EXECUTIVE SUMMARY

ES.1 Monitoring Program Objectives

The following are the major monitoring program objectives, as outlined in the Municipal Stormwater Permit:

- Assess compliance with the Municipal Stormwater Permit CAS004001 (Permit).
- Measure and improve the effectiveness of the Stormwater Quality Management Program (SQMP).
- Assess the chemical, physical, and biological impacts of receiving waters resulting from urban runoff.
- Characterize stormwater discharges.
- Identify sources of pollutants.
- Assess the overall health in receiving water quality, and evaluate long-term trends.

Ultimately, the results of the monitoring requirements should be used to refine the SQMP for the reduction of pollutant loads and the protection and enhancement of the beneficial uses of the receiving waters in Los Angeles County. The monitoring program was designed to address these objectives through the implementation of the following elements:

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

ES.2 Summary of Monitoring Results

ES.2.1 Mass Emission Monitoring

The goals of mass emission monitoring were as follows:

- Estimate the mass emissions from the municipal separate storm sewer system (MS4).
- Assess trends in the mass emissions over time.
- Determine if the MS4 is contributing water quality impacts by comparing results to applicable standards in the Water Quality Control Plan for the Los Angeles Region (Basin Plan), the California Toxics Rule (CTR), and emissions from other discharges.

Flows were measured and water quality samples were taken at the following seven mass emission stations (MES):

- Ballona Creek (S01).
- Malibu Creek (S02).
- Los Angeles River (S10).
- Coyote Creek (S13).
- San Gabriel River (S14).

- Dominguez Channel (S28).
- Santa Clara River (S29).

All MES, except the Santa Clara River site, are equipped with automated samplers with integral flow meters for collecting flow composite samples. Three storm events, including the first storm, and four dry weather events were sampled at each MES. Total suspended solids (TSS) were collected from four storm events at the Santa Clara River MES and from ten storm events at San Gabriel River MES, Ballona Creek MES, Malibu Creek MES, Dominguez Channel MES, Coyote Creek MES, and Los Angeles River MES.

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.

The following subsections summarize the analyses.

ES.2.1.1 Comparison Study for Mass Emission Water Quality

Monitoring results were compared to water quality indicators based on water quality objectives established by the Basin Plan and the CTR. The Basin Plan is designed to enhance water quality and 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.

Two categories of water quality objectives were identified (i.e., Category 1 and Category 2). Category 1 water quality objectives (see table below) are those for which there is no uncertainty regarding the applicable objectives, or the implementation with respect to frequency and duration. Category 2 water quality objectives are those for which there is uncertainty regarding the applicability of the beneficial use (e.g., the conditional use of municipal water supply), or uncertainty regarding implementation of the objective (e.g., four -day averaging periods). Only Category 1 water quality objectives were used for comparison in this study.

The numeric objectives in the table below that are listed as ranges are calculated values based on site-specific conditions. Ammonia concentrations were calculated using measured pH and Table 3-1 (COLD) and Table 3-2 (WARM) of the Basin Plan, assuming a temperature of 25°C (for COLD) and 20 °C (for WARM). Dissolved metals concentrations were calculated using measured hardness and procedures set forth in the CTR.

Category 1 Water Quality Objectives

Constituent	Water Quality Objective	Unit	Reference	Beneficial Use
Chloride	Ballona Creek (S01) None Malibu Creek (S02) < 500 Los Angeles River (S10) < 150 Coyote Creek (S13) None San Gabriel River (S14) < 150 Dominguez Channel (S28) None Santa Clara River (S29) < 100	mg/L	Basin Plan	Groundwater recharge (GWR) and general water quality indicators
Sulfate	Ballona Creek (S01) None Malibu Creek (S02) < 500 Los Angeles River (S10) < 350 Coyote Creek (S13) None San Gabriel River (S14) < 300 Dominguez Channel (S28) None Santa Clara River (S29) < 300	mg/L	Basin Plan	
Total dissolved solids (TDS)	Ballona Creek (S01) None Malibu Creek (S02) < 2,000 Los Angeles River (S10) < 1,500 Coyote Creek (S13) None San Gabriel River (S14) <750 Dominguez Channel (S28) None Santa Clara River (S29) < 1,000	mg/L	Basin Plan	
pH	6.5–8.5	None	Basin Plan	Aquatic life habitat (WARM and COLD)
Dissolved oxygen (DO)	(All) > 5 (WARM) (Malibu Creek) > 6 (COLD) (Malibu Creek) > 7 (SPAWN)	mg/L	Basin Plan	Aquatic life habitat
Fecal coliforms	< 400	MPN/ 100 mL	Basin Plan	Water contact recreation (REC-1)

