Proposition O: Clean Water, Ocean, River, Beach, Bay Storm Water Cleanup Measure
General Obligation Bond

2006-2007

An Evaluation on the Effectiveness of Proposition O Projects for Water Quality Improvement

September 2007

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Executive Summary

Proposition O was intended to fund projects to help achieve water quality requirements under the Federal Clean Water Act. It authorized the City of Los Angeles to issue $500 million in general bonds for projects to clean up pollution in regional waterways and beaches and to improve water quality. After screening 52 submitted projects, 21 proposals were approved for concept development. The on-going project to comply with the Trash TMDLs by installing catch basin inserts and covers in high trash generating areas were also approved for continued funding. To date, $462,432,662 has been allocated for those projects approved by City Council and $12,842,042 has been recommended by COAC and AOC and pending City Council approval.

Our second year report of Proposition O evaluates the effectiveness of projects to improve water quality. Multiple objectives and project readiness were not considered in evaluating projects due to the difficulty in quantification of the benefits and unavailability of specific information. The objectives of this report are summarized as follows:

- How does each project impact stormwater quality?
- How do they fit together to make progress for meeting TMDLs?
- How do the projects rank?
- How do community-based projects and City-proposed projects compare relative to stormwater quality improvements?

Stormwater pollutant loads of the project sites were estimated using an empirical spreadsheet approach that employs land use definitions for pollutant concentrations and runoff coefficients. Dry-weather pollutant load were estimated from dry weather runoff and concentrations collected by the Los Angeles County Department of Public Works' monitoring programs. The performance of proposed Best Management Practices (BMPs) was evaluated assuming all runoff from the drainage area passes through the series of proposed BMPs in a sequential way. The pollution reduction and the effect of a project on TMDL compliance were estimated at the watershed scale because it is required by the TMDL process. Three watersheds were considered: Greater Ballona Creek, Los Angeles River, and Dominguez Channel. It should be noted that our approach uses a state-of-the-art planning level model which is based upon best available data, but is not verified for all conditions at specific sites. The results should be used to compare the relative differences in pollutant removal of the proposed BMPs and the effectiveness of projects. Our evaluation is based on the data presented in the concept reports, data obtained from the Bureau of Sanitation and observations from the COAC meetings to August 2007. Table ES.1 shows the projects titles, applicants and their status.

Table ES.1 Status of projects approved for concept report stage

No	Project Title	Applicant	Status
11	Cesar Chavez Recreation Complex	City of LA, DPW, BOS, SRPCD	Approved by Council and Mayor - in Construction
28	Oros Green Street	North East Trees	
41	Inner Cabrillo Beach Bacterial Water Quality Improvement Project	Port of Los Angeles	
52	Catch Basin Inserts and Coverings Phase II	City of LA	
52b	Catch Basin Opening Screen Covers to Meet 100% Trash Reduction Milestone	City of LA	
20a	Grand Avenue Stormwater BMPs	City of LA, DPW, BOS, WPD	Approved by Council and Mayor - in Design
20c	Mar Vista Rec. Cntr. Stormwater BMPs	City of LA, DPW, BOS, WPD	
51	Santa Monica Bay Beaches Low Flow Diversions Upgrades	City of LA	
9	The LA Zoo Parking Lot	LA Zoo and Botanical Gardens	Approved by Council and Mayor - in Pre-design
10	Strathern Pit Multiuse Project	City of LA, DPW, BOS, County Flood Control District	
12	Cabrito Paseo Walkway/Bike Path	LA Neighborhood Land Trust	
14	Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project	Mountains Recreation and Conservation Authority	
16	South Los Angeles Wetlands Park	Council District 9	
20b	La Cienega/Fairfax Powerline Easement Stormwater BMPs	City of LA, DPW, BOS, WPD	
22a	Imperial Highway Stormwater BMPs	City of LA, DPW, BOS, WPD	
22d	Westminster Dog Park Stormwater BMPs	City of LA, DPW, BOS, WPD	
22e	Temescal Recreation Center Stormwater BMP	City of LA	
22g	Penmar Water Quality Improvement and Runoff Reuse Project	City of LA	
22f	Westchester/LAX Stormwater BMP	City of LA	
29	Echo Park Lake Restoration Project	City of LA, DRP	
35	Rosecrans Recreational Center Stormwater Enhancements	City of LA, DRP	
36	Lake Machado Ecosystem – Water Quality/Habitat Improvement	City of LA, DRP	
36a	Wilmington Drain Multiuse Project	City of LA	
40	Peck Park Canyon Enhancement Project	LA Neighborhood Initiative	
23	Aliso Wash-Limekiln Creek Confluence Restoration Project	Mountains Recreation and Conservation Authority	COAC and AOC recommended
53	LA revitalization master plan	LA River Revitalization Master Plan Team	
15	Fremont High Community Garden	Youth Opportunities Unlimited	in planning process
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(adapted from BOE’s August monthly report, 2007)

Pollution Reduction and TMDL Compliance

No single project greatly impacts TMDL compliance. The most significant projects reduce watershed pollutant loads by 9 to 13% (an average reduction in approximately 10 different water quality parameters) while most projects reduced watershed pollutant loads by less than 1%. This is in spite of the expected high removal efficiency within the project site.

In the Ballona Creek Watershed, most of proposed wet-weather BMPs show high removal efficiencies for bacteria, 90% or more, within the project site. In spite of these projects, the modeling results suggest that the TMDL will be frequently or usually violated. The result of daily mass loads compared with TMDLs based on LADPW monitoring data shows that bacteria TMDLs will always be violated even with the application of all proposed projects. Metal TMDLs will be exceeded for most events, with lead being the closest to compliance. The La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) has the greatest pollutant reduction and has the highest impact of all projects within the Greater Ballona Creek Watershed.

In Los Angeles River Watershed, all projects show high removal efficiencies for TSS and metals, with maximum removal efficiency of more than 80%. However the removal efficiencies for bacteria and nutrients varied. The result of daily mass loads of ammonia-nitrogen and metals, when compared with TMDLs, shows that BMP removals are not sufficiently great to reduce the number of exceedances. Compliance with the TMDL for nitrate and nitrite-nitrogen will not benefit from the BMPs since the TMDLs are rarely exceeded. The Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) will provide the greatest percentage reduction in loads, and therefore have the greatest impact on the water quality improvement, although the impact falls short of meeting TMDL requirements.

In Dominguez Channel Watershed, all projects show high removal efficiencies for TSS and metals (more than 95% removal) and varied removal efficiencies for bacteria and nutrients (~ 30 to 99% removal). The mass balance calculations predict that bacteria TMDLs will be exceeded, even with the application of all proposed projects. The Machado Lake Project (#36) will have the greatest total loads reduction (13%) and the greatest impact on the quality of receiving waters among all approved projects for all watersheds.

The results show that the projects that include the largest drainage area have the greatest impact on receiving water quality. Several projects can make important contributions to meeting the TMDL although and improve the quality of rivers, lakes, beaches and oceans although no single project will significantly change TMDL compliance in any of the watersheds. We recognize that $500 million is insufficient to retrofit all the watersheds in Los Angeles so as to meet TMDL regulations. Additional viable water quality projects will be required to reliably meet the TMDLs. The analysis suggests the need for a systems approach to evaluate projects for achieving water quality standards. The systems approach should include an analysis of the watershed and the proposed BMPs, and the examples provided here are good models for the needed analyses. Mass of removed pollutants, hydrology and economics can all be included in the analyses.

Cost Effectiveness

The cost-effectiveness of projects was evaluated in two ways: 1) the total cost of a project for the drainage area it treats, and 2) total cost per the unit of pollutant load removed. The pollutants considered in the cost analysis were bacteria (total coliform), TSS, metal (zinc), and nutrients (Kjeldahl-N) and were chosen as representative of TMDL requirements and typical BMP removal efficiencies. Table ES.2 shows the rankings. The left side shows the cost per unit drainage area and the right side shows the cost per unit mass of pollutant removed. Note that seven projects could not be evaluated on a cost basis due to uncertainty associated with BMP performance. The result shows that the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and The La Cienega/Fairfax Stormwater BMP (#20b) are the most cost-effective projects for both criteria. Conversely, Westminster Dog Park Stormwater BMPs (#22d), Parking Grove in El Sereno (#31), and Rosecrans Recreational Center Storm Water Enhancements (#35) are the most expensive projects.

Table ES.2 Rank of project for cost effectiveness

No	Project	total cost/ drainage area	No	Project	total cost /mass loads
23	Aliso Wash	$663	20c	Aliso Wash	$1,957
20b	La Cienega/Fairfax	$1,539	20b	Mar Vista	$2,201
51	SMB LFD upgrades	$2,920	23	La Cienega/Fairfax	$2,202
36	Machado Lake	$6,715	22e	Temescal Rec. Cntr.	$11,439
22e	Temescal Rec. Cntr.	$11,739	10	Strathern Pit	$22,543
11	Cesar Chavez	$14,135	36	Machado Lake	$26,738
22f	Westchester/LAX	$15,743	22f	Westchester/LAX	$39,690
22g	Penmar	$16,062	22g	S. LA Wetlands	$54,973
10	Strathern Pit	$16,403	16	Penmar	$57,170
20c	Mar Vista	$18,693	51	SMB LFD upgrades	$130,564
16	S. LA Wetlands	$23,996	20a	Grand Ave	$165,261
14	Hansen Dam	$29,857	22a	Imperial Hw	$170,686
70	Peck Park Canyon	$62,091	28	Oros Green St.	$188,696
20a	Grand Ave	$68,618	29	Echo Park Lake	$253,194
29	Echo Park Lake	$115,066	14	Hansen Dam	$294,037
15	Fremont High	$115,388	31	El Sereno	$457,031
28	Oros Green St.	$115,806	12	Cabrito Paseo	$500,292
22a	Imperial Hw	$164,695	9	LA Zoo Parking Lot	$1,595,734
12	Cabrito Paseo	$232,110	35	Rosecrans	$11,334,565
9	LA Zoo Parking Lot	$421,878	22d	Westminster Dog Park	$13,745,865
22d	Westmister Dog Park	$517,166	40	Peck Park Canyon	$51,922,120
35	Rosecrans	$532,736	11	Cesar Chavez	
31	El Sereno	$1,191,577	15	Fremont High	
30	Boyle Heights		30	Boyle Heights	
33	Lincoln Heights		33	Lincoln Heights	
41	Inner Cabrillo Beach		41	Inner Cabrillo Beach	
52	Catch Basin Ph II		52	Catch Basin Ph II	
52b	Catch Basin Ph III		52b	Catch Basin Ph III	

Ranking against Project Selection Criteria

All projects were evaluated based on the water quality improvement subset of the COAC's project selection criteria proposed in February, 2007. The subset included project significance, compliance with water quality goals, pollutant reduction, and cost effectiveness and account for 65 of the possible 100 points. The quantitative method for calculating pollutant reduction, comparing additional removals to the TMDL, and cost comparisons captured these four criteria. The multiple objective and project readiness (35 points) were not considered in evaluating projects due to the unavailability of quantified or site-specific information. Table ES.3 shows the resulting scores and project ranks.

The results show that projects treating a large drainage area are scored high while the projects addressing small sites tend to be scored low. The top ten ranked projects were all City-proposed projects except one (#23) that was proposed by Mountains Recreation and Conservation Authority, a state agency. The community-based projects scored lower (18-20 ranking). To these rankings, the additional 35 points for multiple benefits and project readiness should be added to obtain a final ranking.

Table ES.3 Rank of projects against new project selection criteria (water quality improvement and cost effectiveness only)

No	Project Title	Applicants	Scores	Rank
20b	La Cienega/Fairfax Powerline Easement Stormwater BMPs	City of LA, DPW, BOS, WPD	64	1
23	Aliso Wash-Limekiln Creek Confluence Restoration Project	Mountains Recreation and Conservation Authority	63	2
36	Lake Machado Ecosystem	City of LA, DRP	62	3
22f	Westchester/LAX Stormwater BMP	City of LA, DPW, BOS, WPD	60	4
51	Santa Monica Bay Beaches LFD Upgrades	City of LA	60	4
22g	Penmar Water Quality Improvement and Runoff Reuse Project	City of LA, DPW, BOS, WPD	59	6
20c	Mar Vista Rec. Cntr Stormwater BMPs	City of LA, DPW, BOS, WPD	57	7
22e	Temescal Rec. Cntr Stormwater BMP	City of LA, DPW, BOS, WPD	54	8
20a	Grand Avenue Stormwater BMPs	City of LA, DPW, BOS, WPD	53	9
29	Echo Park Lake Restoration Project	City of LA, DRP	53	9
10	Strathern Pit Multiuse Project	City of LA, DPW, BOS, CFCD	52	11
16	South Los Angeles Wetlands Park	Council District 9	52	11
9	The LA Zoo Parking Lot	LA Zoo and Botanical Gardens	47	13
22a	Imperial Highway Stormwater BMPs	City of LA, DPW, BOS, WPD	47	13
14	Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project	Mountains Recreation and Conservation Authority	45	15
41	Inner Cabrillo Beach Bacterial Water Quality Improvement Project	Port of Los Angeles	45	15
11	Cesar Chavez Recreation Complex	City of LA, DPW, BOS, SRPCD	44	17
12	Cabrito Paseo Walkway/Bike Path	LA Neighborhood Land Trust	42	18
28	Oros Green Street	North East Trees	42	18
40	Peck Park Canyon Enhancement Project	LANI	41	20
35	Rosecrans Rec. Cntr Storm Water Enhancements	City of LA, DRP	39	21
31	Parking Grove in El Sereno	Council District 14	37	22
22d	Westminster Dog Park Stormwater BMPs	City of LA, DPW, BOS, WPD	36	23
15	Fremont High Community Garden	Youth Opportunities Unlimited		
30	Boyle Heights Joint Use Community Center	Council District 14		
33	Lincoln Heights Interchange Restoration	North East Trees		
52	Catch Basin Inserts and Coverings Ph. II	City of LA		
52b	Catch Basin Opening Screen Covers Ph. III	City of LA		

1. Introduction

1.1 Stormwater Pollution in Los Angeles

Stormwater and urban runoff are the major problems to rivers, lakes, beaches and coastal waters because of rapid urbanization and population growth. The population of the City of Los Angeles is over 3.7 million according to the 2000 census, and has doubled over the last fifty years. The City of Los Angeles is the most populous city in the State of California and the second most populous in the nation (US Census Bureau, 2006). Urbanization increases impervious surfaces which increases the rate and amounts of urban runoff to receiving waters. Urban runoff contains many pollutants such as pathogens, toxic substances, heavy metals, and sediments (Corbett, 1997). Many studies have shown that stormwater pollution from urban watersheds significantly impacts surface water quality (Cohn-Lee and Cameron, 1992; Stenstrom and Strecker, 1993). Stormwater monitoring conducted by Los Angeles County Department of Public Works (LADPW) show that the mass emissions of bacteria, *e.g.* total and fecal coliforms, and heavy metals *e.g.* lead, copper, and zinc, exceeds water quality standards for both dry and wet-weather conditions in all watersheds in the County (LADPW, 2006). Additional studies show that runoff is toxic to receiving waters (Bay *et al*., 1996) and that swimming near storm drains in Santa Monica Bay increases the risk of contracting water-borne diseases (Haile *et al*., 1999).

In the City of Los Angeles, stormwater runoff is collected in a system separate from wastewater collection and the runoff usually discharges straight into the rivers and the ocean without treatment as opposed to wastewater, which is treated in plants. The amount of stormwater flow can be up to 10 billion gallons per day into Santa Monica Bay on wet-weather days and 100 million gallons per day on dry-weather days (BOS). In the City and County of Los Angeles, there have been efforts to reduce stormwater pollution with various best management practices (BMPs). For example, low flow diversion (LFD) systems, suggested by the Pico-Kenter Storm drain task force in the early 1980s (Stenstrom, 1999), divert dry-weather flow in the storm drain to a sanitary sewer and the Hyperion Treatment Plant that treats wastewater. Another example is implementing catch basin inserts and covers to retain trash. The Sun Valley Park demonstration project was initiated to manage stormwater runoff and flooding by installation of underground BMPs (Higgins, 2005). However, some of these managements need retrofitting and other efforts are needed to protect the quality of receiving waters from stormwater pollution and nonpoint source pollution.

1.2 Regulatory Background

In California, the State Water Resources Control Board (SWRCB) is responsible for setting water quality policies and administering the State's stormwater management programs (Hecht, 2004). The California Environmental Protection (CalEPA) and Regional Water Quality Control Board (RWQCB) regulate the discharge of stormwater runoff and nonpoint source pollution under the Federal Clean Water Act (CWA) and the California Porter-Cologne Water Quality Control Act (Swamikannu, 2003; SWRCB, 2006a, 2006b). Under the Porter-Cologne Water Quality Act, the California Water Quality Control Plan, Los Angeles Region, also known as the Basin Plan, sets water standards and implementation programs to protect all water bodies within the State. Under the CWA, the National Pollutant Discharge Elimination System (NPDES) Stormwater Program is the principal regulatory framework for stormwater pollution. The RWQCB issued a NPDES municipal stormwater discharge permit for the County of Los Angeles and incorporated cities including the City of Los Angeles in 2001. It requires developing stormwater management plans such as Standard Urban Stormwater Mitigation Plans (SUSMPs) or a Site Specific Mitigation Plan, implementing BMPs to treat stormwater runoff, and performing stormwater monitoring. Municipal Separate Storm Sewer Systems (MS4) permits regulate stormwater discharges from municipal separate storm sewer systems. These involve inspecting storm drains and eliminating illicit connections to the drains. Construction sites and industrial facilities are regulated by general permits to manage stormwater pollution.

The CWA mandates identifying and listing impaired water bodies, constituting the 303(d) list. Appendix A illustrates the City's impaired water bodies on the 303(d) list, encompassing three watersheds. The CWA also requires each state to prioritize impaired waters and to develop and implement Total Maximum Daily Loads (TMDLs). A TMDL is a maximum amount of a pollutant that a water body can receive without breaching water quality standards. In Southern California, the SWRCB and the RWQCB began to identify over 700 water body-pollutant combinations in the Los Angeles Region (LARWQCB, 1996, 1998) and to develop a TMDL program. This process came about as a result of a court order due to lawsuit brought by the Natural Resources Defense Council, Heal the Bay, and Santa Monica Bay Keeper in 1999 (Swamikannu, 2003). As a result, Los Angeles Region was given 13 years to adopt TMDLs. The TMDL Program is currently a top priority for the SWRCB, RWQCB and the City of Los Angeles. The following list shows the adopted TMDLs in the City:

- Los Angeles River Trash TMDL,
- Ballona Creek Trash TMDL,
- Santa Monica Bay Beaches Dry and Wet-weather Bacteria TMDL,
- Marina Del Rey Dry and Wet-weather Bacteria TMDL,
- Los Angeles Harbor (Inner Cabrillo Beach and Main Ship Channel) Bacteria TMDL,
- Los Angeles River Nutrients TMDL,
- Los Angeles River Metals TMDL,
- Ballona Creek Metals TMDL, and
- Ballona Creek Sediment TMDL.

The trash TMDLs in the Los Angeles River and Ballona Creek Watersheds were adopted by RWQCB on September 19, 2001, and approved by the SWRCB on February 19, 2002 and by the US EPA on August 1, 2002 (SWRCB, 2002a, 2002b). These trash TMDLs require 10% reduction per year of discharges of trash to the Los Angeles River and Ballona Creek. The adopted TMDL document requires the first 20% reduction to be achieved by September 30, 2006 and 100% trash reduction to be achieved by September 30, 2015.

Bacteria TMDLs in the Santa Monica Bay were adopted by RWQCB for dry-weather discharges on January 24, 2002 and for wet-weather discharges on December 12, 2002. They were approved by SWRCB on March 19, 2004 and by US EPA on June 19, 2003 (SWRCB, 2002c, 2002d) respectively. Bacteria TMDLs in the Marina del Rey Harbor were approved by SWRCB on March 18, 2004 and by US EPA on June 19, 2003 (SWRCB, 2005a). The adopted document requires the first milestone compliance by July 15, 2009. Bacteria TMDLs in the Los Angeles Harbor (Inner Cabrillo Beach and Main

Ship Channel) were adopted by RWQCB on July 4, 2004 (BOS; LARWQCB, 2004). Each responsible jurisdiction must develop a shoreline-monitoring plan and an implementation plan to reduce the amount of bacteria. In general, the TMDLs for dry-weather and wet-weather were developed with separate compliance dates and limits. The dry-weather bacteria TMDLs require reducing bacteria acceptable levels to no more than 0 days of exceedance during summer dry-weather days and no more than 3 days of exceedance during winter dry-weather days. The wet-weather TMDL requires that bacteria indicators at beaches should not exceed acceptable levels (no more than 17 days of exceedance) during winter wet-weather days.

Nutrient TMDLs in Los Angeles River watershed were adopted by RWQCB on July 10, 2003, and approved by SWRCB on November 19, 2003 and by US EPA on March 18, 2004 (SWRCB, 2004). These TMDLs address nitrogen compounds such as ammonia, nitrite, and nitrate. The Implementation includes upgrades to the Water Reclamation Plants discharging to Los Angeles River. Ammonia and nitrate reductions will be regulated through interim limits and NPDES permits for major point sources.

The Metal TMDLs in Ballona Creek and Los Angeles River watersheds were adopted by the RWQCB on July 7, 2005 and on June 2, 2005, respectively, and they were approved by SWRCB on October 20, 2005 and by US EPA on December 22, 2005 (SWRCB, 2005b, 2005c). These TMDLs address both dry and wet-weather discharges of copper, lead, and zinc in both watersheds. In addition, dry and wet-weather discharge limits for selenium were also adopted for the Ballona Creek Watershed and wet-weather discharge limit of cadmium was adopted in Los Angeles River Watershed.

Forthcoming TMDLs include toxics for Marina del Rey, historic pesticides and coliforms in Los Angeles river watershed, bacteria, organics for toxic and metal for the Dominguez Channel and Los Angeles Harbors, and trash and nutrients for Machado Lake in the Dominguez Channel Watershed.

1.3 Overview of the Proposition O process

Proposition O, the Clean Water, Ocean, River, Beach, and Bay Stormwater Cleanup Measure, was intended to fund projects to protect water quality and to meet

TMDLs requirement under the Federal Clean Water Act. It authorizes $500 million of general obligation bonds for stormwater projects that

- protect rivers, lakes, beaches, and the ocean,
- conserve and protect drinking water and other water sources,
- reduce flooding and use neighborhood parks to decrease polluted runoff, and
- capture, clean up, and reuse stormwater.

The administrative structure of the proposition consists of a Citizens Oversight Advisory Committee (COAC), an Administrative Oversight Committee (AOC) and the City Council. The COAC, representing the public, consists of nine members, with four appointed by the Mayor and five appointed by the Council President and its members. The committee reviews projects and makes recommendations for funding to the AOC and the City Council. The AOC, representing the Mayor's office, consists of the City Administrative Officer, the Chief Legislative Analyst, a representative from the Mayor's Office, a Board of Public Works Commissioner and the Department of Water and Power's General Manager. The committee makes its own recommendations and sends them to the City Council. The City Council makes the final decision to fund projects.

The Bureau of Sanitation (BOS), Watershed Protection Division (WPD), is the City's agency for managing and administering Proposition O. WPD also oversees the City's Stormwater Program including the development and implementation of stormwater pollution abatement projects throughout the City.

The Project Review Committee (PRC) was established in December, 2005, staffed by representatives from five City agencies: Bureau of Engineering, Bureau of Sanitation, Environmental Affairs Department, Department of Recreation and Parks, and Department of Water and Power. The PRC assessed each project using project selection criteria approved by the AOC and COAC. The committee provided COAC its recommendations and categorization results.

The City received 50 project applications by December 16, 2005 as well as two additional proposals by the City submitted on February 28, 2006. Based on the PRC's evaluations of proposals and their recommendations, the COAC and AOC reviewed and approved 22 proposals by July 19, 2006 to move forward with concept development. To date, 17 proposals have been approved by City Council totaling 24 individual projects, 1 proposal is pending the approval of City Council and the remaining 4 are pending COAC/AOC consideration. The installation of catch basin inserts and covers in high trash generating areas to comply with the Los Angeles River and Ballona Creek Trash TMDLs as shown in Appendix B. In addition, 2 new projects under the LA River Revitalization Master Plan was presented to the COAC and the AOC in February 2007 and recommended by both committees for funding because the plan has regional water quality improvement component and multiple benefits. Table 1.1 shows the status of projects as of August 2007.

1.4 Objectives

Our second-year report of Proposition O evaluates the effectiveness of projects for *water quality improvement*. We did *not* evaluate on *multiple objectives and project readiness* in this report because it is difficult to quantify multiple benefits and specific information was not available. The objectives of this report are summarized as follows:

- How does each project impact stormwater quality?
- How do they fit together to make progress for meeting TMDLs?
- How do the projects rank?
- How do community-based projects and City-proposed projects compare relative to stormwater quality improvements?

Stormwater pollutant loads of the project sites were estimated using an empirical spreadsheet approach that employs land use definitions for pollutant concentrations and runoff coefficients. Dry-weather pollutant load were estimated from dry weather runoff and concentrations collected by the Los Angeles County Department of Public Works' monitoring programs. The performance of proposed Best Management Practices (BMPs) was evaluated assuming all runoff from the drainage area passes through the series of proposed BMPs in a sequential way. The pollution reduction and the effect of a project on TMDL compliance were estimated at the watershed scale because it is required by the TMDL process. Three watersheds were considered: Greater Ballona Creek, Los Angeles River, and Dominguez Channel. The results should be used to compare the relative differences in pollutant removal of the proposed BMPs and the effectiveness of projects.

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(adapted from BOE August Monthly Report, 2007)

2. Stormwater Pollution Management and Modeling Background

2.1 Best Management Practices for Stormwater Pollution

Stormwater and urban runoff are difficult to monitor, model, and control compared with wastewater because there are many outfalls across catchments and pollution varies based on site and storm events (D'Arcy and Frost, 2001). Therefore, the conventional wastewater treatment process is not appropriate for managing stormwater runoff pollution. Alternatively, BMPs are widely used to treat stormwater runoff and there are existing manuals and databases for various BMPs (Schueler, 1987; ASCE, 1998; CASQA, 2003; USEPA, 2002). BMPs are generally categorized into two types: structural and non-structural BMPs (D'Arcy and Frost, 2001; Marsalek and Chocat, 2002; USEPA, 2002). Nonstructural BMPs, also called source control BMPs (ASCE, 1998; US EPA, 1999), prevent pollution at their source before contact with stormwater or by capturing stormwater at its source without constructed infrastructure. These BMPs are "institutional, educational or pollution prevention practices" (USEPA, 2002) including public education, land use planning and green roofs, material management, street and storm drain cleaning and maintenance, spill prevention and cleanup, illegal dumping controls, illicit connection control, and stormwater reuse (ASCE, 1998). For example, the repair of illicit connections in Dover, NH, improved the water quality from a storm sewer (Landry, 2000), and storm sewer inspections in Boston, MA, improved dry-weather water quality. On the other hand, many outreach efforts for stormwater management in the nation have not been successful or reliable (Lehner *et al*., 1999) especially for changing the attitude of the public (Taylor *et al*., 2007). Nevertheless, using non-structural BMPs in conjunction with structural BMPs to meet TMDL requirements can provide significant water quality improvements (Geldof, 2001).

Structural BMPs, also called treatment BMPs, are engineered and constructed systems to control the quantity of stormwater runoff and to treat the quality of stormwater runoff (USEPA, 2002). The performance of structural BMPs is highly dependent on site-specific factors including rainfall intensity, duration, and volume, pollutant concentrations, and climate patterns. There are two major approaches: local-site and regional BMPs (Marsalek and Chocat, 2002; USEPA, 2002). Local-site control is implemented in the form of source controls. Common examples are infiltration facilities *e.g.* infiltration trenches (Marsalek and Chocat, 2002), filtration systems *e.g.* sand filters (Urbonas, 1994; ASCE, 1998; USEPA, 2002) and biofilters (Mothersill *et al.*, 2000). An infiltration BMP can control both the quantity and quality of stormwater by capturing, retaining, and infiltrating stormwater into the ground (Muthukrishnan, *et al.*, 2004). This BMP can increase the recharge of underlying aquifers despite a potential problem of contaminant migration (Schueler, 1987). A filtration system removes stormwater pollution using media such as sand, gravel, organic material, or other treatment media (Muthukrishnan, *et al.*, 2004). This BMP is primarily for water quality control and effective at removing particulate pollutants. A biofiltration system removes stormwater pollution by filtration through vegetated systems, and adsorption and infiltration through the soil (US EPA, 1999; Field and Sullivan, 2003). This system helps to reduce stormwater runoff volume and to remove debris and solid particles (Muthukrishnan, *et al.*, 2004).

There are new emerging practices within local-site BMPs, called Low-Impact Development (LID) that manages stormwater at the source using decentralized controls integrated with landscaping (Muthukrishnan, *et al.*, 2004). Common examples include bio-retention cells, also called rain gardens, that were pioneered by Prince George's County, MD (Prince George's County, 1997; Coffman *et al.*, 1998) and practiced in Maplewood, MN in 1990s (Hager, 2003); grass swales, also called bioswales (Clar *et al.*, 2004), demonstrated in the City of Portland, OR (Liptan and Murase, 2002); vegetative roofs, also known as green roofs, widely used in Europe after being developed in Germany in the 1960s, and recently installed in many cities in the States; rain barrels and cisterns as practiced in a demonstration project in Boston, MA (Hager, 2003); porous pavements (Legret *et al.*, 1996), which have been implemented in Europe (Stotz and Krauth, 1994; Berbee *et al.*, 1999; Bond *et al.*, 1999) and are now introduced in Texas (Barrett *et al.*, 2006) among other US locations. However, there is currently insufficient scientific knowledge to predict the cumulative effects on receiving waters of large numbers of local-site BMPs installed within a watershed and at this point, they are not usually coordinated at a watershed scale. This may lead to a failure to provide protection downstream (USEPA, 2002). Further, many of these require city code changes to implement, and this has not been done in Los Angeles. We recommend more experiments of these approaches coupled with data collection so they can be adequately evaluated against more conventionally proven BMPs. They may also require the collection of non-traditional data such as energy conservation benefits of green roofs, economic benefits of additional landscaping and open space, avoided imported water costs of additional water provided by infiltration, and so forth.

Regional BMPs serving large drainage areas capture all runoff from catchments or watersheds, that may not be collected by local-site practices, and protect downstream water quality. Examples of regional practices are ponds and wetlands. Ponds are used widely in the world and provide flow control and removal of dissolved pollutant (Lawrence *et al*., 1996; Van Buren *et al*., 1997). Such detention type approaches also provide multiple benefits such as habitat restoration, recreation and open space, and aesthetic benefits. One successful application is in Denver Metropolitan area (USEPA, 2002) and resulted in improved stormwater conveyance and detention as well as flood control. Another is the installation of stormwater detention ponds in Austin, TX, that reduced sediment discharge and nutrients (City of Austin, 1995). Constructed wetlands remove stormwater pollution by settling, retention and bio-uptake (Rochfort *et al*., 1997) and provide additional benefits such as flood control and groundwater recharge. These tend to require large land areas to be available for this use. Table 2.1 shows the removal efficiency of various BMPs in the existing literature and Table 2.2 shows the criteria in selecting BMPs for targeting pollutants and other environmental requirements.

