ATTACHMENT J

ANNUAL STORMWATER MONITORING REPORT

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LOS ANGELES COUNTY 2014-2015 Annual Stormwater Monitoring

Final Report

Prepared for:
Los Angeles County Flood Control District

December 2015

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LOS ANGELES COUNTY
2014-2015 Annual Stormwater Monitoring

Final Report

Prepared for:

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December 15, 2015

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ACRONYMS

%	percent
<	less than
2001 Permit	2001 Los Angeles County Municipal Stormwater Permit
2012 Permit	2012 Los Angeles County Municipal Stormwater Permit
ABC	Aquatic Bioassay and Consulting Laboratories, Inc.
ACWM	Los Angeles County Department of Agricultural Commissioner Weights and Measures
ADA	Americans with Disabilities Act
ASBS	Area of Special Biological Significance
Basin Plan	Water Quality Control Plan for the Los Angeles Region
BMP	best management practice
BOD	biochemical oxygen demand
CCC	Criterion Continuous Concentration
CDPH	California Department of Public Health
CFR	Code of Federal Regulations
CIMP	Coordinated Integrated Monitoring Program
CMC	Criterion Maximum Concentration
COC	chain-of-custody
COD	chemical oxygen demand
County	Los Angeles County
CTR	California Toxics Rule
DO	dissolved oxygen
EC	effective concentration
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
EWMP	Enhanced Watershed Management Program
FSID	field sample identification
IC	inhibitory concentration
IMP	Integrated Monitoring Program
LACFCD	Los Angeles County Flood Control District
LADPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
MCL	maximum contaminant level
MDL	method detection limit
MES	mass emission station
mg/L	milligram(s) per liter
mL	milliliter(s)
ML	minimum level
MPN	most probable number
MS4	municipal separate storm sewer system
MTBE	methyl tertiary butyl ether
NA	not applicable
NO_3	nitrate
NOEC	no-observed-effect concentration
NPDES	National Pollutant Discharge Elimination System
NYDH	New York Department of Health

PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pH	hydrogen ion concentration
QA	quality assurance
QC	quality control
REC	recreation
SCCWRP	Southern California Coastal Water Research Project
SOP	standard operating procedure
SQMP	Stormwater Quality Management Program
SWAMP	Surface Water Ambient Monitoring Program
TDS	total dissolved solids
TIE	toxicity identification evaluation
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TKN	total Kjeldahl nitrogen
TPH	total petroleum hydrocarbons
TSS	total suspended solids
TU	toxicity unit
µg/L	microgram(s) per liter
µm	micrometer(s)
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
VSS	volatile suspended solids
WMP	Watershed Management Program
WESTON®	Weston Solutions, Inc.
WQO	water quality objective

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted.

Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Executed on the 15TH day of December 2015,

at ALHAMBRA, CALIFORNIA

ANGELA GEORGE
Assistant Deputy Director
Watershed Management Division

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ADA INFORMATION

Upon 72 hours' notice, the County of Los Angeles Department of Public Works (Public Works) can provide program information and publications in alternate formats or make other accommodations for people with disabilities. In addition, program documents are available at the Public Works main office in Alhambra (900 S. Fremont Avenue), which is accessible to individuals with disabilities. To request accommodations ONLY, or for more Americans with Disabilities Act (ADA) information, please contact the Public Works departmental ADA Coordinator at (626) 458-4081 or TTY (626) 282-7829, Monday through Thursday, from 7:00 a.m. to 5:45 p.m.

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DISCLAIMER

The comparisons to Water Quality Standards are made pursuant to the 2001 Permit's Monitoring and Reporting Program requirements and are for information only.

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EXECUTIVE SUMMARY

ES.1 Introduction

On November 8, 2012, the Los Angeles Regional Water Quality Control Board (LARWQCB) adopted a new National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) Permit, Order R4-2012-0175 (2012 Permit) (LARWQCB, 2012), for the coastal watersheds of Los Angeles County (County). This monitoring report is submitted pursuant to the Monitoring and Reporting Program for the 2012 Permit, attached as Exhibit E to that permit. In accordance with the 2012 permit, permittees were required to develop a new monitoring program. In doing so, each permittee developed an Integrated Monitoring Program (IMP) or Coordinated Integrated Monitoring Program (CIMP) through which it will meet its monitoring obligations. The County of Los Angeles and the Los Angeles County Flood Control District (LACFCD) chose to participate in the development of CIMPs for their respective watersheds. The CIMPs were submitted to the LARWQCB on or before June 30, 2014. Most of these CIMPs have been approved or approved with conditions. The County and the LACFCD are currently awaiting approval of the remaining CIMPs.

Section IV.C.8 of the Monitoring Program provides that the monitoring requirements pursuant to Order No. 0-182 (2001 Permit) (LARWQCB, 2001a), Monitoring and Reporting Program CI 6948, and approved Total Maximum Daily Load (TMDL) monitoring programs shall remain in effect until the Executive Officer approves the CIMPs. Accordingly, monitoring during the 2014-2015 monitoring year was conducted under the protocols set forth in that order and those plans. This report presents the associated results.

ES.1.1 Core Monitoring Program

Pursuant to the protocol set forth in the 2001 Monitoring Program, monitoring was conducted at seven mass emission stations (MES) (i.e., Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), Coyote Creek (S13), San Gabriel River (S14), Dominguez Channel (S28), and Santa Clara River (S29)). The 2001 Monitoring Program also provided that tributaries shall be monitored to identify sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions. During the 2014-2015 monitoring year, sampling was continued at six tributary monitoring stations in the Malibu Creek Watershed, including Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30).

Mass emission samples were also analyzed for toxicity during two dry weather events and during two storm events, with the exception of the San Gabriel River MES, where only one dry weather sample was collected due to dry conditions.

Trash monitoring was also conducted at MES to identify areas impaired for trash. Visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event and at least three additional storm events, with the exception of the Santa Clara

MES (two additional storm events). Trash monitoring was also conducted in the Ballona Creek and Los Angeles River watersheds (described in Appendices I and J, respectively).

In addition, the City of Los Angeles monitored shoreline stations to evaluate the impacts of urban runoff on coastal receiving waters and beneficial uses and performed an annual assessment of shoreline water quality data. The City of Los Angeles's assessment is included as Appendix D of this monitoring report.

ES.1.2 Regional Monitoring

The LACFCD participated in Bight'13 regional monitoring programs, including the study of microbiological quality of coastal streams and the development of water quality guidelines and assessment of water quality conditions of Areas of Special Biological Significance (ASBS). Results are posted on the Southern California Coastal Water Research Project (SCCWRP) website as they become available.

Bioassessment was also conducted to help assess the biological integrity of a waterbody and to help determine potential sources of biological impairment, where they may exist. A total of 16 sampling stations representing the six major watersheds were selected to represent the diverse environments of the Los Angeles region. The final report for the most recent year of the Bioassessment Monitoring Program (2014) is included in Appendix H.

ES.2 Summary of Methodology

The core monitoring program was conducted in compliance with the monitoring protocols set forth by the 2001 Permit and the Stormwater Quality Management Program (SQMP). Water quality samples were collected from seven watersheds and analyzed as part of the 2014–2015 Monitoring Program. The seven watersheds included Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Collection and analysis of stormwater runoff during wet weather conditions and ambient (dry) weather runoff were performed at MES and tributary locations.

Sample collection was required at MES locations for a minimum of three storm events, including the first storm event of the season, and two dry events. Due to dry conditions during the 2014-2015 monitoring season, only one dry weather sample was collected at the San Gabriel River MES (S14).

At the tributary stations located in the Malibu Creek Watershed, sample collection was required for a minimum of four storm events, including the first storm event of the season, and one dry event. Stormwater samples and ambient water samples were analyzed in accordance with the 2001 Permit requirements for chemical constituents, indicator bacteria, and toxicity to bioassay test organisms.

ES.2.1 Precipitation and Flow Monitoring

Precipitation monitoring was conducted at or near each MES using the various automatic rain gauges that LACFCD operates throughout Los Angeles County. Existing gauges near the monitored watersheds were also used in stormwater runoff calculations and were essential in developing runoff characteristics for these watersheds.

Because the monitoring program required flow-weighted composites for many constituents, flow monitoring equipment was used to trigger the automated samplers. Flows were determined from water elevation measurements.

ES.2.2 MES and Tributary Wet and Dry Weather Sampling

During the 2014-2015 monitoring season, analyses of stormwater samples consisted of field measurements, grab samples, and composite samples. Field measurements included temperature, dissolved oxygen and hydrogen ion concentration (pH) at Malibu Creek MES (S02) and Santa Clara MES (S29) during wet weather. Grab samples were collected during the initial portion of the storm event (i.e., on the rising limb of the hydrograph) and were analyzed for indicator bacteria and conventional pollutants. Composite samples consisted of a mixed sample created by combining a series of aliquots of specific volume collected at specific flow-volume intervals. Flow-weighted composite storm samples were obtained using an automated sampler at all stations except the Santa Clara MES, where composite samples were obtained by sampling discretely from the river at 20-minute intervals for the first three hours of the storm (or the duration of the storm if it was less than three hours). The discrete samples were then mixed in the laboratory in proportion to the estimated flow rates. Composite samples were analyzed for conventional constituents, general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, polychlorinated biphenyls (PCBs), organophosphate pesticides, and herbicides. Water column toxicity analyses were also performed during two wet weather events and two dry weather events for composite samples collected at the MES except at the San Gabriel River MES, which was only monitored during one dry weather event. In addition, storm events resulting in at least 0.25 inch of rainfall were monitored for total suspended solids (TSS) at all MES equipped with automatic samplers.

Dry weather sampling methods were similar, except samples were collected as time-weighted composites over a 24-hour period.

Quality assurance (QA)/quality control (QC) is an essential component of the monitoring program. All QA/QC procedures were followed for training of field personnel; labeling of bottles; chain of custody; sampling equipment setup; and sample collection, transport, and analysis.

ES.3 Summary of Monitoring Results

The 2001 Monitoring Program consists of core monitoring, regional monitoring, and special studies. The core monitoring program included the following elements:

- Mass emission monitoring.
- Water column toxicity monitoring.
- Tributary monitoring.
- Shoreline monitoring.
- Trash monitoring.

ES.3.1 Mass Emission Monitoring

Based on results of the mass emission monitoring, the following three water quality analyses were conducted:

- A comparison to applicable water quality standards.
- An analysis of pollutant loads and trends.
- An evaluation of the correlation between constituents of concern and TSS.

Monitoring results were compared to water quality indicators based on water quality objectives (WQOs) established in the Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994) and the California Toxics Rule (CTR), 40 Code of Federal Regulations (CFR) Part 131. The Basin Plan is designed to enhance water quality and to protect the beneficial uses of all regional waters. The CTR promulgates criteria for priority toxic pollutants in the State of California for inland surface waters and enclosed bays and estuaries.

A summary of the constituents that did not meet applicable WQOs at MES for at least one event is presented in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2014-2015 for One or More Events

Mass Emission Station/Watershed	Wet	Dry
Ballona Creek (S01)[1,2,3]	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved lead, Nitrite as N, Dissolved oxygen, pH	NA
Malibu Creek (S02)	*E. coli*, Sulfate	Sulfate
Los Angeles River (S10)[1,2,3]	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved lead, Nitrite as N, Dissolved oxygen	*E. coli*, pH
Coyote Creek (S13)[2,3]	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved oxygen	*E. coli*, pH
San Gabriel River (S14)[2,]	Dissolved copper, Cyanide, Dissolved oxygen	NA
Dominguez Channel (S28)[1,2,3]	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved lead, Dissolved oxygen	*E. coli*, pH
Santa Clara River (S29)	*E. coli* Dissolved copper Dissolved zinc	NA

NA – all applicable water quality objectives were met.
[1]More urbanized watersheds.
[2]Subject to the bacteria water quality objective high-flow suspension (LARWQCB, 2003).
[3]The high flow suspension did not apply to Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel during 2014-15Event04.

ES.3.2 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES. In total, four samples were analyzed for toxicity at each station (i.e., two wet weather samples and two dry weather samples). The only exception was San Gabriel River (S14), where only one dry weather sample was collected due to the absence of flow during the first dry weather monitoring event.

One freshwater species (water flea) and one marine species (sea urchin) were used for toxicity testing. The water flea, *Ceriodaphnia dubia*, was used in chronic seven-day reproduction and survival bioassays. The sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

During wet weather, bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from all seven MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples.

During dry weather, bioassay tests exposing *C. dubia* to dry weather effluent samples from each MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples.

ES.3.3 Wet Weather and Dry Weather Constituent Loads for Each Mass Emission Station

Constituent loads were calculated to determine whether there was a relationship between storm event size and the total load for a given constituent. During wet weather, calculated loads varied between stations and storm events. First-flush loading signatures (i.e., higher loads during the first monitored storm of the season than would be expected based on rainfall totals) were observed for at least one constituent at the following three MES locations: Ballona Creek, Malibu Creek, and Dominguez Channel. No first-flush loading signature was observed at the Los Angeles River, Coyote Creek, San Gabriel River or Santa Clara River MES. Generally, rainfall totals were similar during 2014-15Event09 and 2014-15Event10 (1.06 to 3.00 inches) and were higher than the totals that were observed during 2014-15Event04 (the first monitored event at all MES except Malibu Creek; 0.25 to 0.75 inches) and 2014-15Event08 (the first monitored event at the Malibu Creek MES; 0.98 inches). Many constituent loads were highest during 2014-15Event09 or 2014-15Event10.

During dry weather, constituent loads varied between stations and between sampling events. Loads were generally greater during the first event at the Dominguez Channel and Santa Clara River MES, and during the second event at the Ballona Creek, Malibu Creek, Los Angeles River, and Coyote Creek MES. Variability was generally low (1-3 times), but higher variability was observed in some cases for *E. coli*, TSS, dissolved chromium, and total phosphorus loads.

Overall, constituent loads were highest at the Los Angeles River MES and lowest at the Santa Clara River MES.

ES.3.4 Trash Monitoring

The 2001 Permit required a minimum of one photograph at each MES after the first storm event and three additional storm events per year. During the 2014-2015 monitoring season, visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event and at least three additional storm events, with the exception of the Santa Clara MES (two additional storms).

ES.3.5 Tributary Monitoring

The 2001 Monitoring Program provided that there shall be tributary monitoring in an attempt to identify sub-watersheds where stormwater discharges are causing or contributing to exceedances of water quality standards and to prioritize drainage and sub-drainage areas in need of management actions. A summary of the constituents that did not meet applicable WQOs at tributary stations for at least one event is presented in the table below.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2014-2015 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Upper Las Virgenes Creek (TS25)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved oxygen	*E. coli*, Sulfate, TDS
Cheseboro Canyon (TS26)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved oxygen	Sulfate, TDS
Lower Lindero Creek (TS27)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved cadmium, Dissolved oxygen	*E. coli*, Sulfate
Medea Creek (TS28)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved cadmium, Sulfate, Dissolved oxygen	Sulfate, TDS
Liberty Canyon Channel (TS29)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved oxygen	*E. coli*, Sulfate
PD 728 at Foxfield Dr. (TS30)	*E. coli*, Dissolved copper, Dissolved zinc, Dissolved oxygen	*E. coli*, Sulfate

TDS – total dissolved solids.

ES.3.6 Correlations to Total Suspended Solids

A Spearman's Rank Test was used to determine whether a significant positive or negative correlation existed between analyte results and TSS concentrations at each MES and tributary station during wet weather conditions. Due to the small sample size (n=3) during the 2014-2015 monitoring season, the findings at the MES should be considered as likely correlations. Summaries of constituents found to have correlations to TSS concentrations at the MES and tributary stations are presented in the following tables. Priority constituents (those constituents that did not meet WQOs in one or more monitoring events) are marked with an asterisk.

Likely Correlations Between Constituents and Total Suspended Solids at Mass Emission Stations

Mass Emission/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Ballona Creek (S01) [1]	*E. coli**, alkalinity, total phosphorus, turbidity, VSS, dissolved aluminum, dissolved arsenic, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper*, dissolved iron, dissolved lead*, dissolved nickel, dissolved zinc*, aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, silver, zinc	Total coliform, DO*, pH*, nitrate-NO_3, nitrate-N
Malibu Creek (S02) [1]	VSS	Chloride, dissolved barium, aluminum
Los Angeles River (S10) [1]	Fecal coliform, cyanide, Kjeldahl N, turbidity, VSS, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper*, dissolved iron, dissolved lead*, dissolved nickel, arsenic, barium, cadmium, iron, lead, silver	pH
Coyote Creek (S13) [1]	Fecal coliform, alkalinity, hardness, Kjeldahl N, turbidity, VSS	None
San Gabriel River (S14) [1]	pH, Turbidity, VSS	Total coliform, BOD, COD, dissolved phosphorus, dissolved nickel, antimony, zinc
Dominguez Channel (S28) [1]	Kjeldahl N, turbidity, VSS	*E. coli**, fecal coliform, fecal enterococcus, fecal streptococcus, pH
Santa Clara River (S29) [1]	BOD, dissolved phosphorus, total phosphorus, VSS, arsenic, barium, cadmium, chromium, iron, nickel, silver	Fecal coliform, pH

* Priority constituent
[1] Likely correlations; too few wet weather events for confirmation
DO = dissolved oxygen
VSS = volatile suspended solids
BOD = biochemical oxygen demand
COD = chemical oxygen demand

Correlations Between Constituents and Total Suspended Solids at Tributary Stations

Tributary Station	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Upper Las Virgenes Creek (TS25)	Total phosphorus, VSS, dissolved aluminum, dissolved barium, dissolved cadmium, dissolved iron, dissolved lead, aluminum, arsenic, barium, cadmium, iron, lead	None
Cheseboro Canyon (TS26)	VSS	None
Lower Lindero Creek (TS27)	Kjeldahl N, nitrate-NO_3, nitrate-N, arsenic, iron	None
Medea Creek (TS28)	Kjeldahl N, VSS, dissolved aluminum, dissolved arsenic, dissolved iron, dissolved lead, aluminum, arsenic, chromium, iron	None
Liberty Canyon Channel (TS29)	Dissolved aluminum, dissolved cadmium, dissolved chromium, dissolved iron	None
PD 728 at Foxfield Dr. (TS30)	BOD, chloride, hardness, total phosphorus, VSS, dissolved aluminum, dissolved cadmium, dissolved chromium, dissolved iron	DO*, pH

* Priority constituent
DO = dissolved oxygen
VSS = volatile suspended solids
BOD = biochemical oxygen demand

ES.3.7 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2015 were evaluated separately for wet and dry weather at each MES. The summary table below presents the method used for trend evaluation and the statistical trend information on TSS data collected at each MES over the past 15 years.

