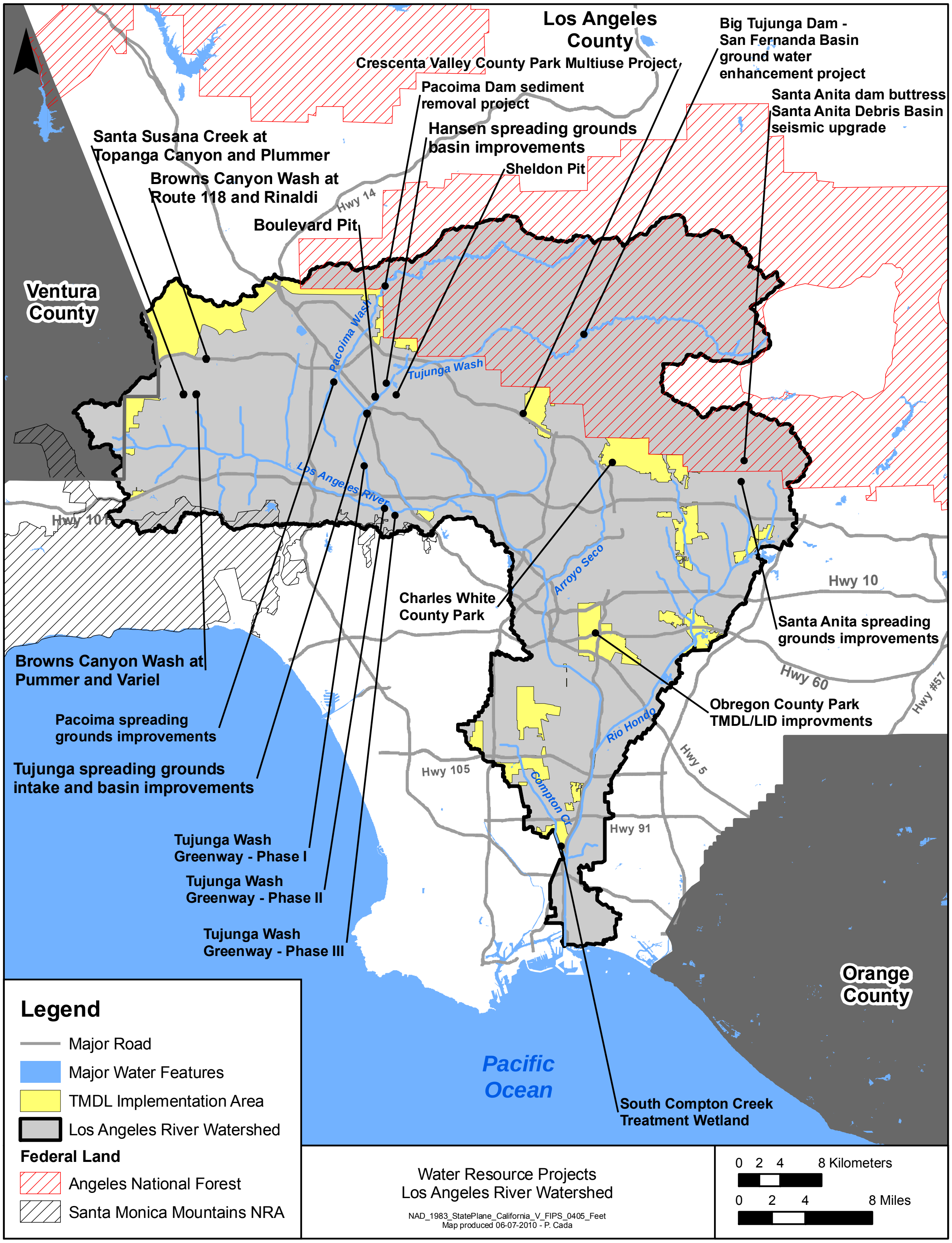

Figure 74. Planned Water Resource Opportunities in the County TMDL Implementation Area

As an overview, improvements to dams and spreading grounds are a meaningful means of increasing total volume of stormwater capture and promoting recharge to groundwater basins. This provides needed water quantity and water supply benefits to the region. It is expected that pretreated water diverted to the facilities, which could return to the Los Angeles River after going through the facilities, is expected to have improved water quality and, therefore, contribute to TMDL compliance. Similarly, reservoir improvements that increase storage are likely to result in more pollutants (e.g., metals, nutrients) settling out of the water column. The major projects planned or proposed by LACDPW that fit into this category are the following:

- Big Tujunga Dam—San Fernando Basin Groundwater Enhancement Project
- Big Tujunga Dam Spillway
- Eaton Wash Spreading Grounds
- Hansen Spreading Grounds Basin Improvements
- Pacoima Dam Sediment Removal Project
- Pacoima Spreading Grounds Improvements
- Santa Anita Dam Buttress
- Santa Anita Debris Basin Seismic Upgrade
- Santa Anita Spreading Grounds Improvements
- Tujunga–Sun Valley Tujunga Wash Diversion Project (Sheldon Pit)

A few key features of those projects are that the Big Tujunga Dam project would significantly increase storage capacity through structural rehabilitation. The Pacoima Dam project would improve water quality with increased storage resulting from sediment removal. Most of the dam projects allow for increased diversion to the spreading grounds and subsequent groundwater recharge. The spreading grounds themselves are optimized through reconfiguration, improvements to the intakes, and enhancements resulting in increased percolation and storage. Because of the need for more recharge through active infiltration for water supply and to meet adjudication of water, many of the spreading ground improvements are of major importance in the Los Angeles River watershed to achieve needed aquifer recharge and storage. This is especially true for the San Fernando Valley Basin, which has little natural recharge to the basin, and the Raymond Basin, which has been completely adjudicated and has suffered declining aquifer levels for many years. Note also that many of the projects include other habitat enhancements that will contribute to improved water quality and recreational opportunities for the public.