Table 2.1 Stormwater pollutant removal efficiency of various BMPs

BMP	Bacteria	TSS	Metal	TN	TP	reference
Vegetative Practices						
Bioretention	NA	75	75-80	50	50	PGDER,1993; USEPA,1999
			93-99	43	81	Davis, *et al*.,1997
	86			90	86	US EPA,2002
	90	90	93-98		70-83	Davis *et al*.,1998; PGDER,1993
Grassed Swales	< 30	30-65	15-45	15-45	15-45	USEPA, 1993
100		60			45	Seattle Metro *et al*.,1992
200		83			29	Novotny,2002
230		81			17	Harper,1988
FL, 230		87				Novotny,2002
VA, 185		65			41	Novotny,2002
MD, 193		-85			12	Novotny,2002
FL, 185		98			18	Novotny,2002
Vegetated Swales	NA	30-90	0-90	0-50	20-85	City of Austin,1995; Claytor & Schueler,1996; Kahn *et al*.,1992; Yousef *et al*,1985; Yu *et al*.,1993, 1994, 1995

		81	42		9	EPA Factsheet
Vegetated Filter Strips	< 30	50-80	30-65	50-80	50-80	USEPA, 1993
	NA	27-70	2-80	20-40	20-40	Yu & Kaighn,1992; Young *et al.*,1996
75ft		54			-25	EPA,2002
150ft		84			40	CWP,2000
Infiltration Facilities						
Infiltration Basin	65-100	50-80	50-80	50-80	50-80	USEPA, 1993
	75-98	75-99	50-90	45-70	50-70	Young *et al.*,1996
Infiltration Trench & basin	75-90		75-90	45-60	50-70	Schueler,1987
	90	75	85-90	55-60	60-70	Schueler,1987; CWP,2000
Infiltration Trenches/ Dry Wells	65-100	50-80	50-80	50-80	15-45	USEPA, 1993
Infiltration Trench	75-98	75-99	75-99	45-70	50-75	Young *et al.*,1996
	90		90	60	60	EPA factsheet
Porous Pavement	65-100	65-100	65-100	65-100	30-65	USEPA, 1993
	NA	82-95	33-99	80-85	60-71	MWCOG,1983 Hogland *et al.*,1987 Young *et al.*,1996
				80-85	65	EPA factsheet
and modular pavement, VA		82		80	65	Schueler,1987; CWP,2000
MD		95	98-99	85	65	Schueler,1987; CWP,2000
Filtration Practices						
Sand filter	55	87	34-80	44		EPA,2002
	76	70		21	33	Galli,1990
Surface Sand Filters	< 30	50-80	50-80	< 30	50-80	USEPA, 1993
	NA	75-92	33-91	27-71	27-80	City of Austin,1990; Welborn & Veenhuis,1987
Underground Sand Filters	NA	70-90	22-91	30-50	43-70	Bell *et al.*,1995; Horner & Horner,1995; Young *et al.*,1996
Peat/sand filter		66	26-75	47		EPA,2002
Other Media Filters	< 30	65-100	50-80	15-45	< 30	USEPA, 1993
Organic Media Filters	90	90-95	48-90	55	49	Claytor & Schueler,1996; Stewart,1992; Stormwater Management,1994
Detention Facilities						
Detention Ponds	NA	46-98	24-89	28-50	20-94	City of Austin,1990, 1995; Harper & Herr,1993; Gain,1996; Martin & Smoot,1986; Young *et al.*,1996; Yu *et al.*, 1988, 1993, 1994
Wet ponds				30-40	50-60	Hartigan,1989
Wet ponds		50-90			30-90	Schueler,1992
Dry detention basins	< 30	30-65	15-45	15-45	15-45	USEPA, 1993
modified, extended dry pond				20-30	20-30	Hartigan,1989
Retention Basins	< 30	50-80	50-80	30-65	30-65	USEPA, 1993
Wetlands						
Wetlands	NA	65	35-65	20	25	USEPA,1993, DOT
	77	67	36	28	49	CWP,1997
Natural		76			5	Strecker *et al.*,1992
Constructed		80			58	Strecker *et al.*,1992
	< 30	50-80	50-80	< 30	15-45	USEPA, 1993
Others						
Oil-Grit Separators	NA	20-40	<10	<10	<10	Young *et al.*,1996
Disinfection	99.9-99.99					USEPA,1999

Table 2.2 BMP Screening Criteria

	Typical Pollutant Removals[1]					**Relative**		**Desired**	
BMPs	**SS**	**Nitrogen**	**Phosphorus**	**Pathogens**	**Metals**	**Land Requirement**	**Drainage Area[2]**	**Soil Conditions**	**Groundwater Elevation**
Vegetative Practices									
Grassed Swales	medium	low-medium	low-medium	low	low-medium	Small	small	permeable	below facility
Filter Strips	medium-high	medium-high	medium-high	low	medium	Varies	small	depends on types	depends on types
Infiltration Facilities									
Infiltration Basins	medium-high	medium-high	medium-	high	medium-high	Large	small-medium	permeable	below facility
Infiltration Trenches /Dry Wells	medium-high	medium-high	low-medium	high	medium-high	Small	small	permeable	below facility
Porous Pavement	high	high	medium	high	high	n/a	small-medium	permeable	below facility
Filtration Practices									
Filtration Basins	medium-high	low	medium-high	low	medium-high	Large	medium-large	permeable	below facility
Sand Filters	high	low-medium	low	low	medium-high	Varies	low-medium	depends on types	depends on types
Detention Facilities							i		
Extended Detention Dry Ponds	medium	low-medium	low-medium	low	low-medium	Large	medium-large	permeable	below facility
Wet Ponds	medium-high	medium	medium	low	medium-high	Large	medium-large	impermeable	near surface
Constructed Wetlands	medium-high	low	low-medium	low	medium-high	Large	large	impermeable	near surface
Others									
Water Quality Inlets	low-medium	low	low	low	low	n/a	small	n/a	n/a

[1] Low= <30-65%, High = 65-100%

[2] Small = <10- acres, Medium = 10-40 acres, Large = > 40 acres

(adapted from Novotny, 1995)

2.2 Stormwater Pollutant Loading Models

Urban land use information is important for stormwater modeling (Wong, 1997; Burian *et al*., 2002) as quantity and quality of stormwater runoff is related to land use. For example, stormwater from residential land use generally contains nutrients, fertilizers, pesticides from grass yards and trees and heavy metals from roof materials (Pitt, 1999; Asaf *et al*., 2004). Stormwater quality from industrial and commercial land uses varies but pollution concentrations are generally high. Transportation land use, such as streets and roads, are often found to be the highest pollutant loading land use (Bannerman *et al*., 1993; Arnold and Gibbons, 1996).

The Runoff Coefficient (RC) is one of the main components for determining stormwater runoff volume and represents the fraction of rainfall that actually reaches the receiving water (Wong *et al*., 1997). RC is highly correlated to imperviousness of the surface and the following equation is used by the County of Los Angeles, Department of Public Works (LADPW, 2000b):

$$RC = 0.8 \times I + 0.1 \tag{2.1}$$

where RC is runoff coefficient, I is impervious fraction. However, RCs used in this report were developed using a Geographical Information System (GIS) as a function of hydrologic soil group, slope, and land use according to Browne relation (1990) in the Ballona Creek Watershed. Table 2.3 shows the resulting RCs by land uses in this watershed and these values tend to be less than the RCs used by LADPW.

Table 2.3 Runoff coefficient by land uses in Ballona Creek Watershed

Land use	**Runoff Coefficient**
High Density Single Family Residential	0.29
Multiple family residential	0.33
Mixed Residential	0.72
Retail/ Commercial	0.72
Education	0.72
Light Industrial	0.69
Transportation	0.75
Vacant	0.23

Then the annual average storm runoff volume is calculated as follows:

$$RV = RC \times A \times RF \times CF \qquad (2.2)$$

where RV is annual stormwater runoff (m^3/yr), A is drainage area (m^2), RF is annual rainfall (mm), and CF is conversion factor. The imperviousness and RCs can be estimated against land use types.

Event Mean Concentrations (EMCs) is an average pollutant concentration during a storm event and widely used for estimating stormwater runoff pollution. The mathematical definition of EMCs is total pollutant mass discharged during an event divided by total volume discharge of the storm event as follows (Huber, 1993):

$$EMC = \frac{M}{V} = \frac{\int C(t)Q(t)dt}{\int Q(t)dt} \qquad (2.3)$$

where M is total mass of pollutant during the storm event, V is total stormwater runoff volume, C(t) is pollutant concentration that is function of time, and Q(t) is stormwater flow rate over time. EMCs are also related to land uses although they are dependent on sites and storm events (Smullen *et al*., 1999). LADPW conducted a stormwater quality monitoring program in compliance with the Los Angeles NPDES Municipal Stormwater Permits (LADPW, 2000). The land use monitoring program identified retail/commercial, light industrial, transportation land uses as the areas generating the highest copper, zinc concentrations and light industrial as the area generating the highest concentrations of suspended solids. Pollution concentrations from residential and educational laud uses were significantly less. Table 2.4 shows the cumulative EMCs by land use from 1994 to 2000, which are also used in this report.

Based on the information of runoff volume and EMCs for each pollutant type, wet-weather pollutant load can be estimated as follows:

$$PL_i = \alpha \times RC \times RF \times A \times EMC_i \qquad (2.4)$$

where PL_i and EMC_i are the annual pollutant load and the EMC for pollutant type i, respectively and α is a conversion factor for consistency of the units. When considering

Table 2.4 EMCs by land use in the County of Los Angeles

	Unit	**SFR**	**MFR**	**MxdR**	**C**	**E**	**I**	**T**	**V**
Total Coliform	MPN /100mL	1395691	n/d	n/d	1733009	n/d	508710	806940	21288
Fecal Coliform	MPN /100mL	1085354	n/d	n/d	1071657	n/d	653070	1340167	2175
SS	mg/L	105	46	69	67	103	229	75	164.68
Oil & Grease	mg/L	1.36	n/d	n/d	3.65	n/d	1.87	3.19	0
Total Copper	μg/L	15	12	17	35	21	31	52	9
Total Lead	μg/L	10	5	9	12	5	15	9	0
Total Zinc	μg/L	80	135	185	239	124	566	279	39
Kjeldahl-N	mg/L	2.80	1.86	2.7	3.37	1.62	3.07	1.81	0.81
NH3-N	mg/L	0.36	0.38	0.58	0.91	0.26	0.48	0.23	0.08
Nitrate-N	mg/L	1.04	1.73	0.71	0.58	0.63	0.86	0.75	1.11
Nitrite-N	mg/L	0.09	0.08	0.1	0.14	0.08	0.09	0.09	0.05
Total P	mg/L	0.39	0.19	0.26	0.41	0.31	0.44	0.44	0.11

Note that SFR is high density single family residential, MFR is multiple family residential, MxdR is mixed residential, C is retail/commercial, E is educational, I is light industrial, T is transportation and V is vacant land uses.
Note that SS is suspended solids, N is nitrogen, and P is Phosphorus.
Note that n/d represents no data were collected.
(adapted from LADPW, 2000)

dry-weather pollution, the following equation can be used to calculate runoff pollutant loads (Chiew and McMahon, 1999):

$$PL_i = RV \times EMC_i + BF \times DWC \qquad (2.5)$$

where BF is base flow and DWC is dry-weather concentration. Dry-weather flow pollutant loads were reported to be significant with lower precipitation (McPherson *et al*., 2002).

These simplistic models are most appropriate for longer time periods, such as seasonal or annual periods, assuming average annual rainfall. The models have been widely used in the region. For example, Stenstrom, *et al*. (1984) used the wet-weather pollutant loading model for a small watershed in Richmond, CA, for oil and grease estimation and ranking BMPs for its mitigation. The model was applied to Ballona Creek Watershed (Stenstrom and Strecker, 1993; Wong *et al*., 1997; Burian *et al*., 2002; Ackerman and Schiff, 2003) to quantify stormwater pollution. Psomas (Sedrak and Murillo, 2005) and Geosyntec Consultants (Susilo *et al*. 2006) developed BMP planning or prioritization tools for the City and the County of Los Angeles using similar concepts.

These approaches are useful to estimate the total mass emissions and often used as planning level models such that the outputs are used to compare the relative differences in pollution generation and the effectiveness of BMPs.

3. Evaluation of Projects

The projects approved for Proposition O funding were based on water quality improvements and especially for stormwater pollution mitigation. Selected projects were evaluated based on the following criteria:

- priority of project location
- stormwater pollutant loads generated from the drainage areas of project sites
- stormwater pollutant load reduction by the proposed BMPs
- compliance with TMDLs
- cost effectiveness

Priority of project location was evaluated by identifying environmentally significant areas within each watershed that need structural BMPs for stormwater cleanup. A Geographical Information System (GIS) was employed to identify the areas generating high pollutant loads and the impact on impaired water bodies on 303(d) list. Stormwater pollutant loads generated from the drainage areas of the project sites were estimated using the empirical models (equation 2.4 and 2.5) described in the previous chapter for selected water quality parameters such as total suspended solids (TSS), bacteria, metals and nutrients. The proposed BMPs were evaluated based on the concept reports assuming all runoff from the drainage area passes through the proposed BMPs in a sequential way. The output is the percentage of pollutant loads removed from the project site by the series of BMPs. Then the amount of pollution reduction was estimated in a watershed scale as the percentage of total pollutant loads from the entire watershed, which provides a measurement of significance of pollution reduction within the watershed. The effect of projects on TMDL compliance was evaluated based on a watershed approach because it is required by the TMDL process, although in most cases watershed boundaries are outside the City’s jurisdiction. The projects were grouped for their location in each watershed: Ballona Creek, Los Angeles River, and Dominguez Channel. Finally, the cost-effectiveness of the projects was evaluated on both the cost per unit of drainage area treated and the cost per the unit mass of pollutant removed. This analysis shows which project is more cost effective to treat stormwater pollution with limited amount of bond money.

In this evaluation, the projects for which land use and drainage area information are available were evaluated for both wet-weather and dry-weather conditions. WPD provided the data for project locations, the drainage areas and land uses of each project, storm drains, and the 303(d) impaired water bodies. Rainfall information and EMCs for each land uses were obtained from LADPW (downloaded from their website, http://ladpw.org/wmd/) and the Southern California Association of Governments (SCAG, 2005) land use information was used for landuse definitions, reduced to nine categories according to our previous work (Park and Stenstrom, 2006). Appendix C shows the project locations in association with Council Districts and watersheds. Appendix D and E show the proposed site plan and land uses of the projects.

3.1 Ballona Creek Watershed

The Ballona Creek Watershed, located in the western portion of the Los Angeles Basin, is highly urbanized with an area of approximately 135,000 acres as shown in Table 3.1. Nonpoint source pollution, especially the stormwater runoff, is the primary contributor to the water impairments (LADPW, 2004b). In addition, illicit sewer connections to the storm drain system may contribute to water impairments in both wet- and dry-weather flows. Typical pollutants in runoff include trash, TSS, bacteria, heavy metals, petroleum hydrocarbons, and nutrients. A toxicity study showed that Ballona Creek stormwater, especially the seasonal first flush, was toxic and sediments generally had higher concentrations of urban pollutants such as metals (Bay *et al*., 1999; LADPW, 2004b). A dry-weather sampling program shows high metals and bacteria discharges from Sepulveda Channel and Benedict Canyon and elevated hydrocarbon levels in the Sepulveda Wash (LADPW, 2004b). As a result, the quality of receiving waters such as Ballona Creek and Estuary, Marina del Rey and Santa Monica Bay are degraded and identified in 2006 303(d) list of impaired water bodies.

In order to protect the receiving waters in the watershed, the SWRCB and the LARWQCB adopted bacteria, trash, metal and sediment TMDLs. The sources of the high levels of bacteria are not all known, but possible sources are sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless

Table 3.1 Land use composition in Ballona Creek Watershed (2005)

Land Use	%
High Density Single Family Residential	36
Multiple Family Residential	11
Mixed Residential	7
Commercial	10
Educational	3
Light industrial	4
Transportation	3
Vacant	26
Other Urban	1
Water	1

(from SCAG, 2005)

encampments, illegal discharges from recreational vehicle holding tanks, malfunctioning septic tanks, and fecal matter from animals and birds (LARWQCB, 2002a, 2002b). The numeric targets for the bacteria TMDL are based on the Basin Plan, which includes both geometric mean and single sample limits. In marine waters, total coliform density shall not exceed 1,000/100 mL; fecal coliform 200/100 mL; and enterococcus 35/100 mL for geometric mean limits whereas total coliform density shall not exceed 10,000/100 mL or 1,000/100 mL, if the ratio of fecal-to-total coliform exceeds 0.1; fecal coliform 400/100 mL; and enterococcus 104/100 mL for single sample limits.

Trash includes suspended and floating material. Floating materials can inhibit the growth of aquatic organisms and other trash including medical and domestic waste is a source of bacteria and toxic substances. The source of these materials is litter, which is transported by the storm drain system (LADPW, 2004b). The numeric target for the trash TMDL is zero trash to the Creek.

Ballona Creek is the largest contributor of sediments and associated chemicals in the Marina. Urban runoff from various land uses introduces metals to waters. Other sources of metals to the marina include marine activities such as boating and antifouling paint (LADPW, 2004b). Most of the metals are in the dissolved form during dry-weather periods whereas they are in the particulate form during wet-weather periods. The numeric targets for metals are based on the California Toxics Rule (CTR) in terms of total recoverable metals. There are separate numeric targets for dry- and wet-weather flows. The dry-weather numeric target for copper is 24 µg/L; lead 13 µg/L; zinc 304 µg/L; and selenium 5 µg/L. The wet-weather numeric targets are similar: copper 24 µg/L; lead 59 µg/L; zinc 119 µg/L; and selenium 5 µg/L.

The following list shows the projects approved for Prop O funding within the watershed:

- Santa Monica Bay / Ballona Creek BMP project (#20)
    - Grand Avenue Stormwater BMPs (#20a)
    - La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b)
    - Mar Vista Recreation Center Stormwater BMPs (#20c)
- Santa Monica Bay Beaches Wet-weather Bacteria TMDL Project (#22)
    - Imperial Highway Stormwater BMPs (#22a)
    - Westminster Dog Park Stormwater BMPs (#22c)
    - Temescal Recreation Center Stormwater BMPs (#22e)
    - Westchester/LAX Stormwater BMPs (#22f)
    - Penmar Water Quality Improvement and Runoff Reuse Project (#22g)
- Santa Monica Bay Beaches Low Flow Diversions Upgrades (#51)

The Santa Monica Bay/Ballona Creek BMP Project (#20) is intended to help comply with the bacteria TMDL and stormwater NPDES permit requirements, and is consistent with Santa Monica Bay Beaches Wet-Weather Bacteria TMDL Implementation Plan (City of LA, 2006a, 2006b, 2006c). The project consists of three sub-projects that target mainly bacteria reduction as well as trash, metals and TSS to Santa Monica Bay and/or Ballona Creek. All these sub-projects are located within Council District 11. The Grand Avenue Stormwater BMP Project (#20a) contains 16 acres and is located in a highly urbanized area, which is composed of mainly residential and commercial land uses. This project will install 20 stormwater bioretention filtration systems, which divert and treat dry-weather flow and a portion of the wet-weather flow from the drainage area (City of LA, 2006a). The La Cienega/Fairfax Powerline Easement Stormwater BMP Project (#20b) will occupy a site of approximately 1 acre, which is owned and operated by the City of Los Angeles, Department of Water and Power (LADWP) (City of LA, 2006b). This project will treat a drainage area of approximately 5,000 acres, which consists of mainly residential, commercial, and light industrial land uses. The proposed BMPs include the installation of a flow diversion facility, a hydrodynamic separator for pretreatment, an underground detention tank for retention of pretreated stormwater, a bioretention system for stormwater pollution removal, and effluent detention tank. The Mar Vista Recreation Center Stormwater BMP project (#20c) has an area of approximately 15 acres, owned and operated by the City of Los Angeles, Department of Recreation and Parks (DRP) (City of LA, 2006c). This project treats a drainage area of approximately 243 acres that are predominantly residential and transportation land uses. The BMPs include the installation of a flow diversion facility, a hydrodynamic separator, an underground detention tank, bioretention system, and chlorination contact tank for disinfection, which will treat up to 4.8 million gallons (MG) per year.

The Santa Monica Bay Beaches Wet-Weather Bacteria TMDL Project (#22) is intended to meet wet-weather bacteria TMDL and stormwater NPDES permit requirements by removing pathogens from existing storm drains. The project is also consistent with Santa Monica Bay Beaches Wet-Weather Bacteria TMDL Implementation Plan (City of LA, 2006d, 2006e, 2007a, 2007b, 2007c). A total of 7 sub-projects were submitted and 5 sub-projects were approved for Prop O funding. All these sub-projects are located within Council District 11. The Imperial Highway Stormwater BMP Project (#22a) treats 17 acres of highway owned by the City of Los Angeles and the runoff currently discharges into the surf at Dockweiler State Beach (City of LA, 2006d). The project will retrofit approximately a 1.3 mile stretch of highway to divert and infiltrate the surface runoff by installing vegetated buffer strip and infiltration trench before discharging into storm drains. The Westminster Dog Park Stormwater BMP Project (#22c) treats runoff from the park with an area of 2.8 acres owned and operated by the City of Los Angeles, DRP (City of LA, 2006e). The runoff is highly contaminated by fecal material and could cause bacteria exceedances during the wet-weather periods. The project includes the installation of a shallow vegetated swale for pretreatment of the surface runoff, a sedimentation forebay for removal of sediments, and modular constructed wetlands to treat on-site runoff before discharging into the storm drains. The Temescal Recreation Center Stormwater BMPs (#22e) is located at Temescal Canyon and Pacific Coast Highway with an area of 50 acres owned and operated by the City of Los Angeles, DRP (City of LA, 2007a). The project treats the runoff from a drainage area of approximately 1,600 acres, which is predominantly vacant land use. The project includes the installation of a flow diversion facility, hydrodynamic separators for pretreatment, an underground detention tank, and disinfection facility. The treated water can be reused for landscape irrigation or fire fighting. The Westchester/LAX Stormwater BMPs (#22f) is located at Los Angeles World Airport property in the North Westchester subwatershed (City of LA, 2007b). The drainage area is approximately 2,080 acres that is predominantly high density residential land use and airports. The proposed BMPs include a diversion facility, hydrodynamic separators, an underground detention tank, a settling tank, and underground infiltration basins (optional). The Penmar Water Quality Improvement and Runoff Reuse Project (#22g) is located within the Santa Monica subwatershed with an area of 90 acres and owned and operated by the City of Los Angeles, DRP, and the City of Santa Monica. This project treats the runoff from a drainage area of approximately 1,470 acres, which is predominantly high-density single-family land uses. The proposed BMPs include a diversion facility, hydrodynamic separators, an underground detention tank, and disinfection facility to capture surface runoff up to 88.4 MG/year.

The Santa Monica Bay Beaches Low Flow Diversions (LFD) Upgrades (#51) are intended to meet Santa Monica Bay Beaches Bacteria TMDL during all dry-weather days (City of LA, 2006f). The project proposes to upgrade and modify its existing LFDs at Marquez Ave. (with a drainage area of 53 acres), Temescal Canyon (1,588 acres), Palisades Park (295 acres), Santa Monica Canyon (9,948 acres), Thornton Place (334 acres), and Venice Pavilion (130 acres). The upgrade involves evaluating the size of pumps and screens, installing flow-sensing automatic operation sensors in the sewer, and providing on-site emergency power and standby & backup pumps. All dry-weather flow during summer and winter will be diverted to the Hyperion Treatment Plant for treatment.

3.1.1 Wet-weather Flow in Ballona Creek Watershed

Annual wet-weather runoff from the watershed was estimated to be approximately 53,000 acre-ft per year assuming annual average rainfall of 12.01 inches. The average runoff coefficient of the entire watershed was 0.39. Table 3.2 shows estimated annual wet-weather loads from the watershed using runoff coefficients and EMCs in Table 2.3

and 2.4. The selected water quality parameters include bacteria such as total coliform, fecal coliform, and fecal enterococcus; TSS; oil and grease; heavy metals such as total copper (Cu), total lead (Pb), and total zinc (Zn); and nutrients such as Kjeldahl nitrogen, ammonia (NH_3)-nitrogen, nitrate-nitrogen, nitrite-nitrogen, and total phosphorus.

Table 3.2 Estimated annual wet-weather mass loads from Ballona Creek Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	7.62×10^{17}
Fecal Coliform	colonies/year	5.92×10^{17}
Suspended Solids	kg/year	6,872,635
Oil and Grease	kg/year	119,991
Total Copper	kg/year	1,414
Total Lead	kg/year	529
Total Zinc	kg/year	11,236
Kjeldahl-N	kg/year	157,338
NH_3-N	kg/year	28,817
Nitrate-N	kg/year	61,742
Nitrite-N	kg/year	6,079
Total Phosphorus	kg/year	15,496

The annual runoff volume from each project site was estimated using Eq. 2.2 as shown in Figure 3.1. The results show that the runoff volume from La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) site is the largest, approximately 3,220 acre-ft per year, corresponding to 6% of total runoff volume from the entire watershed to the receiving waters. It is the sub-regional project with the greatest drainage area. Westchester/LAX Stormwater BMPs (#22f), Penmar Water Quality Improvement and Runoff Reuse Project (#22g), and Temescal Recreation Center Stormwater BMPs (#22e) also generate a large amount of runoff volume, which are approximately 980 acre-ft/year, 580 acre-ft/year, and 400 acre-ft/year, respectively, corresponding to 1-2% of total runoff volume from the entire watershed to Santa Monica Bay. The runoff volumes from Grand Avenue Stormwater BMPs (#20a), Imperial Highway Stormwater BMPs (#22a) and Westminster Dog Park Stormwater BMPs (#22c) are small, less than 0.02% of total runoff from the entire watershed.

The removal efficiencies of the proposed BMPs were estimated using the range of removal efficiencies of proven BMPs found in the existing literature as shown in

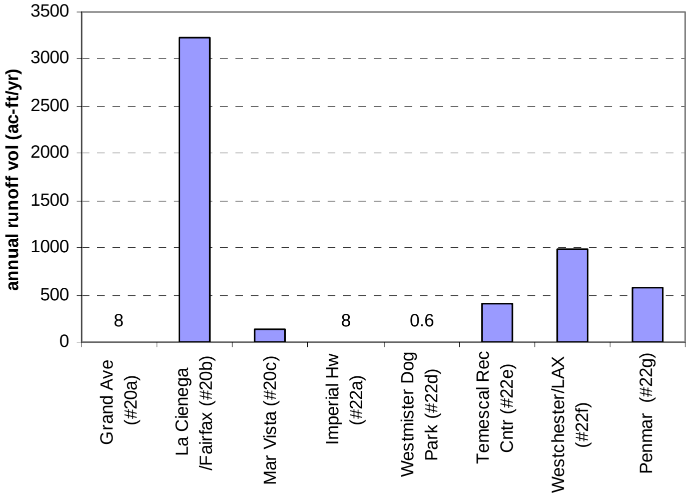

Figure 3.1 Estimated storm water runoff volume from project sites in Ballona Creek Watershed

Table 2.1, which might be different from the removal efficiencies in the concept reports. The differences occur because of BMPs which have undefined removal efficiency in the existing literature and were not included in the series of BMPs. For example, the removal efficiency of underground detention tank was not included in most cases. The results are shown in Table 3.3. All proposed wet-weather BMPs show high removal efficiencies for bacteria, 90% or more within the project site, except the Westminster Dog

Table 3.3 Removal efficiencies of wet-weather BMPs in Ballona Creek Watershed

%	**Santa Monica Bay / Ballona Creek BMP (#20)**						**Santa Monica Bay Beaches Wet-weather Bacteria TMDL Project (#22)**									
	Grand Ave.		**La Cienega /Fairfax**		**Mar Vista**		**Imperial Hw.**		**Westminster Dog Park**		**Temescal Rec. Cntr.**		**Westchester /LAX**		**Penmar**	
	min	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
Total Coliform		90		90	99.9	99.99	76	100		51	99.9	99.99	65	100	99.97	100
Fecal Coliform		90		90	99.9	99.99	76	100		51	99.9	99.99	65	100	99.97	100
Enterococcus	75	90		90	99.9	99.99	76	100		51	99.9	99.99	65	100	99.97	100
TSS		90	75	90			64	100	65	100			50	99	50	99
Oil & grease	75	67		67						75						
Total copper	75	99	75	99			51	100	50	98			50	99	50	99
Total lead	75	99	75	99			51	100	50	99			50	99	50	99
Total zinc	43	99	75	99			51	100	42	98			50	99	50	99
Kjeldahl-N	50	80	43	80			56	96	30	65			45	80	45	80
NH_3-N	43	79	50	79			56	96	30	72			45	80	45	80
Nitrate-N	43	50	43	50			56	96	30	86			45	80	45	80
Nitrite-N	50	50	43	50			56	96	30	65			45	80	45	80
TP		90	50	90			32	95	23	94			15	75	15	75

Park Stormwater BMPs (#22c), for which removal efficiencies are expected to be approximately 51%. It is expected that most of the BMPs will be appropriate to remove bacteria loads that are discharged to receiving waters although the proposed BMPs for the Westminster Dog Park Stormwater BMPs (#22c), *i.e.* vegetated swale and modular constructed wetlands, might not completely remove bacteria. In addition, most of the BMPs are capable of reducing other pollutants such as TSS, metals, and nutrients, which will reduce the impact of these pollutants to the Santa Monica Bay or Ballona Creek.

Table 3.4 shows the estimated annual wet-weather mass loads generated from the project sites and the loads after treatment by the proposed BMPs with the maximum removal efficiencies that were shown in Table 3.3. The mass loads from the La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) are the greatest among the projects, corresponding to 5-9% of loads from the entire watershed depending on the water quality parameters. The annual bacteria loads from the project corresponded to 6-7% of the loads from entire watershed. The Westchester/LAX Stormwater BMPs (#22f) and the Penmar Water Quality Improvement and Runoff Reuse Project (#22g) sites generate the next greatest annual mass load, corresponding to 1-3% of loads from the entire watershed. These three projects have the greatest impact on the quality of receiving waters. As the wet-weather runoff flows through the proposed BMPs, bacteria will be considerably removed. However, the treated runoff from project #20b will still contain 0.7% of bacteria load of the entire watershed, even after 90% of removal. On the other hand, annual bacteria loads from the Westminster Dog Park Stormwater BMPs (#22c) site are less than 0.001% of the loads from the entire watershed.

Figure 3.2 compares the daily mass loads of the 2000-2006 wet-weather seasons based on LADPW monitoring data and the TMDLs. The blue bars on the graph stand for the TMDLs for each water quality parameter for each monitoring event; red bars for the mass loads from entire watershed; and yellow bars for the mass loads reduced by proposed BMPs of an example project. Single sample limits and wet-weather numeric targets were used for bacteria and metal TMDL calculation, respectively. Mass loads from the watershed were calculated using the EMCs and the runoff volume of each event and the load after the proposed BMPs were calculated assuming their maximum removal efficiencies. La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b)

Table 3.4 Estimated annual wet-weather loads before and after BMPs (with maximum removal efficiency) of each project in Ballona Creek Watershed

	Santa Monica Bay/Ballona Creek BMPs (#20)						**Santa Monica Bay Beaches Wet-weather Bacteria TMDL Project (#22)**									
	Grand Ave.		**La Cienega**		**Mar Vista**		**Imperial Hw.**		**Westminster**		**Temescal**		**Westchester**		**Penmar**	
	inf.	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**Inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**
Total coliform	1.E+14	1.E+13	5.E+16	5.E+15	2.E+15	2.E+11	6.E+13	0	7.E+11	4.E+11	2.E+15	2.E+11	1.E+16	0	9.E+15	0
Fecal coliform	1.E+14	1.E+13	4.E+16	4.E+15	2.E+15	2.E+11	1.E+14	0	5.E+11	2.E+11	1.E+15	1.E+11	1.E+16	0	8.E+15	0
Enterococcus	4.E+13	4.E+12	2.E+16	2.E+15	5.E+14	5.E+10	3.E+12	0	4.E+11	2.E+11	4.E+14	4.E+10	3.E+15	0	4.E+15	0
SS	552	55	386368	38637	14636		2122	3	127	0.51	75215		111937	1119	69057	691
Oil & grease	25	8	8952	2954	467		54	54	0.06	0.01	267		3011	3011	1567	1567
Total copper	0.23	0	105	1.05	6		0.92	0	0.01	0	6		41	0.41	19	0.18
Total lead	0.08	0	39	0.39	1		0.15	0	0	0	0.84		10	0.1	6	0.06
Total zinc	2	0.02	1004	10.04	38		5	0.01	0.03	0	31		237	2.37	114	1.14
Kjeldahl-N	25	5.07	10592	2118	383		35	1.39	0.69	0.24	577		2522	504	1735	347
NH_3-N	6	1.34	2180	458	70		4	0.17	0.08	0.02	82		383	77	272	54
Nitrate-N	10	4.96	3070	1535	143		18	0.74	0.91	0.13	525		1044	209	667	133
Nitrite-N	1	0.53	408	204	16		2	0.07	0.04	0.01	28		107	21	67	13
TP	3	0.30	1351	135	63		8	0.40	0.09	0.01	80		453	113	266	67

Note that the unit of bacteria (total coliform, fecal coliform, and enterococcus) is colonies/year and the unit of the other parameters is kg/year.
Note that pollutant mass loads were estimated based on eq. 2.4 using runoff coefficients and EMCs in Table 2.3 and 2.4 for each project.