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2015

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.226	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	**0.028**	Regression	Significant decreasing
Los Angeles River at Wardlow (S10)	0.933	Regression	Not significant
Coyote Creek at Spring (S13)	0.426	Mann-Kendall	Not significant
San Gabriel River (S14)	**0.027**	Regression	Significant decreasing
Dominguez Channel at Artesia (S28)	0.107	Mann-Kendall	Not significant
Santa Clara River (S29)	0.056	Mann-Kendall	Not significant

Bold text indicates significant trend ($p < 0.05$)

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2015

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.581	Regression	Not significant
Malibu Creek at Piuma (S02)	**0.006**	Regression	Significant decreasing
Los Angeles River at Wardlow (S10)	0.348	Regression	Not significant
Coyote Creek at Spring (S13)	0.235	Regression	Not significant
San Gabriel River (S14)	0.154	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.687	Regression	Not significant
Santa Clara River (S29)	**0.005**	Mann-Kendall	Significant Decreasing

Bold text indicates significant trend ($p < 0.05$)

ES.4 Conclusions and Recommendations

Data collected during the 2014-2015 monitoring year were consistent with those observed during previous monitoring years. During wet weather, nutrients and organics continued to meet water quality objectives at the MES and tributary stations. An exception was nitrite, which was measured above the water quality objective at the Ballona Creek and Los Angeles River MES. The last exceedance of nitrite was measured at the Ballona Creek MES during the 2009-2010 monitoring year. E. coli, several dissolved metals (copper, lead and zinc), and pH continued to not meet water quality objectives at several MES and tributary stations during wet weather. During dry weather, dissolved metals, nutrients, and organics continued to meet water quality objectives at MES and tributary stations. E. coli and pH occasionally did not meet water quality objectives, and sulfate continued to not meet water quality objectives at most tributary stations and at the Malibu Creek MES.

Long term trend analysis of the priority constituents in each watershed may provide valuable information regarding evolving watershed conditions. This additional piece of information would assist in management decisions as the County and other agencies move forward under the Watershed Management Programs (WMPs) and Enhanced Watershed Management Programs (EWMPs) developed in accordance with the 2012 Permit. Additionally, field monitoring of DO and pH continue to be incorporated into the monitoring program and will limit the impact of external conditions (sample handling, transportation, water hardness, and alkalinity) on sample results. Sampling guidelines generally call for the measurement of DO as soon as possible after sampling, and measuring pH in the field may limit effects of water hardness and alkalinity on changes to the pH levels measured in the analytical laboratory.

The 2012 Permit provides a watershed management approach to address water quality protection. In accordance with the 2012 Permit, the County of Los Angeles and the LACFCD developed CIMPs for their respective watersheds, through which their monitoring obligations will be met. Most of these CIMPs have been approved, or approved with conditions. The County and the LACFCD are currently awaiting approval of the remaining CIMPs. Assuming the CIMPs are approved prior to the start of the monitoring year, monitoring during the 2015-2016 monitoring year will be conducted under the protocols set forth in those plans.

1.0 INTRODUCTION

1.1 Monitoring Program Status

The 1994–1995 storm season was the first during which stormwater monitoring was required under the 1990 Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit (No. CA0061654) (Los Angeles Regional Water Quality Control Board (LARWQCB), 1990). Automated and manual sampling was conducted to characterize stormwater quality and quantity during the 1994–1995 and 1995–1996 seasons.

The 1996–1997 season was the first storm season during which stormwater monitoring was conducted under the 1996 Municipal Stormwater Permit (No. CAS614001) (LARWQCB, 1996). Under the 1996 Municipal Stormwater Permit, the Monitoring Program scope was expanded to incorporate additional data collection through the mass emission, land use, and critical source monitoring programs as well as new pilot studies (e.g., wide channel and low-flow analyses).

Under the 2001 Los Angeles County Municipal Stormwater Permit (2001 Permit) (LARWQCB, 2001) adopted on December 13, 2001, land use and critical source elements were eliminated from the Monitoring and Reporting Program, and the Program focused on core monitoring, regional monitoring, and three special studies. As a result of the varying compliance dates for each element, only mass emission, water column toxicity, and shoreline monitoring under the core Monitoring Program were addressed in the 2001–2002 Monitoring Report.

The 2002–2003 through 2012-2013 monitoring reports addressed the following programs and associated elements under the 2001 Permit:

- Core Monitoring Program – mass emission, tributary, water column toxicity, shoreline, and trash monitoring.
- Regional Monitoring Program – estuary sampling and bioassessment.
- Special studies – the results of three special studies.

An Integrated Receiving Water Impacts Report, prepared in 2004–2005 (Weston Solutions, Inc. (WESTON), 2005), also incorporated the results, analysis, and progress of the previously mentioned monitoring programs. The report also assessed trends from 1994–2005. Annual stormwater monitoring reports are presented on the Los Angeles County Department of Public Works (LADPW) website at http://dpw.lacounty.gov/wmd/NPDES/report_directory.cfm.

The 2012 Los Angeles County Municipal Stormwater Permit (2012 Permit) (LARWQCB, 2012), which became effective on December 28, 2012, requires permittees to develop a new monitoring program. The County of Los Angeles (County) and the Los Angeles County Flood Control District (LACFCD) have submitted Coordinated Integrated Monitoring Programs (CIMPs) for their respective watersheds to the LARWQCB. Most of the CIMPs have been approved, or approved with conditions. The County and the LACFCD are currently awaiting approval of the remaining CIMPs by the Executive Officer.

Section IV.C.8 of the 2012 Monitoring and Reporting Program provides that the monitoring requirements pursuant to the 2001 Permit, Monitoring and Reporting Program CI 6948, and

approved Total Maximum Daily Load (TMDL) monitoring programs shall remain in effect until the CIMPs are approved. Accordingly, for the 2013-2014 and 2014-2015 monitoring years, monitoring has been conducted under the protocols set forth in that order and those plans. This report, the *2014-2015 Annual Stormwater Monitoring Report,* sets forth the results from June 1, 2014 to May 31, 2015.

1.1.1 Core Monitoring

1.1.1.1 Mass Emission Monitoring

Monitoring was conducted at seven mass emission monitoring stations (i.e., Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), Coyote Creek (S13), San Gabriel River (S14), Dominguez Channel (S28), and Santa Clara River (S29)) during the 2014–2015 reporting period. Mass emission stations (MES) capture runoff from major county watersheds that generally have heterogeneous land use. All MES, except the Santa Clara River station, are equipped with automated samplers, including integral flow meters for flow-composited sample collection.

Sampling at the Santa Clara River MES began during the 2002–2003 storm season. At this station, samples were collected manually, and flow-weighted composite samples were primarily produced using flow estimates obtained by monitoring staff.

The 2001 Monitoring Program specified annual monitoring of a minimum of three wet weather events, including the first storm event of the year. During the 2014-2015 monitoring year, three grab samples and three composite samples were collected during wet weather at each of the MES. This included the first storm of the year, 2014-15Event04 (except at the Malibu Creek MES, where runoff remained at baseflow throughout this storm and therefore samples were not collected).

Grab samples were analyzed for conventional pollutants and bacteria. Composite samples were flow-weighted and were analyzed for general minerals, hydrogen ion concentration (pH), nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, polychlorinated biphenyls (PCBs), organophosphate pesticides, and herbicides. In addition, composite samples from two storm events at each MES were analyzed for toxicity as described in Section 1.1.1.2. Eight additional storms were monitored, for a total of 11 storms, for total suspended solids (TSS) analysis at the San Gabriel River MES. An additional seven storms were monitored, for a total of 10 storms, for TSS at the Coyote Creek MES. An additional six storms were monitored, for a total of nine storms, for TSS at the Ballona Creek, Los Angeles River, and Dominguez Channel MES (TSS was not analyzed at the Los Angeles River MES during 2014-15Event08 due to equipment failure). An additional five storms were monitored, for a total of eight storms, at the Malibu Creek MES. Per the 2001 Monitoring Program, additional TSS analysis was not conducted where manual sampling was required (i.e., Santa Clara River MES).

Two dry weather monitoring events were conducted at each MES except at San Gabriel River, where only one dry weather monitoring event was possible due to dry conditions (no flow). Grab samples were collected and analyzed for conventional pollutants and bacteria during both dry weather monitoring events. Composite samples were also collected for all dry weather events

and were analyzed for TSS, general minerals, pH, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, PCBs, organophosphate pesticides, and herbicides.

Appendix K – Table of Monitoring Events presents the dates of the wet and dry weather sampling events.

1.1.1.2 Water Column Toxicity Monitoring

The 2001 Monitoring Program provided that mass emission samples shall be analyzed for toxicity during two dry weather events and during two storm events, including the first storm of the monitoring year. Composite samples were taken at each MES for toxicity analyses. During the 2014-2015 monitoring year, samples from two wet weather events were analyzed at each MES. Samples from two dry weather events were also analyzed at each MES, with the exception of San Gabriel River, where only one dry weather sample was collected due to dry conditions.

1.1.1.3 Tributary Monitoring

The 2001 Monitoring Program required that tributaries shall be monitored to identify sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions.

During the 2014-2015 monitoring year, sampling was continued at six tributary monitoring stations in the Malibu Creek Watershed. The tributaries monitored included Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30). Sampling at these tributary stations began in the 2011-2012 monitoring year. The 2001 Monitoring Program specified a minimum of four storm events at each tributary station shall be monitored, including the first storm event of the year. During the 2014-2015 monitoring year, this requirement was met; four grab samples and four composite samples were collected during wet weather at each of the tributary stations. Grab samples were analyzed for conventional pollutants and bacteria. Flow-weighted composite samples were analyzed for TSS, general minerals, pH, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, PCBs, organophosphate pesticides, and herbicides.

Two dry weather monitoring events were conducted at each of the tributary stations except Lower Lindero Creek, where three monitoring events were conducted. During each dry weather monitoring event, grab samples were collected and analyzed for conventional pollutants and bacteria. Composite samples were also collected at each tributary station during the dry weather events and analyzed for general minerals, pH, heavy metals, semi-volatiles, TSS, and pesticides (Appendix K).

1.1.1.4 Shoreline Monitoring

The 2001 Monitoring and Reporting Program required the City of Los Angeles to monitor shoreline stations to evaluate the impacts to coastal receiving waters and loss of beneficial uses that result from stormwater/urban runoff. Per the 2001 Monitoring and Reporting Program, the Shoreline Monitoring program consisted of sampling and indicator bacteria analysis of 18 water quality stations along the Pacific Ocean Shoreline within Santa Monica Bay. In addition, the

2001 Permit required that the City of Los Angeles perform an annual assessment of shoreline water quality data and submit these data to the Los Angeles County Flood Control District (LACFCD) for inclusion in the monitoring report. The City of Los Angeles's assessment is included as Appendix D of this monitoring report.

1.1.1.5 Trash Monitoring

In accordance with the protocols of the 2001 Monitoring and Reporting Program, visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event and at least three additional storm events, with the exception of the Santa Clara River MES, where two additional storm events were monitored. At the Ballona Creek, Los Angeles River, Coyote Creek, and San Gabriel River MES, trash monitoring was conducted during one additional storm event, for a total of five storms. At the Malibu Creek MES, four additional storms were monitored for trash, for a total of seven storms. The Malibu Creek MES was not sampled or photographed during the first event since runoff remained at baseflow throughout the storm and sampling was not conducted during that storm.

The 2001 Monitoring and Reporting Program required Permittees in the Ballona Creek and Los Angeles River watersheds to capture and quantify trash. The results of this activity are described in Appendices I and J, respectively.

1.1.2 Regional Monitoring

The 2001 Monitoring and Reporting Program required the LACFCD to participate in regional monitoring programs including estuary and bioassessment monitoring. This section discusses these programs, as well as additional regional monitoring that the County and LACFCD participated in during Bight '13.

1.1.2.1 Estuary Sampling

The LACFCD participated in the coastal ecology committee of the Bight '03 project coordinated by the Southern California Coastal Water Research Project (SCCWRP). The goal of this study was to supplement the regional monitoring of the Southern California Bight estuarine habitats by sampling estuaries for sediment chemistry, sediment toxicity, and benthic infaunal communities and to determine the spatial extent of potential impacts from stormwater discharges. All reports pertinent to the Bight '03 Project have been completed by SCCWRP and were released on the SCCWRP website during the summer of 2007:
(http://www.sccwrp.org/Documents/BightDocuments/Bight03Documents/Bight03AssessmentReports.aspx).

The Los Angeles County Department of Beaches & Harbors, the Los Angeles County Sanitation Districts, and the Los Angeles Department of Water and Power participated in the coastal ecology committee of the Bight '08 project coordinated by SCCWRP. Estuarine habitats were sampled for sediment chemistry, sediment toxicity, and benthic infaunal communities. Reports have been completed by SCCWRP and were released on the SCCRWP website:
(http://www.sccwrp.org/Documents/BightDocuments/Bight08Documents/Bight08AssessmentReports.aspx).

The Los Angeles County Sanitation District participated in the contaminant impact assessment (formerly coastal ecology) committee of the Bight ’13 project coordinated by SCCWRP. Sampling was conducted over the summer of 2013. As in previous Bight studies, marine habitats were sampled for sediment chemistry, sediment toxicity, and benthic infaunal communities. Preliminary findings will be posted on the SCCWRP website as they become available. Planning documents are currently available for review: (http://www.sccwrp.org/Documents/BightDocuments/Bight13Documents/Bight13PlanningDocuments.aspx).

1.1.2.2 Areas of Biological Significance

The County and LACFCD participated in the Area of Special Biological Significance (ASBS) regional monitoring program completed as part of Bight '13. This study was implemented to build on the first-of-its-kind regional ASBS monitoring study completed during Bight ‘08 and was designed to answer several key questions. These questions include identifying natural conditions at reference locations; determining how conditions in the ASBS compare to reference site conditions and assessing if nearby discharges are impacting the ASBS (SCCWRP, 2012b). Findings were recently published in the journal Water Environment Research (Schiff, et al, 2015) and indicate good overall water quality in the ASBS following storm events, with the possible exception of three parameters; total polynuclear aromatic hydrocarbons (PAH), chromium and copper.

1.1.2.3 Coastal Microbiology

The LACFCD also participated in the Bight ’13 Microbiology Drainage Water Study which was designed to assess the marine impact of human fecal matter from coastal runoff. This study sought to ascertain the frequency and extent of human fecal contamination occurring from coastal drainage. Samples were collected from selected sites during both wet and dry weather and were analyzed for human fecal marker HF183 (SCCWRP 2012c). Analysis of study findings will consider the frequency as well as the magnitude of human marker detection. Findings will be posted on the SCCWRP website as they become available. (http://www.sccwrp.org/Documents/BightDocuments/Bight13Documents/Bight13AssessmentReports.aspx).

1.1.2.4 Bioassessment

Bioassessment monitoring was conducted to help assess the biological integrity of waterbodies and to help determine potential sources of biological impairment, where they may exist. A series of metrics or indices are used to characterize the streambed biological community as well as the physical habitat of a station. These metrics can be compared with those found at reference stations to help determine the potential for anthropogenic influences on the biological community. The LACFCD typically performs annual Los Angeles County stream bioassessments in June or July during early summer baseline conditions. Sampling stations are located throughout each of the six major watersheds and were selected to represent the diverse environments of the Los Angeles region. Table 1-1 lists the sampling station locations, and Figure 1-1 shows the geographical location of the sampling stations. In 2014, bioassessment monitoring was conducted at 16 stations – four in the San Gabriel River watershed, six in the Los Angeles River watershed, one in the Dominguez Channel watershed, three in the Santa Monica

Bay watershed, and two in the Santa Clara River watershed. The final report for the 2014 Bioassessment Monitoring Program is included in Appendix H.

Laboratory methods incorporated a new Surface Water Ambient Monitoring Program (SWAMP) laboratory standard operating procedure (SOP) beginning in 2013. The sampling and analysis for the 2014 survey was performed using the same protocols as in the 2009–2012 surveys, with the exception of this SWAMP laboratory protocol.