MPN = most probable number.

Category 1 Water Quality Objectives (continued)

Constituent	Water Quality Objective	Unit	Reference	Beneficial Use
Ammonia	0.7–5 (COLD) 0.9–30 (WARM) (based on pH and temperature)	mg/L	Basin Plan	Aquatic life habitat (acute exposure only)
Cyanide	0.022	mg/L	CTR	
Dissolved arsenic	340	µg/L	CTR	
Dissolved cadmium	Hardness based	µg/L	CTR	
Dissolved chromium +6	Hardness based	µg/L	CTR	
Dissolved chromium	Hardness based	µg/L	CTR	
Dissolved copper	Hardness based	µg/L	CTR	
Dissolved lead	Hardness based	µg/L	CTR	
Dissolved nickel	Hardness based	µg/L	CTR	
Dissolved silver	Hardness based	µg/L	CTR	
Dissolved zinc	Hardness based	µg/L	CTR	

Constituents That Did Not Meet Water Quality Objectives at Mass Emission Stations

At the MES located in urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel) dissolved copper and pH did not meet water quality objectives during at least one wet weather monitoring event. Fecal coliform concentrations were above the water quality objective during two storm events at the Los Angeles River MES. Nitrite and dissolved zinc were measured above water quality objectives in Ballona Creek and Dominguez Channel, respectively, during one storm event. The cyanide concentration was above the water quality objective during one storm event each in the Ballona Creek, Los Angeles River, and Dominguez Channel stations.

During dry weather conditions, pH was measured above water quality objectives during at least one sampling event at each of the urbanized watershed stations. Fecal coliform concentrations were also measured above water quality objectives during one dry weather event at Dominguez Channel. The cyanide concentration was above the water quality objective during one sampling event in the Los Angeles River.

Among the four less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River and Santa Clara River), fecal coliform and sulfate concentrations during wet weather were above water quality objectives at Malibu Creek during two storm events. Dissolved copper and cyanide concentrations were above water quality objectives during one wet weather event in Coyote Creek. In the San Gabriel River, the dissolved zinc and cyanide concentrations were above the water quality objective during one wet weather sampling event. In the Santa Clara River, fecal coliform concentrations were above water quality objectives during one sampling event.

Among the four less urbanized watersheds during dry weather monitoring, sulfate and TDS were above water quality objectives during one dry weather sampling event in Malibu Creek. In

Coyote Creek, fecal coliforms concentrations were above the water quality objective during three dry weather events and pH and cyanide concentrations were above the water quality objective during one event. In the San Gabriel River, fecal coliform concentrations were above the water quality objective during two dry weather events and chloride, sulfate, and cyanide did not meet water quality objectives during one event. In the Santa Clara River, fecal coliform concentrations were above the water quality objectives during one dry weather event and chloride concentrations were above the water quality objectives in three events. The results are summarized in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2009–2010 for One or More Events

Mass Emission/Watershed	Wet	Dry
Ballona Creek (S01)*	pH Nitrite Dissolved copper Cyanide	pH
Malibu Creek (S02)	Fecal coliforms Sulfate	Sulfate TDS
Los Angeles River (S10)*	Fecal coliforms** pH Dissolved copper Cyanide	pH Cyanide
Coyote Creek (S13)	Dissolved copper Cyanide	Fecal coliforms pH Cyanide
San Gabriel River (S14)	Dissolved zinc Cyanide	Fecal coliforms Chloride Sulfate Cyanide
Dominguez Channel (S28)*	pH Dissolved copper Dissolved zinc Cyanide	Fecal coliforms pH
Santa Clara River (S29)	Fecal coliforms	Fecal coliforms Chloride