Other projects that are proposed or planned can significantly improve water quality in the Los Angeles River and include diverting local runoff for treatment wetlands, greenways, groundwater recharge, and stream restoration. Those projects are the following:

- Charles White County Park
- Crescenta Valley County Park Multiuse Project
- Obregon County Park TMDL/LID Improvements
- Compton Creek Wetland
- Tujunga Wash Greenway

The Charles White County Park and Crescenta Valley County Park Multiuse projects are designed to intercept dry weather and low storm flows, which will likely have a significant effect on water quality improvement. By planting native vegetation and increasing infiltration at both sites, volume reduction and sediment and pollutant capture will be enhanced, providing water quality benefits. In addition, including a trash-removal device at Charles White County Park will help reduce the amount of trash and other gross solids from entering the Los Angeles River.

The Obregon County Park TMDL/LID Improvements includes developing stormwater pretreatment devices and infiltration basins that include LID elements designed throughout the park. The project also includes adding native landscaping, installing porous pavement, incorporating green roofs, and applying bioretention swales along the street frontage. Including planter boxes along buildings is also a part of the plans. All these improvements are expected to result in water quality improvements from stormwater runoff sources in the park.

Developing a treatment wetland in the Compton Creek watershed will help to ameliorate the water quality effects of dry weather flow and small stormwater flows from Compton Creek. The treatment wetland is expected to remove pollutants from the runoff before discharge back to the creek. In addition, the project will improve and create habitat for wetland dependant species.

The remaining phases (2 and 3) of the Tujunga Wash Greenway and Stream Restoration project will provide a natural stream course with native vegetation in the County's right-of-way that will provide improved pollutant removal from dry weather flow and infiltration opportunities in the watershed. The stream restoration will also improve habitat conditions along the stream corridor.

Of the above projects, Obregon County Park infiltrates to the Central Basin, Crescenta Valley County Park infiltrates to the Verdugo Basin, and Charles White County Park and the Tujunga Wash Greenway projects would infiltrate to the Raymond and San Fernando Valley basins, respectively. Those latter projects can provide needed groundwater and aquifer recharge in addition to the spreading grounds focused on the San Fernando Valley and Raymond basins, increasing the natural recharge of the basins.

Projects that are planned or proposed by agencies other than the County include efforts by the City of Los Angeles Department of Water and Power, such as the project at Boulevard Pit. That project will provide a multifunctional improvement that includes recharge to the San Fernando Valley groundwater basin and enhancements to reduce pollutant loading including trash, sediment, heavy metals, and bacteria removal that will reduce loading to the Los Angeles River.

Both projects planned by the Mountains Recreation and Conservation Authority in Brown's Canyon Wash will provide water quality benefits. At the route 118 and Rinaldi site, the plans for increased stormwater capacity and constructing detention areas and swales will improve pollutant removal in the watershed. Also re-creating native riparian and upland habitats will provide improved habitat in the canyon. The planned greenway project that will capture and filter stormwater and urban runoff at the Plummer and Variel site will provide water quality benefits and enhance habitat for birds and provide recreational space for the surrounding neighborhood.

The Santa Susana Creek at Topanga Canyon and Plummer, also planned by the Mountains Recreation and Conservation Authority, can increase water retention capacity in the basin through the detention facility, and the vegetated swales can provide improvements in water quality from urban stormwater runoff. In addition using cisterns can provide opportunities for water storage and beneficial use during times of greater need.

7.4. Linkage of Water Resources and TMDL Implementation Planning Efforts

The information gathered here is intended to support strategy development and planning meaningful and quantifiable improvements in the region's water resources management. Three project sites—Charles White County Park, Obregon County Park TMDL/LID Improvements, and Compton Creek Wetland—were included as sites for centralized structural BMP projects to address TMDL implementation. The remaining planned projects are within city incorporated jurisdictions, and although their implementation is promoted, there is limited ability for the County to lead such efforts without significant partnerships established with other agencies. However, partnerships can be sought in the future and as funding becomes available, potential participation in aspects of projects in incorporated areas can occur.

Additional site assessment and BMP evaluation identified additional BMP strategies within public land that could further address integrated water resources planning objectives, including the centralized structural BMPs on public land, distributed structural BMPs for all publicly owned parcels in the County TMDL Implementation Area, and the Pilot Distributed BMP Project for a County Road.

To meet the WLAs, additional need for centralized structural BMPs on private land was identified, and analysis was performed to evaluate different options in terms of the type and size of the BMPs, as well as the drainage area treated. Although the exact locations of candidate private parcels were not identified for acquisition and BMP design, the conceptual BMP capacity proposed for private land provides a goal for implementation. When identifying opportunities for land acquisition, managers can consider other regional water resources planning objects to investigate potential multiuse projects.

Although the primary focus of the above BMPs is stormwater pollutant load reduction, a key process used in the BMPs is infiltration. Much of the infiltrated water is subject to evapotranspiration losses, but a portion of the water has the potential to provide recharge to local groundwater basins. Table 54 lists the structural BMPs proposed, as well as information regarding stormwater inflow and infiltration provided (presented in cubic feet per year for comparison). A considerable portion of stormwater inflow is infiltrated in many of the BMPs. Infiltration capacities are also presented in AFY for comparison to typical recharge rates of groundwater basins in the area discussed in Appendix H.

The proposed structural BMPs for the County TMDL Implementation Area overlay multiple groundwater basins, including most notably the Central, Main San Gabriel, Raymond, and San Fernando Valley basins. The estimated amount of infiltrated water that can serve to recharge those groundwater basins is uncertain without further detailed analysis and would depend on the characteristics of each basin and overlying soil and other obstructions. The BMPs can be viewed as tools for restoring the natural hydrologic processes that have been disrupted by development and resulting excess impervious areas, which stifled stormwater infiltration to groundwater.