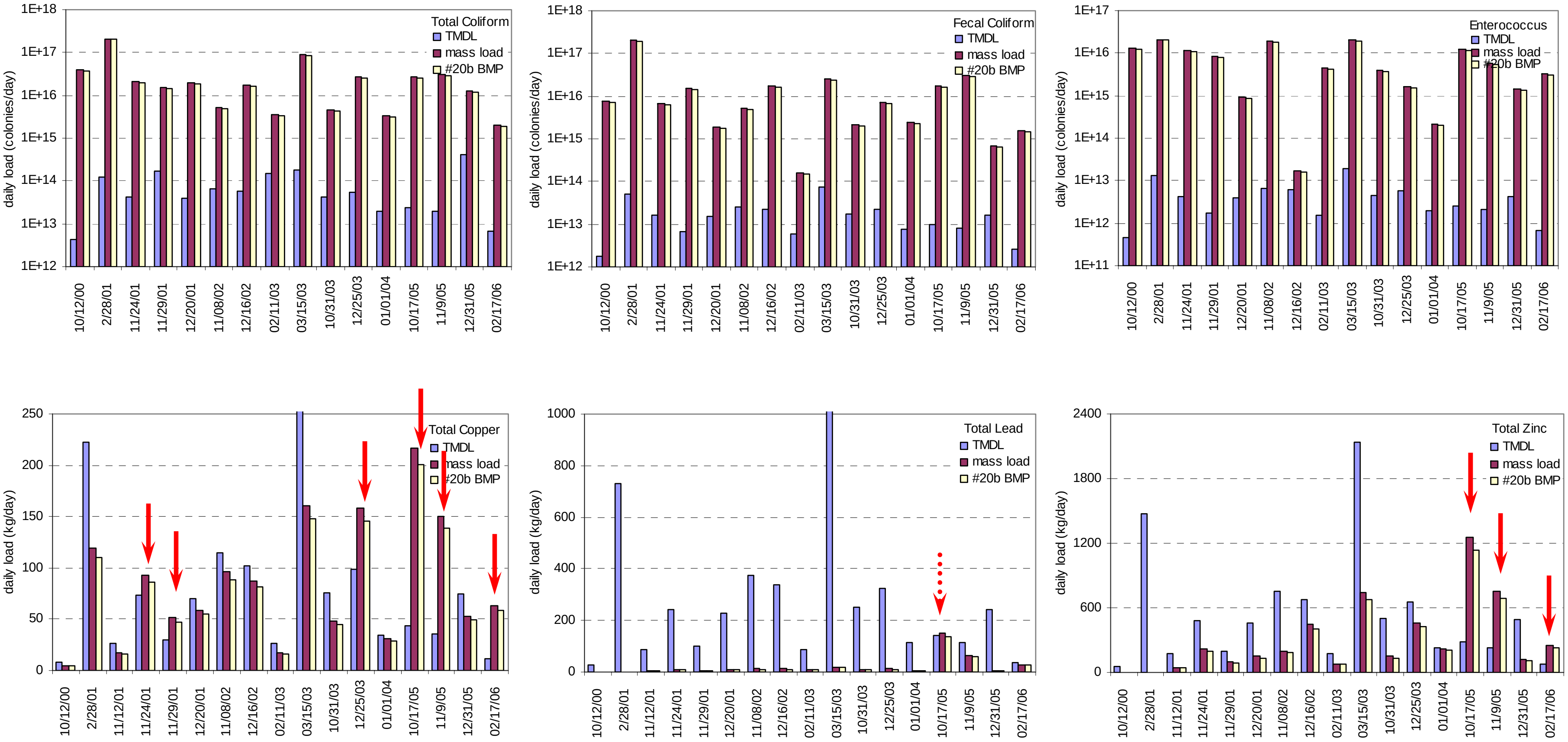

Figure 3.2 Wet-weather TMDL exceedance in Ballona Creek Watershed

Note that blue bars are TMDLs for each water quality parameter for each monitoring event; red bars are the mass loads from entire watershed; and yellow bars are the mass loads reduced by proposed BMPs of an example project. For metals, solid arrows indicate that both mass load from the watershed and the load after BMPs at La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) exceed the TMDL. The dotted arrow indicates the BMP reduces the load so that it does not exceed the TMDL.
Note that the loads were calculated based on eq 2.4 using monitoring rainfall and EMC data in LADPW reports (2000-2006).

was taken as the example project because it had the greatest percentage reduction of all projects in the watershed. The results show that bacteria TMDLs will always be violated and the daily load will still be 23 to 9,000 times more than the TMDLs for total coliform; 27 to 4,200 times for fecal coliform; and 2 to 29,000 times for fecal enterococcus. The installation of the project (#20b) will not achieve the TMDL requirement although it would significantly reduce bacteria loads. Total coliform load after BMP treatment will still exceed the TMDL by 8,500 times; fecal coliform by 4,000 times; and fecal enterococcus by 27,000 times. Even with all proposed projects, the bacteria TMDL will still be violated and the total coliform load will exceed the TMDL by 21-8,200 times; fecal coliform by 24-3,800 times; and fecal enterococcus by 2-26,600 times. Metal TMDLs will frequently be violated with lead being the closest to compliance. Total copper and zinc TMDLs will be exceeded by 30-430% and 220-340%, respectively, when violated, and total lead TMDL will be exceeded only once by 6%. Most of these events will still exceed TMDLs even after the installation of project #20b such that total copper and zinc TMDL will be exceeded by 20-400%; and 190-300%, respectively. However, the total lead TMDL compliance will be improved after the installation of the BMPs. With all proposed projects, total copper TMDL will be still exceeded by 12-370%; and total zinc by 180-290%.

Table 3.5 summarizes the annual mass loads reduced by the proposed BMPs with maximum removal efficiencies as a percentage of total loads from the entire watershed. Again, La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) achieves the greatest percentage of reduction for most water quality parameters although the project alone will not achieve TMDL compliance. The results demonstrate the projects that include the largest drainage area have the greatest impact on the quality of Ballona Creek and Santa Monica Bay. The results also show that no single project will significantly change TMDL compliance in the watersheds and the proposed BMPs are not sufficient to meet the TMDL requirements, although some projects can make important contributions to meeting the TMDL. Additional projects will be required to reliably meet the TMDLs.

Table 3.5 Percentage of maximum wet-weather load reduction by the proposed BMPs in Ballona Creek Watershed

%	Santa Monica Bay / Ballona Creek BMP project (#20)			Santa Monica Bay Beaches Wet-weather Bacteria TMDL Project (#22)				
	Grand Ave.	**La Cienega**	**Mar Vista**	**Imperial Hw.**	**Westminster**	**Temescal**	**Westchester**	**Penmar**
Total coliform.	0.017	6.0	0.27	0.008	0	0.21	1.7	1.2
Fecal coliform.	0.015	6.3	0.32	0.017	0	0.18	2.2	1.3
Enterococcus	0.012	5.4	0.15	0.001	0	0.13	1.1	1.2
TSS	0.007	5.1	0	0.031	0.002	0	1.6	1.0
Oil & grease	0.014	5.0	0	0	0	0	0.0	0.0
Total Copper	0.016	7.4	0	0.065	0.001	0	2.8	1.3
Total lead	0.015	7.2	0	0.029	0	0	1.8	1.2
Total zinc	0.016	8.8	0	0.044	0	0	2.1	1.0
Kjeldahl-N	0.013	5.4	0	0.021	0	0	18	12
NH3-N	0.017	6.0	0	0.014	0	0	2.7	1.9
Nitrate-N	0.008	2.5	0	0.029	0.001	0	7.4	4.7
Nitrite-N	0.009	3.4	0	0.027	0	0	0.8	0.5
TP	0.013	5.8	0	0.037	0	0	3.0	1.8

3.1.2 Dry-weather Flow in Ballona Creek Watershed

The annual dry-weather flow from Ballona Creek Watershed was assumed to be 23 cubic feet per second (cfs) according to LADPW's 2002-2003 runoff monitoring data. Pollutant concentrations were derived from the mean concentration values of the dry weather monitoring data collected by LADPW during the 1998-2006 dry-weather seasons (LADPW, 1999, 2000a, 2001, 2002, 2003, 2004a, 2006). The annual dry-weather pollutant loads from the watershed were estimated using the runoff and concentrations as shown in Table 3.6. The dry-weather loads are small compared with the wet-weather

Table 3.6 Estimated annual dry-weather mass loads from Ballona Creek Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	1.10×10^{16}
Fecal Coliform	colonies/year	3.85×10^{14}
Fecal Enterococcus	colonies/year	8.90×10^{14}
Suspended Solids	kg/year	1,464,410
Total Copper	kg/year	428
Total Lead	kg/year	77
Total Zinc	kg/year	918
Kjeldahl-N	kg/year	21,403
NH_3-N	kg/year	3,430
Nitrate-N	kg/year	23,116
Nitrite-N	kg/year	3,741
Total Phosphorus	kg/year	3,788

loads. For example, dry-weather bacteria loads are only 0.06-1.5% of wet-weather loads; dry-weather TSS load is 21% of wet-weather load; dry-weather metal loads are 8-30% of wet-weather loads; dry-weather nutrient loads are 12-62% of wet-weather loads.

Figure 3.3 shows annual dry-weather loads of each project as a percentage of total loads from the entire watershed. The load from Santa Monica Canyon LFD (#51d) is the greatest, corresponding to approximately 7% of the load of the entire watershed, followed by the La Cienega/Fairfax Powerline Easement Stormwater BMP Project (#20b) corresponding to approximately 4%. The dry-weather loads from Grand Avenue Stormwater BMPs (#20a), Marquez LFD (#51a), and Venice Pavilion LFD (#51f) are trivial, less than 0.1% of total loads of the entire watershed.

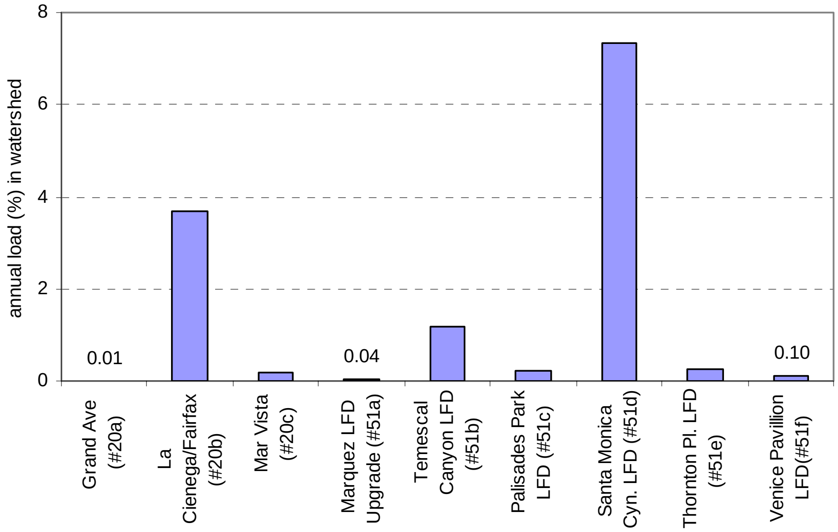

Figure 3.3 Annual dry-weather pollutant loads from project drainage areas of Ballona Creek watershed

Table 3.7 summarizes the removal efficiencies of the proposed BMPs of each project. The removal efficiencies of Santa Monica Bay/Ballona Creek BMP project (#20) are the same as for the wet-weather case. The removal efficiencies of the Santa Monica Bay Beaches LFD Upgrades (#51) were assumed to be 100 % because all of the low flows will be diverted to Hyperion for treatment. The results show that all projects will achieve a reduction of bacteria by 90% or more. For metals, the maximal removal efficiencies will be 99-100%.

Table 3.7 Removal efficiency of dry-weather BMPs in Ballona Creek Watershed

	Santa Monica Bay / Ballona Creek BMP project (#20)						**Santa Monica Bay Beaches Low Flow Diversions Upgrades (#51)**					
	Grand Ave.		**La Cienega /Fairfax**		**Mar Vista**		**Marquez**	**Temescal Canyon**	**Palisades Park**	**Santa Monica Cyn.**	**Thornton Pl.**	**Venice Pavilion**
	min	**max**	**min**	**max**	**min**	**max**						
Total Coli.		90		90	99.9	99.99	100	100	100	100	100	100
Fecal Coli.		90		90	99.9	99.99	100	100	100	100	100	100
Enterococcus	75	90		90	99.9	99.99	100	100	100	100	100	100
TSS		90	75	90			100	100	100	100	100	100
Cu	75	99	75	99			100	100	100	100	100	100
Pb	75	99	75	99			100	100	100	100	100	100
Zn	43	99	75	99			100	100	100	100	100	100
Kjeldahl-N	50	80	43	80			100	100	100	100	100	100
NH3-N	43	79	50	79			100	100	100	100	100	100
Nitrate-N	43	50	43	50			100	100	100	100	100	100
Nitrite-N	50	50	43	50			100	100	100	100	100	100
TP		90	50	90			100	100	100	100	100	100

Table 3.8 shows the estimated annual dry-weather mass loads generated from the project sites and the loads after treatment by the proposed BMPs with maximum removal efficiencies that were shown in Table 3.7. The dry-weather loads from Santa Monica Canyon LFD Upgrades (#51d) are the greatest and all pollutants will be treated at Hyperion. The La Cienega/Fairfax Powerline Easement Stormwater BMPs Project (#20b) generates the second greatest loads and the load discharged after the BMPs will be 0.4% for bacteria, 0.04% for metals, and 0.4-1.8% for nutrient compared with the loads from the entire watershed.

Figure 3.4 compares the daily mass loads of the 1999-2006 dry-weather seasons based on LADPW monitoring data and the TMDLs. (LADPW, 2000a, 2001, 2002, 2003, 2004a, 2006). Single sample limits and dry-weather numeric targets were used for bacteria and metal TMDL calculation, respectively. Santa Monica Canyon LFD (#51d) has the greatest reduction percentage within the watershed and was taken as the example project. The results show that bacteria TMDLs will frequently be violated such that the total coliform load TMDLs will be exceeded by as much as 29 times; fecal coliform by as much as 22 times; fecal enterococcus by as much as 210 times. However, the application of project (#51d alone will not achieve the TMDL compliance. Total coliform TMDL after BMP treatment will still be exceeded by up to 27 times; fecal coliform TMDL by up

Table 3.8 Estimated annual dry-weather loads before and after BMPs (with maximum removal efficiency) of each project in Ballona Creek Watershed

	Santa Monica Bay/Ballona Creek BMPs (#20)						**Santa Monica Bay Beaches Low Flow Diversions Upgrades (#51)**													
	Grand Ave.		**La Cienega**		**Mar Vista**		**Marquez**		**Temescal Cyn**		**Palisades Park**		**Santa Monica Cyn.**		**Thornton Pl.**		**Venice Pavilion**	
	inf.	**eff.**	**inf.**	**eff.**	**Inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**Eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**
Total coliform	1.28E+12	1.28E+11	4.05E+14	4.05E+13	1.98E+13	1.98E+09	4.31E+12	0	1.29E+14	0	2.40E+13	0	8.09E+14	0	2.72E+13	0	1.05E+13	0
Fecal coliform	4.45E+10	4.45E+09	1.42E+13	1.42E+12	6.92E+11	6.92E+07	1.51E+11	0	4.51E+12	0	8.39E+11	0	2.83E+13	0	9.50E+11	0	3.68E+11	0
Enterococcus	1.03E+11	1.03E+10	3.28E+13	3.28E+12	1.60E+12	1.60E+08	3.48E+11	0	1.04E+13	0	1.94E+12	0	6.54E+13	0	2.20E+12	0	8.52E+11	0
SS	170	17	53887	5389	2635		573	0	17174	0	3193	0	107566	0	3615	0	1401	0
Total copper	0.05	0	16	0.16	0.77		0.17	0	5	0	0.93	0	31	0	1.06	0	0.41	0
Total lead	0.01	0	3	0.03	0.14		0.03	0	0.9	0	0.17	0	6	0	0.19	0	0.07	0
Total zinc	0.11	0	34	0.34	1.65		0.36	0	11	0	2	0	67	0	2	0	0.88	0
Kjeldahl-N	2	0.5	788	158	39		8	0	251	0	47	0	1572	0	53	0	20	0
NH_3-N	0.4	0.08	126	27	6		1	0	40	0	7	0	252	0	8	0	3	0
Nitrate-N	3	1.34	851	425	42		9	0	271	0	50	0	1698	0	57	0	22	0
Nitrite-N	0.43	0.22	138	69	7		1	0	44	0	8	0	275	0	9	0	4	0
TP	0.44	0.04	139	14	7		1	0	44	0	8	0	278	0	9	0	4	0

Note that the unit of bacteria (total coliform, fecal coliform, and enterococcus) is colonies/year and the unit of the other parameters is kg/year.

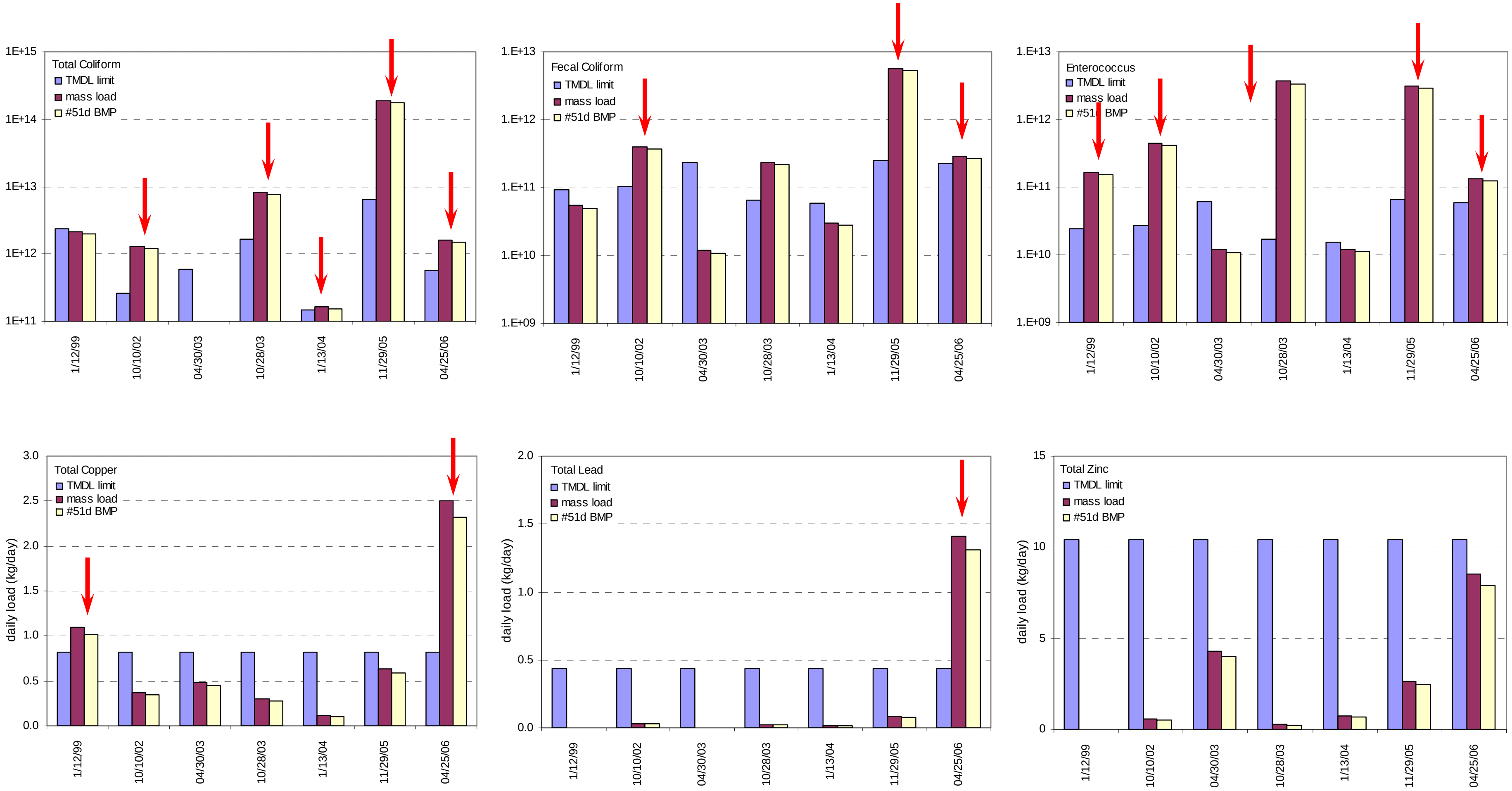

Figure 3.4 Dry-weather TMDL exceedance in Ballona Creek Watershed

Note that blue bars are TMDLs for each water quality parameter for each monitoring event; red bars are the mass loads from entire watershed; and yellow bars are the mass loads reduced by proposed BMPs of an example project. Solid arrows indicate that both mass loads generated from the watershed and after BMPs at Santa Monica Canyon LFD (#51d) exceed the TMDL.

Note that the loads were calculated based on eq 2.5 (dry weather part) using monitoring runoff and pollution concentration data in LADPW report (1998-2006).

to 20 times; and fecal enterococcus TMDL by 195 times. Even with all proposed projects, the bacteria TMDL will still be violated such that total coliform TMDL will still be exceeded by up to 25 times; fecal coliform TMDL by up to 19 times; and fecal enterococcus TMDL by 180 times. For metals, only one or two events will exceed the copper and lead TMDLs, and no exceedance occurs for the zinc TMDL. The copper and lead TMDLs will be exceeded by approximately 35-205% and 220%, respectively, for those events that violate the TMDLs. These events will still exceed TMDLs even after the installation of project #51d such that the copper TMDL will be exceeded by 25-180%, and lead TMDL by 200%. With all proposed projects, the copper and lead TMDLs will still be exceeded by approximately 17-170% and 180%, respectively.

The annual dry-weather mass loads reduced by the proposed BMPs with maximum removal efficiencies as a percentage of total loads from the entire watershed are shown in Table 3.9. Again, the Santa Monica Canyon LFD (#51d) reduces the greatest percentage of loads from the entire watershed for most water quality parameters even though the single project would not achieve TMDL compliance. The results demonstrate that the proposed BMPs are not sufficient to meet the TMDL requirement and there is a need of more projects to meet dry-weather bacteria TMDL to Santa Monica Bay and Ballona Creek.

Table 3.9 Maximum dry-weather load reduction by proposed BMPs as a percentage of total loads from Ballona Creek Watershed

%	**Santa Monica Bay / Ballona Creek BMP project (#20)**			**Santa Monica Bay Beaches Low Flow Diversions Upgrades (#51)**					
	Grand Ave.	**La Cienega /Fairfax**	**Mar Vista**	**Marquez**	**Temescal Canyon**	**Palisades Park**	**Santa Monica Cyn.**	**Thornton Pl.**	**Venice Pavilion**
Total Coli.	0.010	3.312	0.180	0.039	1.173	0.218	7.345	0.247	0.096
Fecal Coli.	0.010	3.312	0.180	0.039	1.173	0.218	7.345	0.247	0.096
Enterococcus	0.010	3.312	0.180	0.039	1.173	0.218	7.345	0.247	0.096
TSS	0.010	3.312	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Cu	0.011	3.643	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Pb	0.011	3.643	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Zn	0.011	3.643	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Kjeldahl-N	0.009	2.944	0.000	0.039	1.173	0.218	7.345	0.247	0.096
NH3-N	0.009	2.907	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Nitrate-N	0.006	1.840	0.000	0.039	1.173	0.218	7.345	0.247	0.096
Nitrite-N	0.006	1.840	0.000	0.039	1.173	0.218	7.345	0.247	0.096
TP	0.010	3.312	0.000	0.039	1.173	0.218	7.345	0.247	0.096

3.2 Los Angeles River Watershed

The Los Angeles River watershed is one of the largest watersheds in the region with an area of approximately 534,000 acres and is less urbanized compared with other watersheds. More than 40% of the watershed is open space as shown in Table 3.10. The Los Angeles River flows 51 miles from San Fernando Valley to Long Beach and the majority of the river is lined with concrete for flood control (LARWQCB, 2001). The river and other water bodies such as Lincoln Park, Echo Park Lake, and Compton Creek are listed as 2006 303(d) impaired water bodies for trash, ammonia, metals, coliform, as well as other pollutants such as pH, algae, scum, odors, and oils, which are associated with urban runoff.

Table 3.10 Land use composition in Los Angeles River Watershed (2005)

Land Use	%
High Density Single Family Residential	30
Multiple Family Residential	4
Mixed Residential	3
Commercial	6
Educational	2
Light industrial	8
Transportation	3
Vacant	43
Other Urban	0
Water	1

(from SCAG, 2005)

To protect its water bodies, the SWRCB and the LARWQCB adopted trash, nutrient and metal TMDLs. Trash is one of the serious water quality problems throughout the Los Angeles River (LARWQCB, 2001). One of the main sources of trash is urban runoff, which conveys trash to the river through storm drains. The numeric target for Trash TMDL is zero loading to the river.

Metal TMDLs in the watershed address both dry- and wet-weather flows (LARWQCB, 2005). However, the cadmium TMDL is only for wet-weather periods and the zinc TMDL is for Rio Hondo Reach 1 during dry-weather periods. The selenium TMDL is confined to Reach 6 and its tributaries. The numeric targets for metals are based on the CTR. There are separate targets for dry- and wet-weather flows. The dry-weather numeric targets for each metal are set for site specific conditions. The wet-weather numeric targets for cadmium is 3.1 µg/L, copper 17 µg/L, lead 62 µg/L, zinc 159 µg/L, and selenium 5 µg/L.

Nitrogen sources to the Los Angeles River include Water Reclamation Plants, urban runoff, stormwater, and groundwater. The numeric ammonia targets are set differently at discharge points: 4.7 mg/L, 1.6 mg/L at Reach 5, 8.7 mg/L, 2.4 mg/L at Reach 3, 10.1 mg/L, 2.3 mg/L at Burbank Western Channel for 1-hour and 30-day average, respectively. The nitrate-nitrogen numeric target is 8 mg/L and nitrite-nitrogen is 1 mg/L for 30-day average.

The following list shows the projects approved for Prop O funding within the watershed:

- Los Angeles Zoo Parking Lot: Demonstration on Environmental Sustainability Project (#9)
- Strathern Pit Multiuse Project (#10)
- Cesar Chavez Recreation Complex Project (#11)
- Cabrito Paseo Walkway/Bike Path Project (#12)
- Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project (#14)
- South Los Angeles Wetlands Park Project (#16)
- Aliso Wash-Limekiln Creek Confluence Restoration Project (#23)
- Oros Streetend Biofiltration Project (#28)
- Echo Park Lake Rehabilitation Project (#29)

The Parking Grove in El Sereno Project (#31) was evaluated in this report although it has not been approved by COAC and AOC. The Cesar Chavez Recreation Complex Project (#11) was not evaluated because the project does not employ conventional BMPs for urban runoff treatment. The concept reports of the following projects were not provided, and therefore were not evaluated in this report:

- Fremont High Community Garden Project (#15)
- Boyle Heights Joint Use Community Center Project (#30)
- Lincoln Heights Interchange Restoration Project (#33)

The Los Angeles Zoo Parking Lot Project (#9) site is located in the northeast corner of Griffith Park within Council District 4 (CDM, 2006a). The project proposes to renovate the Zoo's existing 33-acre parking lot for reduction and management of surface runoff that flows to a California Department of Transportation (Caltrans) right-of-way storm drain and directly into the Los Angeles River. Target pollutants include trash, heavy metals, pathogens, TSS, and oil and grease. The implementation plan consists of two phases: Phase I will design and implement stormwater management measures for a 10-acre parking lot through trash capture devices, porous pavement, and bioswales. Phase II will plan and design BMPs for the remaining 23-acre parking lot, which will include a stormwater collection (cistern) system, detention pond, and sand filtration system.

The Strathern Pit Multiuse Project (#10) site is located in the Community of Sun Valley within Council District 6 (LACFCD *et al*., 2006). The project proposes to convert a 30-acre landfill, owned by the Los Angeles Byproducts Company, to a multi-purpose facility for stormwater retention and treatment, groundwater recharge and flood protection. The drainage area is approximately 1,370 acres that is predominantly light industrial land uses. The proposed BMPs include retention ponds and/or constructed wetlands to capture and treat 100% of stormwater runoff, and the treated runoff would be pumped to the Sun Valley Park for groundwater recharge or for onsite reuse.

The Cesar Chavez Recreation Complex Project (#11) site is located within Council District 6 with an area of 41 acres owned by the City (City of LA *et al*., 2006g). Its drainage area is approximately 675 acres, which is predominantly light industrial, residential, and open land uses. The entire project consists of three phases, the scope of Prop O work is Phase I implementation, which is to restore the water spreading capacity from the current 50 cfs up to 250 cfs during wet-weather in the adjacent Tujunga Spreading Grounds through renovation of the existing landfill gas collection system. Phase II involves extensive grading and earthwork to provide additional cover as well as establishing proper drainage patterns for the existing site. Phase III implementation is park development for the site.

The Cabrito Paseo Walkway/Bike Path Stormwater BMP Project (#12) site, located within Council District 6, is an unused City right of way with an area of approximately 2 acres (CDM, 2006b). Its drainage area is approximately 19 acres, which is mostly urbanized with residential land use. The goal of the project is to minimize stormwater runoff pollutants such as oil and grease, TSS, metals and nutrients. Proposed BMPs include installation of bioswales, trash screens at drain inlets within the site, tree wells and landscaping to aid infiltration, a smart irrigation system and a decomposed granite walkway.

The Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project (#14) site is located in Hansen Dam Recreation Area owned by the U.S. Army Corps of Engineers (ACE) within Council District 7 (City of LA *et al*., 2006h). Its drainage area is 74 acres, which is mostly open land use. The project proposes the installation of bioswales and treatment wetlands to capture and reuse wet- and dry-weather flows from three parking lots.

The South Los Angeles Wetlands Park Project (#16) site is located in the property of the Metropolitan Transportation Authority (MTA) within Council District 9 (CDM, 2006c). Its drainage area is 500 acres, which is mostly urbanized with residential land use. The project proposes to create wetlands and riparian habitat to minimize pollutants from both dry- and wet-weather runoff. Targeted pollutants include nitrogen, oil and grease, TSS, metals, total petroleum hydrocarbons, and pathogens. Proposed BMPs include wetland, trash removal device and oil and grease skimmer, as part of the pump station.

The Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) site is located at Vanalden Park within Council District 12 with an area of approximately 12 acres owned by the City and the Los Angeles County Flood Control District (LACFCD) (CDM, 2007). The drainage area is approximately 11,830 acres, which is mainly residential and open land uses. The proposed BMPs consist of constructing low flow channel diversions; pre-screening devices; bioswales; vegetated detention basins; landscaping with native upland and riparian species; and decomposed granite pathways. The BMPs will treat both offsite and onsite runoff during dry- and wet-weather periods and reduce pollutant loads to Aliso Creek, Limekiln Creek, and Los Angeles River. Targeted pollutants include trash, metals, total coliform, fecal coliform, TSS, and oil and Grease.

The Oros Streetend Biofiltration Project (#28) site is located in the Elysian Valley neighborhood of northeast Los Angeles, within Council District 13 (Pelletier, 2006). The project site is partly owned by the City and partly associated with Steelhead Park on land under MRCA jurisdiction. The drainage area is 8.4 acres that is mostly high density residential land use. The goal of the project is to treat urban runoff of at least 0.75 inch by installing distributed biofiltration BMPs before it enters the Los Angeles River Reach 3, which is listed on 2006 303(d) impaired water bodies. The proposed BMPs are bioretention areas built into the parkways to capture the runoff from private residences, catch basin inserts, and an infiltration basin at the street end to capture all street and excess runoff from private property. These BMPs target pollutants such as trash, bacteria and metals.

The Echo Park Lake Rehabilitation (#29) site is located in the Echo Park/Silver lake community of Los Angeles within Council District 13 (CDM, 2006d). Its drainage area is 732 acres and is predominantly residential land use. Echo Park Lake has an area of 13-acres surrounded by 16-acre recreational open space and the lake itself was listed on 2006 303(d) impaired water bodies for algae, ammonia, copper, eutrophic, lead, odor, PCBs, pH, and trash. The goal of the project is to improve water quality in both the lake and the Los Angeles River Watershed by reducing urban runoff pollutants such as trash, heavy metals, bacteria, TSS, oil and grease, and nutrients. The project includes preliminary studies and site investigations, permitting of proposed improvements, construction of structural improvements to the lake and storm drain infrastructure, water quality related BMPs, habitat restoration, educational efforts pertaining to water quality improvements, and post construction monitoring. Specific implementation includes In-Lake Basin Improvements such as lake draining and sediment removal, replacement of lake liner, redesign of inlet and outlet structure, lake aeration; In-Lake Vegetation and Habitat Improvements; and Parkland Structural BMPs such as grassy swales/infiltration strips, porous pavement.

The Parking Grove in El Sereno (#31) site is located adjacent to Farmdale Elementary School and the El Sereno Recreation Center and Park within Council District 14 (CDM, 2006e). The dirt parking lot is owned by the City. Its drainage area is 3.3 acres and all of the drainage area is open land use. The creation of the Parking Grove will reduce sediment in runoff and dust from the dirt parking lot. Proposed BMPs include porous pavement in the dirt parking lot, tree wells for stormwater uptake and biofiltration, site grading, and a smart irrigation controller system. Targeted pollutants include oil and grease, TSS, metals and gasoline.

3.2.1 Wet-weather Flow in Los Angeles River Watershed

Annual wet-weather runoff from the watershed was estimated to be approximately 191,000 acre-ft/year assuming annual average rainfall of 12.01 inches. The average runoff coefficient of the entire watershed was 0.36. Table 3.11 shows estimated annual wet-weather loads from the watershed using runoff coefficient and EMCs in Table 2.3 and 2.4.