*More urbanized watersheds
**Two of four storms met the requirements of the high flow suspension (LARWQCB, 2003)

ES.2.1.2 Detection Limit Analysis

The monitoring and reporting requirements of the Permit state that constituents monitored at MES below the detection limit for 75% of the first 48 events monitored need not be further analyzed, except for annual confirmation sampling during the first storm of the wet season. Based on a review of the data from 2001 to 2010, several constituents meet these criteria, as summarized in Appendix M. There is a substantial list of organic constituents and several metals that meet the criteria across all MES. In addition, dissolved aluminum, cadmium, chromium +6, and lead meet the criteria at several of the MES.

ES.2.1.3 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES in accordance with the Municipal Stormwater Permit. In total, four samples were analyzed for toxicity at each site (i.e., two wet weather samples and two dry weather samples). Dry weather samples were collected on December 1, 2009 (2009–10Event14), and March 23, 2010 (2009–10Event28). Wet weather samples were collected during the first rain event of the season on October 13, 2009 (2009–10Event13), and on January 17, 2010 (2009–10Event19), at all MES. One freshwater species (i.e., water flea) and one marine species (i.e., sea urchin) were used for toxicity testing. The water flea, *Ceriodaphnia dubia*, was used in chronic 7-day reproduction and survival bioassays; whereas the sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

Toxicity Results by Station – Wet Weather

Bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity was observed for either the survival or reproduction endpoints. The no-observed-effect-concentration (NOEC) was 100% test substance for each of the MES for both survival and reproduction, whereas the inhibitory concentration (IC) 25% (IC_{25}) and IC_{50} values were greater than 100% test substance. These results indicate that no observable adverse effects to the organism's survival or reproduction occurred in exposure to the undiluted test samples.

The *C. dubia* survival and reproduction toxicity tests resulted in one toxicity unit (TU) for survival and one TU for reproduction for each of the MES. A TU is defined in the National Pollutant Discharge Elimination System (NPDES) Municipal Permit as 100 divided by the calculated median test response (e.g., LC_{50} or IC_{50}). A TU value greater than or equal to 1.00 is considered substantially toxic and requires a Phase I toxicity identification evaluation (TIE).

Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from each of the seven MES indicated that no toxicity to *S. purpuratus* fertilization was observed in any of the test samples. NOEC values were 100% of the sample water for each emission station, whereas IC_{25} and IC_{50} values were greater than 100% test substance and TUs were equal to 1 for each of the MES.

Toxicity Results by Station – Dry Weather

Bioassay tests exposing *C. dubia* to dry weather effluent samples from each of the seven MES indicated that no toxicity was observed for either the survival or reproduction endpoints. The NOEC was 100% test substance for each of the MES for both survival and reproduction, and the IC_{25} and IC_{50} values were greater than 100% test substance, indicating that no observable adverse effects to either survival or reproduction in *C. dubia* occurred in exposure to the undiluted test samples. Additionally, the TUs for each test sample in the *C. dubia* 7-day chronic bioassay were calculated to be 1.00.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each of the seven MES indicated that toxicity to *S. purpuratus* fertilization was observed in dry weather samples collected from Ballona Creek MES, Malibu Creek MES, Los Angeles River MES, San Gabriel River MES, Dominguez Channel MES, and Santa Clara River MES. NOECs were calculated to be equal to or less than 6% of the sample water for each of these sites, whereas the NOEC at Coyote Creek was greater than 100% sample water. Although IC_{25} and

IC_{50} values at these stations were all greater than 100% test substance, the TUs for Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Dominguez Channel, and Santa Clara River were calculated to be 16.67.