Table 54. BMP Infiltration Benefits

BMP Type and Location		Flow Volume (ft^3/yr)[a] Inflow (ft^3/yr)	Infiltration (ft^3/yr)	Infiltration (AFY)
Centralized BMPs on Public Land	Belvedere Park	8,414,423	6,326,791	145
	Bethune Park	4,756,491	699,877	16
	Charles White County Park	25,831,406	14,272,117	328
	Enterprise Park	1,479,595	1,344,507	31
	Farnsworth Park	490,595	287,752	7
	G.W. Carver Park	46,063,351	4,409,508	101
	Hugo Reid Park	7,213,788	2,445,148	56
	Loma Alta County Park	6,277,241	4,936,707	113
	Magic Johnson Park	6,912,123	6,505,051	149
	Mona Park	37,358,768	3,867,968	89
	Montebello (Grassy Section Dividing Street)	1,377,249	1,037,002	24
	Obregon Park	8,060,868	3,047,743	70
	Roosevelt Park	2,446,093	2,001,579	46
	Salazar Park	4,304,303	3,784,259	87
	Compton Creek Wetland	222,854,167	1,690,651	39
	Ted Watkins Park Left	1,456,879	919,766	21
	Ted Watkins Park Right	48,301,866	5,988,036	137
	Two Strike Park	7,450,037	6,306,320	145
	Whittier Narrows Park	1,123,825	1,068,774	25
	Whittier Narrows Recreation Area	335,133	269,666	6
Pilot Distributed BMP Project for a County Road	Bioretention	61,107	34,239	1
Distributed on Public Land - High-Infiltration Soil	Porous Pavement	15,419,106	12,372,030	284
	Bioretention	8,902,812	2,764,250	63
Distributed on Public Land - Low-Infiltration Soil	Porous Pavement	11,740,515	4,957,751	114
	Bioretention	7,135,820	1,135,719	26
Centralized on Private Land: Option 1 (D)	Infiltration Basin	351,970,010	125,310,115	2,877
	Extended Detention Pond	435,469,853	--	--

a. Based on model simulation of WY 2003.

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8. Regulatory Requirements and Environmental Permits

This section presents an assessment of the regulatory requirements and environmental permits that could affect the implementation of the proposed BMPs. The discussion focuses on distributed and centralized structural BMPs at selected sites because the nonstructural BMPs are programmatic in nature and are not anticipated to trigger permit requirements.

This analysis considers a variety of federal, state, and local regulations and permits that can affect the feasibility and cost of BMP projects, including the following:

Federal

- CWA
- Endangered Species Act (ESA)
- U.S. Forest Service (USFS) Permits
- Migratory Bird Treaty Act
- National Environmental Policy Act (NEPA)

State

- California Air Resources Board (CARB) Regulations
- California Endangered Species Act (CESA)
- California Environmental Quality Act (CEQA)
- California Coastal Act[3]
- Cultural Resources
- Dam Safety Laws
- Lake and Streambed Alteration Program
- State Lands Leasing and Permits Regulation
- State Park Permits

Local

- Drought-Tolerant Landscaping Requirements
- Geotechnical Reporting Requirements
- Green Building Requirements
- LID Requirements/LID Manual
- Sedimentation and Erosion Control Requirements
- Stormwater Requirements
- Tree Protection Requirements
- Additional County Permits (flood and road permits)
- Recycled Water Laws
- Zoning Regulations
- General Land Use Plan Requirements
- Community Standards District Requirements
- Setback Requirements

[3] None of the County TMDL Implementation Area in the Los Angeles River watershed intersects with the coastal zone. This regulation has been removed from consideration.

- Significant Ecological Areas (SEAs) Requirements
- Sanitation Districts of Los Angeles Requirements

The regulatory requirements and environmental permits listed above are described in detail in Appendix I.

8.1. Distributed Structural BMPs

As stated in Section 5, distributed structural BMPs will be implemented at selected sites within unincorporated County areas. Recommended BMPs in this category include bioretention, linear bioretention trenches, and porous pavement, all of which can be implemented on individual parcels to store, infiltrate, and treat runoff from that parcel. It is important to note that while individual parcels and groups of parcels have been selected for the BMPs, exact locations of the proposed BMPs in those parcels have not been selected. Therefore, uncertainty exists as to whether natural feature disturbance would occur and whether regulations relating to wetlands, streams, hazards, and protected species would apply. In addition, because the BMPs themselves have not been designed, requirements triggered by size (e.g., local stormwater and planning requirements or dam safety laws) might or might not apply. This uncertainty is accounted for in the linkage tables below as "applicable depending on project characteristics."

On the basis of the BMP types selected for implementation, the regulatory requirements and environmental permit requirements that might be applicable are summarized in Table 55 through Table 58.

Table 55. Linkages between Distributed Structural BMPs and Federal Regulations

	Federal Regulations					
BMP	CWA Section 404	CWA Section 401	ESA	USFS Permits	Migratory Bird Treaty Act	NEPA
Bioretention	○		○	○	○	○
Linear Bioretention Trenches	○		○	○	○	○
Porous Pavement				○		○

● Applicable to all projects
○ Applicable depending on project characteristics

Table 56. Linkages between Distributed Structural BMPs and State Regulations

	State Regulations							
BMP	CARB Regulations	CESA	CEQA	Cultural Resources	Dam Safety Laws	Lake & Streambed Alteration Program	State Lands Leasing & Permits Regulation	State Park Permits
Bioretention	●	○	○	○			○	○
Linear Bioretention Trenches	●	○	○	○			○	○
Porous Pavement	●		○	○			○	○