Table 3.11 Estimated annual wet-weather loads from Los Angeles River Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	2.12×10^{18}
Fecal Coliform	colonies/year	1.73×10^{18}
Suspended Solids	kg/year	30,647,717
Oil and Grease	kg/year	363,868
Total Copper	kg/year	4,916
Total Lead	kg/year	1,776
Total Zinc	kg/year	43,841
Kjeldahl-N	kg/year	522,045
NH^3-N	kg/year	87,513
Nitrate-N	kg/year	223,441
Nitrite-N	kg/year	19,790
Total Phosphorus	kg/year	72,097

The annual runoff volume from each project site is shown in Figure 3.5. The results show that the runoff volume from Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) is the largest, approximately 4,400 acre-ft/year, corresponding to 2% of total runoff volume from the entire watershed. On the other hand, the runoff volumes from Los Angeles Zoo Parking Lot Project (#9), Cabrito Paseo Walkway/Bike Path Project (#12), Oros Streetend Biofiltration Project (#28), and Parking Grove in El Sereno Project (#31) are small, less than 0.005% of total runoff from the entire watershed.

The removal efficiencies of the proposed BMPs were estimated as shown in Table 3.12. All proposed BMPs show high removal efficiencies for TSS and metals, with maximum removal efficiency of 80% or more. It is expected that most of the BMPs will be appropriate to remove TSS and metal loads discharged to Los Angeles River. However, the removal efficiencies for nutrients and bacteria varied.

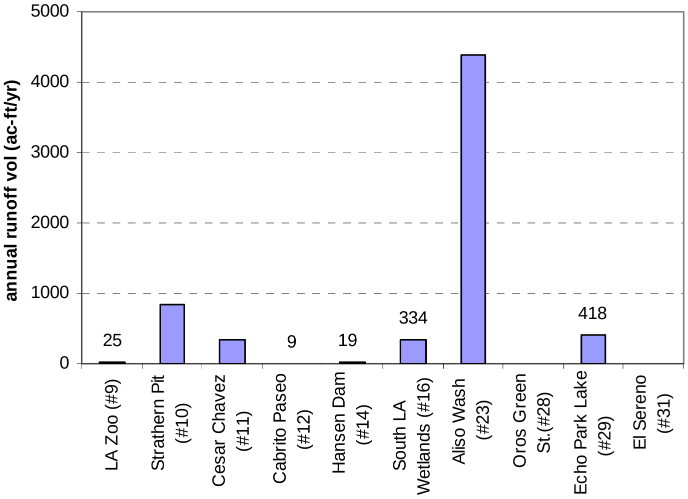

Figure 3.5 Estimated stromwater runoff volume from project sites in Los Angeles River Watershed

Table 3.12 Removal efficiency of proposed BMPs in Los Angeles River Watershed

%	LA Zoo Parking Lot (#9)		Strathern Pit (#10)		Cabrito Paseo (#12)		Hansen Dam (#14)		South LA Wetlands (#16)		Aliso Wash (#23)		Oros Green St.(#28)		Echo Park Lake (#29)		Parking lot El Sereno (#31)	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	Min	max	min	max
Total Coliform.	23	69		30		30		51		30		90	42	97	51	93	76	100
Fecal Coliform	61	83		30		30		51		30		90	42	97	51	93	76	100
Enterococcus	23	69		30		30		51		30		90	42	97	51	93	76	100
TSS	81	100	50	80	30	98	65	100	50	80	75	90	59	96	83	100	74	100
Oil & grease		23				75		75				67		23		90		
Total copper	38	99	50	80	0	90	50	98	50	80	75	99	59	99	74	98	34	100
Total lead	38	99	50	83	0	94	50	99	50	83	75	99	59	99	74	98	22	100
Total zinc	38	99	42	80	0	90	42	98	42	80	75	99	59	99	70	98	34	100
Kjeldahl-N	54	83		30	0	50	30	65	0	30	43	80	44	80	15	69	72	100
NH3-N	54	83	30	44	0	50	30	72	30	44	50	79	47	80	41	75	72	100
Nitrate-N	30	72		30	(-)	80	30	86	0	30	43	50	44	70	15	62	83	100
Nitrite-N	50	83		30	0	50	30	65	0	30	43	50	44	70	15	69	56	100
TP	43	98	15	58	9	85	23	94	15	58	50	90	27	80	41	79	13	94

Table 3.13 shows the estimated annual wet-weather mass loads generated from the project sites and the loads after treatment by the proposed BMPs with maximum removal efficiencies that were shown in Table 3.12. The mass loads from the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) are the greatest among the

projects, corresponding to 2-3% of total loads from the entire watershed. The proposed BMPs will remove considerable amount of metals but the treated runoff will still contain 1% of nutrients loads of the entire watershed. On the other hand, the mass loads from the Los Angeles Zoo Parking Lot Project (#9), the Cabrito Paseo Walkway/Bike Path Project (#12), the Hansen Dam Parking Lot and Wetlands Restoration Project (#14), the Oros Streetend Biofiltration Project (#28), and the Parking Grove in El Sereno Project (#31) are less than 0.01% of the loads from the entire watershed.

Figure 3.6 compares the daily mass loads of the 2000-2006 wet-weather seasons and the TMDLs (LADPW, 2001, 2002, 2003, 2004a, 2006). In this case, 30-day average limit and wet-weather numeric targets were applied for nutrients and metal TMDL calculation. The Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) was taken as the example project because it has the greatest percentage reduction of all projects in the watershed. The results show that ammonia-nitrogen TMDLs will be violated five times whereas nitrate- and nitrite-nitrogen TMDLs will rarely be violated. Ammonia-nitrogen TMDLs will be exceeded by approximately 2-140% when violated. However, the installation of project #23 will not achieve the TMDL requirement except a single event on 11/8/02. Even with all proposed projects, the ammonia-nitrogen TMDL will still be exceeded by 11-130%. Metal TMDLs will frequently be violated with lead being the closest to compliance. Total copper TMDL will often be exceeded by approximately 14-2,200%. All events will still exceed the TMDL by approximately 11-2,150% even after the installation of project #23. Total lead TMDL will be exceeded only once by approximately 17 times. This event will still exceed the TMDL by 16 times with the installation of project #23 or all proposed projects. Total zinc TMDLs will be exceeded 5 times by approximately 6-750%. All these events still exceed the TMDL by 3-720% with the installation of project #23 and by approximately 2-700% with all proposed projects.

Table 3.14 summarizes the annual wet-weather mass loads reduced by the proposed BMPs with maximum removal efficiencies as a percentage of total loads from the entire watershed. The Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) achieves the great percentage reduction even though the single project will not achieve TMDL compliance. However, the Los Angeles Zoo Parking Lot Project (#9), the

Table 3.13 Estimated annual wet-weather loads before and after BMPs (with maximum removal efficiency) of each project in Los Angeles River Watershed

	LA Zoo Parking Lot (#9)		Strathern Pit (#10)		Cabrito Paseo (#12)		Hansen Dam (#14)		South LA Wetlands (#16)		Aliso Wash (#23)		Oros Green St. (#28)		Echo Park Lake (#29)		Parking lot El Sereno (#31)	
	inf.	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**Eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**
Total Coli..	2.4E+14	7.7E+13	5.9E+15	4.2E+15	1.5E+14	1.1E+14	3.9E+13	1.9E+13	5.7E+15	4.0E+15	5.3E+16	5.3E+15	4.0E+13	1.4E+12	7.3E+15	5.1E+14	2.0E+11	0
Fecal Coli.	4.1E+14	6.8E+13	7.1E+15	5.0E+15	1.1E+14	7.8E+13	3.0E+13	1.5E+13	4.3E+15	3.0E+15	4.3E+16	4.3E+15	3.8E+13	1.3E+12	5.5E+15	3.8E+14	2.1E+10	0
Enterococcus	1.1E+13	3.3E+12	1.7E+15	1.2E+15	4.3E+13	3.0E+13	4.6E+12	2.3E+12	2.6E+15	1.8E+15	2.2E+16	2.2E+15	2.1E+13	7.3E+11	3.7E+15	2.6E+14	9.9E+09	0
TSS	2308	0	220659	44132	1352	27	3891	16	34019	6804	732153	73215	767	32	39289	0	156	0
O&G	98	75	1944	1944	28	7	9	2	811	811	8969	2960	7	6	916	9	0	0
Cu	2	0.01	31	6	0.31	0.03	0.3	0.01	9	1.8	116	1	0.11	0	10	0.04	0.01	0
Pb	0	0	14	2	0.13	0.01	0.05	0	3.7	0.63	48	0.48	0.06	0	5	0.02	0	0
Zn	9	0.04	532	106	3	0.3	2	0.05	85	17	1146	11	1.54	0.02	93	0.37	0.04	0
Kjeldahl-N	55	10	3059	2142	35	18	28	10	1103	772	13265	2653	13	3	1399	441	0.77	0
NH3-N	7	1.2	475	266	7	4	4	1	237	133	2133	448	2	0.38	297	75	0.08	0
Nitrate-N	23	6	894	626	9	2	25	3	296	207	5120	2560	4	1.27	395	152	1.05	0
Nitrite-N	3	0.46	91	64	1	0.63	1	0.45	43	30	473	237	0.4	0.12	54	17	0.04	0
TP	14	0.32	441	185	5	0.73	4	0.24	124	52	1848	185	2	0.36	153	7	0.1	0.01

Note that the unit of bacteria (Total coliform, fecal coliform, and enterococcus) is colonies/year and the unit of the other parameters is kg/year.
Note that pollutant mass loads were estimated based on eq. 2.4 using runoff coefficients and EMCs in Table 2.3 and 2.4 for each project.

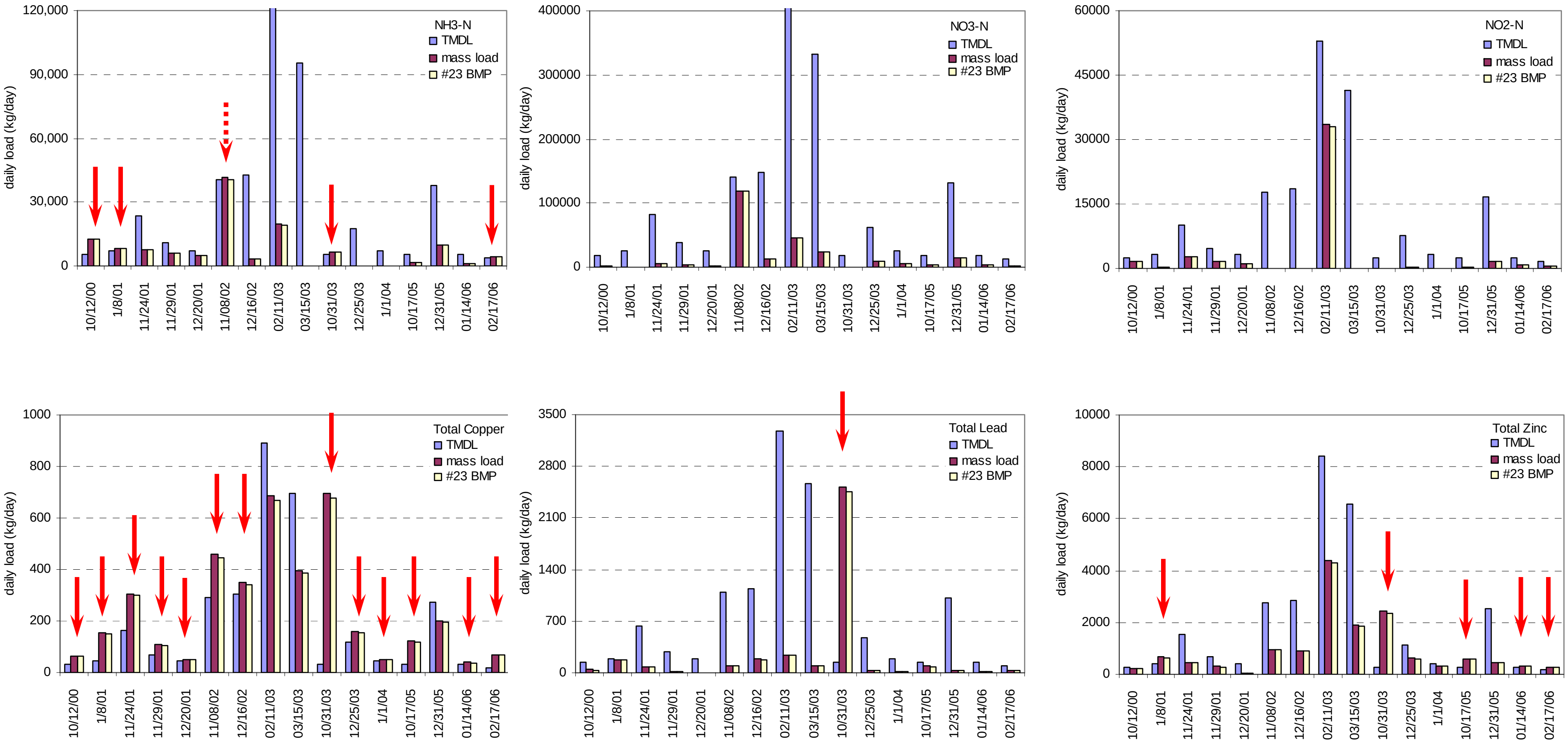

Figure 3.6 Wet-weather TMDL exceedance in Los Angeles River Watershed

Note that blue bars are TMDLs for each water quality parameter for each monitoring event; red bars are the mass loads from entire watershed; and yellow bars are the mass loads reduced by proposed BMPs of an example project. Solid arrows indicate that both mass load generated from the watershed and after BMPs at Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) exceed the TMDL. The dotted arrow indicates the BMP reduces the load not to exceed the TMDL.
Note that the loads were calculated based on eq 2.4 using monitoring rainfall and EMC data in LADPW reports (2000-2006).

Table 3.14 Maximum wet-weather mass load reduction by proposed BMPs as a percentage of total loads from Los Angeles River Watershed

%	LA Zoo Parking Lot (#9)	Strathern Pit (#10)	Cabrito Paseo (#12)	Hansen Dam (#14)	South LA Wetlands (#16)	Aliso Wash (#23)	Oros Green St.(#28)	Echo Park Lake (#29)	Parking lot El Sereno (#31)
Total Coli.	0.004	0.084	0.002	0.001	0.081	2.257	0.002	0.320	9.50E-06
Fecal Coli.	0.007	0.124	0.002	0.001	0.075	2.258	0.002	0.295	1.19E-06
Enterococcus	3.88E-04	0.060	0.002	2.83E-04	0.094	2.395	0.002	0.417	1.19E-06
TSS	0.002	0.576	0.004	0.013	0.089	2.150	0.002	0.128	0.001
O&G	0.006	0.000	0.006	0.002	0.000	1.652	4.72E-04	0.249	0.000
Cu	0.010	0.512	0.006	0.006	0.146	2.342	0.002	0.211	1.75E-04
Pb	0.005	0.676	0.007	0.003	0.173	2.680	0.003	0.257	0.000
Zn	0.006	0.971	0.006	0.005	0.155	2.588	0.003	0.211	8.36E-05
Kjeldahl-N	0.003	0.176	0.003	0.003	0.063	2.033	0.002	0.184	0.000
NH3-N	0.002	0.239	0.004	0.003	0.119	1.926	0.002	0.254	9.01E-05
Nitrate-N	0.003	0.120	0.003	0.010	0.040	1.146	0.001	0.109	4.70E-04
Nitrite-N	0.004	0.138	0.003	0.004	0.065	1.195	0.001	0.187	2.17E-04
TP	0.005	0.355	0.548	0.005	0.100	2.308	0.002	0.203	1.37E-04

Cabrito Paseo Walkway/Bike Path Project (#12), the Hansen Dam Parking Lot and Wetlands Restoration Project (#14), the Oros Streetend Biofiltration Project (#28), and the Parking Grove in El Sereno Project (#31) will not have a great impact on TMDL compliance. The results also demonstrate the projects with the largest drainage area have the greatest impact on the quality of Los Angeles River. The installation of all proposed BMPs are not sufficient to meet the TMDL requirements. Additional projects will be required to reliably meet the TMDLs.

3.2.2 Dry-weather Flow in Los Angeles River Watershed

The annual dry-weather flow for Los Angeles River Watershed is assumed to be 141 cfs according to LADPW’s 2002-2003 runoff monitoring. Pollutant concentrations were derived from the dry-weather monitoring collected by LADPW during the 1998 and 2006 dry-weather seasons (LADPW, 1999, 2000a, 2001, 2002, 2003, 2004a, 2006). The annual dry-weather pollutant loads from the watershed were estimated as shown in Table 3.15. The dry-weather loads are small compared with the wet-weather loads except nutrients. For example, dry-weather bacteria loads are approximately 0.3-5% of wet-weather loads; dry-weather TSS load is 15% of wet-weather loads; and dry-weather metal load are 18-35% of wet-weather loads. On the other hand, dry-weather nutrient loads are 1.3 to 11 times of wet-weather loads.

Figure 3.7 shows the annual dry-weather mass loads of each project. The load from the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) is the greatest, corresponding to approximately 2% of the loads of the entire watershed. The loads from the Los Angeles Zoo Parking Lot Project (#9), the Cabrito Paseo Walkway/Bike Path Project (#12), the Hansen Dam Parking Lot and Wetlands Restoration Project (#14), the Oros Streetend Biofiltration Project (#28), and the Parking Grove in El Sereno Project (#31) are small, less than 0.02% of total loads of the entire watershed.

Table 3.15 Estimated annual dry-weather loads from Los Angeles River Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	9.85×10^{16}
Fecal Coliform	colonies/year	8.18×10^{15}
Fecal Enterococcus	colonies/year	2.28×10^{15}
Suspended Solids	kg/year	4,583,101
Total Copper	kg/year	1,706
Total Lead	kg/year	463
Total Zinc	kg/year	7,927
Kjeldahl-N	kg/year	1,589,253
NH_3-N	kg/year	246,820
Nitrate-N	kg/year	297,667
Nitrite-N	kg/year	211,037
Total Phosphorus	kg/year	222,064

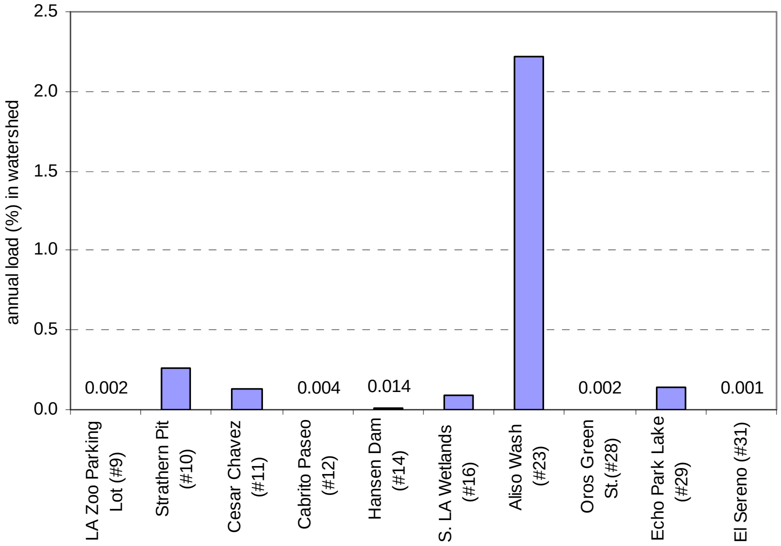

Figure 3.7 Annual dry-weather load of projects as a percentage of total load from Los Angeles River Watershed

Table 3.16 shows the estimated annual dry-weather mass loads generated from the project sites and the loads after BMP treatment with maximum removal efficiencies. The removal efficiencies are the same as for the wet-weather case. The mass loads from the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) are the greatest among the projects, corresponding to 2-3% of loads of the entire watershed. The proposed BMPs will remove considerable amounts of metals and bacteria. On the other hand, the mass loads from the Los Angeles Zoo Parking Lot Project (#9), the Cabrito Paseo Walkway/Bike Path Project (#12), the Hansen Dam Parking Lot and Wetlands Restoration Project (#14), the Oros Streetend Biofiltration Project (#28), and the Parking Grove in El Sereno Project (#31) are less than 0.01% of the loads from the entire watershed. However, the installation of these projects will also remove considerable amount of metals.

Figure 3.8 compares the daily mass loads of the 2002-2006 dry-weather seasons based on LADPW monitoring data and the TMDLs (LADPW, 2003, 2004a, 2006). Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) has the greatest reduction percentage within the watershed and was taken as the example project. The results show that metal TMDLs will always be violated such that copper TMDLs will be exceeded by as much as 29 times and lead by as much as 4 times. However, the installation of project #23 alone will not be sufficiently great to reduce the number of exceedances. The copper TMDL will be exceeded by 28 times and lead TMDL by 4 times. Even the application of all proposed projects will not reduce the number of exceedances. For nutrients, the ammonia- and nitrite-nitrogen TMDLs will be exceeded twice and four times, respectively, and no exceedance occurs for nitrate–nitrogen TMDL. The ammonia- and nitrite-nitrogen TMDLs will be exceeded by approximately 60-110% and 9-60%, respectively. These events will still exceed TMDLs even with the application of project #23 or all proposed projects.

The annual dry-weather mass loads reduced by the proposed BMPs with maximum removal efficiencies are shown in Table 3.17. Again, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) reduces the greatest percentage of loads from the entire watershed even though the project alone would not achieve TMDL

Table 3.16 Estimated annual dry-weather loads before and after BMPs (with maximum removal efficiency) of each project in Los Angeles River Watershed

	LA Zoo Parking Lot (#9)		**Strathern Pit (#10)**		**Cabrito Paseo (#12)**		**Hansen Dam (#14)**		**South LA Wetlands (#16)**		**Aliso Wash (#23)**		**Oros Green St. (#28)**		**Echo Park Lake (#29)**		**Parking lot El Sereno (#31)**	
	inf.	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**Eff.**	**inf.**	**eff.**	**inf.**	**eff.**	**inf.**	**eff.**
Total Coli.	6.08E+12	1.90E+12	2.53E+14	1.77E+14	3.55E+12	2.48E+12	1.37E+13	6.72E+12	9.22E+13	6.64E+13	2.18E+15	2.18E+14	1.55E+12	0.00E+00	1.35E+14	9.45E+12	6.17E+11	0
Fecal Coli.	5.05E+11	8.39E+10	2.10E+13	1.47E+13	2.95E+11	2.06E+11	1.14E+12	5.58E+11	7.66E+12	5.51E+12	1.81E+14	1.81E+13	1.29E+11	0.00E+00	1.12E+13	7.85E+11	5.12E+10	0
Enterococcus	1.41E+11	4.40E+10	5.85E+12	4.10E+12	8.20E+10	5.74E+10	3.17E+11	1.56E+11	2.13E+12	1.54E+12	5.05E+13	5.05E+12	3.58E+10	0.00E+00	3.12E+12	2.19E+11	1.43E+10	0
TSS	283	0.03	11779	2356	165	3	639	3	4293	1085	101547	10155	72	1	6287	0	29	0
Cu	0.11	0.001	4	1	0.06	0.006	0.24	0.005	1.6	0.4	38	0.38	0.03	0	2.34	0.05	0.01	0
Pb	0.03	0	1	0.2	0.02	0.001	0.06	0.001	0.43	0.1	10	0.1	0.01	0	0.63	0.01	0	0
Zn	0.49	0.003	20	4	0.29	0.03	1.1	0.02	7	2	176	2	0.12	0.001	11	0.22	0.05	0
Kjeldahl-N	98	17	4084	2859	57	29	221	77	1489	1071	35213	7043	25	5	2180	687	10	0
NH3-N	15	3	634	355	9	4	34	10	231	136	5469	1148	3.88	1	339	85	2	0
Nitrate-N	18	5	765	536	11	2	41	6	279	201	6595	3298	4.68	1	408	157	2	0
Nitrite-N	13	2	542	380	8	4	29	10	198	142	4676	2338	3.32	1	290	91	1	0
TP	14	0.34	571	240	8	7	31	2	208	95	4920	492	3.49	1	305	65	1	0

Note that the unit of bacteria (Total coliform, Fecal Coliform, and Enterococcus) is colonies/year and the unit of the other parameters is kg/year.

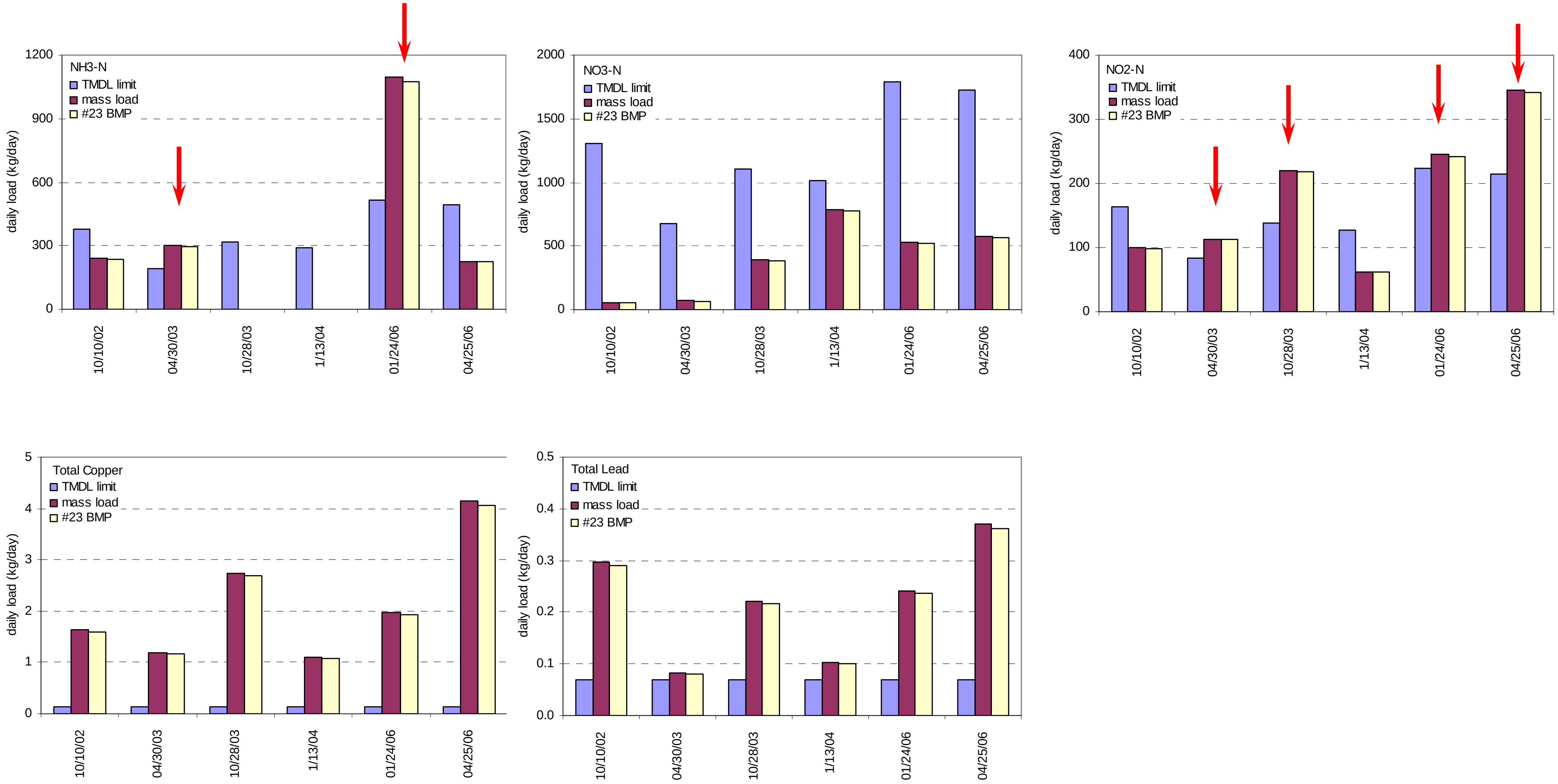

Figure 3.8 Dry-weather TMDL exceedance in Los Angeles River Watershed

Note that blue bars are TMDLs for each water quality parameter for each monitoring event; red bars are the mass loads from entire watershed; and yellow bars are the mass loads reduced by proposed BMPs of an example project. Solid arrows for nutrients indicate that both mass load and the load after BMPs at Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) exceed the TMDL. All metal TMDLs are exceeded.
Note that the loads were calculated based on eq 2.5 (dry weather part) using monitoring runoff and pollution concentration in LADPW reports (2002-2006) .

Table 3.17 Maximum dry-weather load reduction by proposed BMPs as a percentage of total loads from Los Angeles River Watershed

%	LA Zoo Parking Lot (#9)	Strathern Pit (#10)	Cabrito Paseo (#12)	Hansen Dam (#14)	South LA Wetlands (#16)	Aliso Wash (#23)	Oros Green St.(#28)	Echo Park Lake (#29)	Parking lot El Sereno (#31)
Total Coli.	0.0019	0.077	0.001	0.007	0.026	1.994	0.0016	0.128	0.001
Fecal Coli.	0.0019	0.077	0.001	0.007	0.026	1.994	0.0016	0.128	0.001
Enterococcus	0.0019	0.077	0.001	0.007	0.026	1.994	0.0016	0.128	0.001
TSS	0.0019	0.206	0.004	0.014	0.070	1.994	0.0016	0.137	0.001
O&G	0.0019	0.206	0.003	0.014	0.070	2.194	0.0016	0.134	0.001
Cu	0.0019	0.213	0.003	0.014	0.073	2.194	0.0016	0.135	0.001
Pb	0.0019	0.206	0.003	0.014	0.070	2.194	0.0016	0.134	0.001
Zn	0.0019	0.077	0.002	0.009	0.026	1.773	0.0013	0.094	0.001
Kjeldahl-N	0.0019	0.113	0.002	0.010	0.039	1.750	0.0013	0.103	0.001
NH3-N	0.0019	0.077	0.003	0.012	0.026	1.108	0.0013	0.084	0.001
Nitrate-N	0.0019	0.077	0.002	0.009	0.026	1.108	0.0013	0.094	0.001
Nitrite-N	0.0018	0.149	0.306	0.013	0.051	1.994	0.0012	0.108	0.001
TP	0.0019	0.077	0.001	0.007	0.026	1.994	0.0016	0.128	0.001

requirements. The results demonstrate that the proposed BMPs are not sufficient to meet the TMDL requirement.

3.3. Dominguez Channel Watershed

The Dominguez Channel Watershed encompasses approximately 70,400 acres and is highly urbanized as shown in Table 3.18. Water bodies in the watershed include Los Angeles Harbor, Machado Lake, as well as the Dominguez Channel and these are identified in 2006 303(d) list of impaired water bodies. Pollutants for Dominguez Channel include ammonia, dieldrin (tissue), bacteria, lead (tissue), and zinc (sediment) among others; those for Machado Lake are algae, ammonia, chem A, chlordane, DDT, dieldrin, eutrophic, odors, PCBs, and trash; and those for Los Angeles Harbor (Inner Cabrillo Beach) are copper, DDT, and PCBs. The sources of pollutants are historical deposits of DDT and PCBs in sediment, Discharges from Publicly Owned Treatment Works (POTW) and industrial facilities, spills from ships, leaching of groundwater, and stormwater runoff (LARWQCB, 2004).

The Los Angeles Harbor Bacteria TMDL (Inner Cabrillo Beach and Main Ship Channel) was adopted based on the Basin Plan as its numeric targets for both geometric mean and single sample limits (LARWQCB, 2004). The main sources of bacteria are known to be dry- and wet-weather runoff.

Table 3.18 Land use composition in Dominguez Channel Watershed

Land Use	%
High Density Single Family Residential	35
Multiple Family Residential	6
Mixed Residential	6
Commercial	12
Educational	4
Light industrial	21
Transportation	6
Vacant	9
Other Urban	0
Water	1

(from SCAG, 2005)

The following projects located in the watershed were approved for Prop O funding:

- Rosecrans Recreation Center Stormwater Enhancements Project (#35)
- Machado Lake Ecosystem Rehabilitation Project (#36)
- Peck Park Canyon Project (#40)
- Inner Cabrillo Beach Bacterial Water Quality Improvement Project (#41)

The Rosecrans Recreation Center Stormwater Enhancements Project (#35) site is located within Council District 15 and the Rosecrans Recreation Center is owned by the City, DRP (CDM, 2006f). Its drainage area is approximately 13 acres with open space as the largest land use. The objective of the project is to reduce runoff pollution and to provide improved recreational facilities for the community. The proposed BMPs include the installation of bioswales adjacent to parking areas, permeable parking lots, vegetated retention basins, decomposed granite pathways, a synthetic soccer field, grading, and smart irrigation system. Targeted pollutants include bacteria, metals, trash, nutrients, gasoline, oil and grease, and toxic organic compounds.

The Machado Lake Ecosystem Rehabilitation Project (#36) site is located within Council District 15 (CDM, 2006g) and its drainage area is approximately 14,820 acres with high density residential as the largest land use. Urban runoff flows to the lake that is listed on 2006 303(d) impaired water bodies for algae, ammonia, Chem A (tissue), Chlordane (tissue), DDT (tissue), Dieldrin (tissue), Eutrophic, Odors, PCB's and trash. The goal of the project is to improve the water quality, and the biological diversity of the ecosystem. The project implementation involves integrated ecological and engineering strategies and solutions including 1) in-lake rehabilitation techniques, riparian system enhancements, and treatment BMPs at Machado Lake and associated riparian areas such as sediment removal and management, aquascaping, native vegetation enhancements, runoff treatment; 2) trash capture devices, and a lake aeration system; trash capture devices , a low flow channel, two vegetated detention basins, sediment removal, and invasive plants removal at the freshwater marsh; and 3) pervious parking lots, bioswales around the parking lots, and smart irrigation system at strategic parkland areas. Targeted pollutants include trash, metals, bacteria, TSS, and oil and grease. The Wilmington Drain Multiuse Project (#36a) is a subset of Machado Lake project for stormwater treatment, enhanced public access, bank stabilization, and native vegetation restoration. Wilmington Drain itself is identified in 2006 303(d) list of impaired water bodies for ammonia, bacteria, copper, and lead. The project implementation for stormwater management includes trash netting systems, bioswales, porous pavement, and smart irrigation.