Because the initial results from the chronic *S. purpuratus* test exceeded 1.00 TU and control fertilization met acceptance criteria, a TIE study was initiated as required in the NPDES Municipal Permit. However, when baseline tests were conducted on dry weather samples collected from Ballona Creek MES, Malibu Creek MES, Los Angeles River MES, San Gabriel River MES, Dominguez Channel MES, and Santa Clara River MES, no toxicity was observed. NOEC values were 100% for each of the sites. Due to the lack of toxicity observed in baseline testing, there was no reason to continue with further TIE manipulations. The initial toxicity observed in the dry weather samples at Ballona Creek MES, Malibu Creek MES, Los Angeles River MES, San Gabriel River MES, Dominguez Channel MES, and Santa Clara River MES may have been caused by volatile compound(s) that dissipated to non-toxic levels during the baseline TIE tests.

ES.2.1.4 Tributary Monitoring

The goals of tributary monitoring were as follows:

- Identify subwatersheds where stormwater discharges are causing or contributing to non-attainment of water quality standards.
- Prioritize drainage and sub-drainage areas requiring management actions.

Sampling for the 2009–2010 Monitoring Season was conducted at six tributary monitoring stations in the Dominguez Channel Watershed. A total of five storm events, including the first storm of the season, and three dry events were sampled at each tributary monitoring site.

The tributaries monitored included the following:

- **Project No. 1232 (TS19) –** Tributary is located on the northeast corner of Project 1232 and S. Main Street, south of Del Amo Boulevard, in the City of Carson.
- **PD 669 (TS20)** – Tributary is located in the south right-of-way of PD 669, on the southeast corner of Avalon Boulevard and PD 669, north of Del Amo Boulevard, in the City of Carson.
- **Project Nos. 5246 & 74 (TS21) –** Tributary is located north of Artesia Boulevard (State Route 91), east of Vermont Avenue, in the City of Los Angeles.
- **PD 21-Hollypark Drain (TS22)** – Tributary is located on the northeast corner of 135^{th} Street at Dominguez Channel in the City of Gardena.
- **D.D.I. 8 (TS23) –** Tributary is located on the northwest corner of Dominguez Channel and the easterly prolongation of 132^{nd} Street in the City of Gardena.
- **Dominguez Channel at 116^{th} Street (TS24)** – Tributary is located at the corner of 116^{th} Street and Isis Avenue in the City of Lennox.

Constituents That Did Not Meet Water Quality Objectives at Tributary Stations

This subsection summarizes the constituents that were measured above Basin Plan water quality objectives at the tributary monitoring stations during the 2009–2010 Monitoring Season. In general, the constituents that were above water quality objectives were similar to those found at the Dominguez Channel MES. During wet weather, dissolved copper and zinc concentrations were above the water quality objectives in at least one event at all tributary stations. At Stations TS21, TS22, and TS23, pH did not meet water quality objectives during at least one event.

During dry weather, pH did not meet water quality objectives in at least one event at all tributary stations. Fecal coliform concentrations did not meet objectives in at least one event at Stations TS19, TS20, TS23, and TS24. The ammonia concentration did not meet water quality objectives during at least one event at Station TS19 and cyanide concentrations were above the water quality objective during at least one event at Site TS20. The results are summarized in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Tributary Stations during 2009–2010 for One or More Events

Tributary/Sub-watershed	Wet	Dry
Project No. 1232 (TS19)	Dissolved copper Dissolved zinc	Fecal coliforms pH Ammonia
PD 669 (TS20)	Dissolved copper Dissolved zinc	Fecal coliforms pH Cyanide
Project Nos. 5246 & 74 (TS21)	pH Dissolved copper Dissolved zinc	pH
PD 21-Hollypark Drain (TS22)	pH Dissolved copper Dissolved zinc Cyanide	pH
D.D.I. 8 (TS23)	pH Dissolved copper Dissolved zinc	Fecal coliforms pH
Dominguez Channel at 116th Street (TS24)	Dissolved copper Dissolved zinc	Fecal coliforms pH Dissolved copper Dissolved zinc

ES.2.1.5 Priority Constituents and Correlation to Total Suspended Solids

Wet Weather – Mass Emission Sites

Consistent trends were not observed in correlations between TSS and constituents of concern across MES during wet weather. The three most urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel) did, however, have more constituents positively correlated with TSS than the less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River, Santa Clara River) (as summarized in the table below. TDS, volatile suspended solids (VSS), dissolved barium, and specific conductance were positively correlated with two or more of the urbanized stations. Fecal coliform bacteria and DO were negatively correlated with TSS in one urbanized station.