● Applicable to all projects
○ Applicable depending on project characteristics

Table 57. Linkages between Distributed Structural BMPs and Local Regulations

	Local/County Regulations						
BMP	**Drought-Tolerant Landscaping Requirements**	**Geotechnical Reporting Requirements**	**Green Building Requirements**	**LID Requirements/ LID Manual**	**Sedimentation & Erosion Control Requirements**	**Stormwater Requirements**	**Tree Protection Requirements**
Bioretention	○	○	○	○	●	○	●
Linear Bioretention Trenches	○	○	○	○	●	○	●
Porous Pavement		○	○	○	●	○	●

● Applicable to all projects
○ Applicable depending on project characteristics

Table 58. Linkages between Distributed Structural BMPs and Local Regulations (continued)

	Local/County Regulations							
BMP	**Additional County Permits**	**Recycled Water Laws**	**Zoning Regulations**	**General Land Use Plan Requirements**	**Community Standards District Requirements**	**Setback Requirements**	**SEAs Requirements**	**Sanitation Districts of Los Angeles**
Bioretention	○		●	●	○	●	○	
Linear Bioretention Trenches	○		●	●	○	●	○	
Porous Pavement	○		●	●	○			

● Applicable to all projects
○ Applicable depending on project characteristics

8.2. Centralized Structural BMPs

Centralized BMPs refer to stormwater treatment, storage, or infiltration facilities that provide a regional benefit. As described in Section 5, a screening analysis was conducted to identify publicly owned parcels in the unincorporated County areas of the Los Angeles River watershed that would be suitable for centralized BMP implementation. That analysis identified 20 candidate sites. Infiltration basins were optimal at 18 of the sites. Extended dry detention was best suited for Obregon Park. And the County is in the design phase of constructed wetland at Compton Creek. On the basis of the proposed BMPs and the characteristics of the sites selected, the regulatory requirements and environmental permit requirements for the BMPs have been summarized in Table 59 through Table 62.

Table 59. Linkages between Centralized Structural BMPs and Federal Regulations

	Federal Regulations					
BMP	**CWA Section 404**	**CWA Section 401**	**ESA**	**USFS Permits**	**Migratory Bird Treaty Act**	**NEPA**
Infiltration Basins (18 sites)	○		○	○	○	○
Obregon Park – Extended Detention Basin	○		○	○	○	○
Compton Creek – Wetland	●	●				

● Applicable to all projects
○ Applicable depending on project characteristics

Table 60. Linkages between Centralized Structural BMPs and State Regulations

	State Regulations							
BMP	**CARB Regulations**	**CESA**	**CEQA**	**Cultural Resources**	**Dam Safety Laws**	**Lake & Streambed Alteration Program**	**State Lands Leasing & Permits Regulation**	**State Park Permits**
Infiltration Basins (18 sites)	●	○	○	○	○		○	○
Obregon Park – Extended Detention Basin	●	○	○	○			○	○
Compton Creek – Wetland			○			●		

● Applicable to all projects
○ Applicable depending on project characteristics

Table 61. Linkages between Centralized Structural BMPs and Local Regulations

	Local/County Regulations						
Bmp	**Drought-Tolerant Landscaping Requirements**	**Geotechnical Reporting Requirements**	**Green Building Requirements**	**LID Requirements/ LID Manual**	**Sedimentation & Erosion Control Requirements**	**Stormwater Requirements**	**Tree Protection Requirements**
Infiltration Basins (18 sites)		○	○	○	●	○	●
Obregon Park – Extended Detention Basin	○	○	○	○	●	○	
Compton Creek – Wetland		●	○	○	●	○	

● Applicable to all projects
○ Applicable depending on project characteristics

Table 62. Linkages between Centralized Structural BMPs and Local Regulations (continued)

	Local/County Regulations							
BMP	**Additional County Permits**	**Recycled Water Laws**	**Zoning Regulations**	**General Land Use Plan Requirements**	**Community Standards District Requirements**	**Setback Requirements**	**SEAs Requirements**	**Sanitation Districts of Los Angeles**
Infiltration Basins (18 sites)	○		●	●	○	●	○	
Obregon Park – Extended Detention Basin	○		●	●	○	●	○	
Compton Creek – Wetland			●	●	○	●		

● Applicable to all projects
○ Applicable depending on project characteristics

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9. Cost Estimates

Cost estimates for nonstructural and structural BMPs in the Los Angeles River watershed were developed at the level of detail necessary to support planning and strategy development for TMDL implementation. These estimates are based on detailed, site-specific costs and refine the preliminary screening-level cost analysis performed for the optimization discussed in Section 6.2.4.

The detailed costs below are reported in 2009 dollars. Program costs can be updated by applying an approximate inflation rate of 3 percent per year. Capital costs can be updated by applying the *Engineering News–Record* (ENR) Construction Cost Index for Los Angeles as shown in the following equation:

New Base Year Cost = (Old Base Year Cost) × (New Base Year Index / Old Base Year Index)

The 2009 base year index of 9,765.44 has been used.

A period of 20 years was selected as a reasonable project duration for all BMPs, both structural and nonstructural. That period was used for all cost estimates. The lifetime of structural BMPs is generally considered to be about 20 years, and that period is also reasonable for nonstructural BMPs because beyond that time frame, significant changes can occur to a program or practice.

Annual costs are estimated in present value (PV) terms. The PV is the 2009 value of the projected stream of annual cost. The process of calculating PV is known as discounting. Discounting is important because it accounts for how monetary values differ over time compared to a specific reference year and reflects the time preference for consumption. Although it is not synonymous with the interest rate, for governments, it often reflects the rate at which funds can be borrowed and loaned.

A discount rate of 5 percent was used, consistent with the discount rate used in the optimization. For the costs reported in this section, only annual, recurring costs were discounted because upfront costs were assumed to occur at or near the first year of the BMP's implementation.