The Peck Park Canyon Project (#40) site is located in San Pedro within Council District 15 (CDM, 2006h). Its drainage area is approximately 100 acres that is mainly high density residential land use. The objective of the project is to improve the stream and surrounding canyon with erosion and sediment control, flood control, and water quality improvement. The stormwater flow from the site is released to Los Angeles Harbor, Southwest Slip and San Pedro Bay. The proposed BMPs include erosion control and drainage improvements; water quality/infiltration, stream and floodplain naturalization improvements; bed and bank stabilization; invasive species and fire control improvements.

The Inner Cabrillo Beach Bacterial Water Quality Improvement Project (#41) site is located at Inner Cabrillo Beach inside the breakwater of the Port of Los Angeles (POLA) along the San Pedro shore, within Council District 15 (POLA, 2006). The objective is to reduce the number of bacteria violations at the beach during both wet- and dry-weather seasons to meet TMDL requirements. The POLA has enhanced habitat in the beach by constructing a salt water wetland and a shallow water habitat. Local sources of bacteria include leaking sewers, defective storm drains, heavy bird use, restricted circulation, and heavy eelgrass beds with sediments in the swim area. The project implementation is designed in stages and the Prop O funding implementation request consists of: re-contour and replacement of beach sand at the southern recreational beach; the installation of a circulation pumps to enhance circulation; and diversion of stormwater discharges from beach to the high energy area outside the breakwater. This project was not evaluated in this report because its drainage area and its land use composition are not known and the project does not employ conventional BMPs.

3.3.1 Wet-weather Flow in Dominguez Channel Watershed

Annual wet-weather runoff from the watershed was estimated to be approximately 35,000 acre-ft/year assuming annual average rainfall of 12.01 inches. The average runoff coefficient of the entire watershed was 0.49, which indicates that the watershed is most impervious among the three watersheds. Table 3.19 shows the annual wet-weather mass loads for selected water quality parameter from the watershed using runoff coefficients and EMCs in Table 2.3 and 2.4.

The annual runoff volume from each project site was estimated as shown in Figure 3.9. The results show that the runoff volume from Machado Lake Ecosystem Rehabilitation Project (#36) is the largest, approximately 6,100 acre-ft/year, corresponding to 17% of total runoff volume from the entire watershed. The runoff volumes from Rosecrans Recreation Center Stormwater Enhancements Project (#35) and Peck Park Canyon Project (#40) are small, less than 0.1% of total runoff from the entire watershed.

Table 3.19 Estimated annual wet-weather loads from Dominguez Channel Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	4.68×10^{17}
Fecal Coliform	colonies/year	3.95×10^{17}
Suspended Solids	kg/year	5,463,305
Oil and Grease	kg/year	91,209
Total Copper	kg/year	1,137
Total Lead	kg/year	444
Total Zinc	kg/year	11,880
Kjeldahl-N	kg/year	114,258
NH3-N	kg/year	20,507
Nitrate-N	kg/year	36,544
Nitrite-N	kg/year	4,107
Total Phosphorus	kg/year	15,916

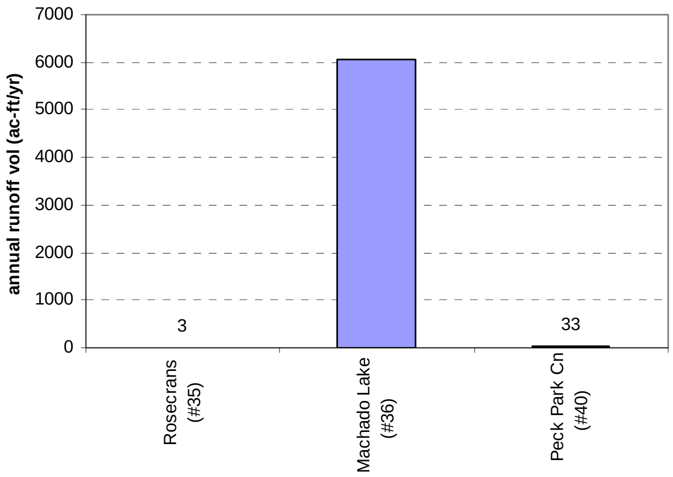

Figure 3.9 Estimated stromwater runoff volume from project sites in Dominguez Channel Watershed

The removal efficiencies of the proposed BMPs were estimated as shown in Table 3.20. Rosecrans Recreation Center Stormwater Enhancements Project (#35) was assumed to employ bioswales and bioretention basin in series. It was difficult to estimate the removal efficiencies of Machado Lake Ecosystem Rehabilitation Project (#36) and Peck Park Canyon Project (#40) because these projects consist of several subsets, and the drainage area and land use composition for each subset were unknown. Machado Lake Ecosystem Rehabilitation Project (#36) was assumed to employ CDS and vegetated detention basin for all projects including Wilmington Drain Multiuse Project (#36a). Peck Park Canyon Project (#40) was assumed to employ infiltration strips, vegetated swales, and stilling basins/energy dissipater. Therefore, the results might be different from actual removal efficiencies especially for each subset of the projects. All projects will have high removal efficiencies for TSS and metals, more than 95% within the project site, but Machado Lake Ecosystem Rehabilitation Project (#36) will not remove much of bacteria and nutrients, less than 50%.

Table 3.20 Removal efficiency of proposed BMPs in Dominguez Channel Watershed

%	Rosecrans (#35)		Machado Lake (#36)		Peck Park Cyn. (#40)	
	min	max	min	max	Min	max
Total Coliform		93		30		66
Fecal Coliform		93		30		66
Enterococcus		93		30		66
TSS	83	100	90	96	74	100
O&G		92	80	90		75
Cu	75	100	58	96	51	100
Pb	75	100	58	97	42	100
Zn	75	100	51	96	41	100
Kjeldahl-N	43	90	0	30	44	97
NH3-N	50	90	30	44	44	97
Nitrate-N	43	90	0	30	65	99
Nitrite-N	43	75	0	30	11	97
TP	55	99	28	92	20	99

Table 3.21 shows the estimated annual wet-weather mass loads generated and the loads after BMP treatment with maximum removal efficiencies that are shown in Table 3.20. The mass loads from the Machado Lake Ecosystem Rehabilitation Project (#36) are the greatest among the projects, corresponding to 12-20% of total loads from the entire watershed. The project has the greatest impact on the quality of receiving waters. The installation of the project will remove bacteria load by as much as 6%, metal loads by 12% and nutrient loads by 5-10% from the entire watershed. On the other hand, the mass loads from the Rosecrans Recreation Center Stormwater Enhancements Project (#35) are less than 0.01% of entire watershed.

Figure 3.10 compares the daily mass loads of the 2002-2006 wet-weather seasons and the TMDLs (LADPW, 2003, 2004a, 2006). In this case, single sample limits were applied for bacteria TMDLs. The Machado Lake Project (#36) was selected as an example project. The results show that bacteria TMDLs will always be violated and total coliform TMDL will be exceeded by approximately 30-3,000 times; fecal coliform TMDL by approximately 40-1,250 times; and fecal enterococcus TMDL by approximately 50-8,700 times. The installation of project #36 or all proposed projects will not reduce the number of exceedances. Total coliform TMDL will still be exceeded by 28-2,800 times; fecal coliform TMDL by 40-1,200 times; and fecal enterococcus TMDL by 45-8,100 times after the application of the project.

Table 3.21 Estimated annual wet-weather loads before and after BMPs (with maximum removal efficiency) of each project in Dominguez Channel Watershed

	Rosecrans (#35)		**Machado Lake (#36)**		**Peck Park Cyn. (#40)**	
	inf.	**eff.**	**inf.**	**Eff.**	**inf.**	**eff.**
Total Coli.	6.41E+12	0	9.13E+16	6.39E+16	5.76E+14	2.82E+14
Fecal Coli.	4.52E+12	0	7.05E+16	4.94E+16	4.24E+14	2.08E+14
Enterococcus	3.73E+12	0	3.40E+16	2.38E+16	2.85E+14	1.40E+14
TSS	580	0	823275	164655	4126	13
O&G	0.56	0.18	15235	15235	73	18
Cu	0.04	0	173	35	0.7	0.01
Pb	0	0	68	12	0.35	0
Zn	0.16	0	1447	289	4	0.08
Kjeldahl-N	4	0	19311	13518	105	10
NH3-N	0.42	0	3470	1943	15	2
Nitrate-N	4	0	6735	4715	40	2
Nitrite-N	0.19	0	718	503	4	0.4
TP	0.52	0.02	2640	1109	15	0.4

Note that the unit of bacteria (total coliform, fecal coliform, and enterococcus) is colonies/year and the unit of the other parameters is kg/year.
Note that pollutant mass loads were estimated based on eq. 2.4 using runoff coefficients and EMCs in Table 2.3 and 2.4 for each project.

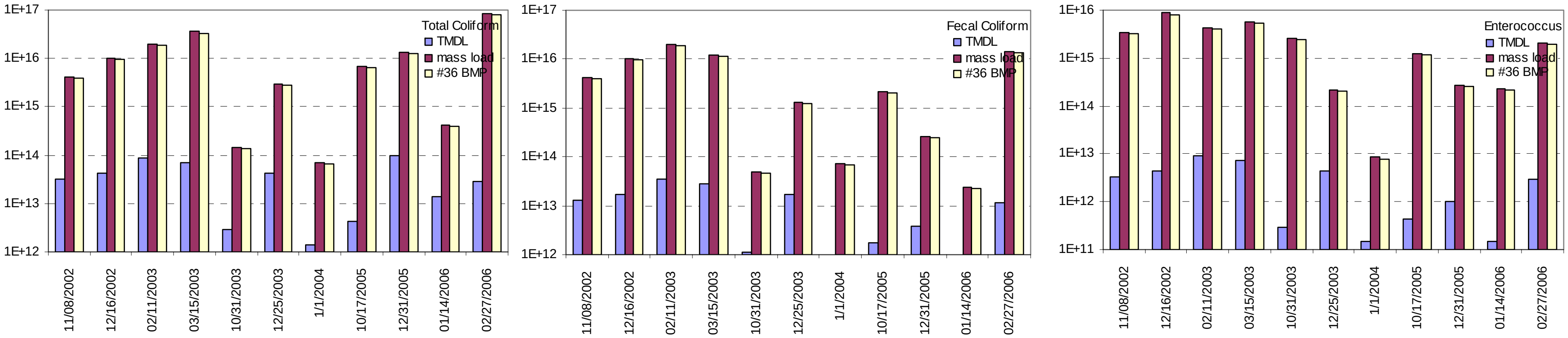

Figure 3.10 Wet-weather TMDL exceedance in Dominguez Channel Watershed
Note that blue bars are TMDLs for each water quality parameter for each monitoring event; red bars are the mass loads from entire watershed; and yellow bars are the mass loads reduced by proposed BMPs of an example project. Solid arrows indicate that both mass load and the load after BMPs at Machado Lake Project (#36) exceed the TMDL.
Note that the loads were calculated based on eq 2.4 using monitoring rainfall and EMC data in LADPW reports (2002-2006).

Table 3.22 summarizes the annual wet-weather mass loads reduced by the proposed BMPs with maximum removal efficiencies. The Machado Lake Project (#36) reduces the greatest percentage of total loads. The results emphasize the impact of the project with the large drainage area on receiving water quality. Again, no single project will significantly change TMDL compliance in the watersheds. Additional projects will be required to reliably meet the TMDLs.

Table 3.22 Maximum load reduction by proposed BMPs as a percentage of total loads from Dominguez Channel Watershed

%	Rosecrans (#35)	Machado Lake (#36)	Peck Park Cyn. (#40)
Total Coliform	0.001	5.9	0.081
Fecal Coliform	0.001	5.4	0.070
Enterococcus	0.002	6.5	0.119
TSS	0.011	12.1	0.075
O&G	0.001	0.0	0.060
Cu	0.003	12.2	0.061
Pb	0.001	12.8	0.078
Zn	0.001	9.7	0.034
Kjeldahl-N	0.003	5.1	0.088
NH3-N	0.002	7.4	0.072
Nitrate-N	0.010	5.5	0.107
Nitrite-N	0.003	5.2	0.088
TP	0.003	9.6	0.091

3.3.2 Dry-weather Flow in Dominguez Channel Watershed

The annual dry-weather flow for Dominguez Channel Watershed was assumed to be 25 cfs. Pollutant concentrations were derived from the dry-weather monitoring collected by LADPW during the 2003 and 2006 dry-weather seasons (LADPW, 2004a, 2006). Table 3.23 shows the annual dry-weather pollutant loads from the watershed. Again, the dry-weather loads are small compared with the wet-weather loads. For example, dry-weather bacteria loads are only 0.1-9% of wet-weather loads; dry-weather TSS load is 5% of wet-weather loads; dry-weather metal loads are 6-27% of wet-weather loads; and dry-weather nutrient loads are 19-113% of wet-weather loads. Figure 3.11 shows the annual dry-weather mass loads of each project. The load from the Machado Lake Project (#36) is the greatest, corresponding to approximately 21% of the load of the entire watershed. The load from the Peck Park Canyon Project (#40) is less than 0.2%.

Table 3.23 Estimated annual dry-weather mass loads from Dominguez Channel Watershed

Pollutants	Unit	Annual Mass Loads
Total Coliform	colonies/year	4.08×10^{16}
Fecal Coliform	colonies/year	9.95×10^{14}
Fecal Enterococcus	colonies/year	1.62×10^{14}
Suspended Solids	kg/year	287,286
Total Copper	kg/year	311
Total Lead	kg/year	26
Total Zinc	kg/year	822
Kjeldahl-N	kg/year	21,352
NH_3-N	kg/year	4,262
Nitrate-N	kg/year	27,057
Nitrite-N	kg/year	4,645
Total Phosphorus	kg/year	3,343

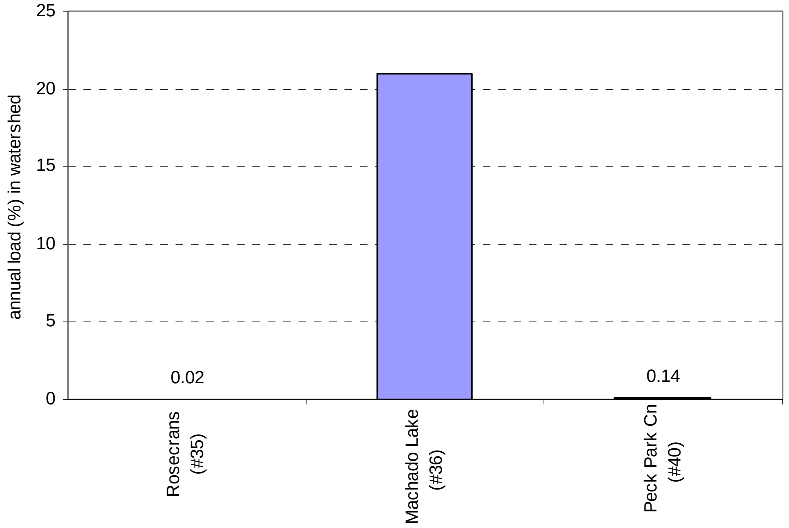

Figure 3.11 Annual dry-weather pollutant loads from project sites in Dominguez Channel Watershed

Table 3.24 shows the estimated annual dry-weather mass loads generated from the sites and after BMP treatment with maximum removal efficiencies. All proposed projects will effectively remove metals but not bacteria loads. However, the TMDL exceedance was not evaluated due to the lack of runoff data.

Table 3.24 Estimated annual dry-weather loads before and after BMPs (with maximum removal efficiency) of each project in Dominguez Channel Watershed

	Rosecrans (#35)		**Machado Lake (#36)**		**Peck Park Cyn. (#40)**	
	inf.	**eff.**	**Inf.**	**eff.**	**Inf.**	**eff.**
Total Coliform	7.34E+12	5.14E+11	8.58E+15	6.01E+15	5.77E+13	1.98E+13
Fecal Coliform	1.79E+11	1.25E+10	2.09E+14	1.47E+14	1.41E+12	4.83E+11
Enterococcus	2.91E+10	2.04E+09	3.40E+13	2.38E+13	2.29E+11	7.84E+10
TSS	52	0.1	60440	12088	407	0.26
Cu	0.06	0	65	13	0.44	0
Pb	0	0	6	0.95	0.04	0
Zn	0.15	0	173	35	1	0
Kjeldahl-N	4	0.38	4492	3145	30	0.42
NH3-N	0.77	0.08	897	502	6	0.08
Nitrate-N	5	0.49	5692	3985	38	0.54
Nitrite-N	0.84	0.21	977	684	7	0.09
TP	0.6	0.01	703	295	5	0.05

3.4 Priority of Project Location

For prioritizing the location for BMP implementation in the City, environmentally significant areas were identified using a GIS to estimate stormwater pollution generation (Wong *et al*., 1997). A load-based approach was utilized to determine the significance of pollution from each catchment by dividing selected pollutant loads from each catchment by the area of the catchment. Then the values were classified into five classes, *i.e.* very low, low, medium, high, and very high, based on natural breaks for each watershed. A similar approach has been used for the BMP prioritization tools by Geosyntec and other models in the Los Angeles region (Ackerman and Schiff, 2003; Sedrak and Murillo, 2005; Susilo *et al*. 2006) and the load-based approach is recommended by the County for the first flush phenomenon dominated stormwater pollution in the area (Susilo *et al.* 2006).

Figures 3.12-14 show the resulting maps for selected water quality parameters: bacteria (total coliform), metal (Zn) and nutrient (TKN) with the location of the projects. In the Ballona Creek Watershed, the drainage area of the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b) mostly consists of high loading catchments for these water quality parameters while the drainage area of the Temescal Recreation Center Stormwater BMPs (#22e) is located in a low loading catchment. In Los Angeles River Watershed, the drainage areas of the Cabrito Paseo Walkway/Bike Path Project (#12), the South Los Angeles Wetlands Park (#16), and the Echo Park Lake Rehabilitation Project

(#29) encompass high loading catchments. Conversely, the drainage area of the Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project (#14) is located in low loading catchments. In the Dominguez Channel Watershed, there is no project located in high loading catchments but the drainage area of the Peck Park Canyon Project (#40) is located in low loading catchments.

The proximity of a project to 303 (d) list impaired water bodies is also important to prioritize projects. The runoff from all projects in the Ballona Creek Watershed is directly discharged to Santa Monica Bay. In the Los Angeles River Watershed, the runoff from the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the Echo Park Lake Rehabilitation Project (#29) directly drains to Aliso Wash and Echo Park Lake, respectively, which are listed on 303 (d) impaired water bodies. In the Dominguez Channel Watershed, the Machado Lake Ecosystem Rehabilitation Project (#36) is located adjacent to Lake Machado listed on 303 (d) impaired water bodies and the runoff directly drains to the impaired water bodies.

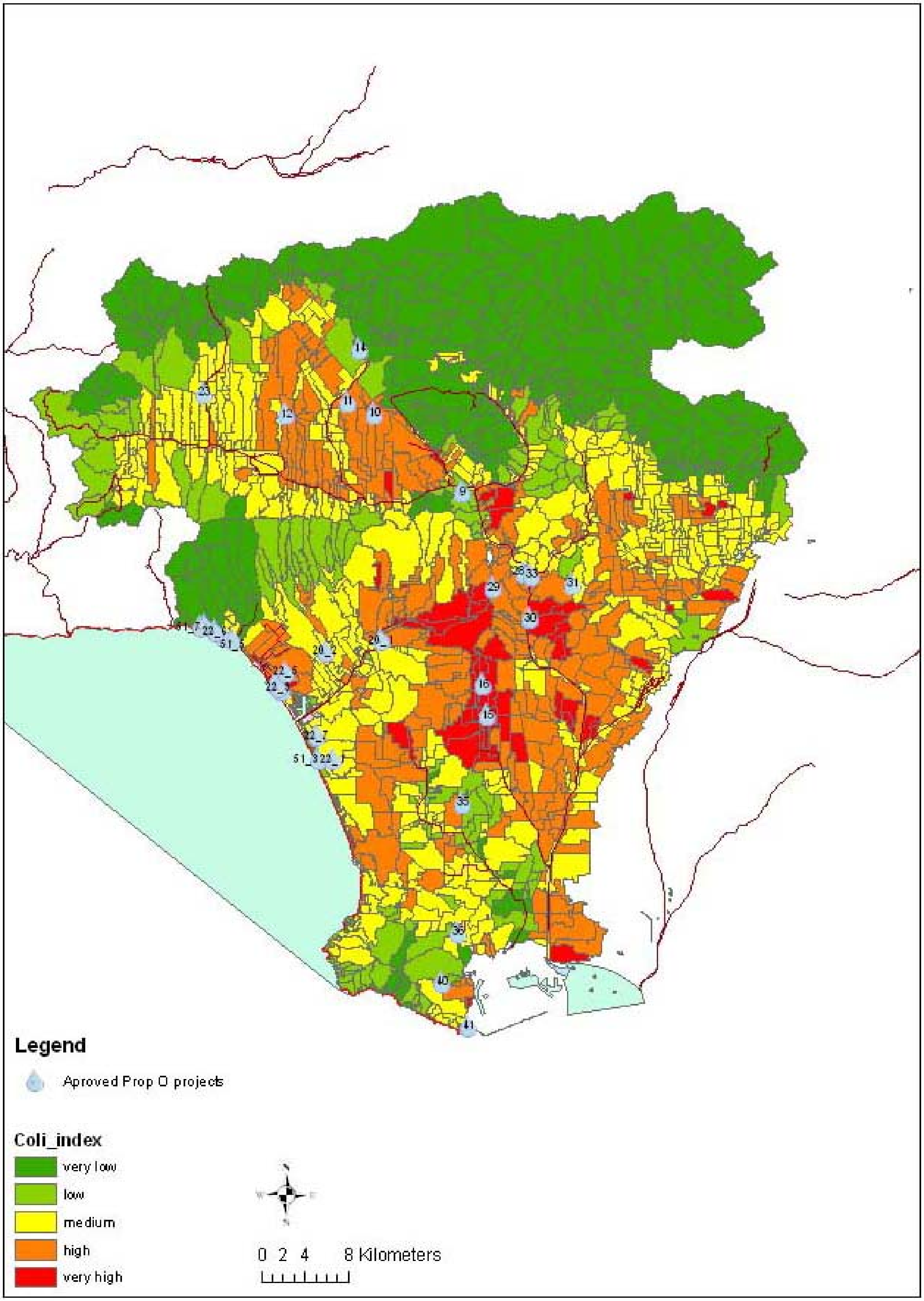

Figure 3.12 Prioritization of projects based on Total Coliform hotspots

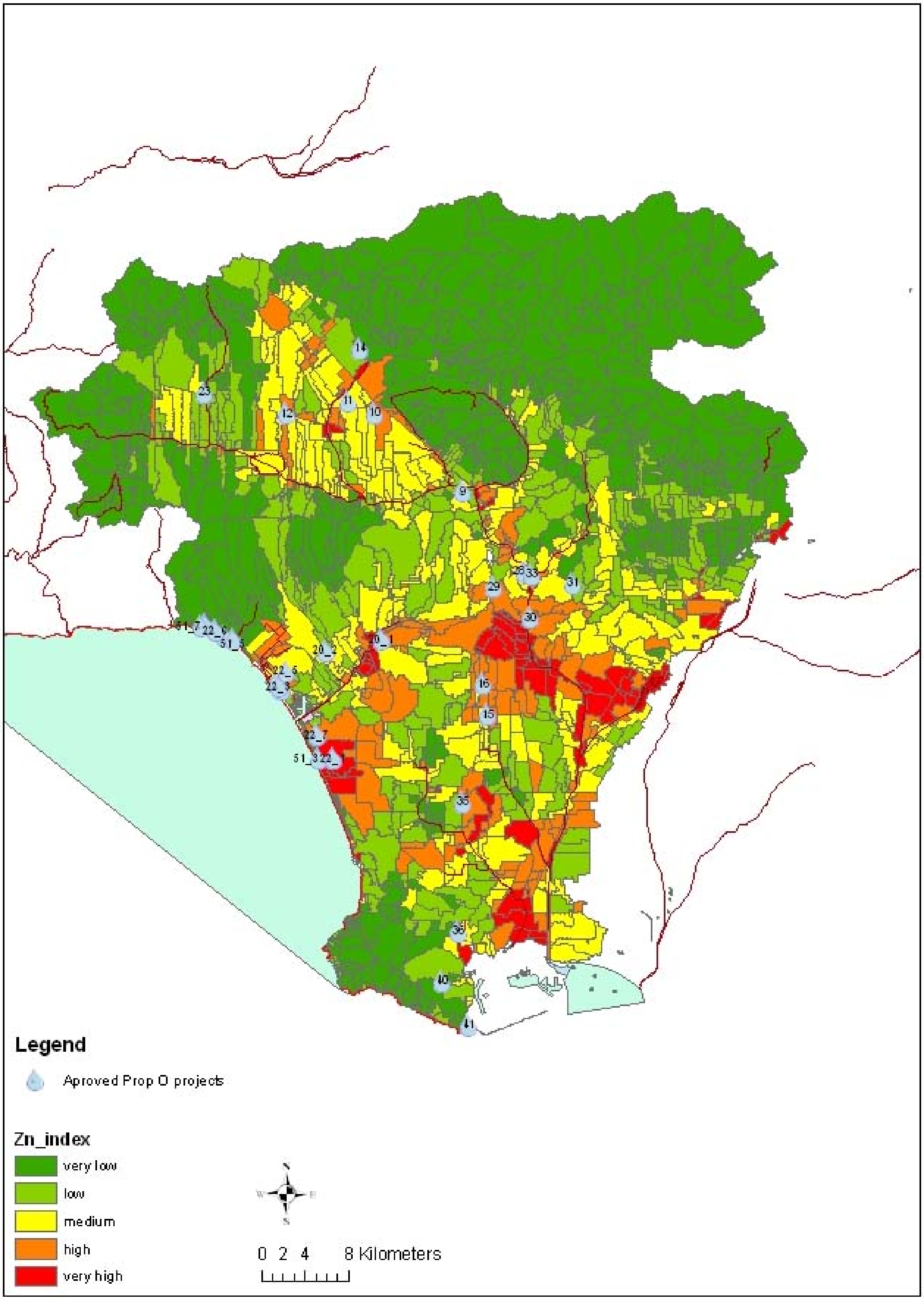

Figure 3.13 Prioritization of projects based on zinc hot spots

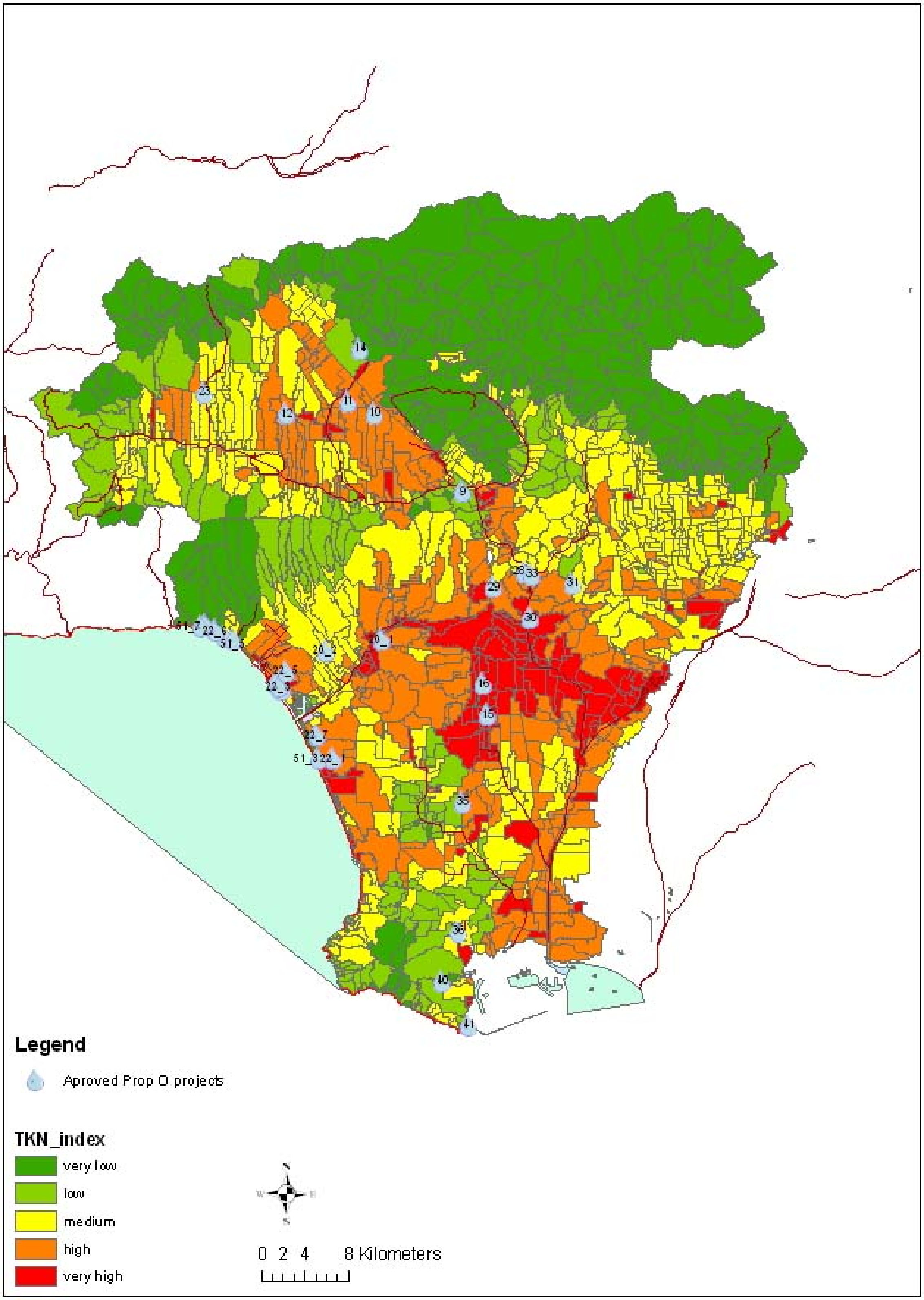

Figure 3.14 Prioritization of projects based on TKN hot spots

3.5 Cost Effectiveness

Most of Prop O funding has been allocated to projects as shown in Table 3.25 as of August, 2007. A total of 17 proposals (25 projects, approximately $462 million) have been approved by the City Council and 2 proposals (approximately $13 million) have been recommended by COAC and AOC and pending the approval of City Council and Mayor. The other projects might not be approved because no more funding is available. Most of these approved projects were originally proposed by the City, except for two projects proposed by the MRCA and Council District 9, and three projects that were proposed by community or non-profit organizations. The City has subsequently taken responsibility for these five projects. The amount of Prop O funding allocated for these five projects was approximately $18 million.

The cost-effectiveness of projects was evaluated in two ways: 1) the total cost of a project per the drainage area it treats, and 2) total cost per the unit of pollutant load removed. The total cost and Prop O request of projects per their drainage area are shown in Figure 3.15. The result shows that the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) is the most cost-effective because it costs less per acre of drainage area ($663/acre). The La Cienega/Fairfax Stormwater BMP (#20b), the Santa Monica Bay Beaches LFD upgrades (#51) and the Machado Lake Project (#36) are also cost-effective projects that cost less than $10,000/acre. Conversely, Parking Grove in El Sereno (#31) is the most expensive project that costs approximately $1.2 million/acre. Rosecrans Recreational Center Storm Water Enhancements (#35), Westminster Dog Park Stormwater BMPs (#22d) and The LA Zoo Parking Lot Project (#9) are also expensive projects that cost more than $0.4 million/acres.