In the less urbanized watersheds, no consistent correlations with TSS were apparent.

Dry Weather – Mass Emission Sites

During dry weather in the urbanized watersheds, dissolved and total metals had significant positive correlations with TSS across most MES. Nutrients (i.e., dissolved phosphorus and nitrate as NO_3) and DO had a significant negative correlation with TSS in one urbanized watershed station.

In the less urbanized watersheds, total and dissolved metals were positively correlated with TSS at three of the four stations during dry weather. Turbidity, total Kjeldahl nitrogen (TKN), and VSS were also positively correlated with TSS at Coyote Creek during dry weather. TKN was negatively correlated with TSS at Malibu Creek, whereas nitrate was negatively correlated with TSS at Coyote Creek.

Correlations between Constituents and Total Suspended Solids at Mass Emission Stations

Mass Emission/Watershed	Wet		Dry	
	Positively correlated with TSS	Negatively correlated with TSS	Positively correlated with TSS	Negatively correlated with TSS
Ballona Creek (S01)	Specific conductance, TDS, and VSS	Fecal coliforms	Biochemical oxygen demand (BOD) and dissolved chromium	Dissolved phosphorus and nitrate as NO_3
Malibu Creek (S02)	Aluminum, barium, and dissolved chromium	None	Arsenic, dissolved arsenic, and zinc	TKN
Los Angeles River (S10)	Ammonia, dissolved barium, NH_3 as N, total organic carbon (TOC), and VSS	None	Dissolved nickel and VSS	DO
Coyote Creek (S13)	pH and TKN	None	Aluminum, copper, dissolved antimony, TKN, lead, turbidity, and VSS	Nitrate as NO_3 and nitrate as N
San Gabriel River (S14)	None	None	Copper	Dissolved nickel
Dominguez Channel (S28)	Chloride, dissolved barium, dissolved chromium, enterococci, streptococci, TKN, specific conductance, sulfate, TDS, and VSS	DO	Zinc	None
Santa Clara River (S29)	None	Chemical oxygen demand (COD), fluoride, hardness as $CaCO_3$ specific conductance, and TDS	None	None

Wet Weather – Tributary Stations

During wet weather, ammonia, NH_3 as N, and VSS had a significant positive correlation with TSS at most of the tributary stations, as summarized in the table below. Of these constituents, only VSS was positively correlated with TSS at the Dominguez Channel MES. The metal selenium was negatively correlated with TSS at PD 669. No other constituents had significant negative correlations with TSS at tributary stations during wet weather.

Dry Weather – Tributary Stations

Two stations had constituents that were positively correlated with TSS during dry weather. Dissolved nickel and VSS were positively correlated with TSS at Project Nos. 5246 & 74, whereas fecal coliforms and VSS were positively correlated with TSS at Dominguez Channel at 116th Street. None of these constituents were found to have a positive correlation with TSS during dry weather at the Dominguez Channel MES.

No consistent pattern emerged among constituents that were negatively correlated with TSS during dry weather at the tributary stations, as no constituent had a negative correlation with TSS at more than one site. At Project No. 1232, pH and chromium were negatively correlated to TSS, whereas at PD 669, aluminum and TKN were negatively correlated to TSS. Hardness as $CaCO_3$ had a significant negative correlation with TSS at PD21-Hollywood Park Drain, whereas at Dominguez Channel at 116th Street, DO and TOC were negatively correlated with TSS.