The cost estimates in this section reflect costs independent of the BMP implementation schedule. For the phased implementation of BMPs recommended in Section 10, costs after 2010 are discounted according to the year the costs occur as specified in the implementation schedule. As a result, most of the costs reported in Section 10, including planning and construction costs occurring in later years, are less than those reported in this section.

Appendix K provides detailed assumptions and cost estimates for all nonstructural and structural BMPs independent of the implementation schedule. Table 63 provides an initial comparison of the BMP cost estimates. The order of magnitude differences among the BMPs are expected. The centralized structural BMPs are estimated to cost more than most nonstructural BMPs because structural components including construction are costly, and many of the nonstructural BMPs are based on improvements to existing County programs. Among the nonstructural BMPs, costs for Reduction of Irrigation Return Flow and Improved Street Sweeping Technology are more than $10 million greater than other nonstructural BMPs. Reduction of Irrigation Return Flow is costly, in part, because it involves creating several new County programs and providing incentives. The cost of this BMP is also uncertain and could be reduced if a cost savings can be realized through reduced water usage. The cost for Improved Street Sweeping Technology assumes that regenerative air sweeping would occur biweekly in addition to the current sweeping operations. Those costs might be reduced if less mechanical sweeping is needed and regenerative air sweepings can be reallocated from other areas outside the watershed.

The costs for distributed BMPs on public property represent the unit costs for a surface area of approximately 1 acre. Smaller projects are likely to cost more per square foot due to economies of scale. Planning and permitting can be reduced conducted for multiple projects at one time. Ranges are provided to represent the lower cost of high-infiltration soils and the higher cost for low-infiltration soils. The 1-acre pilot project costs reflect an average of low and high-infiltration soils.

The cost estimates in Table 63 are based on BMP unit prices and assume that all costs associated with planning through construction of the BMPs are incurred now (i.e., in year 0 of implementation), with annual recurring costs, such as O&M, beginning in 2010. As explained above, Section 10 shows cost estimates associated with phased implementation of BMPs and incurring costs throughout the TMDL compliance period ending 2028.

Table 63. Summary of Structural and Nonstructural BMP Cost Estimates

BMP Description	Total PV
Nonstructural BMPs	
TMDL-Specific Stormwater Training	$320,000
Enhancement of Commercial and Industrial Facility Inspections	$14,000
Smart Gardening Program Enhancements	$370,000
Reduction of Irrigation Return Flow	$11,060,000
Enforcement Escalation Procedures	N/A[a]
Improved Street Sweeping Technology	$12,690,000
Distributed BMP – Catch Basin Inserts Phase 2 (66%)	$23,140,000
Distributed BMP – Catch Basin Inserts Phase 3 (34%)	$12,340,000
Distributed BMPs on Public Property without Monitoring[b]	**$27 to $32 per square foot of surface area**
Distributed BMPs on Public Property with Monitoring[b]	**$29 to $35 per square foot of surface area**
Distributed BMPs on Public Property without Monitoring (1-acre pilot project on public roads) [b]	**$29 per square foot of surface area**
Distributed BMPs on Public Property with Monitoring (1-acre pilot project on public roads) [b]	**$32 per square foot of surface area**
Centralized Structural BMPs on Public Property	
Belvedere Park	$6,540,000
Bethune Park	$1,010,000
Charles White County Park	$9,390,000
Enterprise Park	$2,130,000
Farnsworth Park	$830,000
G.W. Carver Park	$4,010,000
Hugo Reid Park	$1,830,000
Loma Alta County Park	$5,490,000
Magic Johnson Park	$8,970,000
Mona Park	$2,960,000
Northside Drive Median	$1,230,000
Obregon Park	$12,100,000
Roosevelt Park	$2,370,000
Salazar Park	$4,570,000
Compton Creek Wetland	$9,740,000

BMP Description	Total PV
Ted Watkins Park Left	$1,810,000
Ted Watkins Park Right	$4,440,000
Two Strike Park	$6,370,000
Whittier Narrows Park	$1,400,000
Whittier Narrows Recreation Area	$1,470,000
Centralized Structural BMPs on Private Property	
Infiltration Basin	$1,398,000 /AF storage capacity

a. A reasonably accurate cost could not be estimated for this BMP because of uncertainties in program scope and feasibility.

b. Unit costs are most representative of a project or a group projects implementated together with a total surface area of about 1 acre. Smaller projects are expected to be more expensive per square foot.

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10. TMDL Implementation Plan Summary

This section provides a summary of the Multi-Pollutant TMDL Implementation Plan for the Los Angeles River. The recommended BMPs for each of the three phases are presented with their associated costs. The TMDL Implementation Plan was evaluated using a range of criteria, including certainty of meeting TMDL requirements, the practical considerations of cost and feasibility, and how well the BMPs meet multiple community benefits. This evaluation identified current strengths of the TMDL Implementation Plan and areas that might be revised and strengthened further in the future. An iterative and adaptive management approach will be taken in an effort to take advantage of new information or treatment technologies that may emerge in the future and result in more effective and efficient implementation of the TMDL Implementation Plan's later phases.

10.1. Recommended BMPs for TMDL Implementation

The foundation of the TMDL Implementation Plan was the optimization results (Section 6), which contains three phases to achieve the wet weather metals TMDL requirements. The optimization results provided the recommended order and phasing for the structural BMPs and one nonstructural BMP (Reduction of Irrigation Return Flow and Improved Street Sweeping Technology). The remaining nonstructural BMPs were placed in implementation phases on the basis of the feasibility of accomplishing a BMP within a phase and the need for achieving a TMDL requirement by a certain date.