1.1.3 Special Studies

The 2012 Permit's monitoring program requires each permittee to conduct the special studies required in an effective TMDL or an approved applicable TMDL Monitoring Plan.

2.0 STATION DESCRIPTIONS

MES were established and monitored throughout the LACFCD in an effort to characterize the water quality of the channels and streams. Tributary stations were selected to characterize the water quality of channels and streams in the subwatersheds.

2.1 Mass Emission Station Selection

During the 2014-2015 monitoring year, the LACFCD monitored seven MES, including Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. The collective drainage area from the seven MES encompasses approximately 2,060 square miles.

Four of the MES locations installed under the original 1990 Municipal Stormwater Permit were retained under the 1996 and the 2001 Municipal Stormwater Permits, including Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), and San Gabriel River (S14). The Coyote Creek (S13) MES was monitored under the 1990, 1996, and 2001 Municipal Stormwater Permits; however, monitoring was not required under the 1996 Municipal Stormwater Permit. Monitoring began at the Dominguez Channel (S28) MES during the 2001–2002 season, and sampling at the Santa Clara (S29) MES began during the 2002–2003 season.

2.2 Mass Emission Station Monitoring Locations and Drainage Areas

Figure 2-1 provides an overview of the study area, showing all MES monitoring locations. Table 2-1a indicates the dominant land use associated with each monitoring station and the total drainage area.

The following subsections present descriptions of the seven MES locations, including Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Figures 2-2 through 2-8 show the location of each monitoring station along with a description of its land use.

Ballona Creek Monitoring Station (S01)

The Ballona Creek monitoring station is located in the creek at the existing stream gauge station (i.e., Stream Gauge F38C-R) between Sawtelle Boulevard and Sepulveda Boulevard in the City of Los Angeles and was chosen to avoid tidal influences. The upstream tributary watershed of Ballona Creek is 88.8 square miles. The entire Ballona Creek Watershed is 127.1 square miles. Ballona Creek is a concrete-lined trapezoidal channel at the gauging station. This station is located at 33.998318^{o} latitude and -118.40269^{o} longitude.

Malibu Creek Monitoring Station (S02)

The Malibu Creek monitoring station is located in the creek at the existing stream gauge station (i.e., Stream Gauge F130-9-R) near Malibu Canyon Road, south of Piuma Road. The tributary watershed to Malibu Creek at this location is 104.9 square miles, and the entire Malibu Creek

Watershed is 109.9 square miles. This station is located at 34.077562^{o} latitude and -118.701998^{o} longitude.

Los Angeles River Monitoring Station (S10)

The Los Angeles River monitoring station is located in the river at the existing stream gauge station (i.e., Stream Gauge F319-R) between Willow Street and Wardlow Road in the City of Long Beach and was chosen to avoid tidal influences. The river is a concrete-lined trapezoidal channel at this station. The total upstream tributary drainage area for the Los Angeles River is 825 square miles. This river is the largest watershed outlet to the Pacific Ocean in the Los Angeles County Coastal watershed. This station is located at 33.815985^{o} latitude and -118.205523^{o} longitude.

Coyote Creek Monitoring Station (S13)

The Coyote Creek monitoring station is located in the creek at the existing U.S. Army Corps of Engineers (USACE) stream gauge station (i.e., Stream Gauge F354-R) below Spring Street in the lower San Gabriel River Watershed. Monitoring at this station assists in determining the mass loading for the San Gabriel River Watershed. The upstream tributary area is 150 square miles and extends into Orange County. The station was chosen to avoid backwater effects from the San Gabriel River to ensure that all water being sampled is from Coyote Creek only. Coyote Creek is a concrete-lined trapezoidal channel at this location. The Coyote Creek MES location has been an active stream gauging station since 1963. This station is located at 33.809861^{o} latitude and -118.077062^{o} longitude.

San Gabriel River Monitoring Station (S14)

The San Gabriel River monitoring station is located in the river at a historic stream gauge station (i.e., Stream Gauge F263C-R), below San Gabriel River Parkway in Pico Rivera. The upstream tributary area is 450 square miles at this location. The San Gabriel River has a grouted rock-concrete stabilizer along the western levee and a natural section on the eastern side. Flow measurement and water sampling are conducted in the grouted rock area along the western levee of the river. The length of the concrete stabilizer is nearly 70 ft. The San Gabriel River MES location has been an active stream gauging station since 1968. This station is located at 34.013425^{o} latitude and -118.064156^{o} longitude.

Dominguez Channel Monitoring Station (S28)

The Dominguez Channel monitoring station is located in the channel at Dominguez Channel and Artesia Boulevard in the City of Torrance and was chosen to avoid tidal influence. Flow at this station is measured by the flow meter attached to the auto sampler. The upstream tributary area is 33 square miles. The Dominguez Channel monitoring station is located in a concrete-lined rectangular channel. This station is located at 33.872604^{o} latitude and -118.311138^{o} longitude.

Santa Clara River Monitoring Station (S29)

The Santa Clara monitoring station is located in the river at the Santa Clara River and the Interstate 5 Freeway in Santa Clarita. The Santa Clara River is primarily a soft bottom channel, which makes accurate flow monitoring extremely difficult. This location was originally chosen because flow monitoring was possible from the existing United States Geological Survey (USGS) 11108000 Santa Clara River near Saugus, California, Stream Gauging Station.

Currently, the LADPW Water Resources Division operates a real-time stream gauging station at the station. The flow gauging operation has been subject to shifting river conditions in recent years. The upstream tributary area is approximately 411 square miles. This station is located at 34.425979^{o} latitude and -118.584464^{o} longitude.

2.3 Tributary Station Selection

The six tributary monitoring stations monitored during the 2014-2015 monitoring year were selected to collect water quality data from subwatersheds in the Malibu Canyon Watershed Management Area. These stations were established in accordance with the 2001 Municipal Stormwater Permit Monitoring program. Monitoring of the Malibu Canyon Watershed tributary stations began in the 2011-2012 monitoring year.

2.4 Tributary Monitoring Locations and Drainage Areas

Figure 2-9 is an overview of the study area showing all the tributary monitoring stations. Table 2-1b contains the dominant land uses for each station.

Descriptions of the six tributary monitoring stations monitored for the 2014-2015 Monitoring Season, are presented in the following subsections. Stations were identified using four alphanumeric digits, Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30). Figures 2-10 through 2-15 show the location of each tributary monitoring station.

Upper Las Virgenes Creek (TS25)

The Upper Las Virgenes Creek Tributary monitoring station is located in the creek, south of Parkmor Road, east of the intersection with La Virgenes Road (County Highway N1) in the City of Calabasas. The upstream tributary watershed area is approximately 5,795 acres. This station is located at 34.153464^{o} latitude and -118.696719^{o} longitude.

Cheseboro Canyon (TS26)

The Cheseboro Canyon Tributary monitoring station is located in the creek, south of Agoura Road to the southwest of the intersection of Agoura Road and Cornell Road in the City of Agoura Hills. The upstream tributary watershed area is approximately 5,346 acres. This station is located at 34.142964^{o} latitude and -118.757709^{o} longitude.

Lower Lindero Creek (TS27)

The Lower Lindero Creek Tributary monitoring station is located in the creek, south of Agoura Rd to the west of Kanan Road (County Highway N9) in the City of Agoura Hills. The upstream tributary watershed area is approximately 4,160 acres. This station is located at 34.143080^{o} latitude and -118.764276^{o} longitude.

Medea Creek (TS28)

The Medea Creek Tributary monitoring station is located in the creek, south of Agoura Road to the southwest of the intersection of Agoura Road and Cornell Road in the City of Agoura Hills. The upstream tributary watershed area is approximately 4,091 acres. This station is located at 34.143278^{o} latitude and -118.757872^{o} longitude.

Liberty Canyon Channel (TS29)

The Liberty Canyon Channel Tributary monitoring station is located in the channel, east of Liberty Canyon Road, south of the intersection with Park Vista Road in the City of Agoura Hills. The upstream tributary watershed area is approximately 905 acres. This station is located at 34.125898^{o} latitude and -118.723916^{o} longitude.

PD 728 at Foxfield Drive (TS30)

Tributary monitoring station PD 728 is located in the channel, south of Lindero Canyon Road east of Foxfield Drive, in the City of Westlake Village. The upstream tributary watershed area of this station is approximately 1,789 acres. This station is located at 34.139011^{o} latitude and -118.819473^{o} longitude.

3.0 METHODS

This section describes the field and laboratory methods used to implement the 2014-2015 Monitoring Program.

In accordance with the 2012 Permit, the core monitoring program was conducted in compliance with the monitoring protocols set forth by the 2001 Permit's monitoring program. Collection and analysis of stormwater runoff during wet weather conditions and ambient (dry) weather runoff was performed at the MES in seven watersheds, Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Stormwater runoff during wet weather conditions and ambient (dry) weather runoff was also collected and monitored at six tributary locations within the Malibu Creek Watershed as described in Section 2.4.

The 2001 Permit's monitoring program requires sample collection at MES locations for a minimum of three storm events (including the first storm event of the season) and two dry events and at tributary stations for a minimum of four storm events (including the first storm event of the season) and one dry event. Under the 2001 Permit's monitoring program, tributary monitoring rotated between the seven watersheds. During the 2011-2012, 2012-2013, 2013-2014 and 2014-2015 monitoring years, tributary monitoring was conducted in the Malibu Creek Watershed. Stormwater samples and dry weather samples were analyzed for chemical constituents, indicator bacteria, and toxicity to bioassay test organisms (MES only).

Storm events at the Malibu Creek MES and Santa Clara River MES were monitored with the assistance of an environmental consulting firm, WESTON®.

3.1 Precipitation and Flow Monitoring

3.1.1 Precipitation Monitoring

Precipitation monitoring was conducted at or near each MES using the various automatic rain gauges that LACFCD operates throughout Los Angeles County. A minimum of one automatic tipping bucket (intensity measuring) rain gauge was located nearby or within the tributary watershed for each MES. In some cases, large watersheds used multiple rain gauges to accurately characterize the rainfall. Existing gauges near the monitored watersheds were also used in stormwater runoff calculations and are essential in developing runoff characteristics for these watersheds.

3.1.2 Flow Monitoring

Because the 2001 Permit's monitoring program requires flow-weighted composites for many constituents, flow monitoring equipment was used to trigger the automated samplers. Flows were determined from water elevation measurements as described below.

The water elevation of an open channel was measured by the stage monitoring equipment, and the flow rate was derived from a previously established site-specific rating table or calculated with an equation (e.g., Manning's Equation). The LACFCD uses rating tables generated from

open channel, cross-section analysis and upstream/downstream flow characteristics. Previous flow measurement efforts indicated that all stations require multiple events to gather the data necessary for calibration of the measurement devices. The automatic samplers used pressure transducers as the stage measurement device. At the Santa Clara River MES, stadia rods were used to measure depth, and stream velocity was estimated by timing floating objects (leaf technique) as they traveled between rods set a fixed distance apart.

3.2 Wet Weather and Dry Weather Monitoring

During the 2014-2015 monitoring season, analyses of stormwater and dry weather samples consisted of field measurements, grab samples, and composite samples in accordance with the methods described below. A field log was completed at each site for each event. The field log sheets included empirical observations of the site and water quality characteristics.

3.2.1 Wet Weather Sample Collection Methods

Field Measurements – Field measurements, which included pH, dissolved oxygen (DO), conductivity, turbidity, and temperature, were conducted using a calibrated YSI (or similar meter) at the Malibu and Santa Clara River MES. Meters were allowed to stabilize for one minute prior to recording readings. Operation of meters was conducted as per manufacturer instructions, and meters were calibrated per manufacturer specifications within one week prior to use to ensure accurate functionality.

Photographic Trash Surveys - Trash monitoring was conducted to assess the quantities of trash in receiving waters after storm events and to identify areas impaired for trash. Visual observations of trash were made and photographs were taken at the MES locations after four storm events (three at Santa Clara MES), including the first flush.

Grab Sample - A grab sample is a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents not amenable to composite sampling due to short holding times and specific collection or preservation needs. Grab samples were analyzed for indicator bacteria and for conventional pollutants, as shown in the table below.

Grab Sample Constituents	
Conventional Constituents/Parameters	**Indicator Bacteria**
▪ Oil & grease ▪ Total phenols ▪ Cyanide ▪ Dissolved oxygen (DO) ▪ Total petroleum hydrocarbons (TPH) ▪ Methyl tertiary butyl ether (MTBE) ▪ 2-Chloroethyl vinyl ether	▪ Total coliforms ▪ Fecal coliforms ▪ Fecal streptococci ▪ Fecal enterococci ▪ *E. coli*

Analytical methods, method detection limits (MDLs), and holding times for these constituents are provided in Table 3-1.

Grab samples were collected during the initial portion of the storm event (i.e., on the rising limb of the hydrograph), placed on ice, and taken directly to the laboratory. Samples were collected from the horizontal and vertical center of the channel if possible and kept clear from uncharacteristic floating debris. Because oil and grease and other petroleum hydrocarbons tend to float, oil and grease grab samples were collected at the air–water interface unless flows did not allow for the safe collection of samples. In these cases, grab samples were collected using the automated samplers. Bacteria samples were collected in a sterile sample bottle and then placed on ice for transport to the laboratory for analysis within 8 hours of collection

Composite Sample - A composite sample is a sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific flow-volume intervals. Composite sampling is ideally conducted over the duration of the storm or other monitoring event. Composite samples were analyzed for conventional constituents, general minerals, pH, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, PCBs, organophosphate pesticides, and herbicides. Samples from the MES were also analyzed for toxicity, which is described in detail in Section 3.3.3. In addition, all storm events resulting in at least 0.25 inch of rainfall were monitored for TSS at all MES equipped with automated samplers. Per the 2001 Permit, this additional TSS analysis was not conducted where manual sampling was required (i.e., Santa Clara River MES). In addition, TSS was not analyzed at the Los Angeles River MES during 2014-15Event08 due to equipment failure. Telemetry will be installed at all automated MES for the 2015-16 storm season to improve responsiveness to equipment failures and ensure collection of all required storm events. New auxiliary pumps will also be installed at all automated MES to prevent future equipment malfunctions.

Composite Sample Constituents	
▪ General ▪ pH ▪ Nutrients ▪ Metals ▪ Semivolatile organics ▪ Base/neutral	▪ Chlorinated pesticides ▪ Polychlorinated biphenyls ▪ Organophosphate pesticides ▪ Herbicides ▪ Toxicity

Specific composite analytes, analytical methods, MDLs, and holding times for these constituents are provided in Table 3-1.

Most flow-weighted composite storm samples were obtained using an automated sampler programmed to collect samples at flow-paced intervals. Since an automated sampler has not yet been installed at the Santa Clara River MES, composite samples were obtained at this location by sampling discretely from the river at 20-minute intervals for the first three hours of the storm (or the duration of the storm if it was less than three hours). The discrete samples were then combined in the laboratory in proportion to the estimated flow rates (i.e., a flow-weighted composite).

During the storm season, the automated samplers were programmed to start automatically when the water level in the channel or storm drain exceeded a minimum predetermined level above base flow or prevailing pre-storm flow. Some MES also use an automatic tipping bucket rain gauge installed at the station to start the automated sampler program only when storm flow and rainfall exceed established thresholds. These practices were developed based on years of monitoring experience in local watersheds. It was particularly useful when automated samplers needed to be reset to capture storms occurring a little over 24 hours apart and it was not possible to wait for flows to return to base flow conditions.

A sample was collected each time a set volume of water had passed the monitoring point. This volume is referred to as the pacing volume or trigger volume. Samples were stored in 2.5-gallon glass containers within the sampler. An 8-liter minimum sample volume was required to conduct the necessary laboratory analyses. The automated sampler was deactivated by field personnel within 24 hours after the end of each storm event. Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall, discrete sample times and runoff data were logged and stored for transfer to the office. For TSS only sampling events, sample bottles were collected about 48-hours after the end of each storm event as this was permissible due to the 7-day holding time for TSS. Samples were only collected while flows remained above an established threshold.

3.2.2 Dry Weather Sample Collection Methods

Dry weather monitoring protocols were similar to those used for wet weather monitoring.

Grab samples were collected and analyzed for the constituents identified in Section 3.2.1. During dry weather sampling for the MES with automated samplers, composite samples were collected as time-weighted composites over a 24-hour period, and automated samplers were programmed to start at a specified time. Santa Clara River MES composite samples were obtained by sampling discretely from the river at 20-minute intervals for three hours. Composite samples were analyzed for the constituents identified in Section 3.2.1.

3.2.3 Field Quality Assurance / Quality Control

Quality assurance (QA)/quality control (QC) is an essential component of the monitoring program. *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde, 1996) describes the procedures used for bottle labeling, chain-of-custody (COC) tracking, sampling equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory.

An important part of the QA/QC plan is the continued education of field personnel. Field personnel were trained from the onset and were informed regarding new or revised stormwater sampling techniques on a continual basis. Field personnel also evaluated the field activities required by the QA/QC plan, and the plan was updated if necessary. Accurate data were obtained by proper monitoring station setup, water sample collection, sample transport, and laboratory analyses.

QA/QC for sampling processes included proper collection of the samples to minimize the possibility of contamination. Samples were collected in clean sample bottles, sterilized by the laboratory. Sampling personnel were trained according to the field sampling SOPs. Additionally, the field staff was made aware of the significance of the project's detection limits and the requirement to avoid contamination of samples.