Figure 3.16 shows total cost of projects per the unit of pollutants. Blue bars stand for the cost per the unit of pollutants with minimum removal efficiency and red bars with maximum removal efficiency. Four water quality parameters are selected, *i.e.* bacteria (total coliform), TSS, metal (zinc), and nutrient (Kjeldahl-N) because these are representative of TMDL requirements and typical BMP removal efficiencies. These

Table 3.25 Project Cost Estimation and Funding Status (as of August, 2007)

No	Project Title	Total Funding Needed	Prop O Funding Request	Prop O Funding Approved
9	The LA Zoo Parking Lot: Demonstration on Environmental Sustainability	$13,904,242	$13,904,242	$13,904,242
10	Strathern Pit Multiuse Project	$22,505,000	$17,800,000	$17,800,000
11	Cesar Chavez Recreation Complex	$9,540,000	$2,231,850	$3,040,000
12	Cabrito Paseo Walkway/Bike Path	$4,463,009	$1,337,696	$1,337,696
14	Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project	$2,220,702	$2,220,702	$2,220,702
15	Fremont High Community Garden	$5,600,000	$3,700,000	
16	South Los Angeles Wetlands Park	$12,000,000	$8,420,000	$8,100,000
20a	Grand Avenue Stormwater BMPs	$1,075,927	$1,075,927	$1,075,927
20b	La Cienega/Fairfax Powerline Easement Stormwater BMPs	$7,667,887	$7,667,887	$7,667,887
20c	Mar Vista Recreation Center Stormwater BMPs	$4,556,186	$4,556,186	$4,556,186
22a	Imperial Highway Stormwater BMPs	$2,723,403	$2,723,403	$2,723,403
22d	Westminster Dog Park Stormwater BMPs	$1,438,755	$1,438,755	$1,438,755
22e	Temescal Recreation Center Stormwater BMP	$18,646,000	$18,646,000	$18,646,000
22f	Westchester/LAX Stormwater BMP	$32,722,000	$32,722,000	$32,722,000
22g	Penmar Water Quality Improvement and Runoff Reuse Project	$23,585,000	$23,585,000	$23,585,000
23	Aliso Wash-Limekiln Creek Confluence Restoration Project	$7,842,042	$7,842,042	
28	Oros Green Street	$972,651	$386,000	$386,000
29	Echo Park Lake Restoration Project	$84,263,313	$84,263,313	(pre-)design $10,997,899 (set aside) $73,265,414
30	Boyle Heights Joint Use Community Center	TBD	TBD	
31	Parking Grove in El Sereno	$3,984,635	$3,984,635	
33	Lincoln Heights Interchange Restoration	TBD	TBD	
35	Rosecrans Recreational Center Storm Water Enhancements	$6,754,033	$4,829,119	$4,829,119
36	Lake Machado Ecosystem - Water Quality/Habitat Improvement	$99,523,897	$99,523,897	(pre-)design $10,124,312 (set aside) $89,399,585
36a	Wilmington Drain Multiuse Project	$17,942,534	$17,942,534	(pre-) design $2,200,613 (set aside) $15,741,921
40	Peck Park Canyon Enhancement Project	$6,190,000	$6,190,000	$6,190,000
41	Inner Cabrillo Beach Bacterial Water Quality Improvement Project	$16,000,000	$15,035,780	$8,000,000
51	Santa Monica Bay Beaches Low Flow Diversions Upgrades	$38,800,000	$8,500,000	(pre-) design $5,980,000
52	Catch Basin Inserts and Coverings Phase II	$10,000,000	$10,000,000	$10,000,000
52b	Catch Basin Opening Screen Covers, Phase III	$44,500,000	$44,500,000	$44,500,000
53	LA River Revitalization Plan	$78,000,000	$30,000,000	$25,000,000
0	Catch Basin Inserts and Coverings Phase I	$17,000,000	$17,000,000	$17,000,000

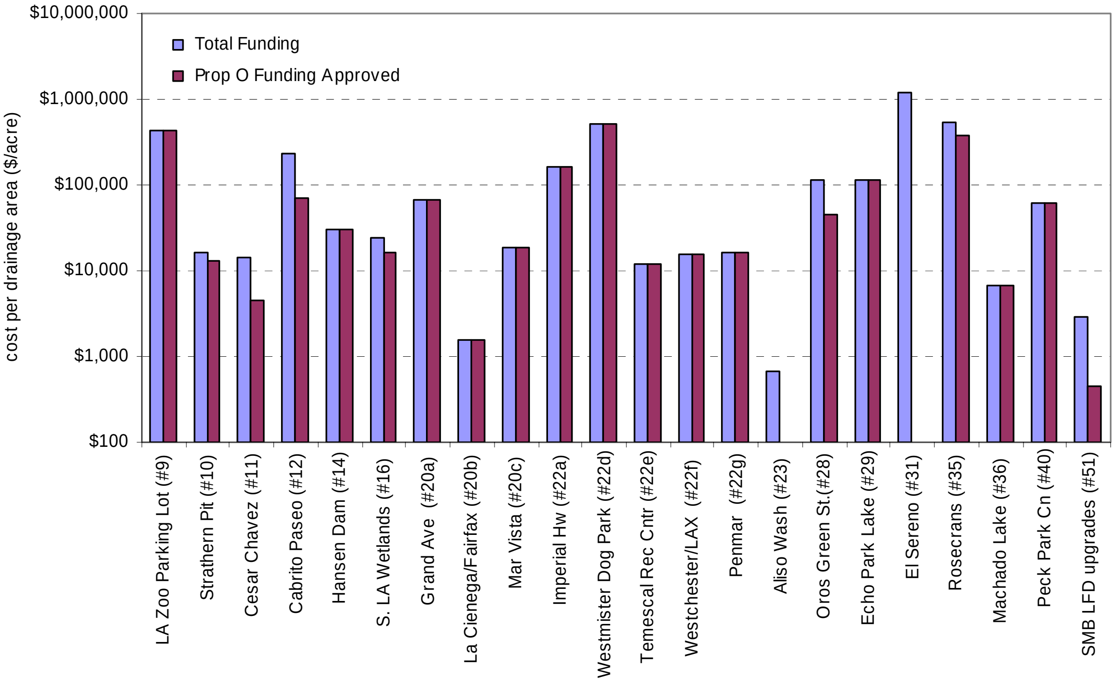

Figure 3.15 Project cost per unit of drainage area

parameters were calculated independently in that total cost was divided by the annual pollutant load removed and the following numbers are based on maximum removal efficiency. For bacteria removal, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b) are the most cost-effective projects that cost approximately $0.2/billion coliforms. Mar Vista Recreation Center Stormwater BMPs (#20c), Westchester/LAX Stormwater BMP (#22f), Penmar Water Quality Improvement and Runoff Reuse Project (#22g), Machado Lake Project (#36), South Los Angeles Wetlands Park (#16) and Grand Avenue Stormwater BMPs (#20a) are also cost-effective projects that cost less than $10/billion coliforms. The Peck Park Canyon Enhancement Project (#40) is the most expensive project because it costs $31,000/billion coliforms. Westminster Dog Park Stormwater BMPs (#22d) and Rosecrans Recreational Center Storm Water Enhancements (#35) are also expensive projects that cost more than $1,000/billions coliforms. For TSS removal, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b) are the most cost-effective projects that cost less than $25/TSS kg. Strathern Pit Multiuse Project (#10), the

Machado Lake Project (#36), the Santa Monica Bay Beaches LFD upgrades (#51), Westchester/LAX Stormwater BMP (#22f), Penmar Water Quality Improvement and Runoff Reuse Project (#22g), and South Los Angeles Wetlands Park (#16) cost less than $500/TSS kg. The Peck Park Canyon Enhancement Project (#40) is the most expensive project that costs $40,000/TSS kg. The LA Zoo Parking Lot Project (#9), Rosecrans Recreational Center Storm Water Enhancements (#35) and Westminster Dog Park Stormwater BMPs (#22d) are also expensive projects that cost more than $10,000/TSS kg. For metal removal, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b) are the most cost-effective projects that cost less than $10,000/Zn kg. Strathern Pit Multiuse Project (#10) and the Machado Lake Project (#36) cost less than $100,000/Zn kg. The Peck Park Canyon Enhancement Project (#40) is the most expensive that costs approximately $170 million/Zn kg. LA Zoo Parking Lot Project (#9), Rosecrans Recreational Center Storm Water Enhancements (#35) and Westminster Dog Park Stormwater BMPs (#22d) are also expensive projects that cost more than $40 million/Zn kg. For nutrient removal, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the La Cienega/Fairfax Powerline Easement Stormwater BMPs(#20b) are the most cost effective projects that cost approximately $1,000/TKN kg. Westchester/LAX Stormwater BMP (#22f), Penmar Water Quality Improvement and Runoff Reuse Project (#22g), Machado Lake Project (#36), Santa Monica Bay Beaches LFD upgrades (#51), and Strathern Pit Multiuse Project (#10) cost less than $25,000/TKN kg. The Peck Park Canyon Enhancement Project (#40) is the most expensive project because it costs approximately $8 million/TKN kg. The LA Zoo Parking Lot Project (#9), Rosecrans Recreational Center Storm Water Enhancements (#35) and Westminster Dog Park Stormwater BMPs (#22d) are also expensive projects that cost more than $1 million/TKN kg. On the whole, the Aliso Wash-Limekiln Creek Confluence Restoration Project (#23) and the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b) are most cost-effective and the Peck Park Canyon Enhancement Project (#40) is the most expensive project.

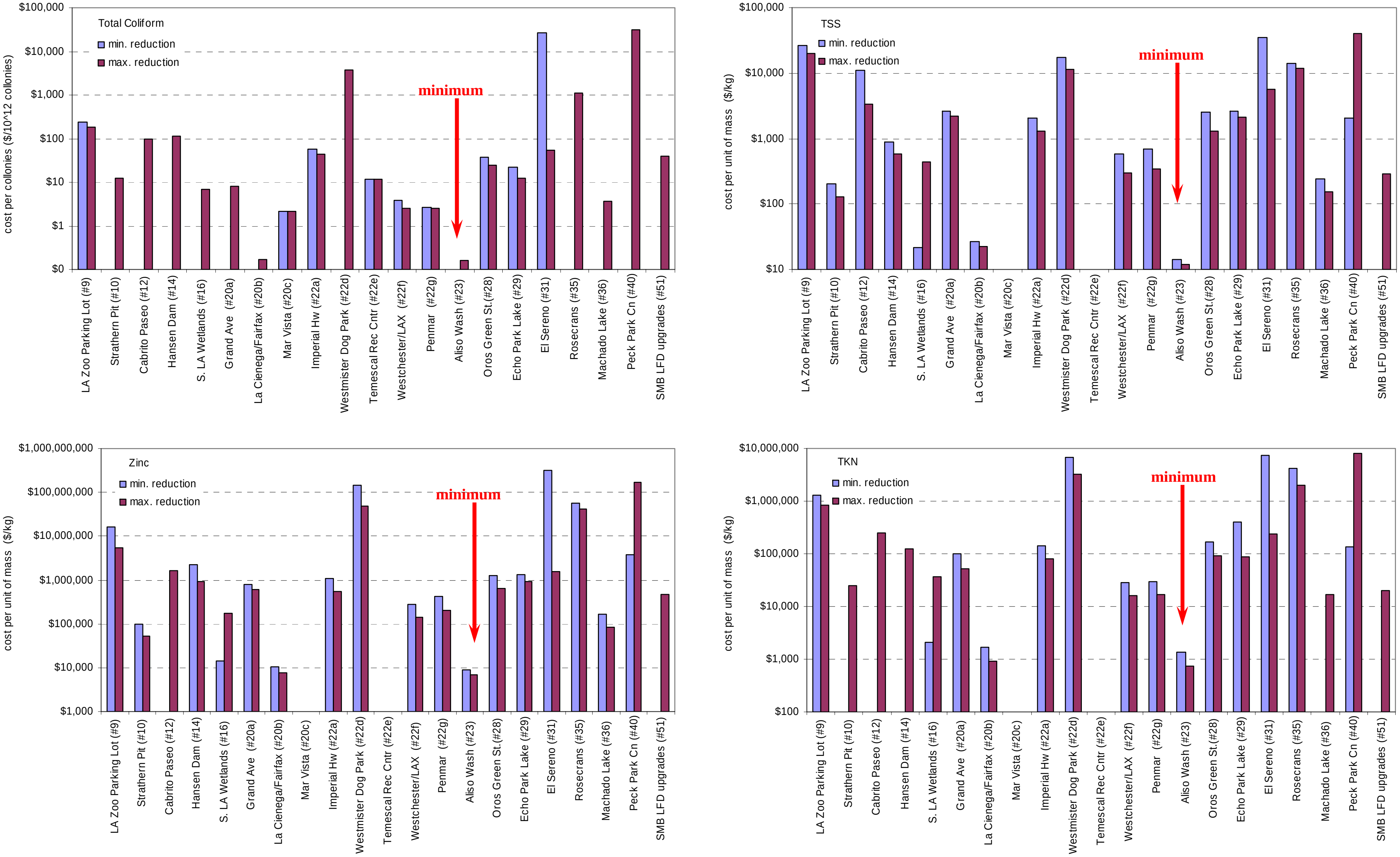

Figure 3.16 Total cost needed for project per unit of pollutant reduction

3.6 Ranking projects against project selection criteria

In order to evaluate the relative effectiveness of the projects, all projects were evaluated based on the project selection criteria that were developed by COAC in February, 2007 as shown in Appendix F. However, these criteria have not yet been approved by the City Council and were not used to select any of the funded projects. In this case, the subsets of water quality improvements and cost effectiveness were evaluated. Water quality improvement criteria consist of three sub criteria: project significance, compliance with water quality goals, and pollution reduction. Project significance was evaluated on whether each project drains directly to 303 (d) list impaired water bodies and whether the runoff pollution from the site is significant and generated from the environmentally significant hotspots (up to 5 points). Compliance with water quality goals was evaluated on the impact of each project on TMDL compliance with pollutant load reduction as a percentage of the total load from the entire watershed, and on whether they address dry and/or wet-weather flows (up to 30 points). Pollution reduction was evaluated on the removal efficiencies of the proposed BMPs (up to 20 points), which was based on existing literature that used in this report. Cost effectiveness was evaluated based on both total cost of projects per the acreage of drainage area and total cost per the unit of pollutant load reduction (up to 10 points). The subsets account for 65 points out of 100 points. The multiple objective and project readiness (35 points) were not considered in evaluating projects due to the unavailability of quantified or site-specific information. Table 3.26 shows the resulting score and the rank of the projects.

The results show that the highest ranked project is the La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b). This project will remove 1% or more of total loads from the entire watershed and will have the greatest impact on meeting TMDL requirements in the watershed, addressing both dry- and wet-weather flows. The project will also remove multiple pollutants, especially trash, bacteria, and heavy metals, using proven BMPs with maximum removal efficiencies of more than 90%. The project is cost-effective because both total cost per drainage area and total cost per the unit of pollutant load is less than $10,000. The Aliso Wash-Limekiln Creek Confluence Restoration Project (#23), the Lake Machado Ecosystem - Water Quality/Habitat Improvement (#36), the Santa Monica Bay Beaches LFD Upgrades (#51), and the Westchester/LAX Stormwater BMP (#22f) are also high ranked projects with the scores of 60 points or more. These projects tend to have large drainage areas compared to other projects

Conversely, the lowest ranked project is the Westminster Dog Park Stormwater BMPs (#22d) followed by the Parking Grove in El Sereno (#31) and the Rosecrans Recreational Center Storm Water Enhancements (#35) with the scores of less than 40 points. The Westminster Dog Park Stormwater BMPs (#22d) will not help to achieve TMDL requirements in a watershed scale because it would reduce only less than 0.001% of total loads from the watershed. This project is expensive because it costs more than $500,000 per acre and per the unit of pollutant loads. The runoff from the Parking Grove in El Sereno (#31) and the Rosecrans Recreational Center Storm Water Enhancements (#35) projects do not directly drain to impaired water bodies. These projects will not help to achieve TMDL requirements in a watershed scale because they will reduce only less than 0.001% and 0.005% of total loads from the watershed, respectively. These projects are also expensive projects that cost generally more than $500,000 per the acre and per the unit of pollutant loads.

The results show that projects treating a large drainage area were scored high while the projects addressing small sites were scored low. However, community-based projects (#12, 28, and 40) ranked relatively lower (18-20) compared with other projects although they can serve multiple objectives to meet community need or to create recreational spaces. If multiple objectives are taken into account, the ranking results might be different. It should be noted that Catch Basin Inserts and Coverings Projects (#52) were not scored as they are not able to be evaluated against the criteria. The projects without conventional BMPs, e.g. Inner Cabrillo Beach Bacterial Water Quality Improvement Project (#41) and Cesar Chavez Recreation Complex Projects (#11), were also scored low not because of their performance but because of the lack of quantitative information such as removal efficiencies or drainage areas. This project does not employ conventional structural BMPs and therefore it is difficult to evaluate the performance of the BMPs to reduce pollutant loads and to meet TMDL requirements, and to estimate its cost-effectiveness.

Table 3.26 Rank of projects against new project selection criteria (water quality improvement and cost effectiveness only)

No	Project Title	Applicants	Scores	Rank
20b	La Cienega/Fairfax Powerline Easement Stormwater BMPs	City of LA, DPW, BOS, WPD	64	1
23	Aliso Wash-Limekiln Creek Confluence Restoration Project	Mountains Recreation and Conservation Authority	63	2
36	Lake Machado Ecosystem	City of LA, DRP	62	3
22f	Westchester/LAX Stormwater BMP	City of LA, DPW, BOS, WPD	60	4
51	Santa Monica Bay Beaches LFD Upgrades	City of LA	60	4
22g	Penmar Water Quality Improvement and Runoff Reuse Project	City of LA, DPW, BOS, WPD	59	6
20c	Mar Vista Rec. Cntr Stormwater BMPs	City of LA, DPW, BOS, WPD	57	7
22e	Temescal Rec. Cntr Stormwater BMP	City of LA, DPW, BOS, WPD	54	8
20a	Grand Avenue Stormwater BMPs	City of LA, DPW, BOS, WPD	53	9
29	Echo Park Lake Restoration Project	City of LA, DRP	53	9
10	Strathern Pit Multiuse Project	City of LA, DPW, BOS, CFCD	52	11
16	South Los Angeles Wetlands Park	Council District 9	52	11
9	The LA Zoo Parking Lot	LA Zoo and Botanical Gardens	47	13
22a	Imperial Highway Stormwater BMPs	City of LA, DPW, BOS, WPD	47	13
14	Hansen Dam Recreational Area Parking Lot and Wetlands Restoration Project	Mountains Recreation and Conservation Authority	45	15
41	Inner Cabrillo Beach Bacterial Water Quality Improvement Project	Port of Los Angeles	45	15
11	Cesar Chavez Recreation Complex	City of LA, DPW, BOS, SRPCD	44	17
12	Cabrito Paseo Walkway/Bike Path	LA Neighborhood Land Trust	42	18
28	Oros Green Street	North East Trees	42	18
40	Peck Park Canyon Enhancement Project	LANI	41	20
35	Rosecrans Rec. Cntr Storm Water Enhancements	City of LA, DRP	39	21
31	Parking Grove in El Sereno	Council District 14	37	22
22d	Westminster Dog Park Stormwater BMPs	City of LA, DPW, BOS, WPD	36	23
15	Fremont High Community Garden	Youth Opportunities Unlimited		
30	Boyle Heights Joint Use Community Center	Council District 14		
33	Lincoln Heights Interchange Restoration	North East Trees		
52	Catch Basin Inserts and Coverings Ph. II	City of LA		
52b	Catch Basin Opening Screen Covers Ph. III	City of LA		

4. Conclusion

Proposition O was proposed to help the City of Los Angeles comply with the TMDL requirements of the Clean Water Act, and "all projects shall provide water quality benefits and have as their primary purpose the reduction of pollutant loads to the impaired waters of the City to meet water quality standards". The effectiveness of the proposition was examined to show whether it achieves the goal of meeting water quality standards. Our analysis shows the most effective single projects will remove at most 13% of pollutant loads from one of the three major watersheds (Dominguez Channel), and no single project will achieve TMDL compliance, although several projects can make important contributions to reduce pollutant loads to eventually comply with the TMDLs. These projects, even taken as a whole, will not be sufficient to meet the TMDLs. The short fall in the required pollutant reductions to meet the TMDLs should not be counted as a failure of Proposition O, since it was not intended to remedy all polluted runoff in the City of Los Angeles. The projects will contribute to protect river, lakes, beaches, oceans and other water sources and to clean up stormwater by reducing stormwater runoff and pollution.

The analysis of the projects shows the importance of taking a watershed approach to meet TMDLs. Portions of the three major watersheds are outside the City of Los Angeles' jurisdiction. Runoff from the portions of the watersheds outside of the City cannot be mitigated by Prop O funding or similar future bonds, and this runoff in many cases is sufficient, by itself, to violate the TMDLs. To meet the TMDLs it will be necessary for other jurisdictions to also implement BMPs. This problem illustrates the critical need to build more regional alliances to construct projects to meet TMDL, and to develop coherent in regional plans. Accordingly, more funds will be needed to resolve regional problems. Our recommendation is to implement regional projects based on a watershed approach. Current implementation of small, local projects address only small amounts of the runoff in each watershed and do not significantly reduce TMDL exceedances. Greater progress in meeting TMDLs could have been achieved if projects had been selected to meet specific TMDLs. The projects providing catchbasin inserts and covers to meet the Trash TMDL are good examples of targeting projects to achieve the greatest impact. Low flow diversions are another good example of effective, targeted BMPs.

Proposition O is different from other City bond programs because the ballot did not identify specific implementation plans before soliciting projects. As a result, the Prop O funds were solicited to fund BOS projects that had been under consideration as well as new projects and projects from groups outside of BOS and City government. There was limited guidance for the groups and the net result was a scattershot approach that created many projects that are unlikely to build upon one another in a coherent manner to meet TMDL requirements. No single project will meet the TMDL requirements, although the major result of at least some of the projects will be incremental progress in meeting TMDLs.

The approach used for Prop O implementation should have been developed based on an optimal implementation plan that clearly identifies priorities and environmentally significant catchments to resolve urgent problems. Such an approach would have more effectively allocated funds, but would have provided little opportunity for individuals or community groups to participate in project creation. An alternative approach could be to develop a water quality improvement master plan prior to authorize funding and to include a wide audience for proposing projects. The plan should employ a systems approach that includes an analysis of the watershed and the proposed BMPs, and the examples provided here are good models for the needed analyses. The implementation plan should also be consistent with the regional plans to resolve regional water problems caused by different or overlapping jurisdictions. Overlapping jurisdictions create challenging problems which must be addressed to create the maximum benefit of fund expenditures.

A major shortcoming of Prop O is the lack of a mechanism to evaluate the success and the effectiveness of the funded projects. Funds for monitoring should be identified and monitoring should be conducted before and after the installation of BMPs in order to learn from the successes and failures. Monitoring data could also be used to validate the pollution reduction models, improve the design of BMPs, and develop ranking procedures. Most of concept reports did not have monitoring data to support the proposed BMPs. Only a few provided monitoring data which were based only on a small number of events, and are probably not sufficient to evaluate the expected performance of the proposed BMPs. Monitoring is recommended to help understand how effectively bond funds have been spent and how the projects will improve water quality to meet the TMDLs.

One of the fundamental problems in evaluating projects is quantifying multiple benefits. The absence of a quantitative method for evaluating multiple project benefits may skew the evaluation and the ranking of projects. Our results reflect only the water quality components (65 out of 100 points). Projects focusing on stormwater cleanup measures with well defined BMPs and landuse ranked high, while projects rich in multiple benefits but hard to quantify water quality improvement ranked low. Multiple benefits such as creating recreational space, flood control or groundwater recharge may help improve water quality in an indirect way but are difficult to quantify using the current ranking system. We suggest that there is a need to develop methods to better quantify multiple benefits, or to create different metrics that take other values into account. One example is the measurement of the relationship between green space and the quality of life for City residents.

The allocation of Prop O funds is nearly complete although some projects are pending the approval of City Council and Mayor. Currently, approximately $8 million dollars are allocated for three projects that were originally proposed by community or non-profit organizations, $10 million for projects that were originally proposed by other government agencies than the City whereas $444 million is allocated for City-proposed projects. All these projects will be implemented by the City. The community-based projects are ranked low based upon our quantitative criteria, but appear to have multiple benefits that are not included in our ranking.

A major task of the Prop O evaluation and management groups, now that most of the funding is allocated, should be informing the public about the effectiveness of the bond expenditures by providing scientific proof and other evidence of the effectiveness of the approved projects.

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City of Los Angeles, DPW, BOS, WPD (2007c) Penmar Water Quality Improvement and Runoff Reuse Project, Santa Monica Bay Beaches Bacterial TMDL implementation plan, Concept Report

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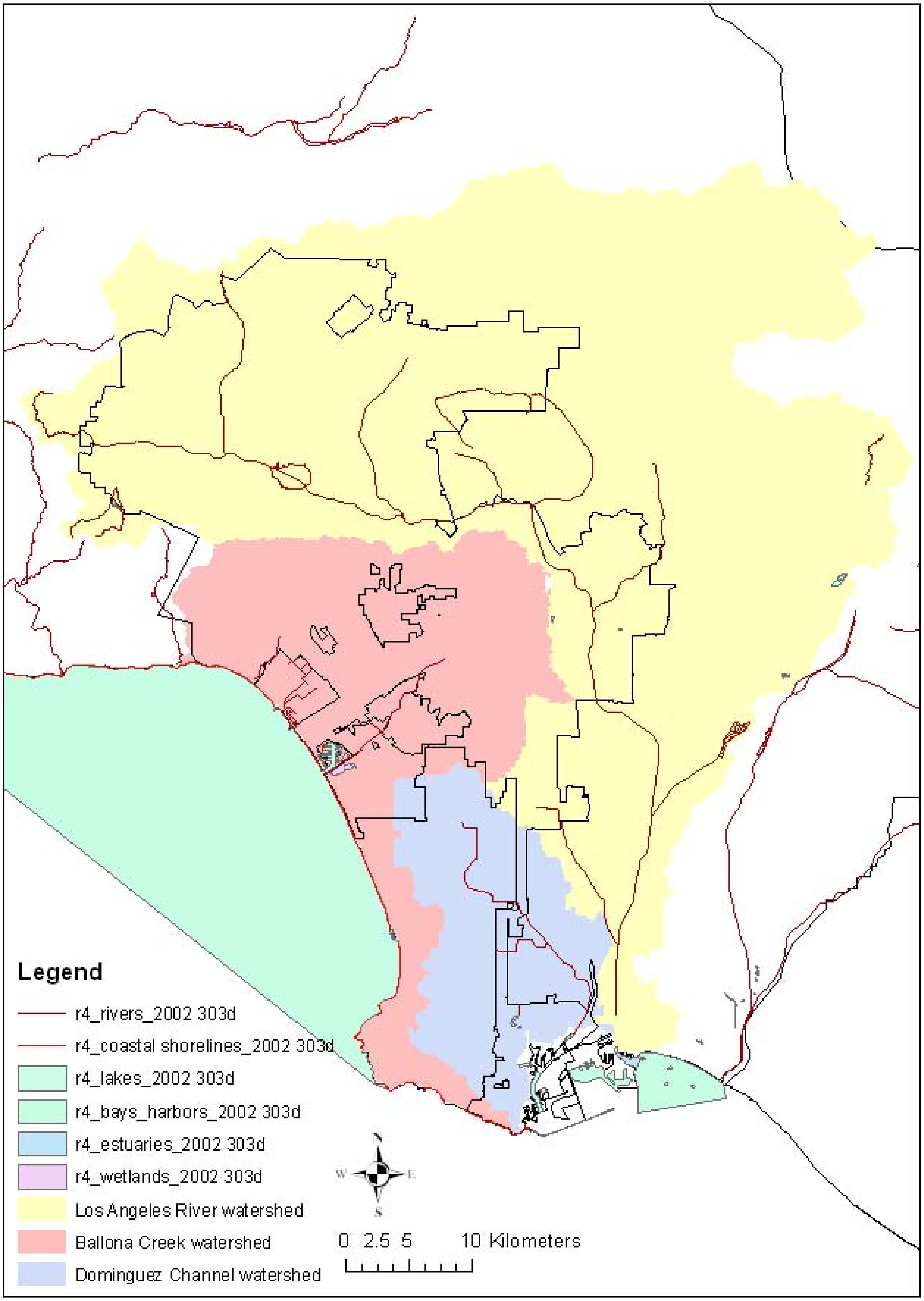
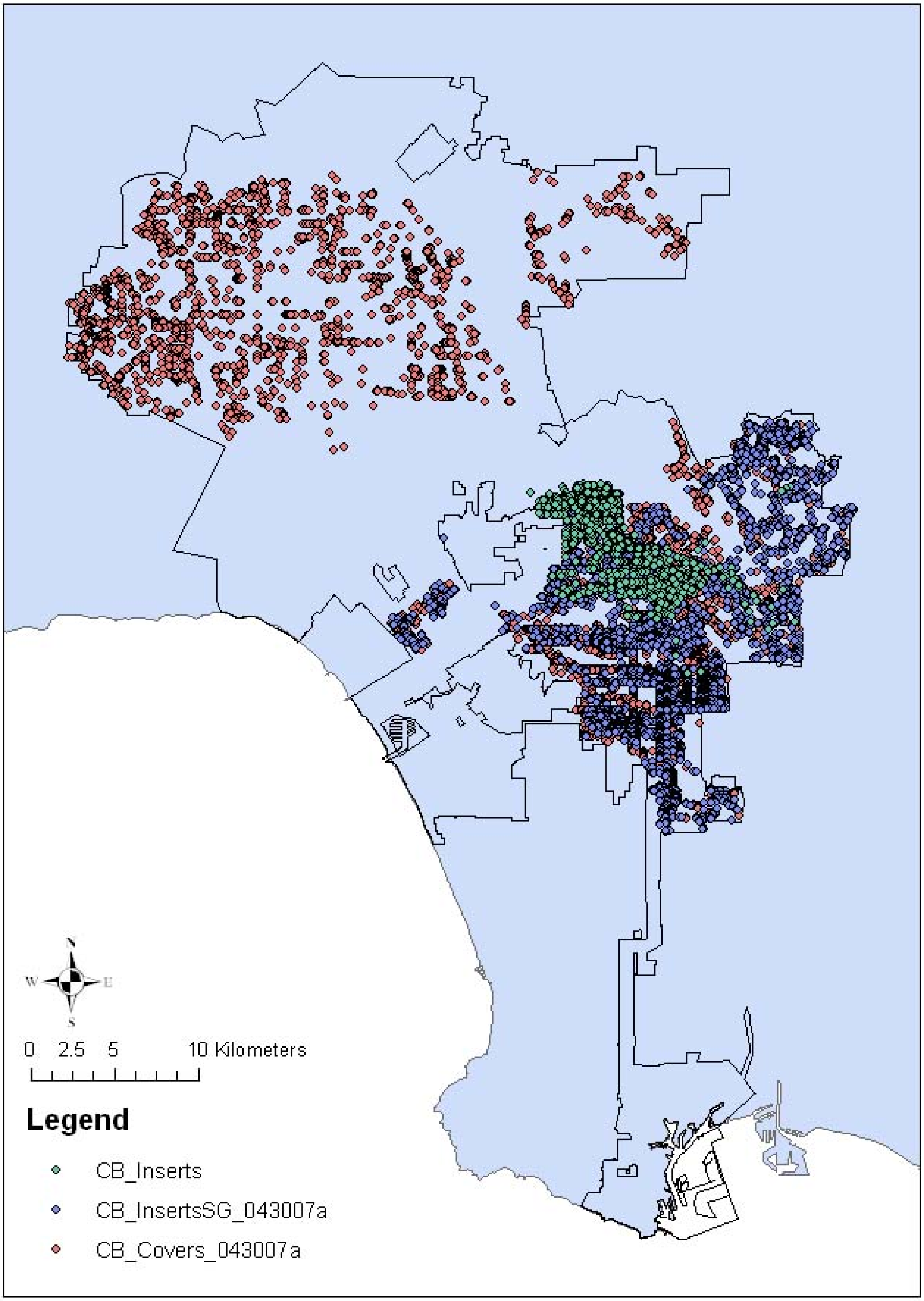
Appendix A. Impaired water bodies of 303 (d) list in the watersheds with the City of Los Angeles boundary