Table 64 lists the BMPs recommended for achieving the TMDL requirements, as well as the estimated cost of each BMP during phased implementation. Generally, structural BMPs were recommended to address phased load reductions, rather than phased percent of drainage area treated, to meet the wet weather metals requirements. This recommendation was based on the most cost-effective and feasible option for prioritizing centralized BMPs on private land within select BMP Drainage Zones. The nonstructural BMPs are recommended to address the remaining dry weather metals reduction requirements. The nonstructural BMPs could also provide further reduction in wet weather metals loads, beyond the treatment provided by the structural BMPs.

The TMDL Implementation Plan provides the timing and planning-level costs for BMPs in the County TMDL Implementation Area. Planning efforts can be further defined to account for locations of pollutant loading priorities. Implementation of BMPs should be focused on the communities identified as the highest source of pollutant loading. The highest ranking communities in terms of area-based pollutant loads (wet weather) are South El Monte Island, La Cresenta-Montrose, San Pasqual, East Compton, and East Los Angeles. Implementing structural BMPs should be the highest priority in those communities, especially during Phase 1. Eight areas tied for the highest dry-weather pollutant sources according to their total loads: Altadena, East Los Angeles, East Pasadena-East San Gabriel, Florence-Firestone, La Crescenta-Montrose, Oat Mountain, South Monrovia Islands, and Whittier Narrows. Nonstructural BMPs should be given a higher priority in those communitities.

Section 10 discusses the schedule for implementation in more detail. The schedule suggests that not all centralized BMPs on public property can be implemented in Phase 1 because of the limited time frame. Therefore, the schedule assumes that construction for all BMPs proposed for Phase 1 will begin within the phase and will be completed within a few years of the Phase 2 start.

Table 64. Recommended TMDL Implementation BMPs

Phase	BMP Type	Quantified In Model	Cost
1	G.W. Carver Park – Infiltration Basin	●	$3,630,000
	Mona Park – Infiltration Basin	●	$2,680,000
	Compton Creek Wetland	●	$8,830,000
	Ted Watkins Park (Right) – Infiltration Basin	●	$4,020,000
	Belvedere Park – Infiltration Basin	●	$5,640,000
	Bethune Park – Infiltration Basin	●	$900,000
	Charles White County Park – Infiltration Basin	●	$8,100,000
	Farnsworth Park – Infiltration Basin	●	$740,000
	Hugo Reid Park – Infiltration Basin	●	$1,570,000
	Northside Drive Median	●	$1,050,000
	Roosevelt Park – Infiltration Basin	●	$1,950,000
	Salazar Park – Infiltration Basin	●	$3,750,000
	Ted Watkins Park (Left) – Infiltration Basin	●	$1,480,000
	Nonstructural BMP – Smart Gardening Program Enhancements		$370,000
	Nonstructural BMP – TMDL-Specific Stormwater Training		$320,000
	Nonstructural BMP – Enforcement Escalation Procedures		N/A[a]
	Nonstructural BMP – Enhancement of Commercial and Industrial Facility Inspections		$10,000
	Total Phase 1 Costs		**$45,040,000**
2	Magic Johnson Park – Infiltration Basin	●	$7,020,000
	Two Strikes Park – Infiltration Basin	●	$4,740,000
	Whittier Narrows Park – Infiltration Basin	●	$1,040,000
	Whittier Narrows Recreation Area – Infiltration Basin	●	$980,000
	Distributed BMPs – Public Roads (1-acre pilot project)	●	$280,000
	Distributed BMP – Catch Basin Inserts Phase 2 (66%)	●	$14,910,000
	Nonstructural BMP – Reduction of Irrigation Return Flow	●	$6,160,000
	Nonstructural BMP – Improved Street Sweeping Technology	●	$9,940,000
	Total Phase 2 Costs		**$45,070,000**
3	Enterprise Park – Infiltration Basin	●	$1,370,000
	Loma Alta County Park – Infiltration Basin	●	$3,210,000
	Obregon Park – Extended Detention	●	$6,730,000
	Distributed BMPs – Public Industrial and Commercial Areas – High Infiltration Soils	●	$7,110,000
	Distributed BMPs – Public Industrial and Commercial Areas – Low Infiltration Soils	●	$8,090,000
	Distributed BMP – Catch Basin Inserts Phase 3 (34%)	●	$5,860,000
	Centralized BMPs on Private Property – Infiltration Basins	●	$169,660,000
	Total Phase 3 Costs		**$202,030,000**
Total TMDL Implementation Plan Costs			**$292,140,000**

a. A reasonably accurate cost could not be estimated for this BMP because of uncertainties in program scope and feasibility.

10.2. TMDL Implementation Plan Evaluation Criteria

The TMDL Implementation Plan described above was evaluated on the basis of criteria that reflect TMDL requirements, cost-effectiveness, and other considerations. Criteria identified to evaluate the implementation plan fall into six categories:

- **Certainty of Meeting TMDL Requirements**—As the BMPs are phased in over time, are TMDL requirements met for the County TMDL Implementation Area?
- **Cost Effectiveness**—How do the life cycle costs and cost-effectiveness compare across phases?
- **Complementary Integration**—How well do the BMPs complement each other in meeting water quality objectives (e.g., a vegetated swale draining to a bioretention cell)? Are certain projects time-sensitive or phase-sensitive (e.g., an upstream BMP might need to be implemented for a downstream BMP to function sustainably over time)?
- **Feasibility**—What constraints exist on-site or in the community that affect the feasibility of implementation?
- **Integrated Water Resources Planning**—How well do the BMPs meet integrated water resources planning objectives?
- **Other Sustainability Benefits**—Do the BMPs provide other sustainability benefits or affect sustainability negatively?