Field parameters were measured and recorded at Malibu Creek MES and Santa Clara River MES using the appropriate calibrated equipment and were reviewed immediately using best professional judgment to ensure accurate measurement of parameters.

3.2.3.1 Field Setup Procedures

Automated field sampling stations were at fixed locations, with the sampler placed on a public road right-of-way or flood control easement. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the station design. Inspection of the intake tube, pressure transducer, and auxiliary pump was performed during daylight hours in normal (i.e., non-storm) conditions.

For stormwater sample collection, the automated samplers were programmed prior to the event based upon weather forecast information. The automated samplers were checked at the beginning of the storm to ensure proper working conditions and to determine whether flow composite samples were being collected properly. Grab samples were taken during the rising limb of the hydrograph where feasible.

For dry weather, following the initial grab sample collection, field staff prepared the sampler to collect subsequent time-weighted composite samples until the entire set had been completed for that station. Dry weather collection techniques were similarly performed for both grab samples and 24-hour composite samples.

When a complete set of samples had been collected for a given event, the bottles were removed from the sampler, labeled, and packed with ice and foam insulation inside individually marked ice chests. COC forms were completed by field staff before transporting the samples to the laboratory. Under no circumstances were samples removed from the ice chest during transportation from the field to the laboratory.

3.2.3.2 Bottle Preparation

A minimum of two sets of bottles were prepared for each monitoring station so that change-outs could be made quickly between closely occurring storms. Bottle labels included the following information:

- LACFCD's Field Sample Identification (FSID) number.
- Station (site) number.
- Station (site) name.
- Laboratory analysis requested.
- Date (written at time of sampling).
- Sampler name: Los Angeles County Department of Public Works, Watershed Management Division

Bottles were cleaned at the laboratory prior to use, labeled, and stored in sets. Each station was provided with the same number, type, and size bottles for each rotation, unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles not in use at the time of sampling were stored in clean dry conditions for later use. Composite sample bottles were limited to a maximum of 2.5 gallons each, to ensure ease of handling.

3.2.3.3 Chain-of-Custody Procedure

COC procedures (Woodward-Clyde, 1996) were used for all samples throughout the collection, transport, and analytical process. Samples were considered to be in custody if they were: (1) in the custodian's possession or view (2) retained in a secured place (under lock) with restricted access, or (3) placed in a container and secured with an official seal to prevent the sample from being reached without breaking the seal. COC records, field logbooks, and field tracking forms were the principal documents used to identify samples and to document possession. The COC procedures were initiated during sample collection. A COC record was provided with each sample or group of samples. Each person with sample custody signed the form and ensured the samples were not left unattended unless properly secured. Documentation of sample handling and custody included the following:

- Project name and the company name and address
- Bottle label information (i.e., the LACFCD FSID number, station (site) number, station (site) name, laboratory analyses requested, and date (written at time of sampling)).
- Time (written at time of sampling).
- Number of bottles.
- Temperature of sample.
- Sampler(s), laboratory and sampler/courier signatures, and time(s) sample(s) changed possession (completed upon sample transfer(s)), including total number of containers received and sample condition at receipt.
- Check box for "Hold Analysis" or "Final Samples".
- Comments.

3.2.3.4 New Zealand Mud Snails

Due to concern about the spread of non-native New Zealand Mud Snails, additional decontamination of monitoring equipment between Malibu MES and tributary monitoring stations was conducted. A designated set of sampling equipment (exclusive of temperature and pH field meters) was used for each of the stations in the Malibu watershed (Malibu MES and tributary stations), and was decontaminated before and after each event. Decontamination procedures as described by the California Department of Fish and Game (Hosea and Finlayson, 2005) were employed and included immersion of sampling equipment in Sparquat 256.

Field meters utilize sensitive osmotic membranes for use in measurement of pH. Therefore, the use of freezing or Sparquat 256 as a decontamination method was not employed. Field meters were visually inspected after use at each location; and all snails, mud, algae, and debris were

removed. The meters were then thoroughly rinsed on-site with tap water and allowed to dry completely. Visual inspection of the field meters was completed prior to departure from the station and before use at the next monitoring location.

3.3 Laboratory Analyses

The chemical and toxicological analyses conducted during the 2014-2015 monitoring year are described in the following sections.

3.3.1 Laboratory Background and QA/QC

The Los Angeles County Department of Agricultural Commissioner Weights and Measures (ACWM) Environmental Toxicology Laboratory provides water quality laboratory and related services to LACFCD. The ACWM Laboratory is state certified to perform water quality analyses and maintains a laboratory analysis program and quality assurance manual with quality QA/QC protocols consistent with the monitoring program.

The ACWM subcontracts toxicity testing with Aquatic Bioassay Consulting Laboratories, Inc. (ABC) of Ventura, California. This laboratory is accredited by the State of California's Environmental Laboratory Accreditation Program (ELAP; certificate number 1907) for whole effluent toxicity of wastewater testing as well as for other types of analyses. Analyses were conducted in accordance with procedures set forth in the laboratory's QA/QC manual.

The QA/QC objectives for the chemical and toxicological analyses conducted by the participating analytical laboratories are detailed in their Laboratory QA Manuals. The objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and SOPs
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Preventative maintenance
- Internal QC
- Procedures to ensure data accuracy and completeness

QC samples that failed to meet the specified QC criteria in the methodology were identified, and the corresponding data qualified.

A review of the 2014-2015 reported results for dissolved metals identified certain anomalies that were investigated. Should these anomalies arise again during the 2015-2016 monitoring period, a further investigation may be conducted, the results of which would be provided in next year's report, as appropriate.

3.3.2 Chemical and Biological Analyses

The 2001 Permit specified a suite of analyses and associated minimum levels (MLs) for samples collected at the MES and tributary locations, as detailed in Table 3-1. The laboratory methods used for analyzing stormwater samples are approved by the California Department of Public

Health (CDPH) and conform to United States Environmental Protection Agency (EPA)-approved methods.

3.3.3 Toxicity Analysis

Toxicity testing was performed on flow-weighted composite samples collected from the MES locations concurrently with the water chemistry analyses during two wet weather events. Toxicity testing was also performed on time-weighted composite samples during two dry weather events at the MES locations.

Toxicity testing is an effective tool for assessing the potential impact of complex mixtures of unknown pollutants on aquatic life in receiving waters. Rather than performing chemical analysis on a sample for a host of compounds potentially toxic to aquatic life, toxicity testing provides a direct measure of the toxicity of the sample to laboratory test organisms. Interactions among the complex mixture of chemicals and physical constituents inherent to environmental samples can lead to additive or antagonistic effects, potentially causing an individual compound to become either more or less toxic than it would be if it were isolated. Although the potential effects of these interactions cannot be derived from simple chemical measurements, they are directly accounted for in toxicity tests. If toxicity is identified in a given sample, toxicity identification evaluations (TIEs) may be used to help characterize and identify the constituent(s) causing or contributing to the observed toxicity. Toxicity testing can provide information on both potential short-term (i.e., acute) effects as well as longer-term (i.e., chronic) effects.

Toxicity analysis was performed using the following methods:

- *Ceriodaphnia dubia* 7-day (chronic) survival and reproduction tests.
- *Strongylocentrotus purpuratus* (sea urchin) (chronic) fertilization test.

The tests were performed using multiple sample concentrations ranging from 0 percent (%) (N-control) to 100%, such that the desired toxicity endpoints could be adequately observed. Based on the endpoints of reproduction and survival, the no-observed-effect concentrations (NOEC), inhibitory concentrations (IC), effective concentrations (EC), and toxicity units (TU) were calculated and reported for each test. Toxicity units are calculated by dividing 100 by the calculated median test response value (e.g., IC_{50}), per the 2001 Permit's monitoring program. The *C. dubia* and *S. purpuratus* tests were conducted under guidelines prescribed in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA, 2002) and *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (EPA, 1995), respectively. Water quality measurements (i.e., temperature, pH, DO, conductivity, salinity, hardness, and alkalinity) were recorded for each sample at the beginning and throughout each test. These measurements were performed to ensure that there were no large variations in water quality, which can affect the accuracy of the toxicity tests.

3.3.3.1 2012 Permit Toxicity Analysis

In accordance with the 2012 Permit, the core monitoring program was conducted during 2014-2015 in compliance with the monitoring protocols set forth by the 2001 Permit's monitoring program. Monitoring will be conducted under the CIMPs, once they are approved by the Regional Board, and will include updated toxicity testing requirements in the 2012 Permit monitoring program.

4.0 RESULTS, ANALYSES, AND RECOMMENDATIONS

This section describes the results and data analyses and includes a discussion of probable constituent sources and recommendations.

4.1 Hydrology – Precipitation and Flow

4.1.1 Analysis of Precipitation and Flow Data and a Discussion of the Hydrographs

This subsection discusses the precipitation and flow data and the hydrologic analysis of the monitoring area. Precipitation data and hydrographs can be used to address the following management question:

How did the 2014-2015 storm season differ in comparison to previous storm seasons?

This management question is answered in the following two ways:

1. Figure 4-1 illustrates total precipitation by storm season observed in downtown Los Angeles at Station 716, Ducommun Street. The total annual rainfall during the 2014-2015 storm season in downtown Los Angeles was approximately two-thirds of the 143-year average annual rainfall and was the fourth storm season in a row with below average precipitation totals.

2. Figure 4-2 is a comparison of the total monthly rainfall for the 2014-2015 storm season and the long-term pattern of rainfall observed in downtown Los Angeles at Station 716, Ducommun Street. During the 2014-2015 storm season, rainfall was less than the 143-year historic rainfall average for every month except December 2014 and September 2015. December had the highest monthly rainfall total of the 2014-2015 monitoring year. Only a little over a half inch of rain fell during February, historically the wettest month. The historic seasonal pattern of rainfall includes an increase in precipitation in October, November, and December that peaks in January and February before decreasing during March, April, and May. The seasonal pattern observed for the 2014-2015 monitoring year differed from the historic pattern, due to the relatively dry conditions observed in January and February as well as the higher than average rainfall observed in September.

4.1.2 Hydrographs for Monitoring Stations

Hydrographs are provided for all monitoring station events for which flow-weighted composite samples were collected during the 2014-2015 monitoring season (Appendix A). Each hydrograph includes the known times of the composite sample aliquot collection, including the first and last aliquots, sample volume interval, runoff volume, and percent of storm sampled. A summary of the hydrologic data for the MES is provided in Table 4-1.

The hydrographs and composite sampling start and end times can be used to address the following management question:

What percentage and what portion of the storm event were sampled?

This question is answered by examining the hydrographs (Appendix A). Each hydrograph contains the percent of the storm that was sampled and the first and last composite samples, which provides a visual representation of the sampled portion of the storm. Whenever possible, the initial portion of the event was sampled, rather than the tailing end of the hydrographs. Good faith effort was made to capture composite samples most representative of the full duration of each monitored storm event. While the sampled portion of the storm varied widely based on individual site conditions, the average percent of the storm that was sampled was 76% (does not include S29 which was sampled for the first three hours of each storm, in accordance with the 2001 Monitoring Program).

4.2 Water Quality Objectives

This subsection and the following subsection address the following key management question:

What constituents were measured at concentrations that do not meet water quality objectives?

Water quality standards consist of defined beneficial uses of water and numeric or narrative water quality objectives (WQOs) used to evaluate whether beneficial uses are protected. Numeric water quality objectives are expressed in the following terms:

- Magnitude – Defined as the threshold concentration at which beneficial uses are threatened or impaired.
- Frequency – Defined as the number of exceedances of threshold concentrations in a given time period that indicates impairment.
- Duration – Defined as the length of time the ecosystem is exposed to concentrations above the threshold.

Analyses that compare measurements to objectives consider magnitude. Aquatic life objectives established in the California Toxics Rule (CTR), 40 Code of Federal Regulations (CFR) Part 131, also include an exceedance frequency of no more than once every three years (EPA, 2000). Human-health-based objectives, such as mercury in the CTR or maximum contaminant levels (MCLs) cited in the Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994), do not specify an exceedance frequency.

The duration for many objectives for aquatic life are usually expressed as acute (i.e., one-hour exposure) or chronic (i.e., four-day exposure). In the CTR, acute objectives for aquatic life are expressed as Criterion Maximum Concentrations (CMC) while chronic objectives are expressed as Criterion Continuous Concentrations (CCC). Other objectives (e.g., human health criteria in the CTR) are expressed as instantaneous thresholds.

For monitoring conducted during the 2014-2015 monitoring year, analyses performed were based on instantaneous grab samples or composite samples. For dry weather analyses, 24-hour

composite samples were used. Comparisons to applicable Basin Plan objectives and CTR acute water quality objectives (CMCs) were made for all samples.

Applicable water quality objectives used in this assessment, which are not sample specific, are listed in the tables below by station. Sample specific WQOs that are based on calculations for sample-specific conditions are listed as ranges in Tables 4-4 and Table 4-5 (summary of water quality data for mass emission and tributary stations, respectively). Examples of these sample-specific objectives include ammonia water quality objectives that are based on sample pH and are determined using measured pH and Table 3-1 of the Basin Plan; dissolved metals water quality objectives that are calculated using measured sample hardness and procedures set forth in the CTR; and pentachlorophenol water quality objectives that are calculated based upon sample pH values and procedures set forth in the CTR.

Water Quality Objectives at Mass Emission Stations

Constituent	Units	Water Quality Objective Source	Station ID						
			S01	S02	S10	S13	S14	S28	S29
4-4'-DDT	µg/L	CTR CMC	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Aldrin	µg/L	CTR CMC	3	3	3	3	3	3	3
Chloride	mg/L	Basin Plan	NA	500	150	NA	150	NA	150
Cyanide	mg/L	CTR CMC	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Dieldrin	µg/L	CTR CMC	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Dissolved arsenic	µg/L	CTR CMC	340	340	340	340	340	340	340
Dissolved oxygen (DO)	mg/L	Basin Plan	5	7	5	5	5	5	5
E. coli	MPN/ 100 mL	Basin Plan	576	235	235	235	235	235	235
alpha-Endosulfan	µg/L	CTR CMC	0.22	0.22	0.22	0.22	0.22	0.22	0.22
beta-Endosulfan	µg/L	CTR CMC	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Endrin	µg/L	CTR CMC	0.086	0.086	0.086	0.086	0.086	0.086	0.086
gamma-BHC (lindane)	µg/L	CTR CMC	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heptachlor	µg/L	CTR CMC	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Heptachlor epoxide	µg/L	CTR CMC	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Nitrate (NO_3)	mg/L	Basin Plan	45	45	45	45	45	45	45
Nitrate-N	mg/L	Basin Plan	10	10	10	10	10	10	10
Nitrite-N	mg/L	Basin Plan	1	1	1	1	1	1	1
pH	pH units	Basin Plan	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5
Sulfate	mg/L	Basin Plan	NA	500	350	NA	300	NA	600
Total dissolved solids (TDS)	mg/L	Basin Plan	NA	2,000	1,500	NA	750	NA	1,200
Toxaphene	µg/L	CTR CMC	0.73	0.73	0.73	0.73	0.73	0.73	0.73

NA = not applicable.
µg/L = microgram per liter
MPN = most probable number.
CTR = California Toxics Rule.
mg/L = milligram per liter.
mL = milliliter.
CMC – Criterion Maximum Concentration

Water Quality Objectives at Tributary Stations

Constituent	Units	Water Quality Objective Source	Station ID					
			TS25	TS26	TS27	TS28	TS29	TS30
4-4'-DDT	µg/L	CTR CMC	1.1	1.1	1.1	1.1	1.1	1.1
Aldrin	µg/L	CTR CMC	3	3	3	3	3	3
Chloride	mg/L	Basin Plan	500	500	500	500	500	500
Cyanide	mg/L	CTR CMC	0.022	0.022	0.022	0.022	0.022	0.022
Dieldrin	µg/L	CTR CMC	0.24	0.24	0.24	0.24	0.24	0.24
Dissolved arsenic	µg/L	CTR CMC	340	340	340	340	340	340
Dissolved Oxygen (DO)	mg/L	Basin Plan	5	5	5	5	5	5
E. coli	MPN/100 mL	Basin Plan	235	235	235	235	235	235
alpha-Endosulfan	µg/L	CTR CMC	0.22	0.22	0.22	0.22	0.22	0.22
beta-Endosulfan	µg/L	CTR CMC	0.22	0.22	0.22	0.22	0.22	0.22
Endrin	µg/L	CTR CMC	0.086	0.086	0.086	0.086	0.086	0.086
gamma-BHC (lindane)	µg/L	CTR CMC	0.95	0.95	0.95	0.95	0.95	0.95
Heptachlor	µg/L	CTR CMC	0.52	0.52	0.52	0.52	0.52	0.52
Heptachlor epoxide	µg/L	CTR CMC	0.52	0.52	0.52	0.52	0.52	0.52
Nitrate (NO_3)	mg/L	Basin Plan	45	45	45	45	45	45
Nitrate-N	mg/L	Basin Plan	10	10	10	10	10	10
Nitrite-N	mg/L	Basin Plan	1	1	1	1	1	1
pH	pH units	Basin Plan	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5
Sulfate	mg/L	Basin Plan	500	500	500	500	500	500
Total Dissolved Solids (TDS)	mg/L	Basin Plan	2,000	2,000	2,000	2,000	2,000	2,000
Toxaphene	µg/L	CTR CMC	0.73	0.73	0.73	0.73	0.73	0.73

µg/L = microgram per liter
MPN = most probable number.
CTR = California Toxics Rule.
mg/L = milligram per liter.
mL = milliliter.
CMC – Criterion Maximum Concentration

4.2.1 Bacteria Water Quality Objectives

Water quality objectives for indicator bacteria are based on the recreation (REC) beneficial use designation at each station. The Basin Plan Amendment – Resolution No. R10-005 (Update of the Bacteria Objectives for Freshwaters Designated for Water Contact Recreation), was adopted December 5, 2011, and removed the fecal coliform water quality objectives for the beneficial uses REC-1 (water contact recreation – full immersion) and LREC-1 (limited contact recreation) (LARWQCB, 2010).