Correlations between Constituents and Total Suspended Solids at Tributary Stations

Tributary Station/Watershed	Wet		Dry	
	Positively correlated with TSS	**Negatively correlated with TSS**	**Positively correlated with TSS**	**Negatively correlated with TSS**
Project No. 1232 (TS19)	Ammonia, NH_3 as N, and VSS	None	None	pH and chromium
PD 669 (TS20)	VSS	Selenium	None	Aluminum and TKN
Project Nos. 5246 & 74 (TS21)	None	None	Dissolved nickel and VSS	None
PD 21-Hollypark Drain (TS22)	Ammonia, NH_3 as N, and VSS	None	None	Hardness as $CaCO_3$
D.D.I. 8 (TS23)	Ammonia and NH_3 as N	None	None	None
Dominguez Channel at 116th Street (TS24)	VSS	None	Fecal coliforms and VSS	DO and TOC

ES.2.1.6 Wet Weather and Dry Weather Constituent Loads for Each Mass Emission Station

Constituent loads were calculated for each sampling event based on flow rates and constituent concentrations. The storm event beginning January 17, 2010 (2009–10Event19), had substantially higher rainfall totals than any of the other monitored storm events and, thus, generally had the highest loads for most constituents. At the more urbanized watershed monitoring stations, a first-flush signature (i.e., higher loads during the first monitored storm of the season than would be expected based on rainfall totals) was observed for some constituents (e.g., TKN, total phosphorus, and TDS); whereas at the less urbanized watershed monitoring stations, no such phenomena were observed. The total TSS load for each MES is shown in Table 4-8. An estimate of the total constituent loads for each MES is shown in Table 4-9. Overall, calculated TSS loads on the Los Angeles River and San Gabriel River were approximately one order of magnitude greater than TSS loads at any of the other five MES during wet weather.

During dry weather, constituent loads varied greatly from station to station and among sampling events. Calculated TSS loads on the Los Angeles River were approximately one order of magnitude greater than TSS loads at any of the other six MES during dry weather.

ES.2.1.7 Total Suspended Solids Trend Analysis

TSS concentrations from 2001 to the 2010 were examined using non-parametric Mann-Kendall trend analysis to determine if significant positive or negative trends occurred in any of the seven monitored watersheds. The table below presents statistical trend information on TSS data collected at each of the MES over the past ten years.

Coyote Creek had the only significant trend (i.e., p-value less than 0.05) in TSS concentration over the last ten years. The TSS trend at Coyote Creek was a negative trend, indicating that TSS concentrations have decreased significantly over time at this location. Malibu Creek (p-value = 0.077), San Gabriel River (p-value = 0.053), and Santa Clara River (p-value = 0.054), also had negative trends that did not quite reach the 0.05 p-value that determined whether or not the trend was significant. The more urbanized watersheds of Ballona Creek (p-value = 0.378), Los Angeles River (p-value = 0.477), and Dominguez Channel (p-value = 0.481) had substantially higher p-values than the less urbanized watersheds and, hence, did not demonstrate either a positive or negative TSS trend.

ES.2.1.8 Trash Monitoring

The objectives of trash monitoring are as follows:

- Assess the quantities of trash in receiving waters after storm events.
- 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 three additional storm events.

Results of trash compliance monitoring can be found in Appendix C (pictures), Appendix I (*Ballona Creek Watershed Trash Compliance Monitoring Report*), and Appendix J (*Los Angeles River Watershed Trash Compliance Monitoring Report*).

ES.4 Recommendations

The following recommendation for improving monitoring techniques is presented below. As it is a recommended monitoring change, it could be initiated by LACFCD, after appropriate consultation with the Los Angeles RWQCB and Copermittees

- Tributary monitoring is recommended for Malibu Creek to distinguish between naturally occurring and anthropogenic concentrations of sulfate, and other priority constituents. Tributary concentrations in developed areas of the watershed could be compared against undeveloped areas of the watershed to identify naturally occurring constituent concentrations. If no significant sulfate concentrations are detected in the developed portion of the watershed, it could be inferred that any concentrations measured above these concentrations are naturally occurring.