The first four evaluation criteria were applied to evaluate and recommend BMPs for the TMDL Implementation Plan. The category Complementary Integration was used as a guide to the timing of BMP implementation. All the criteria were used to evaluate the recommended TMDL Implementation Plan both to identify areas of strength as well as areas that might be strengthened in the future through iterative and adaptive management. Appendix L provides more detail on the six categories and specific criteria.

As discussed in Sections 5 and 7, the BMPs for the TMDL Implementation Plan provide multiple water resources benefits. Various strategic planning efforts are underway that have a common goal of diversifying water supplies for the region, with a special emphasis on developing local supplies. Many agencies rely on artificial recharge of aquifers to support local groundwater production. Several planned projects in these regional plans fall within the TMDL Implementation Area: the Obregon Park BMP, Charles White Park BMP, and the Compton Creek BMP. These projects were included in the TMDL Implementation Plan. Moreover, all proposed centralized and distributed BMPs can support rainwater capture and groundwater replenishment. The TMDL Implementation Plan also meets other integrated water resources goals, including enhanced habitat, enhanced open space and recreation opportunities, and flood protection. Table 65 highlights how each recommended BMP provides multiple water resources benefits. Note that the private centralized BMPs could provide additional benefits depending on their actual design and location.

Table 65. Support of Integrated Water Resources Planning

BMPs Included in the TMDL Implementation Plan	Water Quality	Water Conservation	Groundwater Replenishment	Improved Aesthetics	Open Space/Recreation	Enhanced Habitat	Flood Protection
Centralized Structural BMPs on Public Land							
Infiltration Basins	✓	✓	✓	✓	✓		✓
Extended Detention	✓	✓	✓	✓	✓		✓
Wetland	✓			✓		✓	
Distributed Structural BMPs on Public Land							
Distributed Structural BMPs on Public Land	✓	✓	✓	✓	✓	✓	✓
Pilot Distributed BMP Project for a County Road	✓	✓	✓	✓	✓	✓	✓
Catch Basin Inserts	✓						
Nonstructural BMPs							
TMDL-Specific Stormwater Training	✓						
Enhancement of Commercial and Industrial Facility Inspections	✓						
Smart Gardening Program Enhancements	✓	✓	✓		✓	✓	
Reduction of Irrigation Return Flow	✓	✓	✓				
Enforcement Escalation Procedures	✓						
Improved Street Sweeping Technology	✓				✓		
Centralized Structural BMPs on Private Land							
Infiltration Basins	✓	✓	✓	✓			✓
Extended Detention Basins	✓	✓	✓	✓			✓

Key findings of the evaluation included the following:

- The recommended TMDL Implementation Plan meets the TMDL regulatory criterion because, despite some uncertainties, it was developed to maximize the available opportunities for meeting WLAs in terms of metals load reductions. Phases for TMDL implementation are likewise based on percent load reductions rather than percent of drainage area treated, which assures greater certainty in actually achieving goals to improve receiving water quality.
- The optimization identified the most cost-effective solutions in meeting the multiple TMDL requirements; however, the BMPs identified become significantly less cost effective in Phase 3. It was determined that the cost criterion is only partially met.
- No implementation conflicts are posed among the BMPs recommended, and most of the recommended BMPs complement two or more of the other proposed BMPs. For example, the Smart Gardening workshops and tips could enhance the functioning of distributed BMPs along public roads and support the program for Reduction of Irrigation Return Flow. The TMDL-specific stormwater training would complement the Smart Gardening workshops.

- A number of feasibility factors such as ownership and physical constraints (e.g., utilities) were considered across the proposed BMPs. It was determined that the TMDL Implementation Plan partially meets the feasibility decision criterion. However, where feasibility constraints exist, planning and implementation methods are available to minimize them.
- The BMPs provide multiple water resources benefits (e.g., groundwater recharge, diversifying water supplies), although they are somewhat limited.
- More than 80 percent of the BMPs support four or more sustainability benefits, with all BMPs linked to at least one sustainability benefit. Table 65 indicates how each proposed BMP provides different sustainability benefits.

In summary, the most important criterion, certainty of meeting TMDL requirements, is fully met, while the next most important criteria, cost and feasibility, are partially met. The latter points to the need for the iterative and adaptive management approach to identify and employ new, cost-effective BMPs or strategies as they become available in the later phases. On the whole, the recommended BMPs are successful at meeting multiple benefits and supporting other County policies and initiatives.

10.3. Special Considerations for Implementation of Centralized BMPs on Private Land

A major constraint for feasibility of centralized BMPs on private land is the ability to identify available and strategically located sites to treat 100 percent of the select BMP Drainage Zones, per requirements of the phased WLAs for the Los Angeles River TMDLs. However, as reported in Section 6.2.4, a robust, quantitative analysis was performed that suggests alternative strategies for centralized BMP implementation could treat less than 100 percent of these areas and still meet TMDL reduction targets.

Two options were presented in Section 6.2.4 that illustrate alternative centralized BMP considerations with different BMP Drainage Zones addressed. Analysis revealed that TMDL compliance can be achieved by only treating areas with high infiltration (e.g., BMP Drainage Zones 3, 5 and 7), which is significantly more cost-effective than treating 100 percent of the drainage area of all BMP Drainage Zones as prescribed by the TMDL WLAs.