Since the adoption of Resolution R10-005 in 2011, the REC-1 water quality objective for bacteria is 235 MPN/100 mL of *E. coli*, and the LREC-1 water quality objective for bacteria is 576 most probable number in 100 milliliters (MPN/100 mL) of *E. coli*. The REC-2 (non-contact recreation) water quality objective of 4,000 MPN/100 mL of fecal coliform applies to waters that

are not also designated for water contact recreation (REC-1). The table below summarizes the recreational beneficial uses by station among the watersheds monitored.

Summary of Recreational Beneficial Uses and Applicable Bacteria Water Quality Objectives

Station ID	Station Name	High Flow Suspension	REC-1	LREC-1	REC-2	Applicable *E. coli* WQO (MPN/100 mL)
S01	Ballona Creek	X	P*	E	E	576
S02	Malibu Creek		E		E	235
S10	Los Angeles River	X	E		E	235
S13	Coyote Creek	X	P		I	235
S14	San Gabriel River	X	E		E	235
S28	Dominguez Channel	X	P		E	235
S29	Santa Clara River		E		E	235
TS25	Upper Las Virgenes		E		E	235
TS26	Cheseboro Canyon		E		E	235
TS27	Lower Lindero Creek		I		I	235
TS28	Medea Creek		E		E	235
TS29	Liberty Canyon Channel		E		E	235
TS30	PD 728		I		I	235

*- The REC-1 use designation does not apply to recreational activities associated with the swimmable goal or the associated bacteriological objectives.
E- Existing beneficial use
I – Intermittent beneficial use
WQO = water quality objective.
P – Potential beneficial use
MPN = most probable number.
mL = milliliter.

4.2.1.1 High Flow Suspension

Basin Plan Amendment – Resolution No. 2003-010 (High-Flow Suspension of Recreational Uses) was adopted November 2, 2004 (LARWQCB, 2003). The High Flow Suspension suspends recreational beneficial uses (REC-1, LREC-1, and REC-2) and the associated bacteria water quality objectives during wet weather storm events with rainfall greater than 0.5 inch in 24 hours. This suspension only applies to engineered channels, identified in Table 2-1a of the Basin Plan.

The storm events for which the high flow suspension applied during 2014-2015 are identified in the exceedance summary in Subsection 4.3 for each drainage area as well as in Table 4-1, Summary of Hydrologic Data for Mass Emissions Stations. The high-flow suspension was applied at one or more of the MES during three storms events monitored during the 2014-2015 season. Measurements above the bacteria water quality objective were not highlighted for these events.

4.3 2014-2015 Monitoring Results

The following sections summarize the constituents that did not meet applicable water quality objectives at MES and tributary stations sampled during the 2014-2015 Monitoring Program. Results are grouped by wet weather or dry weather, and by watershed. Specific results are available in Appendix B for all stations and sampling events.

Additionally, a summary of the water quality monitoring data is presented in Table 4-4 and Table 4-5 for the MES and tributary stations, respectively. Figures 4-3.1 through 4-6.6 provide a graphical summary of water quality data for all MES and tributary stations, respectively. Wet weather monitoring data are shown on Figures 4-3.1 through 4-4.6, and dry weather monitoring data are shown on Figures 4-5.1 through 4-6.6. For each station, the constituents are represented as the ratio of the concentration measured during the monitoring event to the applicable water quality objective. For instance, if the total dissolved solids (TDS) concentration for a given storm was 2,000 milligrams per liter (mg/L) and the water quality objective was 2,000 mg/L at that location, then the ratio would be 1 on the graph.

4.3.1 Mass Emission Stations During Wet Weather

4.3.1.1 Ballona Creek (S01)

A summary of the constituents that did not meet applicable water quality objectives at the Ballona Creek MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-3.1.

E. coli concentrations ranged from 34,500 to 57,940 MPN/100 mL and were above the water quality objective of 576 MPN/100 mL during all three events monitored for bacteria. The highest *E. coli* concentration at Ballona Creek was measured during 2014-15Event04. During wet weather high-flow periods, Ballona Creek is subject to a suspension of the recreational beneficial uses. As a result of this suspension, *E. coli* concentrations above 576 MPN/100 mL are not highlighted for 2014-15Event09 and 2014-15Event10. Based on this assessment, one of the three wet weather events analyzed for bacteria (2014-2015Event04) did not meet the *E. coli* water quality objective (Table 4-4.1 and Figure 4-3.1).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Ballona Creek (Table 4-4.1). Dissolved copper concentrations ranged from 43.7 to 95.6 micrograms per liter (µg/L) and were above the water quality objective for all three of the wet weather samples collected at Ballona Creek. Dissolved zinc was also above the hardness-based water quality objective for all three wet weather samples, with concentrations ranging from 286 to 970 µg/L. Dissolved lead concentrations ranged from 24.8 to 93.0 µg/L, and two of the three concentrations (measured during 2014-15Event04 and 2014-15Event10) were above the hardness-based water quality objective. Hardness values for samples collected during wet weather at Ballona Creek ranged from 50 to 135 mg/L.

Dissolved oxygen concentrations ranged from 3.71 to 9.68, and one of the three values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-4.1).

pH values ranged from 6.31 to 7.24 and were slightly below the lower limit of the water quality objective range of 6.5–8.5 pH units for one of the three wet weather samples (Table 4-4.1).

Nitrite as N concentrations ranged from <0.1 to 3.45 mg/L. One of the three values (measured during 2014-15Event04) was above the water quality objective of 1.0 mg/L (Table 4-4.1).

All other applicable water quality objectives at the Ballona Creek MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.2 Malibu Creek (S02)

A summary of the constituents that did not meet applicable water quality objectives at the Malibu Creek MES during the 2014–2015 Wet Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-3.2. Runoff remained at baseflow throughout the first storm of the monitoring season (2014-15Event04); therefore samples were not collected at the Malibu Creek MES during that event.

E. coli bacteria concentrations ranged from 146 to 21,100 MPN/100 mL, and two of the three values (measured during 2014-15Event08 and 2014-15Event09) were above the applicable water quality objective of 235 MPN/100 mL (Table 4-4.2 and Figure 4-3.2). The highest *E. coli* concentration at Malibu Creek was measured during 2014-15Event08. Malibu Creek is not subject to the high flow suspension of the recreational beneficial uses.

Sulfate concentrations ranged from 392 to 739 mg/L. One of the three values (measured during 2014-15Event08) was above the water quality objective of 500 mg/L (Table 4-4.2).

All other applicable water quality objectives at the Malibu Creek MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.3 Los Angeles River (S10)

A summary of the constituents that did not meet applicable water quality objectives at the Los Angeles River MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-3.3. TSS was not sampled at the Los Angeles River MES during 2014-15Event08 due to equipment failure.

E. coli concentrations ranged from 54,600 to 178,900 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all three storm events monitored for bacteria at Los Angeles River. The highest *E. coli* concentration at Los Angeles River was measured during 2014-15Event04. During wet weather high-flow periods, Los Angeles River is subject to a suspension of the recreational beneficial uses. As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2014-15Event09 or 2014-15Event10. Based on this assessment, one of the three wet weather events analyzed for bacteria (2014-15Event04) did not meet the *E. coli* water quality objective (Table 4-4.3 and Figure 4-3.3).

Dissolved oxygen concentrations ranged from 1.56 to 9.38, and one of the three values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-4.3).

Nitrite as N concentrations ranged from <0.1 to 1.44 mg/L. One of the three values (measured during 2014-15Event04) was above the water quality objective of 1.0 mg/L (Table 4-4.3).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Los Angeles River (Table 4-4.3). Dissolved copper concentrations ranged from 45.4 to 155 µg/L and were above the water quality objective for all three of the wet weather samples collected at Los Angeles River. Dissolved zinc was also above the hardness-based water quality objective for all three wet weather samples, with concentrations ranging from 328 to 980 µg/L. Dissolved lead concentrations ranged from 30.0 to 88.0 µg/L, and one of the three concentrations (measured during 2014-15Event10) was above the hardness-based water quality objective. Hardness values for samples collected during wet weather at Los Angeles River ranged from 58 to 160 mg/L (Table 4-4.3).

All other applicable water quality objectives at the Los Angeles River MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.4 Coyote Creek (S13)

A summary of the constituents that did not meet applicable water quality objectives at the Coyote Creek MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-3.4.

E. coli concentrations ranged from 10,462 to 21,300 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all three storm events monitored for bacteria at Coyote Creek. The highest *E. coli* concentration at Coyote Creek was measured during 2014-15Event04. During wet weather high-flow periods, Coyote Creek is subject to a suspension of the recreational beneficial uses. As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2014-15Event09 or 2014-15Event10. Based on this assessment, one of the three wet weather events analyzed for bacteria (2014-2015Event04) did not meet the *E. coli* water quality objective (Table 4-4.4 and Figure 4-3.4).

Dissolved oxygen concentrations ranged from 2.9 to 9.7, and one of the three values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-4.4).

Dissolved copper concentrations ranged from 20.0 to 52.8 µg/L and were above the hardness-based water quality objective for all three of the wet weather samples collected at Coyote Creek. Dissolved zinc was also above the hardness-based water quality objective for all three wet weather samples, with concentrations ranging from 143 to 472 µg/L. Hardness values for samples collected during wet weather at Coyote Creek ranged from 45 to 135 mg/L (Table 4-4.4).

All other applicable water quality objectives at the Coyote Creek MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.5 San Gabriel River (S14)

A summary of the constituents that did not meet applicable water quality objectives at the San Gabriel River MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-3.5.

E. coli concentrations ranged from 21,430 to 51,720 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all three storm events monitored for bacteria at San Gabriel River. The highest *E. coli* concentration at San Gabriel River was measured during 2014-15Event04. During wet weather high-flow periods, San Gabriel River is subject to a suspension of the recreational beneficial uses. As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for all three of the monitored wet weather events (2014-15Event04, 2014-15Event09 and 2014-15Event10) (Table 4-4.5 and Figure 4-3.5).

Cyanide concentrations ranged from <0.005 to 0.029 mg/L, and one of the three values (measured during 2014-15Event04) was above the water quality objective of 0.022 mg/L (Table 4-4.5).

Dissolved oxygen concentrations ranged from 2.91 to 9.2, and one of the three values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-4.5).

Dissolved copper concentrations ranged from 8.78 to 21.5 µg/L and were above the hardness-based water quality objective for one of the three of the wet weather samples collected at San Gabriel River (measured during 2014-15Event09). Hardness values for samples collected during wet weather at San Gabriel River ranged from 90 to 213 mg/L (Table 4-4.5).

All other applicable water quality objectives at the San Gabriel River MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.6 Dominguez Channel (S28)

A summary of the constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-3.6.

E. coli concentrations ranged from 17,329 to 36,540 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all three storm events monitored for bacteria at Dominguez Channel. The highest *E. coli* concentration at Dominguez Channel was measured during 2014-15Event09. During wet weather high-flow periods, Dominguez Channel is subject to a suspension of the recreational beneficial uses. As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2014-15Event09 and 2014-15Event10. Based on this assessment, one of the three wet weather events analyzed for bacteria (2014-15Event04) did not meet the *E. coli* water quality objective (Table 4-4.6 and Figure 4-3.6).

Dissolved oxygen concentrations ranged from 3.67 to 9.97, and one of the three values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-4.6).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Dominguez Channel (Table 4-4.6). Dissolved copper concentrations ranged from 27.8 to 172 µg/L and were above the water quality objective for all three of the wet weather samples collected at Dominguez Channel. Dissolved zinc was also above the hardness-based water quality objective for all three wet weather samples, with

concentrations ranging from 142 to 880 µg/L. Dissolved lead concentrations ranged from 14.2 to 38.8 µg/L, and one of the three concentrations (measured during 2014-15Event10) was above the hardness-based water quality objective. Hardness values for samples collected during wet weather at Dominguez Channel ranged from 25 to 145 mg/L (Table 4-4.6).

All other applicable water quality objectives at the Dominguez Channel MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.1.7 Santa Clara River (S29)

A summary of the constituents that did not meet applicable water quality objectives at the Santa Clara River MES during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-3.7.

E. coli bacteria concentrations ranged from 16,000 to 61,310 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all three of the sampled storm events at Santa Clara River (Table 4-4.7 and Figure 4-3.7). The highest *E. coli* concentration at Santa Clara River was measured during 2014-15Event10. Santa Clara River is not subject to the high-flow suspension of the recreational beneficial uses.

Dissolved copper concentrations ranged from 23.2 to 85.4 µg/L and were above the hardness-based water quality objective for all three of the wet weather samples collected at Santa Clara River. Dissolved zinc concentrations were also above the hardness-based water quality objective for two of the three wet weather samples (2014-15Event04 and 2014-15Event10), with concentrations ranging from 108 to 437 µg/L. Hardness values for samples collected during wet weather at Santa Clara River ranged from 38 to 228 mg/L (Table 4-4.7).

All other applicable water quality objectives at the Santa Clara River MES were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2 Tributary Stations During Wet Weather

4.3.2.1 Upper Las Virgenes Creek (TS25)

A summary of the constituents that did not meet applicable water quality objectives at the Upper Las Virgenes Creek Tributary Station (TS25) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-4.1.

E. coli bacteria concentrations ranged from 7,400 to 44,100 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four wet weather events monitored for bacteria (Table 4-5.1 and Figure 4-4.1). The highest *E. coli* concentration at Upper Las Virgenes Creek was measured during 2014-15Event04. Malibu Creek tributaries are not subject to a high-flow suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 3.79 to 10.1, and was below the water quality objective of 5 mg/L during 2014-15Event04 (Table 4-5.1).

Dissolved copper concentrations ranged from 11.7 to 29.4 µg/L and were above the hardness-based water quality objective for one of the four wet weather samples collected at Upper Las Virgenes Creek (measured during 2014-15Event10). Dissolved zinc concentrations were also above the hardness-based water quality objective for one of the four wet weather samples (2014-15Event04), with concentrations ranging from 57.9 to 483 µg/L. Hardness values for samples collected during wet weather at Upper Las Virgenes Creek ranged from 100 to 408 mg/L (Table 4-5.1).

All other applicable water quality objectives at Upper Las Virgenes Creek were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2.2 Cheseboro Canyon (TS26)

A summary of the constituents that did not meet applicable water quality objectives at the Cheseboro Canyon Tributary Station (TS26) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-4.2.

E. coli bacteria concentrations ranged from 4,100 to 41,060 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four wet weather events monitored for bacteria (Table 4-5.2 and Figure 4-4.2). The highest *E. coli* concentration at Cheseboro Canyon was measured during 2014-15Event10. Malibu Creek tributaries are not subject to a high-flow suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 3.92 to 9.97, and two of the four values (measured during 2014-15Event04 and 2014-15Event08) were below the water quality objective of 5 mg/L (Table 4-5.2).

Dissolved copper concentrations ranged from 13.6 to 36.1 µg/L and were above the hardness-based water quality objective for three of the four wet weather samples collected at Cheseboro Canyon (measured during 2014-15Event08, 2014-15Event09, and 2014-15Event10). Dissolved zinc concentrations were also above the hardness-based water quality objective for three of the four wet weather samples (2014-15Event04, 2014-15Event08, and 2014-15Event09), with concentrations ranging from 67.7 to 745 µg/L. Hardness values for samples collected during wet weather at Cheseboro Canyon ranged from 53 to 275 mg/L (Table 4-5.2).

All other applicable water quality objectives at Cheseboro Canyon were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2.3 Lower Lindero Creek (TS27)

A summary of the constituents that did not meet applicable water quality objectives at the Lower Lindero Creek Tributary Station (TS27) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.3 and Figure 4-4.3.

E. coli bacteria concentrations ranged from 2,359 to 13,330 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four of the wet weather events monitored for bacteria (Table 4-5.3 and Figure 4-4.3). The highest *E. coli* concentration at Lower

Lindero Creek was measured during 2014-15Event10. Malibu Creek tributaries are not subject to a high-flow suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 3.54 to 9.79, and one of the four values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-5.3).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Lower Lindero Creek (Table 4-5.3). Dissolved copper concentrations ranged from 17.9 to 83.9 µg/L, and two of the four concentrations (measured during 2014-15Event04 and 2014-15Event08) were above the hardness-based water quality objective. Dissolved cadmium concentrations ranged from 0.728 to 46.4 µg/L and were above the water quality objective for one of the four wet weather samples collected at Lower Lindero Creek (2014-15Event04). Dissolved zinc was also above the hardness-based water quality objective for one of four wet weather samples (2014-15Event04), with concentrations ranging from 26.5 to 645 µg/L. Hardness values for samples collected during wet weather at Lower Lindero Creek ranged from 228 to 455 mg/L (Table 4-5.3).