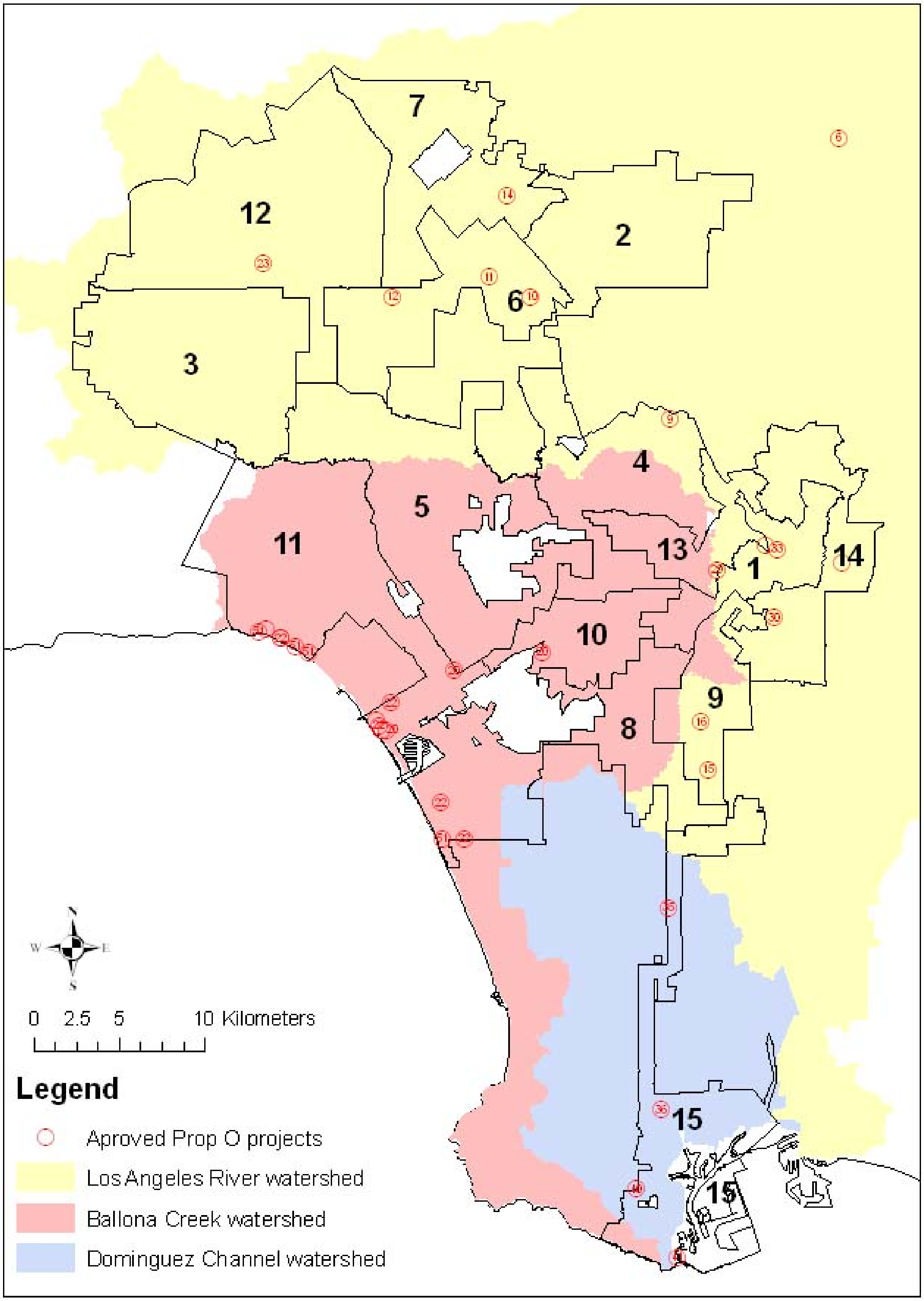
(data adapted from Bureau of Sanitation, Watershed Protection Division)

Appendix B. Catchbasin inserts and coverings installation



(data adapted from Bureau of Sanitation, Watershed Protection Division)

Appendix C. Location of projects approved for Proposition O funding



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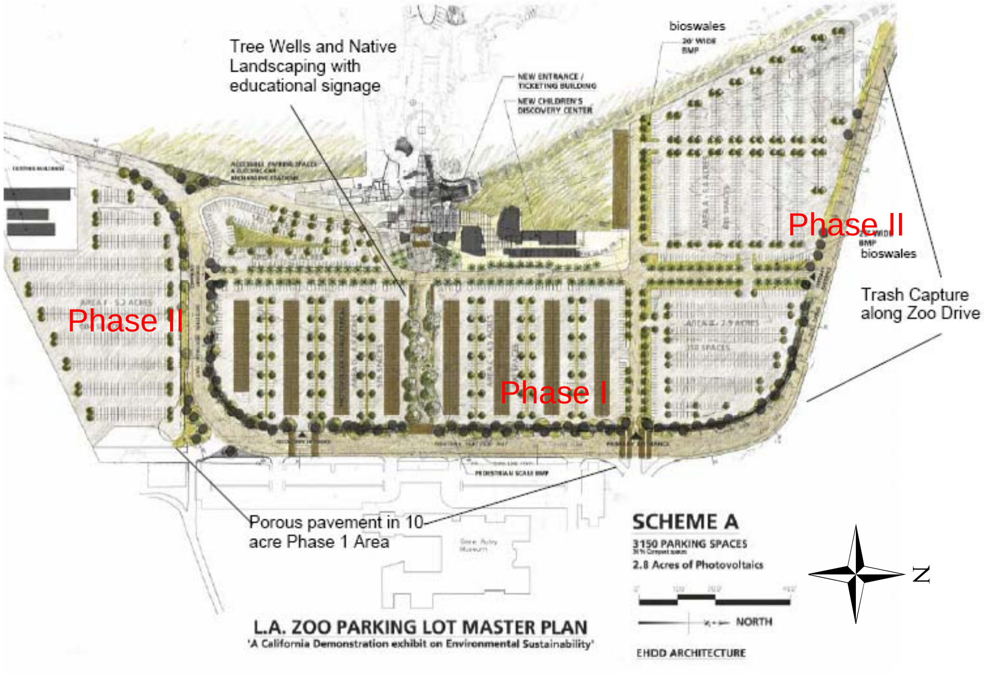
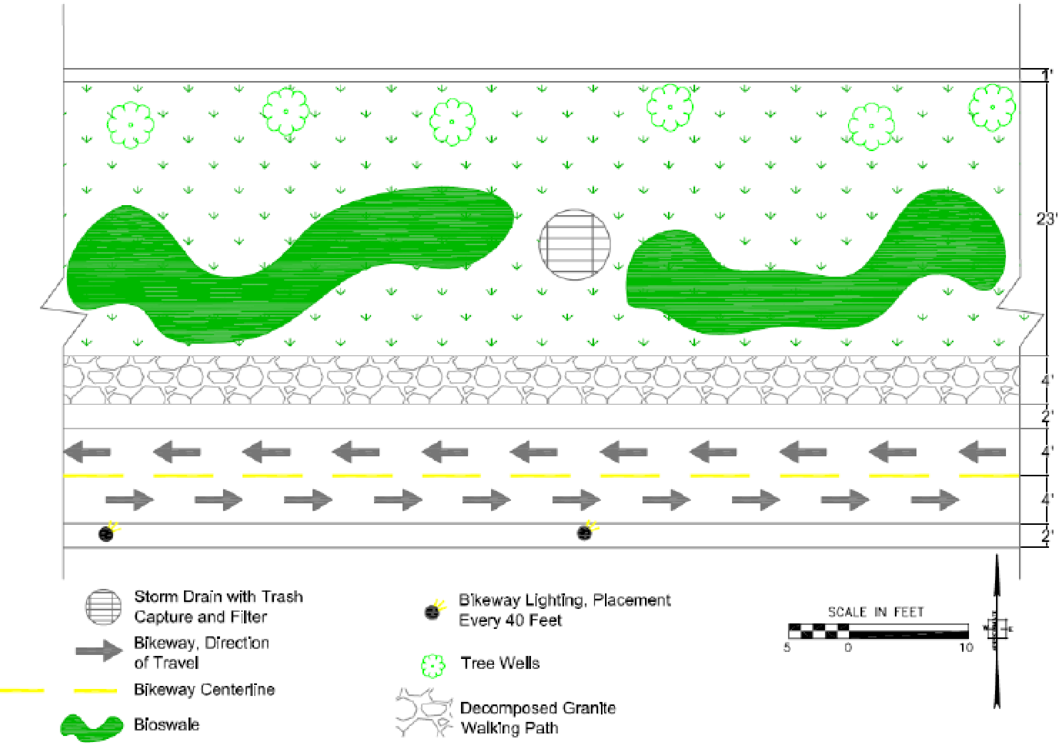
Appendix D. Concept Site Plans for Proposed Projects (from concept reports)



Los Angeles Zoo Parking Lot (#9)

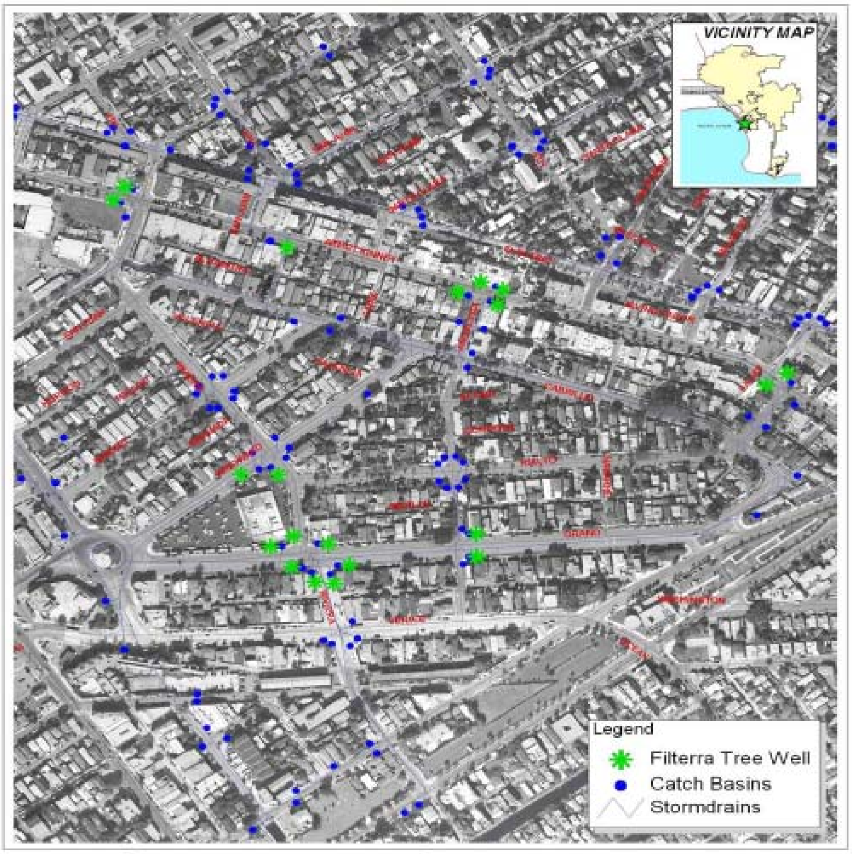
Strathern Pit Multiuse Project (#10)



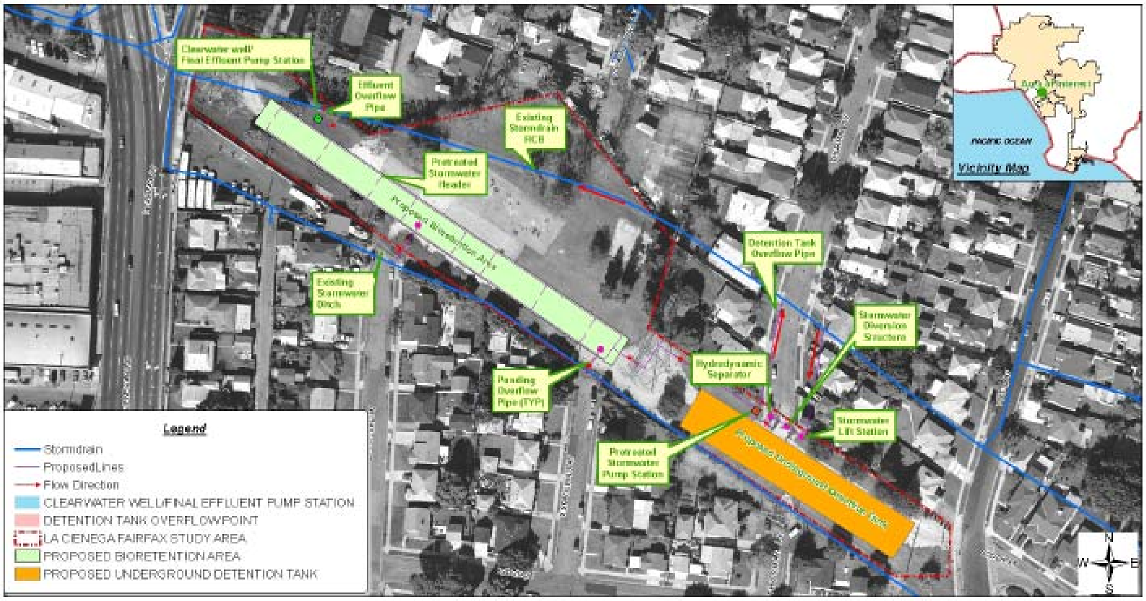
Cabrito Paseo Walkway/Bike Path Project (#12)

Hansen Dam Recreational Area Parking Lot and Wetlands Restoration (#14)

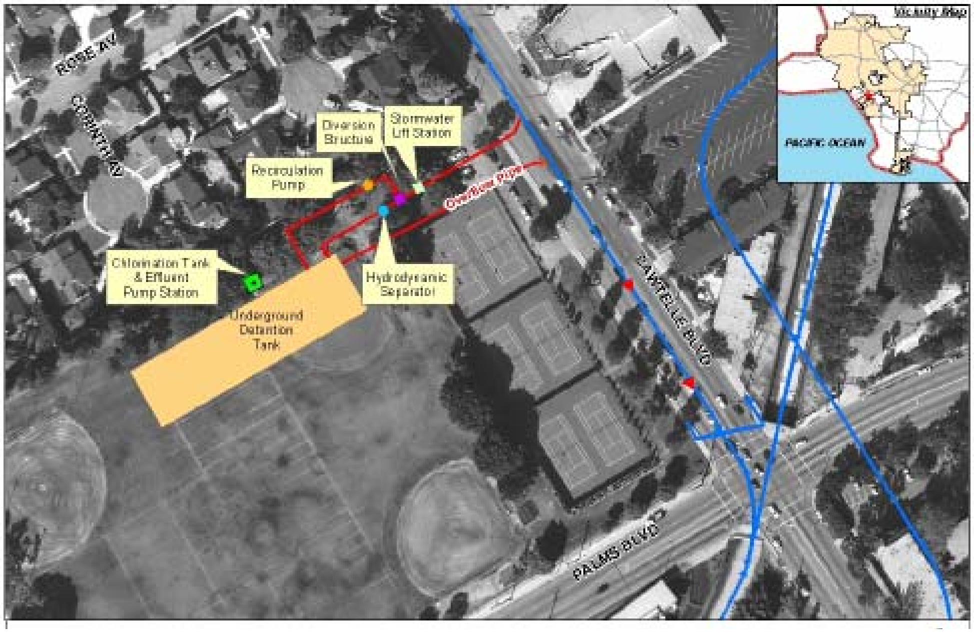
South Los Angeles Wetlands Park (#16)



Grand Avenue Stormwater BMPs (#20a)



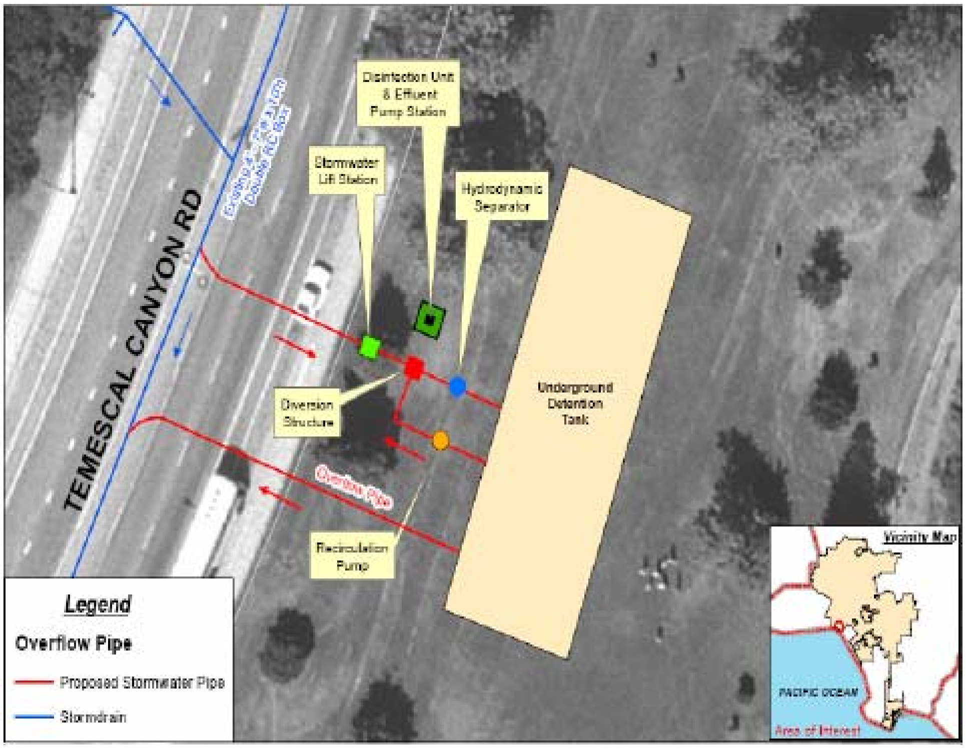
La Cienega/Fairfax Powerline Easement Stormwater BMPs (#20b)



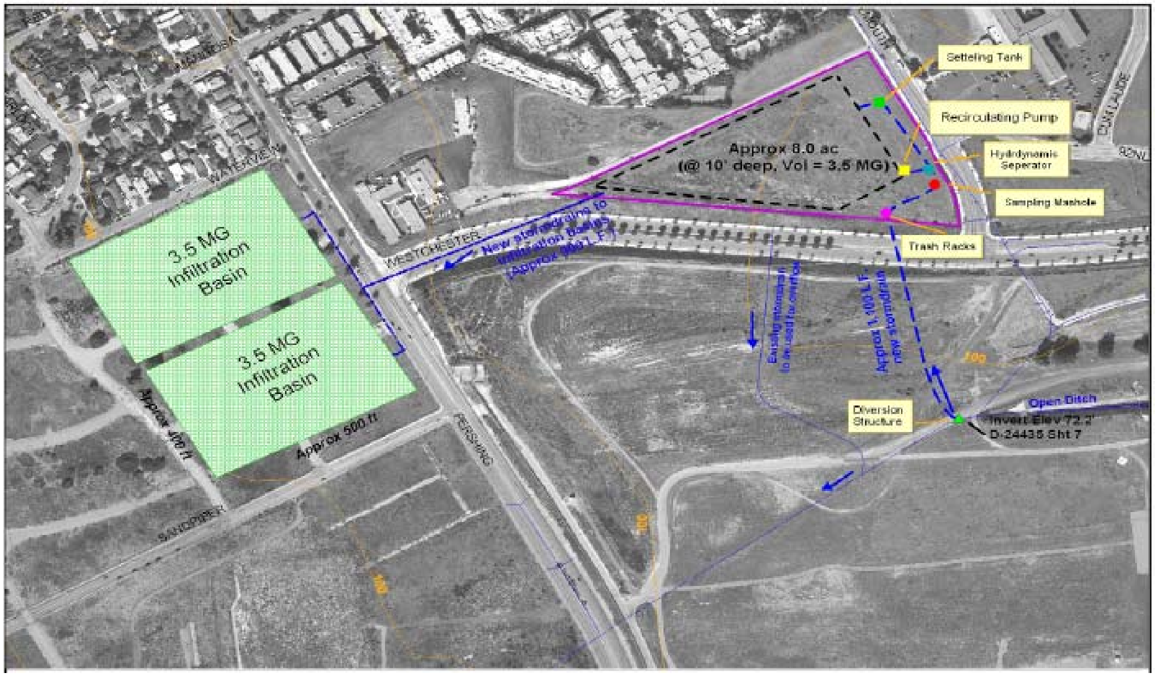
Mar Vista Recreation Center Stormwater BMPs (#20c)

Imperial Higyway Stormwater BMPs (#22a)

Westminster Dog Park Stormwater BMPs (#22d)



Temescal Recreation Center Stormwater BMP (#22e)

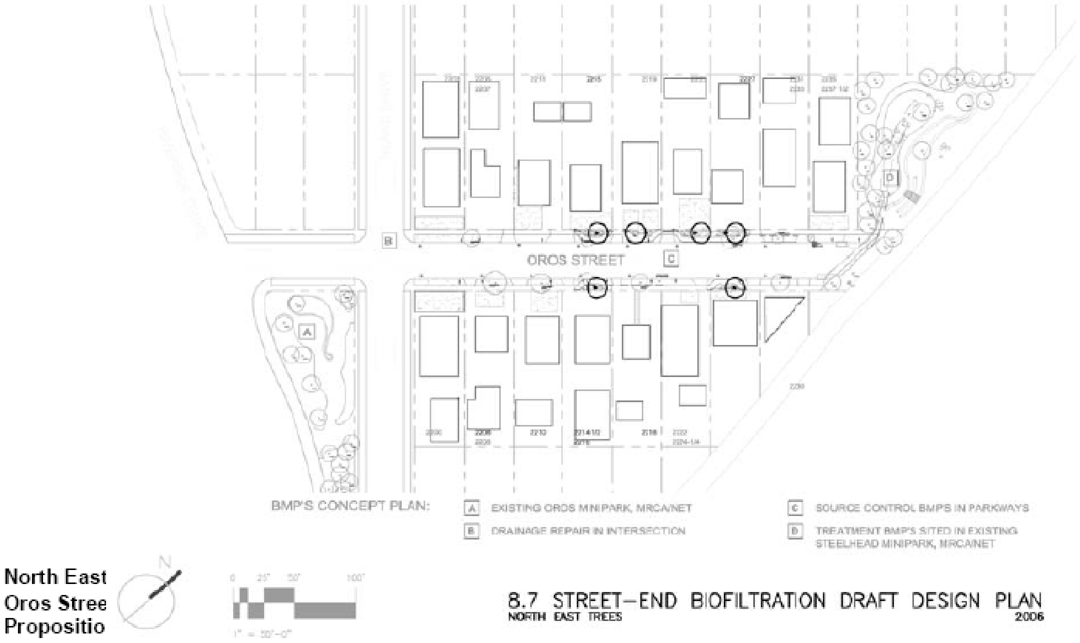


Westchester/LAX Stormwater BMP (#22f)

Penmar Water Quality Improvement and Runoff Reuse Project (#22g)

Area 1
① Low flow weir
② Pump station & pretreatment
③ Bioswales
④ Vegetated detention/ retention basin
⑤ Revegetated area
Area2
⑥ Vegetative Enhancement
Area3
⑦ Open space & wildlife refuge
⑧ Vegetated detention basin
Area4
⑨ Low flow weir
⑩ Pump station & pretreatment
⑪ Vegetated detention basin
⑫ Revegetation
⑬ Discharge to channel
Other
⑭ Permeable pavement

Aliso Wash - Limekiln Creek Confluence Restoration Project (#23)



Oros Green Street (#28)

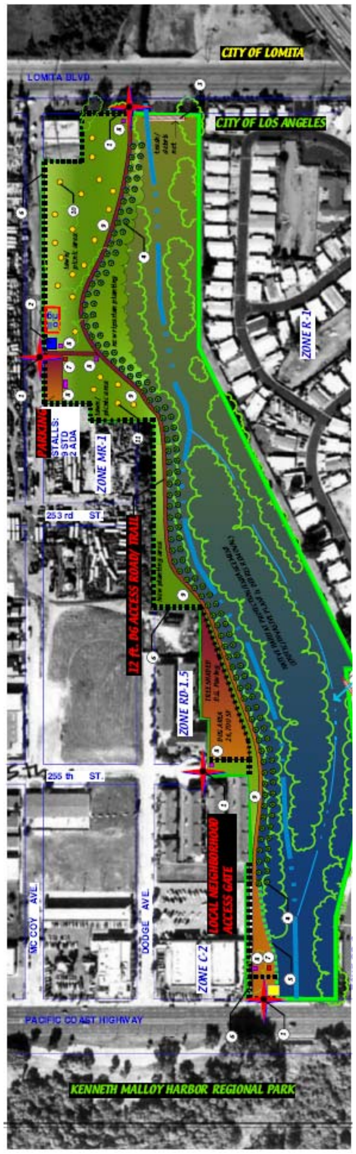
1. **Potable water inflow**
2. **City of Los Angeles storm drain outfalls**
3. **Los Angeles County storm drain outfalls**
4. **Lake outlet**
5. **Existing floating wetlands**
6. **Lotus beds**
7. **Lake edge treatments - including terraces**
8. **Permeable paving trails**
9. **Grassy swales/ infiltration strips**
10. **Lake-edge retaining wall**

Echo Park Lake Rehabilitation (#29)

Parking Grove in El Sereno (#31)

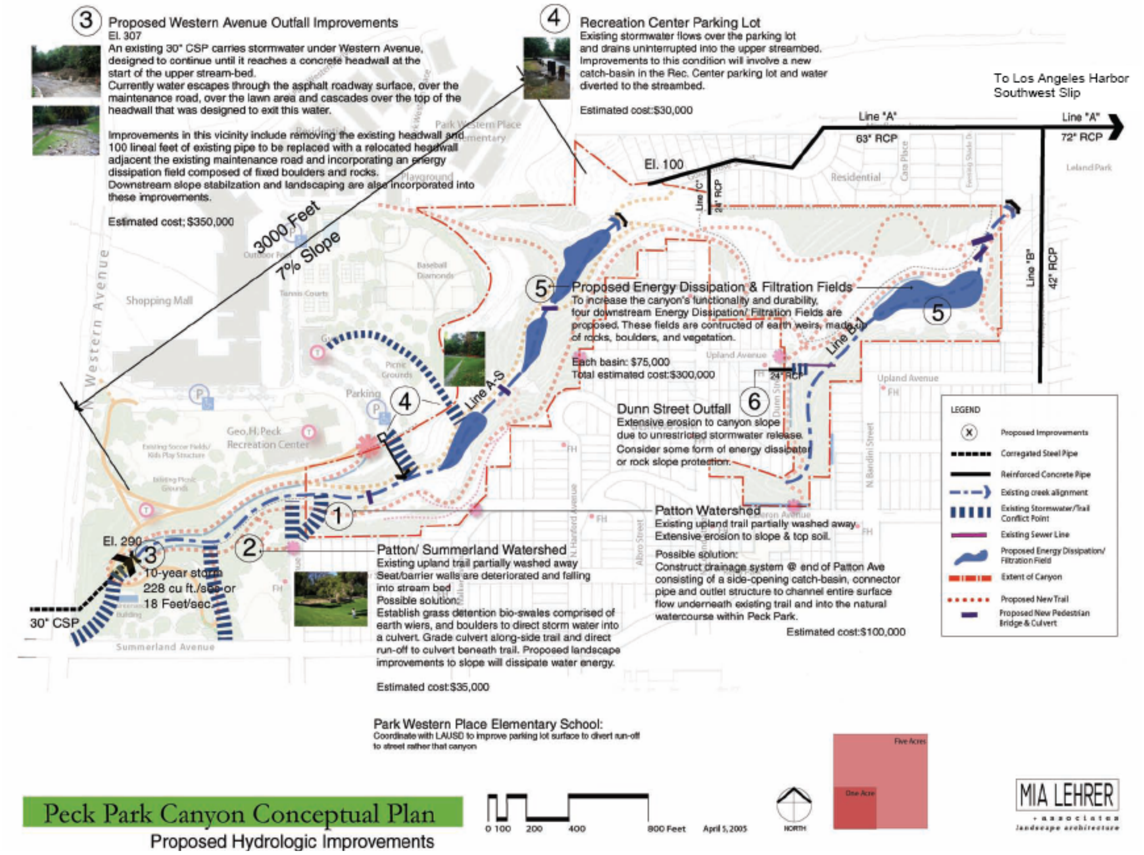
Rosecrans Recreation Center Stormwater Enhancements (#35)

Machado Lake Ecosystem Rehabilitation Project (#36)



SYMBOL	REF. #	DESCRIPTION	QUANTITY
✦	①	NEW PUBLIC &/or UTILITY ACCESS GATE 4 ped. gates 2 vehicular gates	4
🟦	②	NEW ADA restroom	2-STALL
▨	③	TRASH NETTING SYSTEM	2
✲		24" BOX TREE (Location not Indicated)	22
✲		5 G. Tree (Location not Indicated))	33
●	④	WATTLES	1000
▪▪▪▪▪▪▪	⑤	GABION BANK STABILIZATION (VEGETATED)	350 LF/ 1100 CY
■■■■■■■	⑥	NEW 6 FT. TUBE STL. FENCING	3000 LF
🟥	⑦	INTERPRETIVE KIOSK	2
🟪	⑧	WASTE RECEPTACLE	5 +1 DUMPSTER
🟧	⑨	INTERPRETIVE SIGNAGE (at VIEWING AREA)	15
🟡	⑩	PICNIC TABLE	22
🟩		IRRIGATED LANDSCAPE AREA (lawn or native planting)	158,000 SF / 4.3 AC
🟧		3" DECOMPOSED GRANITE (D.G.) PAVING	69,900 SF
🟦		NATIVE HABITAT PROTECTION/ENHANCEMENT (EXOTIC/INVASIVE PLANT & DEBRIS REMOVAL)	592,000 SF (13.6 Ac)

Wilmington Drain Multiuse Project (#36a)



③ **Proposed Western Avenue Outfall Improvements**
El. 307
An existing 30" CSP carries stormwater under Western Avenue, designed to continue until it reaches a concrete headwall at the start of the upper stream-bed.
Currently water escapes through the asphalt roadway surface, over the maintenance road, over the lawn area and cascades over the top of the headwall that was designed to exit this water.

Improvements in this vicinity include removing the existing headwall and 100 lineal feet of existing pipe to be replaced with a relocated headwall adjacent the existing maintenance road and incorporating an energy dissipation field composed of fixed boulders and rocks.
Downstream slope stabilzation and landscaping are also incorporated into these improvements.

Estimated cost; $350,000

④ **Recreation Center Parking Lot**
Existing stormwater flows over the parking lot and drains uninterrupted into the upper streambed. Improvements to this condition will involve a new catch-basin in the Rec. Center parking lot and water diverted to the streambed.

Estimated cost:$30,000

⑤ **Proposed Energy Dissipation & Filtration Fields**
To increase the canyon's functionality and durability, four downstream Energy Dissipation/ Filtration Fields are proposed. These fields are contructed of earth weirs, made up of rocks, boulders, and vegetation.

Each basin: $75,000
Total estimated cost:$300,000

Dunn Street Outfall ⑥
Extensive erosion to canyon slope due to unrestricted stormwater release.
Consider some form of energy dissibater or rock slope protection.

Patton Watershed
Existing upland trail partially washed away.
Extensive erosion to slope & top soil.

Possible solution:
Construct drainage system @ end of Patton Ave consisting of a side-opening catch-basin, connector pipe and outlet structure to channel entire surface flow underneath existing trail and into the natural watercourse within Peck Park.

Estimated cost:$100,000

Patton/ Summerland Watershed
Existing upland trail partially washed away
Seat/barrier walls are deteriorated and falling into stream bed
Possible solution:
Establish grass detention bio-swales comprised of earth wiers, and boulders to direct storm water into a culvert. Grade culvert along-side trail and direct run-off to culvert beneath trail. Proposed landscape improvements to slope will dissipate water energy.