Actual implementation of centralized BMPs on private land will require strategic planning to identify a feasible solution that considers site availability, cost-effective BMPs given site characteristics and ability to infiltrate, characteristics of the drainage area treated by each BMP, and proximity of available sites within the drainage network. Implementing BMPs on private land can be based on the following process:

1. Identifying available privately owned parcels for acquisition as sites on which to implement centralized BMPs. The County should consider the following for each site:
    - *Proximity to the drainage network*: A drainage network should be in close proximity to the parcel where stormwater can be routed to minimize the cost of modifying the drainage system.
    - *Percent impervious area*: Locations with a higher percent of impervious area should be targeted for greater potential volume reduction and water quality improvements.
    - *Watershed treatment area*: Sufficient space should exist on the parcel for BMPs to adequately treat, store, and infiltrate runoff from the Unincorporated County drainage area.
    - *Soil type*: Soil type serves as a proxy for infiltration rate and water-holding capacity. Sites with HSG A, B, or C soils have suitable infiltration for infiltration BMPs and should be further investigated. Soil types should be verified in the field.
    - *Slope*: Sites should be screened for moderate slopes (less than 10 percent). If moderate slopes are present (as verified in the field), the site can be considered for centralized BMPs.

- o *Multi-benefit use*: Centralized BMPs can offer multiple benefits. For example, infiltration basins can be used for stormwater management and community park space. Parks or open space can be altered to enhance stormwater treatment and storage.
- o *Other site characteristics*: Surface infiltration rate and depth to the seasonal high groundwater table should be verified in the field.

2. Comparing available sites to priority areas established in the Pollutant Source Characterization and Prioritization process and BMP Drainage Zones determined most feasible for BMP implementation.
3. Estimating pollutant load reductions achieved through BMP implementation at each site and incorporating them within a decision framework used to compare site-specific benefits relative to other sites to prioritize aquisition.
4. Implementing a land acquisition program.
5. Designing and constructing (including pre- and post-construction monitoring) centralized BMPs on the aquired land.

The above process will be further refined through the iterative and adaptive approach to TMDL implementation, which will improve as new information becomes available and decision support systems evolve. Private land will be aquired and BMPs will be designed and constructed as funding becomes available.

11. Implementation Schedules

Table 66 provides the implementation schedule for each proposed BMP in order to meet the TMDL compliance milestones. Currently none of the proposed BMPs are funded, and the timeframe to secure the necessary funding for each BMP is not incorporated in the implementation schedules. With the current state of our economy, the availability of financial resources is extremely limited, and the lack of funding would likely delay the implementation start and end dates.

Assumptions used to develop the schedules are further discussed in Appendix M.

Table 66. BMP Implementation Scheduling

BMP	Duration (months)	Implementation Year																		
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028[a]
G.W. Carver Park – Infiltration Basin																				
Planning through O&M	319																			
Mona Park – Infiltration Basin																				
Planning through O&M	319																			
Compton Creek Wetland																				
Planning through O&M	323																			
Ted Watkins Park (Right) – Infiltration Basin																				
Planning through O&M	320																			
Belvedere Park – Infiltration Basin																				
Planning through O&M	321																			
Bethune Park – Infiltration Basin																				
Planning through O&M	316																			
Charles White County Park – Infiltration Basin																				
Planning through O&M	321																			
Farnsworth Park – Infiltration Basin																				
Planning through O&M	315																			
Hugo Reid Park – Infiltration Basin																				
Planning through O&M	316																			
Northside Drive Median – Infiltration Basin																				
Planning through O&M	316																			
Roosevelt Park – Infiltration Basin																				
Planning through O&M	319																			
Salazar Park – Infiltration Basin																				
Planning through O&M	318																			
Ted Watkins Park (Left) – Infiltration Basin																				
Planning through O&M	320																			

BMP	Duration (months)	Implementation Year																		
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028[a]
Nonstructural BMP – Smart Gardening Program Enhancements																				
Initial Workshops Planning	6																			
Initial Workshops Operation and Evaluation	37																			
Long-term Planning through Construction	18																			
Long-term Program Operation and Evaluation	207																			
Nonstructural BMP – TMDL-Specific Stormwater Training																				
Planning through Operation and Evaluation	246																			
Nonstructural BMP – Strengthen Enforcement Escalation Procedures																				
Planning through Operation and Evaluation	277																			
Nonstructural BMP – Enhancement of Commercial and Industrial Facility Inspections																				
Planning through Operation and Evaluation	243																			
Magic Johnson Park – Infiltration Basin																				
Planning through O&M	321																			
Two Strike Park – Infiltration Basin																				
Planning through O&M	320																			
Whittier Narrows Park – Infiltration Basin																				
Planning through O&M	320																			
Whittier Narrows Recreation Area – Infiltration Basin																				
Planning through O&M	316																			
Distributed BMPs – Public Roads (1-acre pilot project)																				
Planning through O&M	302																			
Distributed BMP – Catch Basin Inserts Phase 2 (66%)																				
Planning through Operation and Evaluation	277																			
Nonstructural BMP – Reduction of Irrigation Return Flow																				
Planning through Operation and Evaluation	301																			
Nonstructural BMP – Improved Street Sweeping Technology																				
Planning through Operation and Evaluation	246																			
Enterprise Park – Infiltration Basin																				
Planning through O&M	316																			

BMP	Duration (months)	Implementation Year																		
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028[a]
Loma Alta County Park – Infiltration Basin																				
Planning through O&M	318																			
Obregon Park – Extended Detention																				
Planning through O&M	322																			
Distributed BMPs – Public Industrial and Commercial Areas – High Infiltration Soils																				
Planning through O&M (Tier 1)	302																			
Planning through O&M (Tier 2)	290																			
Planning through O&M (Tier 3)	290																			
Distributed BMPs – Public Industrial and Commercial Areas – Low Infiltration Soils																				
Planning through O&M	290																			
Distributed BMP – Catch Basin Inserts Phase 3 (34%)																				
Planning through Operation and Evaluation	261																			
Centralized BMPs on Private Property – Infiltration Basins																				
Planning through O&M (Tier 1)	325																			
Planning through O&M (Tier 2)[b]	325																			

a. O&M continues 20 years past the start date.

b. Post-construction monitoring continues two years after year shown.

Planning through construction

O&M

Land acquisition

Pre-construction monitoring

Post-construction monitoring

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