All other applicable water quality objectives at Lower Lindero Creek were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2.4 Medea Creek (TS28)

A summary of the constituents that did not meet applicable water quality objectives at the Medea Creek Tributary Station (TS28) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.4 and Figure 4-4.4.

E. coli bacteria concentrations ranged from 4,100 to 21,870 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four wet weather events monitored for bacteria (Table 4-5.4 and Figure 4-4.4). The highest *E. coli* concentration at Medea Creek was measured during 2014-15Event04. Malibu Creek tributaries are not subject to a suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 3.57 to 9.99, and two of the four values (measured during 2014-15Event04 and 2014-15Event08) were below the water quality objective of 5 mg/L (Table 4-5.4).

The sulfate concentration was slightly above the water quality objective of 500 mg/L for one of the four monitored wet weather events (2014-15Event04). Sulfate concentrations ranged from 105 to 508 mg/L (Table 4-5.4).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Medea Creek (Table 4-5.4). Dissolved copper concentrations ranged from 23.5 to 74.4 µg/L, and two of the four concentrations (measured during 2014-15Event04 and 2014-15Event10) were above the hardness-based water quality objective. Dissolved cadmium concentrations ranged from 5.47 to 26.9 µg/L and were above the water quality objective for one of the four wet weather samples collected at Medea Creek (2014-15Event04). Dissolved zinc was also above the hardness-based water quality objective for one of

four wet weather samples (2014-15Event04), with concentrations ranging from 59.2 to 398 µg/L. Hardness values for samples collected during wet weather at Medea Creek ranged from 170 to 578 mg/L (Table 4-5.4).

All other applicable water quality objectives at Medea Creek were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2.5 Liberty Canyon Channel (TS29)

A summary of the constituents that did not meet applicable water quality objectives at the Liberty Canyon Channel Tributary Station (TS29) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.5 and Figure 4-4.5.

E. coli bacteria concentrations ranged from 8,164 to 48,900 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four wet weather events monitored for bacteria at Liberty Canyon Channel (Table 4-5.5 and Figure 4-4.5). The highest *E. coli* concentration at Liberty Canyon Channel was measured during 2014-15Event08. Malibu Creek tributaries are not subject to a suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 4.74 to 10.0, and one of the four values (measured during 2014-15Event04) was slightly below the water quality objective of 5 mg/L (Table 4-5.5).

Dissolved copper concentrations ranged from 15.1 to 99.7 µg/L and were above the hardness-based water quality objective for three of the four wet weather samples collected at Liberty Canyon Channel (measured during 2014-15Event04, 2014-15Event09, and 2014-15Event10). Dissolved zinc concentrations were also above the hardness-based water quality objective for one of the four wet weather samples (2014-15Event04), with concentrations ranging from 62.2 to 655 µg/L. Hardness values for samples collected during wet weather at Liberty Canyon Channel ranged from 73 to 353 mg/L (Table 4-5.5).

All other applicable water quality objectives at Liberty Canyon Channel were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.2.6 PD 728 at Foxfield Drive (TS30)

A summary of the constituents that did not meet applicable water quality objectives at the PD 728 at Foxfield Drive Tributary Station (TS30) during the 2014-2015 Wet Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-4.6.

E. coli bacteria concentrations ranged from 6,131 to 20,100 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all four monitored wet weather events at the PD 728 at Foxfield Drive Tributary Station (Table 4-5.6 and Figure 4-4.6). The highest *E. coli* concentration at PD728 at Foxfield Drive was measured during 2014-15Event09. Malibu Creek tributaries are not subject to a suspension of the recreational beneficial uses.

Dissolved oxygen concentrations ranged from 4.1 to 10.0, and one of the four values (measured during 2014-15Event04) was below the water quality objective of 5 mg/L (Table 4-5.6).

Dissolved copper concentrations ranged from 11.5 to 53.2 µg/L and were above the hardness-based water quality objective for two of the four wet weather samples collected at PD 728 at Foxfield Drive (measured during 2014-15Event04 and 2014-15Event09). Dissolved zinc concentrations were also above the hardness-based water quality objective for one of the four wet weather samples (2014-15Event04), with concentrations ranging from 46.1 to 354 µg/L. Hardness values for samples collected during wet weather at PD 728 at Foxfield Drive ranged from 108 to 270 mg/L (Table 4-5.6).

All other applicable water quality objectives at PD 728 at Foxfield Drive were met during the 2014-2015 Wet Weather Monitoring Season.

4.3.3 Mass Emission Stations During Dry Weather

4.3.3.1 Ballona Creek (S01)

All applicable water quality objectives at the Ballona Creek MES were met during the 2014-2015 Dry Weather Monitoring Season (Table 4-4.1).

4.3.3.2 Malibu Creek (S02)

A summary of constituents that did not meet applicable water quality objectives at the Malibu Creek MES during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-5.2.

Sulfate concentrations ranged from 527 to 531. Both values were slightly above the water quality objective of 500 mg/L (Table 4-4.2).

All other applicable water quality objectives at the Malibu Creek MES were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.3.3 Los Angeles River (S10)

A summary of constituents that did not meet applicable water quality objectives at the Los Angeles River MES during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-5.3.

E. coli bacteria concentrations ranged from 100 to 288 MPN/100 mL. One of the two values (measured during the second event, 2014-15Event18) was slightly above the applicable water quality objective of 235 MPN/100 mL (Table 4-4.3).

pH values ranged from 9.29 to 9.48 and were above the upper limit of the water quality objective range of 6.5–8.5 pH units for both dry weather samples (Table 4-4.3).

All other applicable water quality objectives in the Los Angeles River MES were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.3.4 Coyote Creek (S13)

A summary of constituents that did not meet applicable water quality objectives at the Coyote Creek MES during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-5.4.

E. coli bacteria concentrations ranged from 305 to 546 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both events (Table 4-4.4). The highest *E. coli* concentration at Coyote Creek was measured during 2014-15Event18.

pH values ranged from 8.55 to 8.77 and were slightly above the upper limit of the water quality objective range of 6.5-8.5 pH units for both dry weather samples (Table 4-4.4).

All other applicable water quality objectives at Coyote Creek were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.3.5 San Gabriel River (S14)

One dry weather event (2014-15Event18) was sampled at San Gabriel River MES during the 2014-2015 Dry Weather Monitoring Season due to lack of flow during the first dry weather event (2014-15Event 13). All applicable water quality objectives at the San Gabriel River MES were met during the 2014-2015 Dry Weather Monitoring Season (Table 4-4.5).

4.3.3.6 Dominguez Channel (S28)

A summary of constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-5.6.

E. coli bacteria concentrations ranged from 63 to 520 MPN/100 mL, and one of the two values (2014-15Event16) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-4.6). The highest *E. coli* concentration at Dominguez Channel was measured during 2014-15Event16.

pH values ranged from 8.51 to 8.63 and were slightly above the water quality objective range of 6.5–8.5 pH units for both dry weather samples (Table 4-4.6).

All other applicable water quality objectives at Dominguez Channel were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.3.7 Santa Clara River (S29)

All applicable water quality objectives at the Santa Clara River MES were met during the 2014-2015 Dry Weather Monitoring Season (Table 4-4.7).

4.3.4 Tributary Stations During Dry Weather

4.3.4.1 Upper Las Virgenes Creek (TS25)

A summary of the constituents that did not meet applicable water quality objectives at Upper Las Virgenes Creek (TS25) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-6.1.

E. coli bacteria concentrations ranged from 79.4 to 1,000, and one of the two values (measured during 2014-15Event18) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.1 and Figure 4-6.1).

Sulfate concentrations ranged from 1,130 to 1,410 mg/L and were above the water quality objective of 500 mg/L for both of the dry weather events at Upper Las Virgenes Creek (Table 4-5.1).

Concentrations of TDS ranged from 2,430 to 2,890 mg/L and were above the water quality objective of 2,000 mg/L during both monitored dry weather events at Upper Las Virgenes Creek (Table 4-5.1).

All other applicable water quality objectives in Upper Las Virgenes Creek were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.4.2 Cheseboro Canyon (TS26)

A summary of the constituents that did not meet applicable water quality objectives at the Cheseboro Canyon Tributary Station (TS26) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-6.2.

Sulfate concentrations ranged from 1,190 to 1,330 mg/L and were above the water quality objective of 500 mg/L for both of the dry weather events at Cheseboro Canyon (Table 4-5.2).

Concentrations of TDS ranged from 2,620 to 2,710 mg/L and were above the water quality objective of 2,000 mg/L during both monitored dry weather events at Cheseboro Canyon (Table 4-5.2).

All other applicable water quality objectives in Cheseboro Canyon were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.4.3 Lower Lindero Creek (TS27)

A summary of the constituents that did not meet applicable water quality objectives at the Lower Lindero Creek Tributary Station (TS27) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.3 and Figure 4-6.3. Three dry weather samples were collected at the Lower Lindero Creek station during 2014-2015 dry weather monitoring. An extra dry weather monitoring event was conducted January 15, 2015 in anticipation of a construction project that may have impacted the ability to sample the station.

E. coli bacteria concentrations ranged from 100 to 630 MPN/100 mL, and one of the three values (measured during the third event, 2014-15Event18) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.3 and Figure 4-6.3).

Sulfate concentrations ranged from 604 to 762 mg/L and were above the water quality objective of 500 mg/L for all three dry weather events at Lower Lindero Creek (Table 4-5.3).

All other applicable water quality objectives in Lower Lindero Creek were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.4.4 Medea Creek (TS28)

A summary of the constituents that did not meet applicable water quality objectives at the Medea Creek Tributary Station (TS28) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.4 and Figure 4-6.4.

The sulfate concentration measured during both dry weather events at Medea Creek was 1,250 mg/L, which is above the water quality objective of 500 mg/L (Table 4-5.4).

Concentrations of TDS ranged from 2,680 to 2,820 and were above the water quality objective of 2,000 mg/L for both of the dry weather events at Medea Creek (Table 4-5.4).

All other applicable water quality objectives in Medea Creek were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.4.5 Liberty Canyon Channel (TS29)

A summary of the constituents that did not meet applicable water quality objectives at the Liberty Canyon Channel Tributary Station (TS29) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.5 and Figure 4-6.5.

E. coli bacteria concentrations ranged from 98 to 410 MPN/100 mL, and one of the two values (measured during the second event, 2014-15Event18) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.5 and Figure 4-6.5).

Sulfate concentrations ranged from 654 to 859 mg/L and were above the water quality objective of 500 mg/L for both dry weather events at Liberty Canyon Channel (Table 4-5.5).

All other applicable water quality objectives in Liberty Canyon Channel were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.4.6 PD 728 at Foxfield Drive (TS30)

A summary of constituents that did not meet applicable water quality objectives at the PD 728 at Foxfield Drive Tributary Station (TS30) during the 2014-2015 Dry Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-6.6.

E. coli bacteria concentrations ranged from 175 to 1,750 MPN/100 mL, and one of the two values (measured during the first event, 2014-15Event13) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.6 and Figure 4-6.6).

Sulfate concentrations ranged from 619 to 636 mg/L and were above the water quality objective of 500 mg/L during both of the dry weather events at PD 728 at Foxfield Drive (Table 4-5.6).

All other applicable water quality objectives in PD 728 at Foxfield Drive were met during the 2014-2015 Dry Weather Monitoring Season.

4.3.5 Summary of Constituents That Did Not Meet Water Quality Objectives

A summary of the constituents that did not meet applicable water quality objectives at the MES and tributary stations is presented in the following subsections.

4.3.5.1 Mass Emission Stations

This subsection and the table that follows summarize the constituents that did not meet water quality objectives at the MES monitoring stations during the 2014–2015 Monitoring Season.

During wet weather, indicator bacteria did not meet water quality objectives during at least one event at all seven MES. Following the application of the high-flow suspension of *E. coli* water quality objectives (where appropriate), *E. coli* concentrations were above the water quality objective during one of three wet weather events at Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel; during two of three events at Malibu Creek, and during all three events at Santa Clara River. The high-flow suspension does not apply at the Malibu Creek and Santa Clara River MES.

At the MES located in urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel) and at the Coyote Creek MES, dissolved copper and dissolved zinc did not meet water quality objectives during all three wet weather events. Additional metals that did not meet water quality objectives included dissolved copper during one of three events at San Gabriel River and all three events at Santa Clara River; dissolved zinc during two of three events at Santa Clara River; and dissolved lead during two of three events at Ballona Creek, and one of three events at Los Angeles River and Dominguez Channel.

pH, dissolved oxygen, nitrite as N, sulfate, and cyanide also did not meet water quality objectives at one or more MES locations during wet weather. pH was slightly above the upper limit of the water quality objective range during one of three events at Ballona Creek. Nitrite as N did not meet the water quality objective during one of three events at Ballona Creek and Los Angeles River. Sulfate did not meet the water quality objective during one of three events at Malibu Creek. Cyanide did not meet the water quality objective during one of three wet weather events at San Gabriel River. Dissolved oxygen was measured below the water quality objective during 2014-15Event04 at Ballona Creek, Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel.

During dry weather conditions, pH and *E. coli* were the analytes that most frequently did not meet water quality objectives. pH values were above the upper limit of the water quality

objective range during both events at Los Angeles River, Coyote Creek, and Dominguez Channel. *E. coli* did not meet water quality objectives during both dry weather events at the Coyote Creek MES and one event at the Los Angeles River and Dominguez Channel MES. Sulfate also did not meet water quality objectives at the Malibu Creek MES location during both dry weather events; both values were slightly above the water quality objective.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2014-2015 for One or More Events

Mass Emission Station/Watershed	Wet	Dry
Ballona Creek (S01)[1,2,3]	*E. coli* Dissolved copper Dissolved zinc Dissolved lead Nitrite as N Dissolved oxygen pH	NA
Malibu Creek (S02)	*E. coli* Sulfate	Sulfate
Los Angeles River (S10)[1,2,3]	*E. coli* Dissolved copper Dissolved zinc Dissolved lead Nitrite as N Dissolved oxygen	*E. coli* pH
Coyote Creek (S13)[2,3]	*E. coli* Dissolved copper Dissolved zinc Dissolved oxygen	*E. coli* pH
San Gabriel River (S14)[2,]	Dissolved copper Cyanide Dissolved oxygen	NA
Dominguez Channel (S28)[1,2,3]	*E. coli* Dissolved copper Dissolved zinc Dissolved lead Dissolved oxygen	*E. coli* pH
Santa Clara River (S29)	*E. coli* Dissolved copper Dissolved zinc	NA

NA – all applicable water quality objectives were met.
[1]More urbanized watersheds.
[2]Subject to the bacteria water quality objective high-flow suspension (LARWQCB, 2003).
[3]The high flow suspension did not apply to Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel during 2014-15Event04.

4.3.5.2 Tributary Monitoring Stations

This subsection and the table that follows summarize the constituents that did not meet water quality objectives at the tributary monitoring stations during the 2014–2015 Monitoring Season.

During wet weather, *E. coli* concentrations did not meet the water quality objective during all monitored events at all six tributary stations. In addition, dissolved copper, and dissolved zinc did not meet the hardness-based water quality objective during at least one wet weather event at all six tributary stations. Dissolved oxygen also did not meet the water quality objective during at least one wet weather event at all six tributary stations. Dissolved cadmium did not meet the hardness-based water quality objective during one event each at the Lower Lindero Creek and Medea Creek tributary stations.

The only other analyte that did not meet water quality objectives during wet weather was sulfate, which was measured at a concentration slightly above the water quality objective during one of four wet weather events at Medea Creek. There was also a sulfate exceedance during wet weather at the Malibu Creek MES.

During dry weather, sulfate did not meet water quality objectives during both monitored events at all six tributary stations. Sulfate also exceeded the water quality objective during both dry weather events at the Malibu Creek MES.

In addition, *E. coli* and TDS frequently did not meet water quality objectives during dry weather monitoring at the tributary stations. *E. coli* was above the water quality objective during one of two dry weather events at Upper Las Virgenes Creek, Liberty Canyon Channel, and PD28 at Foxfield Drive and during one of three events at Lower Lindero Creek. TDS was above the water quality objective during both monitored dry weather events at the Upper Las Virgenes Creek, Cheseboro Canyon, and Medea Creek tributary stations. *E. coli* and TDS met water quality objectives during both dry weather events at the Malibu Creek MES.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2014-2015 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Upper Las Virgenes Creek (TS25)	*E. coli* Dissolved copper Dissolved zinc Dissolved oxygen	*E. coli* Sulfate TDS
Cheseboro Canyon (TS26)	*E. coli* Dissolved copper Dissolved zinc Dissolved oxygen	Sulfate TDS
Lower Lindero Creek (TS27)	*E. coli* Dissolved copper Dissolved zinc Dissolved cadmium Dissolved oxygen	*E. coli* Sulfate
Medea Creek (TS28)	*E. coli* Dissolved copper Dissolved zinc Dissolved cadmium Sulfate Dissolved oxygen	Sulfate TDS
Liberty Canyon Channel (TS29)	*E. coli* Dissolved copper Dissolved zinc Dissolved oxygen	*E. coli* Sulfate
PD 728 at Foxfield Dr. (TS30)	*E. coli* Dissolved copper Dissolved zinc Dissolved oxygen	*E. coli* Sulfate

TDS – total dissolved solids.