Estimated cost:$35,000

Park Western Place Elementary School:
Coordinate with LAUSD to improve parking lot surface to divert run-off to street rather that canyon

LEGEND

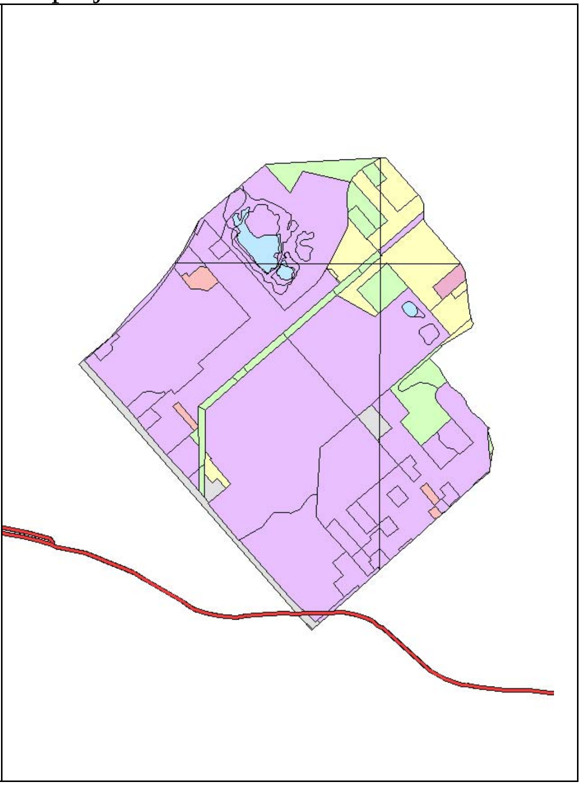
⊗	Proposed Improvements
▬ ▬ ▬	Corregated Steel Pipe
▬▬▬	Reinforced Concrete Pipe
─ · ─〉	Existing creek alignment
▮▮▮▮▮	Existing Stormwater/Trail Conflict Point
▬▬▬	Existing Sewer Line
▬	Proposed Energy Dissipation/ Filtration Field
▬ ╎ ▬ ╎ ▬	Extent of Canyon
• • • • • •	Proposed New Trail
▬	Proposed New Pedestrian Bridge & Culvert

Peck Park Canyon Conceptual Plan
Proposed Hydrologic Improvements

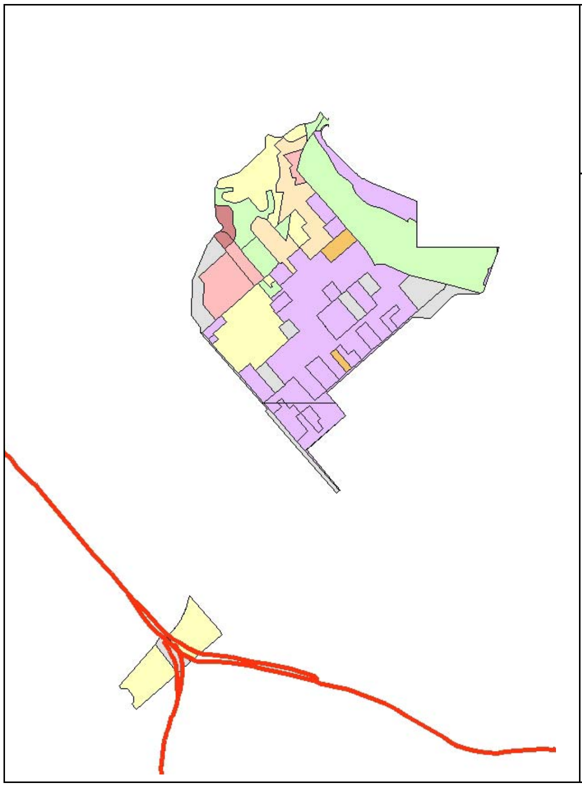
Peck Park Canyon Enhancement Project (#40)

Appendix E. Drainage area and Land use of the projects

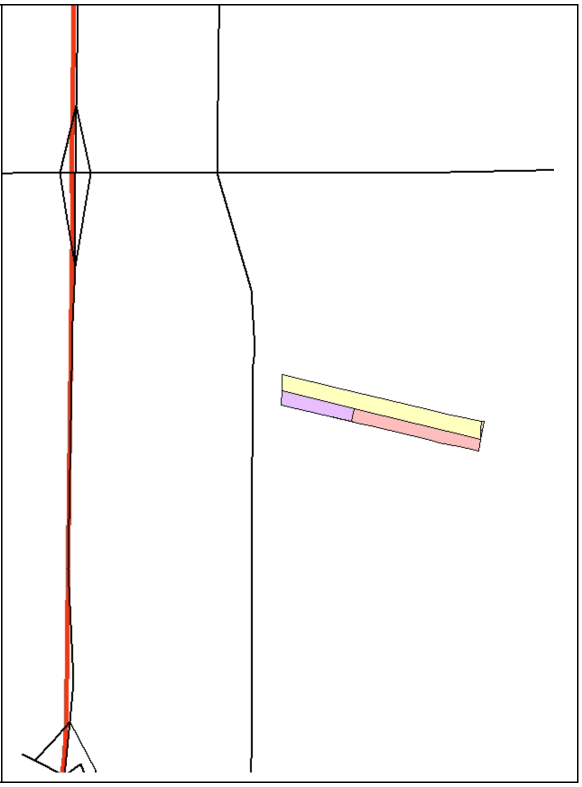
Los Angeles Zoo Parking Lot (#9)



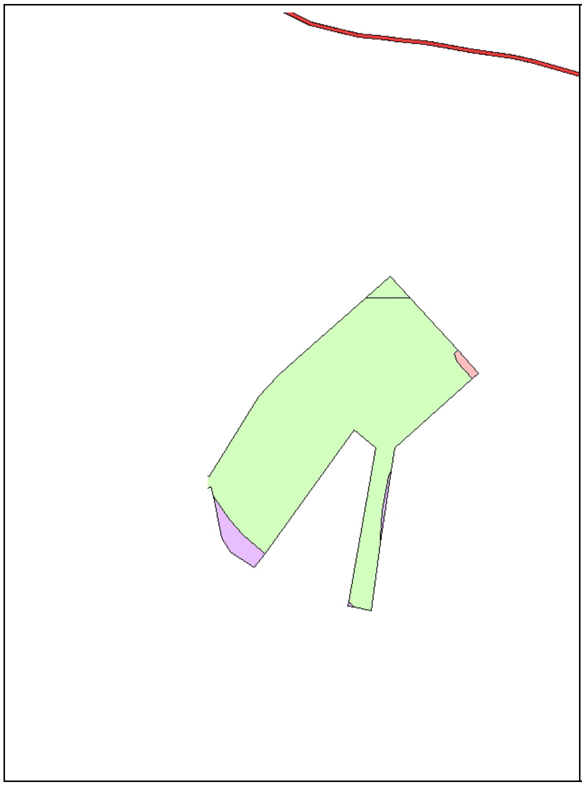
Strathern Pit Multiuse Project (#10)



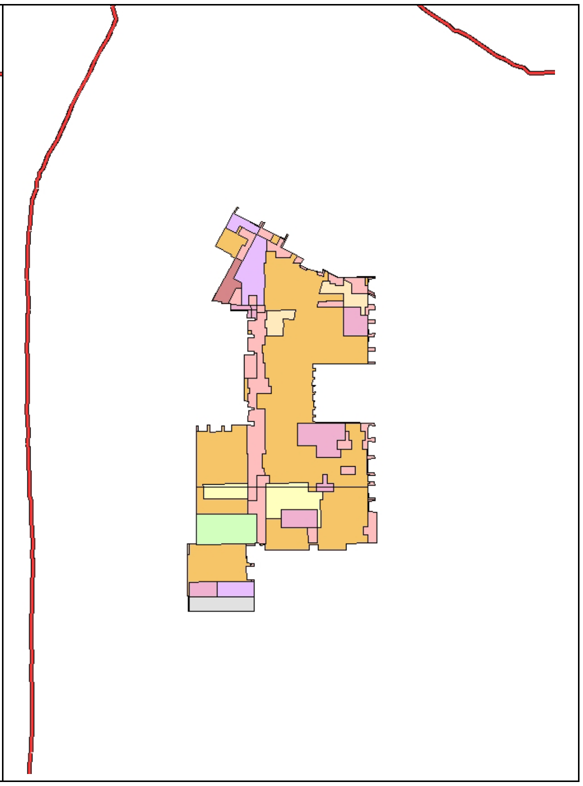
Cesar Chavez Rec. Complex (#11)



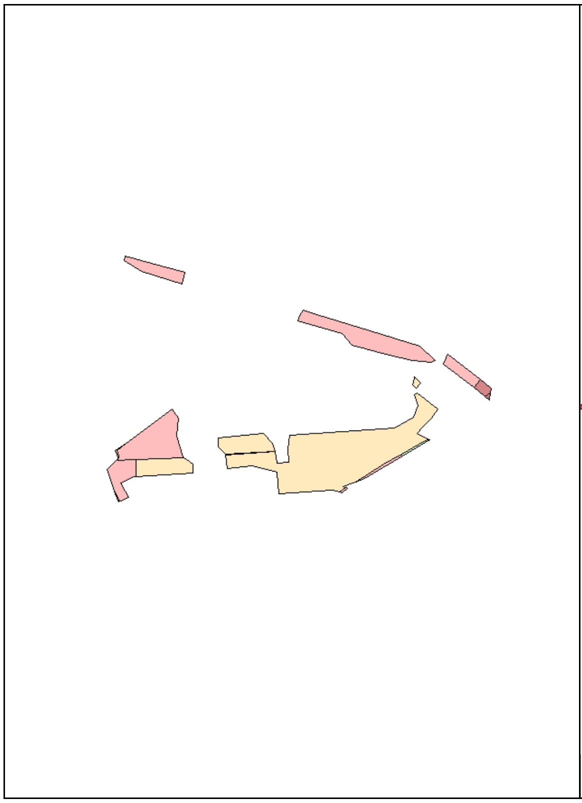
Cabrito Paseo Walkway/Bike Path (#12)



Hansen Dam Parking Lot (#14)



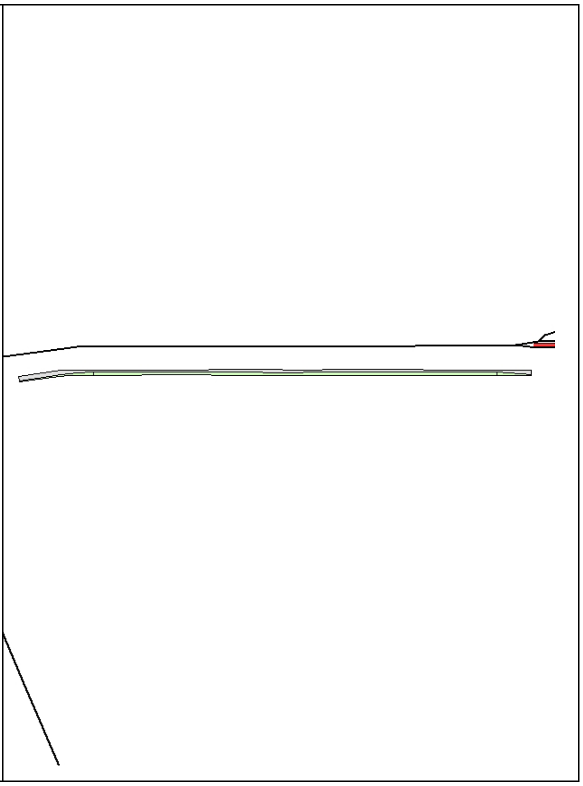
South Los Angeles Wetlands Park (#16)



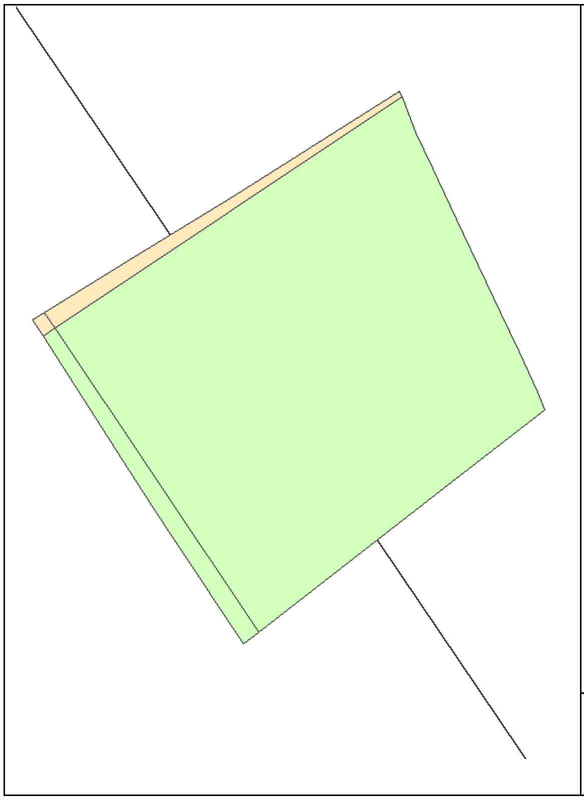
Grand Avenue Stormwater BMPs (#20a)

La Cienega/Fairfax Powerline Easement (#20b)

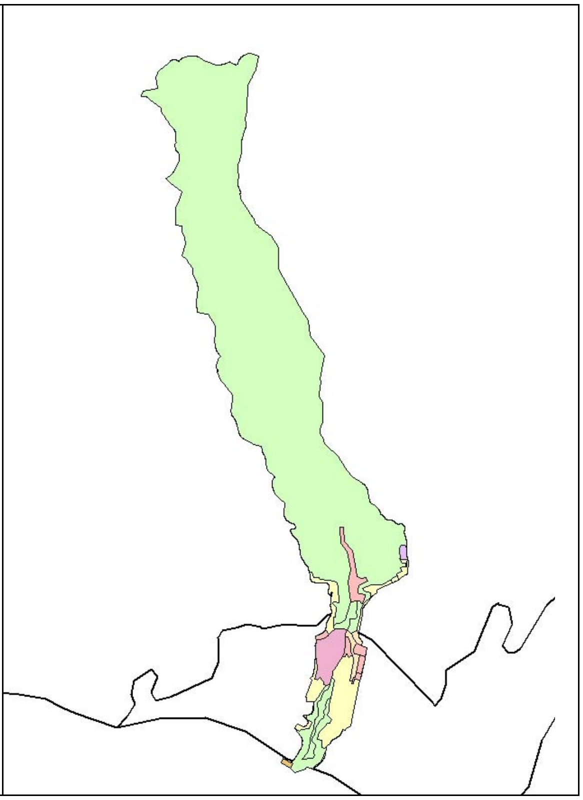
Mar Vista Rec. Cntr Stormwater BMPs (#20c)



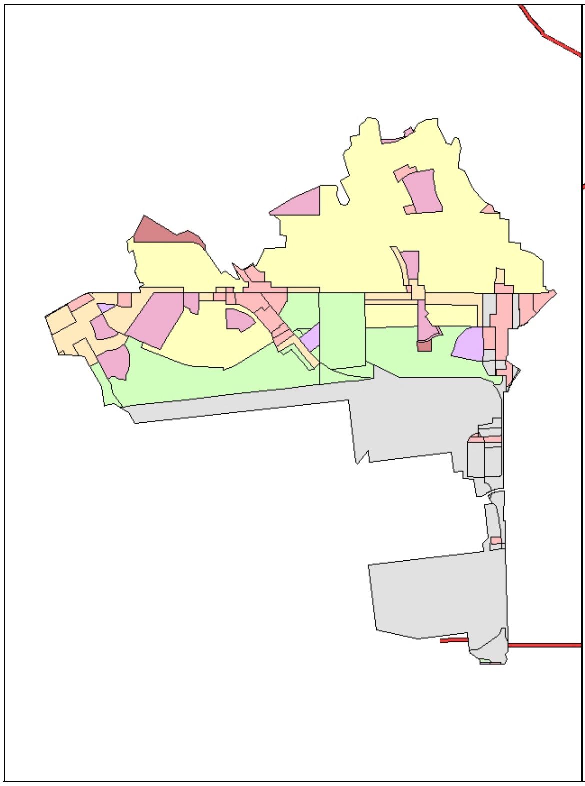
Imperial Highway Stormwater BMPs (#22a)



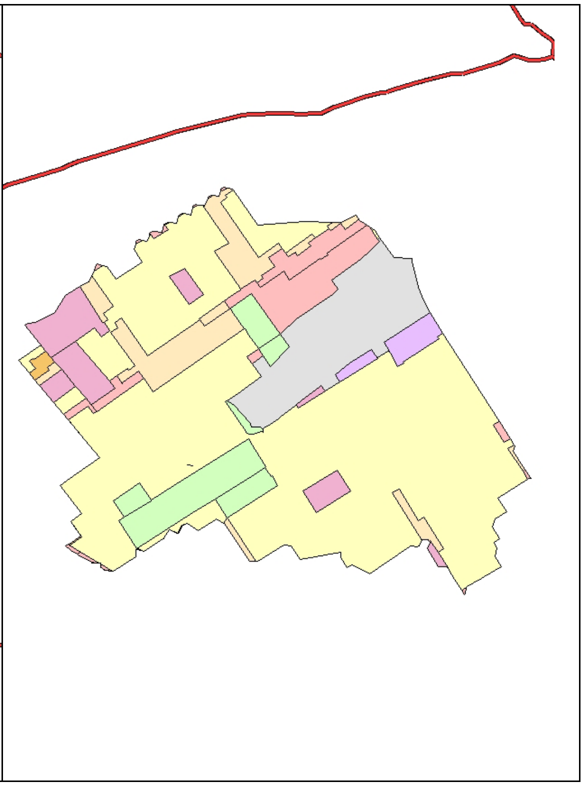
Westminster Dog Park Stormwater BMPs (#22d)



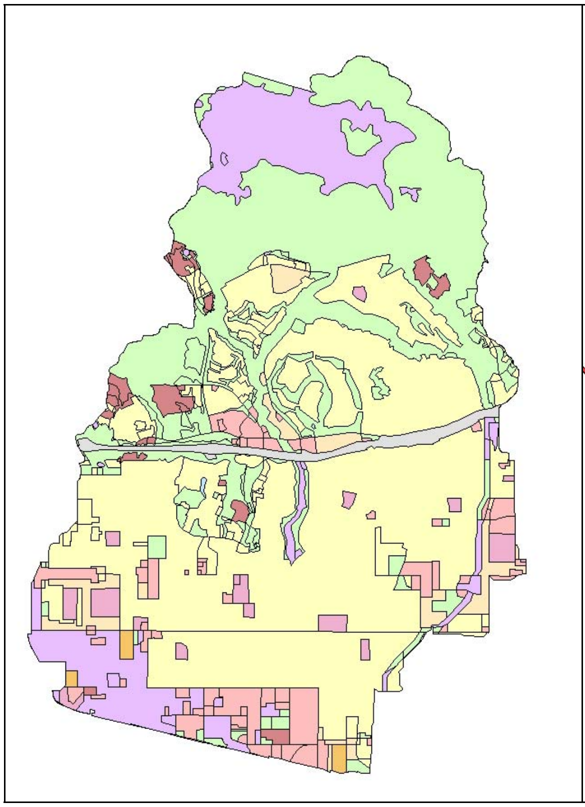
Temescal Rec. Cntr Stormwater BMP (#22e)



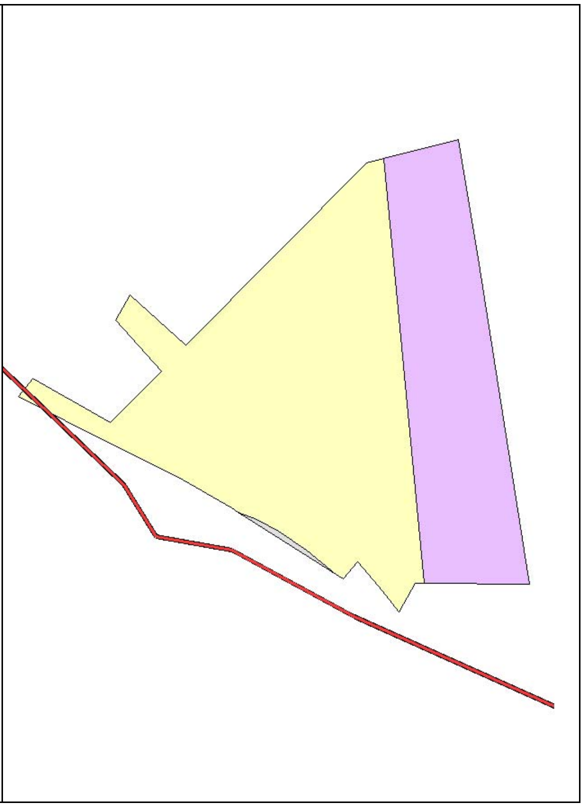
Westchester/LAX Stormwater BMP (#22f)



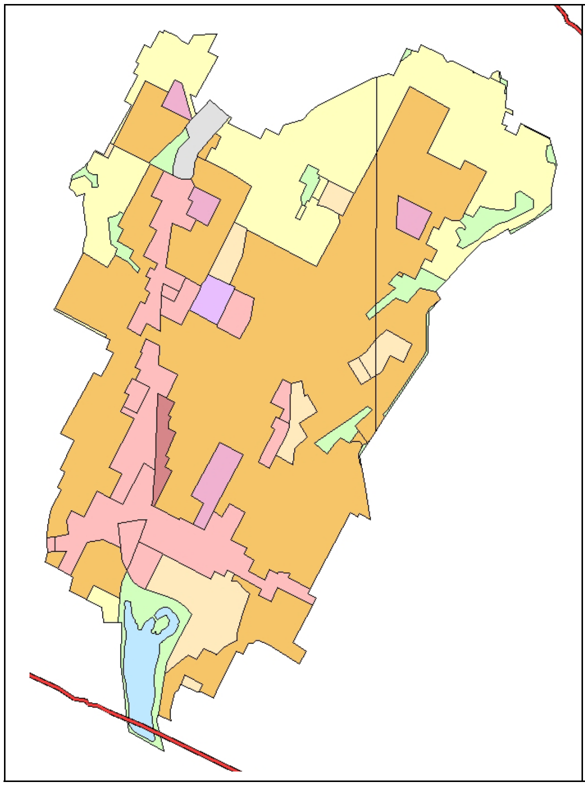
Penmar WQ Improvement (#22g)



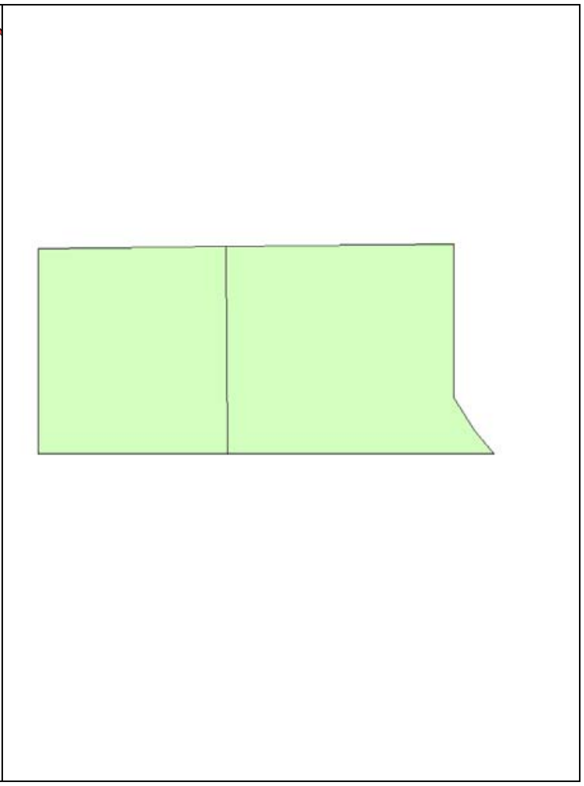
Aliso Wash - Limekiln Creek (#23)



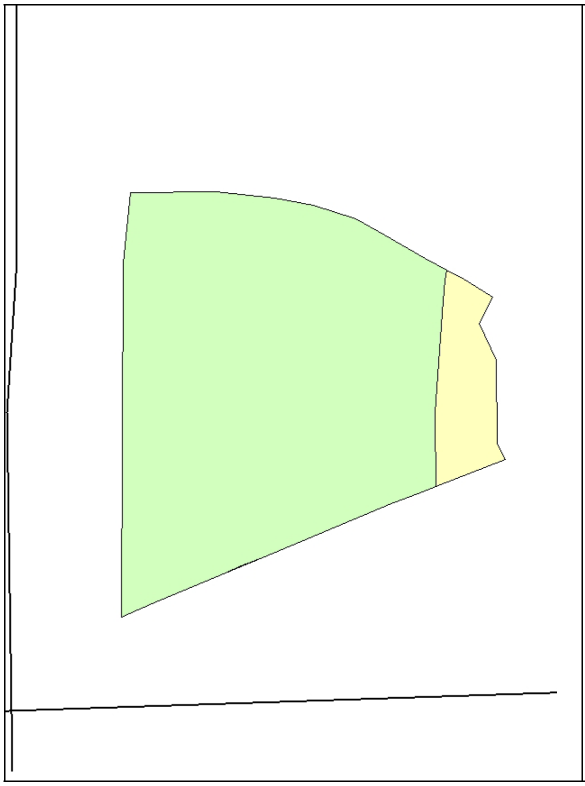
Oros Green Street (#28)



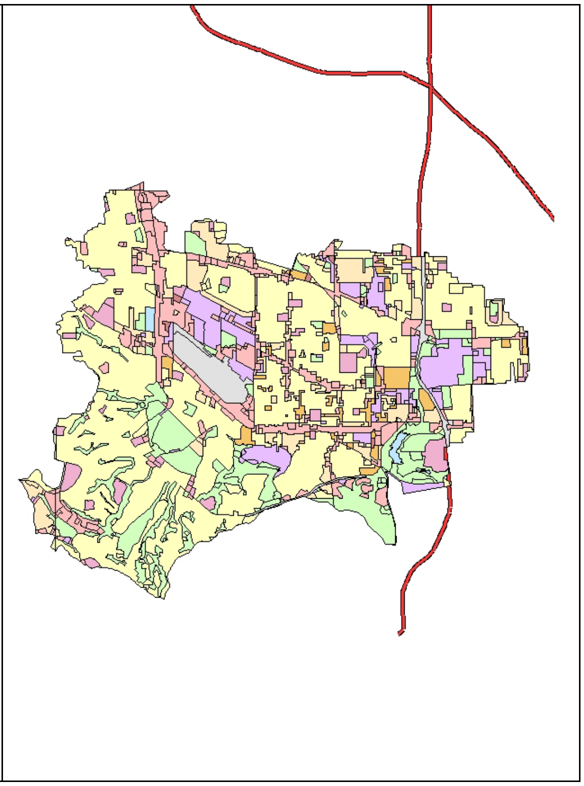
Echo Park Lake Restoration Project (#29)



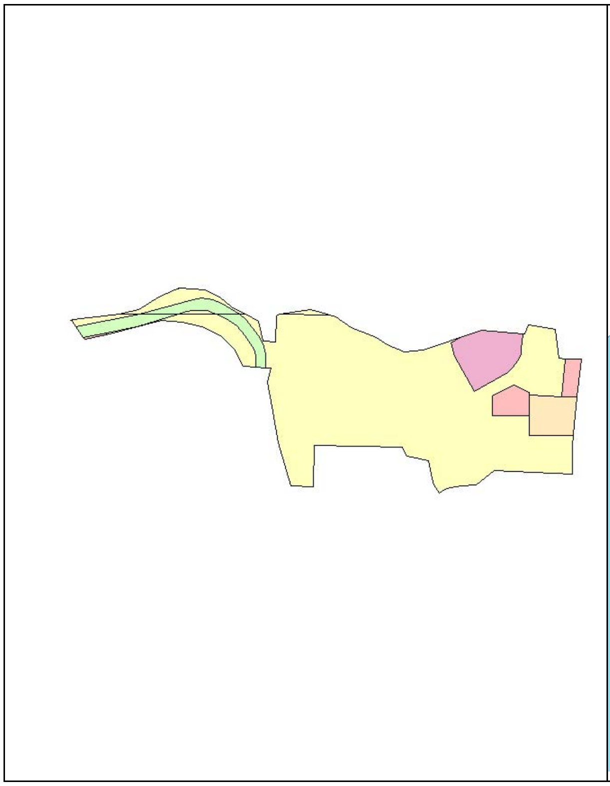
Parking Grove in El Sereno (#31)



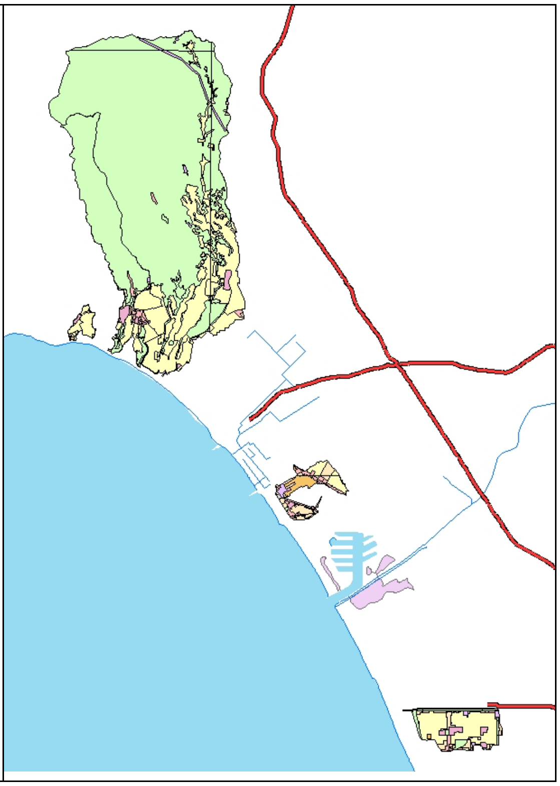
Rosecrans Rec. Cntr. (#35)



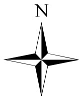
Lake Machado Ecosystem (#36)



Peck Park Canyon Enhancement Project (#40)



Santa Monica Bay Beaches LFD Upgrades (#51)



Land use
🟨 high density single family residential
🟧 multiple family residential
🟧 mixed residential
🟥 retail/commercial
🟪 educational
🟪 light industrial
⬜ transportation
🟥 other
🟩 vacant/agriculture

━ freeway
— major road

(data adapted from Bureau of Sanitation, Watershed Protection Division)

Appendix F. Project Selection Criteria

Proposition O, a $500M General Obligation Bond that was approved by 76% of the City of LA voters, says "all projects shall provide water quality benefits and have as their primary purpose the reduction of pollutant loads to the impaired waters of Los Angeles to meet water quality standards."

The proposed project selection criteria, below, will help meet the intent of the bond language and will be applicable to all projects in order to meet Water Quality Standards set by the RWQCB. Proposition O projects must demonstrate that they will alone, or with other proposed or existing projects, result in attainment of one or more Water Quality Standards (WQS).

The Purpose of These Criteria

These criteria are provided as a guide for City staff to use as they review projects proposed to receive funding from Proposition O funds.

The project selection criteria have been developed so that staff can select projects that meet the intent of the bond language that appears above.

Proposed projects found to be consistent with these criteria will be evaluated in detail. Those projects that are evaluated in detail will then be scored. Staff will present proposed projects that exceed specified scores to the Proposition O Citizens Advisory Committee (COAC) and the Proposition O Administrative Oversight Committee (AOC).

Eligibility to be scored

The project must demonstrably reduce pollutant loads to the impaired waters of Los Angeles to comply with Water Quality Standards as identified in the 303(d) list. Funds can be used for project planning, design, construction and monitoring. The project shall avoid or mitigate negative impacts including: flood control, loss of habitat hardening of creeks or rivers, and shall not exacerbate any existing environmental problems in the vicinity or downstream of the project.

Eligibility for Presentation to the COAC and AOC:

Projects can be judged eligible for presentation to the COAC and AOC if projects receive a total of 75 points from any of the project selection criteria. Any project that does not obtain a minimum of 75 points will not be considered for further investigation.

Project Evaluation Criteria:

Project Significance	
5 points	1. Is the project located in a high priority catchment area? 2. Are the pollution problem and the loads for the drainage area served by the project site Best Management Practices BMPs treatment train significant?
Compliance with Water Quality Goals	
30 points	1. Does the project BMP treatment train help achieve water quality standard compliance for the impaired waters? 2. Can compliance objectives be quantified? 3. During which seasons (wet and/or dry) would compliance be achieved? (year-round improvement is the preferred goal)
Pollution Reduction	
10 points	1. Does the project result in reduction of loads/concentrations of more than one impairing pollutant? 2. What are the number and types of impairing pollutants that can be reduced? Trash, bacteria, toxic sediment, and metals have highest priority. 3. Does the project cause positive or negative impacts to other pollution problems? (Up to 4 pts for positive and minus 4 pts for negative)
10 points	1. Is the BMP a proven BMP for pollutant removal of this type based upon available ASCE, USEPA, or site-specific BMP scientific data? 2. What are the magnitude and percent of overall load/concentration reduction predicted by the BMP treatment train? The magnitude/removal percentage is very significant.
Multiple Objectives	
25 points (max)	These criteria are intended to serve as guidelines for awarding points to a proposed project. Other environment enhancements not found in this list maybe used. (5 pts. maximum for each criteria) 1. Does the project augment local water supply? Quantify. 2. Does the project significantly reduce flood risk? Quantify. 3. Does the project provide stream restoration? Quantify. 4. Does the project provide recreational open space? Quantify. 5. Does the project provide significant habitat value? Quantify. 6. Does the project address an environmental justice issue? How? 7. Is the project visible (i.e. can it be visually seen)? 8. Is the project environmentally sustainable? How? 9. Does the project integrate with IRP, IRWMP, TMDLs Implementation plans, LA River Revitalization Plan, and other existing watershed management plan? How? 10. Does the project have a strong community support? 11. Does the project involve a multi-agency and stakeholder partnership? 12. Does the project provide educational or demonstrational functions?

Project Cost Effectiveness	
10 points	1. Do the project capital and O&M costs meet industry wide standards? How long does the project remain in operation before its replacement? 2. What is cost per unit of pollutant reduction? (example – cost per pound of pollutant reduced) 3. Can the project be cost effectively adapted to changing conditions (regulatory, pollution, land-use, etc)? 4. Does the project leverage any existing or potential funds from state and other sources? How much and from where?
Project Readiness	
10 points	1. How ready is the project for construction? 2. How complete are the project plans and specifications? When will the project be completed? 3. What is the status of CEQA and other permitting requirements? Is it CEQA ready? 4. Is there a site available for the project? Or, does a clear process exist for attainment (the parcel size, proximity to an impaired water body, soil condition, permeability, etc. are some characteristics considered when identifying a candidate parcel.)? What is the project's construction duration?
Total	100 points

Note (1): In evaluating the different categories, an adopted plan or a validated and calibrated computer model would be used in the assessment.

Note (2): The breakdown of points in each category is for the ease of project evaluation and scoring. Even though summation of each category's sub-points may exceed the category maximum allowable points, only maximum allowable points for the category will be allocated.

Note (3), Legend: American Society of Civil Engineer (ASCE), United States Environmental Protection Agency (USEPA) , Integrated Resources Planning (IRP), Integrated Regional Water Management Plan (IRWMP), Total Maximum Daily Load (TMDLs), Operation and Maintenance (O&M), California Environmental Quality Act (CEQA), Best Management Practices (BMP).