4.3.6 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES. In total, four samples were analyzed for toxicity at each station (i.e., two wet weather samples and two dry weather samples). The only exception was San Gabriel River (S14), where only one dry weather sample was collected due to the absence of flow during the first dry weather monitoring event. Wet weather samples were collected during the first rain event of the season on November 1-3, 2014 (2014–15Event04) for each of the MES locations except S02, which was collected on December 1, 2014 (2014-15Event08). The second wet weather samples were collected on December 2-4, 2014 (2014–15Event09) for each of the MES locations. The first dry weather samples were collected on January 8, 2015 (2014–15Event13) for each of the MES locations except S28, which was collected on January 22, 2015 (2014–15Event16), and San Gabriel River (S14) due to dry conditions (no flow). The second dry weather samples were collected on February 11-12,

2015 (2014-15Event18) for each of the MES locations. The toxicity results from these samples are summarized in Table 4-10a (dry weather) and Table 4-10b (wet weather).

One freshwater species (water flea) and one marine species (sea urchin) were used for toxicity testing. The water flea, *Ceriodaphnia dubia*, was used in chronic 7-day reproduction and survival bioassays. The sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

4.3.6.1 Toxicity Results – Wet Weather

Bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. All of the IC_{25} and IC_{50} values were greater than 100%, the NOEC values were 100%, and the TUs (100/ $IC_{50)}$ were calculated as < 1.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from all seven MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples. All of the NOEC values were 100%, IC_{25} and IC_{50} values were greater than 100%, and the TUs were calculated as < 1.

4.3.6.2 Toxicity Results – Dry Weather

Bioassay tests exposing *C. dubia* to dry weather effluent samples from each MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. All of the IC_{25} and IC_{50} values were greater than 100%, the NOEC values were 100%, and the TUs were calculated as < 1.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples. All of the IC_{25} and IC_{50} values were greater than 100% test substance, the NOEC values were 100%, and the TUs were < 1.

4.3.7 Trash Monitoring Analysis

In accordance with the 2001 Monitoring and Reporting Program, visual observations of trash were made and at least one photograph was taken at each MES after the first storm event and after at least three additional storm events during the 2014-2015 monitoring season. The only exception was the Santa Clara River MES, the only MES that is not automated and does not require TSS sampling after three storm events are monitored. At this station, photographs were taken during the first storm event and two additional storm events. Per the Monitoring and Reporting Program, four trash surveys are required at all stations, include the Santa Clara MES. Photographs are presented in Appendix C. Ballona Creek Watershed and Los Angeles River Watershed Trash Compliance Monitoring Reports are presented in Appendices I and J, respectively.

4.4 2014-2015 Data Analyses

Data analyses completed for the 2014-2015 monitoring season include evaluations of TSS correlations, watershed constituent loads, and trends. Results of these analyses are discussed in the following subsections.

4.4.1 Correlations to Total Suspended Solids

A Spearman's Rank Test was used to determine whether a significant positive or negative correlation existed between analytical chemistry results and TSS concentrations at each MES and tributary station during wet weather conditions. The TSS concentrations from composite samples collected during wet weather events are summarized in Table 4-6. Other constituents analyzed that had significant correlations to TSS are detailed in Table 4-7 and discussed below. Scatter plots of selected constituents that had significant correlations with TSS are presented in Figure 4-7.

Spearman's Rank Test is a rank-based correlation that uses the ranks of the data instead of the actual sample results. This non-parametric test is employed when the data are not normally distributed. The ranks of each data set to be correlated are ordered from highest to lowest, with the highest number in each set given a rank of "1" and so on to the lowest value in each data set. The Spearman rank correlation coefficient, r_s, is then calculated using the ranks and compared to the critical r_s value. The critical r_s value is based on the number of samples and the required alpha (0.05 for this analysis). If the r_s is greater than the critical r_s, then the correlation is considered "significant," or the result has a less than 5% chance of occurring randomly (there is a 95% confidence that this result did not occur by chance).

Many constituents have a strong binding affinity for sediment particles in stormwater effluent; particularly bacteria, metals, organics, and total organic carbon (TOC). It is important to note that the correlations discussed below were based on a small data set and may not be representative of actual conditions during a storm.

4.4.1.1 Wet Weather – Mass Emission Stations

Due to the small sample size (n=3) at all MES stations during the 2014-2015 Wet Weather Monitoring Season, all correlations at the MES are discussed as likely correlations; results should be considered in the context of the small sample size. The results of the correlation analyses are summarized in the table below.

Only a few relationships were observed while evaluating correlations between TSS and priority constituents (those constituents that did not meet water quality objectives in one or more monitoring events) across MES during wet weather. Priority constituents evaluated for relationships with TSS included *E. coli*, dissolved metals (copper, zinc, and lead), nitrite as N, and dissolved oxygen at Ballona Creek; *E. coli* and sulfate at Malibu Creek; *E coli*, dissolved metals (copper, zinc, and lead), nitrite as N, and dissolved oxygen at Los Angeles River; *E. coli*, dissolved metals (copper and zinc), and dissolved oxygen at Coyote Creek; dissolved copper, cyanide, and dissolved oxygen at San Gabriel River; *E. coli*, dissolved metals (copper, zinc, and

lead), and dissolved oxygen at Dominguez Channel; and *E. coli* and dissolved metals (copper and zinc) at Santa Clara River.

The only likely positive correlations of TSS to priority constituents were *E. coli*, dissolved copper, dissolved lead, and dissolved zinc at Ballona Creek and dissolved copper and dissolved lead at Los Angeles River. The only likely negative correlations to priority constituents were DO and pH at Ballona Creek, and *E. coli* at Dominguez Channel.

At Ballona Creek, several constituents were likely positively correlated with TSS. These constituents included *E. coli* (a priority constituent), alkalinity, total phosphorus, turbidity, volatile suspended solids (VSS), dissolved aluminum, dissolved arsenic, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper (a priority constituent), dissolved iron, dissolved lead (a priority constituent), dissolved nickel, dissolved zinc (a priority constituent), aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc. Likely negative correlations to TSS at Ballona Creek included total coliform, DO (a priority constituent), pH (a priority constituent), nitrate, and nitrate as N.

At Malibu Creek, the only likely positive correlation to TSS was VSS and likely negative correlations included chloride, dissolved barium, and aluminum.

Likely positive correlations to TSS at Los Angeles River included fecal coliform, cyanide, Kjeldahl N, turbidity, VSS, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper (a priority constituent), dissolved iron, dissolved lead (a priority constituent), dissolved nickel, arsenic, barium, cadmium, iron, lead, and silver. The only likely negative correlation to TSS was pH.

At Coyote Creek, likely positive correlations to TSS included Fecal coliform, alkalinity, hardness, Kjeldahl N, turbidity, and VSS. No likely negative correlations were observed.

Likely positive correlations to TSS at San Gabriel River included pH, turbidity, and VSS, and likely negative correlations included total coliform, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved phosphorus, dissolved nickel, antimony, and zinc.

At Dominguez Channel, likely positive correlations included Kjeldahl N, turbidity, and VSS. Likely negative correlations to TSS included *E. coli* (a priority constituent), fecal coliform, fecal enterococcus, fecal streptococcus, and pH.

At Santa Clara River, likely positive correlations to TSS included BOD, dissolved phosphorus, total phosphorus, VSS, arsenic, barium, cadmium, chromium, iron, nickel, and silver. Likely negative correlations included fecal coliform and pH.

Likely Correlations Between Constituents and Total Suspended Solids at Mass Emission Stations

Mass Emission/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Ballona Creek (S01) [1]	*E. coli**, alkalinity, total phosphorus, turbidity, VSS, dissolved aluminum, dissolved arsenic, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper*, dissolved iron, dissolved lead*, dissolved nickel, dissolved zinc*, aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, silver, zinc	Total coliform, DO*, pH*, nitrate-NO_3, nitrate-N
Malibu Creek (S02) [1]	VSS	Chloride, dissolved barium, aluminum
Los Angeles River (S10) [1]	Fecal coliform, cyanide, Kjeldahl N, turbidity, VSS, dissolved barium, dissolved cadmium, dissolved chromium, dissolved copper*, dissolved iron, dissolved lead*, dissolved nickel, arsenic, barium, cadmium, iron, lead, silver	pH
Coyote Creek (S13) [1]	Fecal coliform, alkalinity, hardness, Kjeldahl N, turbidity, VSS	None
San Gabriel River (S14) [1]	pH, Turbidity, VSS	Total coliform, BOD, COD, dissolved phosphorus, dissolved nickel, antimony, zinc
Dominguez Channel (S28) [1]	Kjeldahl N, turbidity, VSS	*E. coli**, fecal coliform, fecal enterococcus, fecal streptococcus, pH
Santa Clara River (S29) [1]	BOD, dissolved phosphorus, total phosphorus, VSS, arsenic, barium, cadmium, chromium, iron, nickel, silver	Fecal coliform, pH

* Priority constituent
[1] Likely correlations; too few wet weather events for confirmation
DO = dissolved oxygen
VSS = volatile suspended solids
BOD = biochemical oxygen demand
COD = chemical oxygen demand

4.4.1.2 Wet Weather – Tributary Stations

The results of the TSS correlation analyses at the tributary stations are summarized in the table below.

Priority constituents evaluated for relationships with TSS included *E. coli*, dissolved metals (copper and zinc), and dissolved oxygen at Upper Las Virgenes Creek; *E. coli*, dissolved metals (copper and zinc) and dissolved oxygen at Cheseboro Canyon; *E coli*, dissolved metals (copper, zinc, and cadmium), and dissolved oxygen at Lower Lindero Creek; *E. coli*, dissolved metals (copper, zinc, and cadmium), sulfate, and dissolved oxygen at Medea Creek; *E. coli*, dissolved metals (copper and zinc), and dissolved oxygen at Liberty Canyon Channel; and *E. coli*, dissolved metals (copper and zinc), and dissolved oxygen at PD728 at Foxfield Drive. There were no positive correlations of TSS to priority constituents, and the only negative correlation of TSS to a priority constituent was dissolved oxygen at PD728 at Foxfield Drive.

At Upper Las Virgenes Creek, several constituents were positively correlated with TSS. These constituents included total phosphorus, VSS, dissolved aluminum, dissolved barium, dissolved cadmium, dissolved iron, dissolved lead, aluminum, arsenic, barium, cadmium, iron, and lead. No negative correlations to TSS were observed.

At Cheseboro Canyon, the only positive correlation to TSS was VSS, and no negative correlations were observed.

Positive correlations to TSS at Lower Lindero Creek included Kjeldahl N, nitrate, nitrate as N, arsenic, and iron. No negative correlations were observed.

At Medea Creek, positive correlations to TSS included Kjeldahl N, VSS, dissolved aluminum, dissolved arsenic, dissolved iron, dissolved lead, aluminum, arsenic, chromium, and iron. No negative correlations were observed.

Positive correlations to TSS at Liberty Canyon Channel included dissolved aluminum, dissolved cadmium, dissolved chromium, and dissolved iron. No negative correlations were observed.

At PD728 at Foxfield Drive, positive correlations included BOD, chloride, hardness, total phosphorus, VSS, dissolved aluminum, dissolved cadmium, dissolved chromium, and dissolved iron. Negative correlations included dissolved oxygen (a priority constituent) and pH.

Correlations Between Constituents and Total Suspended Solids at Tributary Stations

Mass Emission/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Upper Las Virgenes Creek (TS25)	Total phosphorus, VSS, dissolved aluminum, dissolved barium, dissolved cadmium, dissolved iron, dissolved lead, aluminum, arsenic, barium, cadmium, iron, lead	None
Cheseboro Canyon (TS26)	VSS	None
Lower Lindero Creek (TS27)	Kjeldahl N, nitrate-NO_3, nitrate-N, arsenic, iron	None
Medea Creek (TS28)	Kjeldahl N, VSS, dissolved aluminum, dissolved arsenic, dissolved iron, dissolved lead, aluminum, arsenic, chromium, iron	None
Liberty Canyon Channel (TS29)	Dissolved aluminum, dissolved cadmium, dissolved chromium, dissolved iron	None
PD 728 at Foxfield Dr. (TS30)	BOD, chloride, hardness, total phosphorus, VSS, dissolved aluminum, dissolved cadmium, dissolved chromium, dissolved iron	DO*, pH

* Priority constituent
DO = dissolved oxygen
VSS = volatile suspended solids
BOD = biochemical oxygen demand

4.4.2 Watershed Load Analysis

Constituent loads at each MES and tributary station were calculated for storm events that occurred during the 2014-2015 Wet Weather Monitoring Season. An estimate of the total constituent loads for each station is shown in Table 4-9. TSS loads were also calculated for storm events of at least 0.25 inch of total rainfall at all MES equipped with automated samplers. The TSS concentration for each event is shown in Table 4-6 and depicted in Figures 4-9 through 4-12. The total TSS loads for each MES is shown in Table 4-8.

Sample loads were calculated using the following equation:

$$concentration\ x\ volume\ x\ conversion\ factor\ = load$$

The sample concentration was multiplied by the volume of water sampled for each event, or in the case of the dry weather monitoring, the base flow for a 24-hour period in January (2014-15Event13 or 2014-15Event16) and February (2014-15Event18) at all stations except San

Gabriel River, which was only monitored in February due to dry conditions during the first dry weather monitoring event. Volumes used in the calculation are included in Table 4-1.

For discussion purposes, a limited constituent list comprised of *E. coli*, nitrate, total phosphorus, total petroleum hydrocarbons (TPHs), total Kjeldahl nitrogen (TKN), TDS, TSS, dissolved chromium, copper, and zinc is discussed for each MES. These constituents were chosen because of their prevalence in stormwater runoff. Loads for other analyzed constituents and for tributary stations are presented in Table 4-9.

4.4.2.1 Wet Weather and Dry Weather Constituent Loads for Each Mass Emission Station

Constituent loads were calculated to determine whether there was a relationship between storm event size and the total load for a given constituent. Calculated loads varied between stations and storm events. First-flush loading signatures (i.e., higher loads during the first monitored storm of the season than would be expected based on rainfall totals) were observed for at least one constituent at three of the seven MES locations: Ballona Creek, Malibu Creek, and Dominguez Channel. No first-flush loading signature was observed at the Los Angeles River, Coyote Creek, San Gabriel River, or Santa Clara River MES. Generally, rainfall totals were similar during 2014-15Event09 and 2014-15Event10 (1.06 to 3.00 inches) and were higher than the totals that were observed during 2014-15Event04 (the first monitored event at all MES except Malibu Creek; 0.25 to 0.75 inches) and 2014-15Event08 (the first monitored event at the Malibu Creek MES; 0.98 inches). Many constituent loads were highest during one of those two events, as discussed in the following subsections.

Dry weather loads were calculated for 2014-15Event13 (January 5, 2015) and 2014-15Event18 (February 9, 2015) at each MES except Dominguez Channel MES, where dry weather loads were calculated for 2014-15Event16 (January 22, 2015) and 2014-15Event18; and at San Gabriel River MES where monitoring did not occur during 2014-15Event13 due to dry conditions. During dry weather, constituent loads varied between stations and between sampling events. Loads were generally greater during the first event at the Dominguez Channel and Santa Clara River MES, and during the second event at the Ballona Creek, Malibu Creek, Los Angeles River, and Coyote Creek MES. Variability was generally low (1-3 times), but higher variability was observed in some cases for *E. coli*, TSS, dissolved chromium, and total phosphorus loads.

Overall, constituent loads were highest at the Los Angeles River MES and lowest at the Santa Clara River MES.

Ballona Creek (S01)

The wet weather event with the highest rainfall total at the Ballona Creek MES was 2014-15Event10 (1.33 inches). Rainfall totals for the other two wet weather events monitored at the Ballona Creek MES were 0.37 inches during 2014-15Event04 and 1.06 inches during 2014-15Event09. For each of the constituents except TKN and TDS, loads were highest during 2014-15Event10, which had the highest rainfall total and the highest intensity of the three storms monitored at the Ballona Creek MES. The load for TKN was highest during the first event, 2014-15Event04, indicating a first-flush loading signature, and the load for TDS was highest during the second event (2014-15Event09).

Dry weather loads at Ballona Creek were higher during the first event (2014–15Event13) than the second event (2014-15Event18) for total phosphorus, TSS, and dissolved chromium, and were higher during the second event for *E. coli*, TKN, nitrate, TDS, TPH, dissolved copper, and dissolved zinc. Variability was low (higher loads were only 1.1 to 3.4 times the lower loads).

Malibu Creek (S02)

The wet weather event with the highest rainfall total at the Malibu Creek MES was 2014-15Event09 (2.07 inches). The rainfall totals for the other two wet weather events monitored at the Malibu Creek MES were 0.98 inches during 2014-15Event08 and 1.64 inches during 2014-15Event10. For each of the constituents evaluated except *E. coli*, loads were highest during 2014-15Event10, which had the highest intensity of the three storms monitored at the Malibu Creek MES. The load for *E. coli* was highest during the first event, 2014-15Event08, which was the event with the lowest rainfall total. This indicates a first-flush loading signature for *E. coli*.

Dry weather loads at Malibu Creek were higher during the second event (2014-15Event18) than the first event (2014-15Event13) for each of the constituents evaluated except nitrate. Loads did not vary greatly between the two events. The highest variability was observed for dissolved copper, which was 5.5 times higher during the second event.

Los Angeles River (S10)

The highest rainfall total at the Los Angeles River MES occurred during 2014-15Event09 (1.65 inches). The rainfall totals for the other two wet weather events monitored at the Los Angeles River MES were 0.25 inches during 2014-15Event04 and 1.1 inches during 2014-15Event10. The intensity during 2014-15Event10 (0.226 inches per hour) was much higher than that during the other two events (0.031 to 0.042 inches per hour). For each constituent analyzed, the highest loads were observed either during 2014-15Event09 or 2014-15Event10. First-flush loading signatures were not observed for any of the assessed constituents.

Dry weather loads for nitrate, TSS, and dissolved chromium were higher during the first event (2014-15Event13) than the second event (2014-15Event18), whereas the loads for *E. coli*, total phosphorus, TDS, TPH, dissolved copper, and dissolved zinc were higher during the second event. Load variability was relatively low (up to 3.3 times) between the two dry weather events.

Coyote Creek (S13)

At the Coyote Creek MES, the rainfall total was highest during 2014-15Event09 (1.72 inches). The rainfall totals for the other two wet weather events monitored at the Coyote Creek MES were 0.35 inches during 2014-15Event04 and 1.32 inches during 2014-15Event10. Intensities were similar for the three storm events (0.044 to 0.049 inches per hour). For each constituent analyzed, the highest loads were observed either during 2014-15Event09 or 2014-15Event10. First-flush loading signatures were not observed for any of the assessed constituents.

Dry weather loads for nitrate, TSS, and dissolved chromium were higher during the first dry event (2014-15Event13) compared to the second dry event (2014-15Event18), and loads for E. coli, TKN, total phosphorus, TDS, TPH, dissolved copper, and dissolved zinc were higher during the second event at Coyote Creek. Load variability was generally low (less than three times) between the two dry weather events with the exception of the total phosphorus load, which was 29.5 times greater during the second event.

San Gabriel River (S14)

The highest rainfall total at the San Gabriel River MES occurred during 2014-15Event10 (1.99 inches). The rainfall totals for the other two wet weather events monitored at the San Gabriel River MES ranged from 0.75 during the first event, 2014-15Event04, to 1.8 inches during 2014-15Event09. The intensity was much higher during 2014-15Event10 (0.221 inches per hour) than during the other two events (0.053 to 0.094 inches per hour). For each constituent analyzed, the highest loads were observed either during 2014-15Event09 or 2014-15Event10. First-flush loading signatures were not observed for any of the assessed constituents.

Flow was only observed during one dry weather event (2014-15Event18) at San Gabriel River MES since there was no storm runoff during the first dry weather event (2014-15Event 13).

Dominguez Channel (S28)

The rainfall total at the Dominguez Channel MES was highest during 2014-15Event09 (2.12 inches). Rainfall totals for the other two monitored wet weather events at the Dominguez Channel MES were 0.37 inches during 2014-15Event05 and 1.19 inches during 2014-15Event10. Intensities were similar (0.038 to 0.048 inches per hour) for each event. Loads for *E. coli*, TKN, total phosphorus, TPH, TSS, and dissolved chromium were highest during 2014-15Event10 and the highest loads for TDS and dissolved zinc were observed during 2014-15Event09. The nitrate and dissolved copper loads were highest during 2014-15Event04, indicating a first-flush loading signature for these constituent. Loads for TDS and dissolved zinc during the first event were just below the highest observed loads at Dominguez Channel for those constituents, which is also indicative of first-flush loading signatures.

Dry weather loads for *E. coli*, nitrate, total phosphorus, TDS, TPH, dissolved chromium, and dissolved copper were higher during the first event at the Dominguez Channel MES (2014-15Event16), while loads for TKN, TSS, and dissolved zinc were higher during the second event (2014-15Event18). Loads did not vary greatly (less than two times) with the exceptions of *E. coli*, TSS, and dissolved chromium, which varied by 11.2 to 13.2 times.

Santa Clara River (S29)

The rainfall totals during 2014-15Event09 (3.0 inches) and 2014-15Event10 (2.77 inches) at the Santa Clara River MES were similar and were much higher than the rainfall total during the first monitored wet weather event, 2014-15Event04 (0.51 inches). The rainfall intensity was much higher during 2014-2015Event10 than the other events, and loads for each constituent evaluated were also greatest during that event. Even though the rainfall total during the first event, 2014-15Event04, was much lower than during the other two events, the second-highest load for each constituent was observed during this event. This is indicative of first-flush loading signatures.

Dry weather loads for all constituents evaluated for this analysis were greater during the first event (2014-15Event13) than the second (2014-15Event18) at the Santa Clara River MES. Load variability was generally low (less than 3 times) between the two dry weather events with the exceptions of the *E. coli*, dissolved chromium, and TKN loads, which were 19.0, 12.2, and 6.9 times greater during the first event, respectively.

4.4.3 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2015 were evaluated for normality and log-normal distributions separately for wet and dry weather at each MES using the Shapiro-Wilk test. If the TSS concentrations were normal or log-normally distributed, then a regression analysis was used to evaluate trends. Multiple samples during each monitoring season were treated as replicates. If a normal or log-normal distribution was not found, then it was determined that the distribution of the data was not known. These results were evaluated for trends using the Mann-Kendall non-parametric method. The summary table below presents the method used for trend evaluation and the statistical trend information on TSS data collected at each MES over the past 15 years. The data are shown graphically in Figures 4-13.1 through 4-13.4.

Two significant trends for TSS were identified for wet weather, based on an alpha of 0.05. TSS was identified as a significantly decreasing trend at the Malibu Creek and San Gabriel River MES locations. The TSS trend analysis of dry weather data identified two significant trends based on an alpha of 0.05, including significantly decreasing trends in TSS at the Malibu Creek and Santa Clara River MES (Table 4-11). The p values indicating significant trends are bolded in the tables below.

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2015

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.226	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	**0.028**	Regression	Significant decreasing
Los Angeles River at Wardlow (S10)	0.933	Regression	Not significant
Coyote Creek at Spring (S13)	0.426	Mann-Kendall	Not significant
San Gabriel River (S14)	**0.027**	Regression	Significant decreasing
Dominguez Channel at Artesia (S28)	0.107	Mann-Kendall	Not significant
Santa Clara River (S29)	0.056	Mann-Kendall	Not significant

Bold text indicates significant trend ($p < 0.05$)

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2015

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.581	Regression	Not significant
Malibu Creek at Piuma (S02)	**0.006**	Regression	Significant decreasing
Los Angeles River at Wardlow (S10)	0.348	Regression	Not significant
Coyote Creek at Spring (S13)	0.235	Regression	Not significant
San Gabriel River (S14)	0.154	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.687	Regression	Not significant
Santa Clara River (S29)	**0.005**	Mann-Kendall	Significant Decreasing

Bold text indicates significant trend ($p < 0.05$)

4.4.4 Identification of Possible Constituent Sources

This subsection summarizes some of the key points regarding known or suspected sources for each of the constituents that did not meet applicable water quality objectives.

4.4.4.1 Indicator Bacteria

Multiple studies have found urban runoff to be a source of indicator bacteria in the municipal separate storm sewer system (MS4). The SCCWRP conducted bacteria source identification studies of Ballona Creek, and the results were published in 2005 in the journal *Water, Air, and Soil Pollution* (Stein and Tiefenthaler, 2005). In addition, the City of Los Angeles conducted a bacteria source identification study of the Los Angeles River, and the results were published in November 2008. Both of these studies found urban runoff to be a source of indicator bacteria. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* (LARWQCB, 2001b), published on November 8, 2001, urban runoff from the storm drain system may have elevated levels of indicator bacteria as a result of sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, illegal discharges from recreational vehicle holding tanks, and/or malfunctioning septic tanks. Fecal matter from animals, including pets, livestock, and birds, can also be important contributors to elevated bacteria levels. A July 2007 report by ENSR International for EPA New England Region 1, *Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts* (ENSR International, 2007) also discussed the previously mentioned sources.

Bacteria have a strong binding affinity for sediment particles in stormwater effluent. A recent study published in *Environmental Toxicology and Chemistry* examined stormwater particle size distribution in Ballona Creek (Brown et al., 2013). The study suggested that commonly employed best management practices (BMPs) designed to capture larger particles (≥ 250 micrometers (μm)) may not capture the majority of the bacterial contaminant load due to the association of bacteria with small particles (≤ 6 μm).

In addition to bacteria sources, certain factors can amplify bacteria concentrations by promoting bacteria growth. Organic carbon provides food for bacteria. Sunlight can kill bacteria; therefore, covered water can promote bacterial growth. Slow-moving, stagnant water also can promote bacterial growth.

4.4.4.2 Metals

According to the article "Regulating Copper in Urban Stormwater Runoff" (Lee and Lee, 2000), copper may originate from brake pads or industrial (e.g., the textile industry) and mining sources. A metals source study is discussed in the article "Loadings of Lead, Copper, Cadmium, and Zinc in Urban Runoff from Specific Sources" (Davis et al., 2001), which concludes that elevated levels of metals were found from urban areas, especially in highway runoff. The abstract identifies important sources, such as building siding for lead, copper, cadmium, and zinc; vehicle brake emissions for copper; and tire wear for zinc. On January 21, 2015, the EPA, the Environmental Council of the States, and automotive industry signed a copper-free brake initiative to reduce copper in brake pads incrementally to less than 0.5 percent by 2025, joining the states of California and Washington, which implemented the program in 2010. Prior to the

signing of these initiatives, an estimated 1.3 million pounds of copper was released into the environment in California in 2010 (EPA, 2015).

Atmospheric deposition has also been identified as an important source of cadmium, copper, and lead. Details behind these findings are presented in the May 2005 Technical Report from SCCWRP entitled *Contributions of Trace Metals from Atmospheric Deposition to Stormwater Runoff in a Small Impervious Urban Catchment* (Sabin et al., 2005). A historic comparison completed by SCCWRP (Sabin and Schiff, 2008) indicated atmospheric deposition sources of copper and zinc have increased near harbor and urban sites over the past 30 years.

4.4.4.3 Sulfate

Elevated sulfate concentrations measured in the Malibu Creek watershed may be at least partially attributable to the Monterey Formation, a natural geologic source of sulfur in the watershed. Large quantities of greenish rock with amphiboles and sediment are found near the Malibu Creek MES within the watershed. The hillside is composed primarily of what appears to be decomposed, somewhat grainy, greenish marine or lagoon sediment/glauconite and less decomposed, greenish-brown shale with clear fossils and embedded detritus. These sediments are known to be sulfur bearing (Orton, 2011). Sulfate levels measured during the comprehensive study outlined in Orton (2011) indicated that water samples from all Malibu Creek tributaries draining the Monterey Formation were above the Basin Plan objective, while none of the tributaries not associated with the formation were above water quality objectives. Lower reaches of the creek, where several tributaries draining different geologic formations combine, varied seasonally from below the Basin Plan objective to well above it. The Monterey Formation may also be a source of other pollutants in the region, such as metals and phosphorus.

Another potential sulfur source may be effluent from the nearby Tapia Water Reclamation Facility, located just upstream from the sampling station. Sulfur is used in wastewater processes such as flocculation. However, other MES near wastewater treatment plants did not show highly elevated sulfur concentrations. Tests and/or a review of effluent reports would be necessary to determine whether effluent from the plant is a significant contributor to the raised sulfur concentrations of these waters.

4.4.4.4 pH

The pH value is a measure of the acid (or H+ ion) concentration in solutions. When the concentrations of acid and base (or OH- ion) are exactly equal, the pH is equal to 7.0. Natural rainwater has a pH of approximately 5.5 (i.e., slightly acidic). As minerals dissolve into rainwater, the pH increases because of the “buffering” effect of minerals such as calcium and magnesium carbonate. Sources that may decrease pH below the water quality objective of 6.5 include illicit discharges (e.g., swimming pools, battery acid, and other light and heavy industrial chemicals).

Six pH measurements during the 2014-2015 monitoring year were above the water quality objective range (basic). A pH above 8.5 could indicate highly mineralized waters; for example, groundwater seepages that are not as diluted, especially during dry weather. These basic readings were all measured during dry weather and were generally only slightly above the water quality objective range. Common human factors that may cause high pH in surface waters include the

discharge of concrete wash water, surfactants in cleaning agents, and illicit washing. Algal blooms may also cause elevated pH during the day as they use carbon dioxide for photosynthesis and decreased pH at night as they respire.

One pH value was below the water quality objective (acidic), and this incidence occurred during wet weather. It is possible that sudden rain events can bring the pH below 6.5, if the water sampled is not heavily mineralized. This would be expected in a watershed that is mostly hardscape, with little vegetation to provide detention or interaction with soils. The sudden influx of rainwater is the most likely explanation for the low pH value observed during wet weather.

4.4.4.5 Nitrite

Nitrite is a naturally occurring inorganic ion that is part of the nitrogen cycle. Microbial action in soil or water decomposes wastes containing organic nitrogen into ammonia, which is then oxidized to nitrite and nitrate. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters. Contamination with nitrogen-containing fertilizers (e.g., potassium nitrate and ammonium nitrate), or animal or human organic wastes, may raise the concentration of nitrate in water. Only two nitrite exceedances were measured during the 2014-2015 monitoring year, one at the Ballona Creek MES (which also had an exceedance during the 2009-2010 monitoring year), and at the Los Angeles River MES (which was only slightly above the water quality objective). Both of these exceedances occurred during the first flush storm event, 2014-15Event04.

Ammonia exists naturally in the environment and is also an important commercial and industrial chemical, according to the New York Department of Health (NYDP, 2008). It is used in agriculture (fertilizers), as a refrigerant, in water treatment processes, in cleaning products, and in the manufacture of many other products including chemicals, plastics, textiles, explosives, and pesticides. One particular source of interest is wastewater treatment plants. According to *Water Supply and Pollution Control*, by Warren Viessman, Jr. and Mark J. Hammer (1998), there is an average of 24 mg/L of ammonia–nitrogen (NH_3-N) in biologically treated domestic wastewater that has not undergone denitrification.

4.4.4.6 Dissolved Oxygen

Aquatic plants photosynthesize to produce oxygen during daylight hours and dissolved oxygen levels also vary with temperature; warmer temperatures decrease dissolved oxygen levels. Therefore, dissolved oxygen levels fluctuate seasonally and temporally. Dissolved oxygen levels also vary spatially, with fast-moving sections of a waterbody containing more oxygen than stagnant or slow-moving water.

A low dissolved oxygen value may indicate that plant or animal waste or other organic matter, often from agricultural use or landscaping, may be present in the stormwater runoff. These organic materials use up the dissolved oxygen (i.e., have a high BOD) as they decompose. If dissolved oxygen levels decline enough, some animals exposed to the reduced oxygen levels may be negatively affected (EPA, 2012).

Thirteen dissolved oxygen values were below the water quality objective during the 2014-2015 monitoring year, all during storm events. Measured BOD values were generally higher in these samples than in those with higher dissolved oxygen values (Appendix B).

4.4.4.7 Cyanide

Sources of cyanide in receiving water samples may include industrial operations such as manufacturing of synthetic fabrics, plastics, and metal processing or electroplating operations. Fumigation operations can also contribute to cyanide in the environment as can commercial printers and pharmaceutical manufacturers. Additionally, incomplete combustion during forest fires may also contribute a large amount of cyanide to the environment. Only one cyanide exceedance (not necessarily due to the sources listed above) was measured during the 2014-2015 monitoring year, during wet weather at the San Gabriel River MES.

4.5 Conclusions and Recommendations

Data collected during the 2014-2015 monitoring year were consistent with those observed during previous monitoring years. During wet weather, nutrients and organics continued to meet water quality objectives at the MES and tributary stations. An exception was nitrite, which was measured above the water quality objective at the Ballona Creek and Los Angeles River MES. The last exceedance of nitrite was measured at the Ballona Creek MES during the 2009-2010 monitoring year. *E. coli*, several dissolved metals (copper, lead and zinc), and pH continued to not meet water quality objectives at several MES and tributary stations during wet weather. During dry weather, dissolved metals, nutrients, and organics continued to meet water quality objectives at MES and tributary stations. *E. coli* and pH occasionally did not meet water quality objectives, and sulfate continued to not meet water quality objectives at most tributary stations and at the Malibu Creek MES.

Long-term trend analysis of the priority constituents in each watershed may provide valuable information regarding evolving watershed conditions. This additional piece of information would assist in management decisions as the County and other agencies move forward under the Watershed Management Programs (WMPs) and Enhanced Watershed Management Programs (EWMPs) developed in accordance with the 2012 Permit. Additionally, field monitoring of DO and pH continue to be incorporated into the monitoring program and will limit the impact of external conditions (sample handling, transportation, water hardness, and alkalinity) on sample results. Sampling guidelines generally call for the measurement of DO as soon as possible after sampling, and measuring pH in the field may limit effects of water hardness and alkalinity on changes to the pH levels measured in the analytical laboratory.

The 2012 Permit provides a watershed management approach to address water quality protection. In accordance with the 2012 Permit, the County of Los Angeles and the LACFCD developed CIMPs for their respective watersheds, through which their monitoring obligations will be met. Most of these CIMPs have been approved, or approved with conditions. The County and the LACFCD are currently awaiting approval of the remaining CIMPs. Assuming the CIMPs are approved prior to the start of the monitoring year, monitoring during the 2015-2016 monitoring year will be conducted under the protocols set forth in those plans.

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