This section describes the results, data analysis, and recommendations for the 2005-2006 Monitoring Program.

4.1 HYDROLOGY: PRECIPITATION AND FLOW

The monthly rainfall during the 2005-2006 storm season was compared to the long-term pattern of rainfall in Figure 4-1. During this storm season, the total rainfall was about 10.28 inches. Figure 4-2 shows that the total annual rainfall of 10.28 inches during the 2005-2006 storm season in downtown Los Angeles was just about two-thirds the average annual rainfall. The average annual rainfall over 133 seasons at Station # 716, Ducommun Street in downtown Los Angeles is about 15.51 inches. Table 4-1 summarizes the hydrologic and meteorologic conditions of each station-event monitored during this storm season. A collection of 2005-2006 season hydrographs for each storm event from the monitored sites is included in Appendix A. Each hydrograph includes the time of the first and last composite sample aliquot collection, the sample volume interval, and the percent of storm sampled. Due to a recent change in the operation and maintenance of the gaging station at the Santa Clara River Mass Emission station, flow data for the first storm, October 17,2005, was not captured. The Department's Water Resources Division was still setting up the station with its own equipment after taking it back from the United States Geological Survey. Estimated flows for the first storm at the Santa Clara River site were generated by comparing flows between that station and those from the nearest United States Geological Survey gaging station, which is downstream near the City of Piru, for the three subsequent storms.

4.2 STORM WATER QUALITY

An inventory of the composite and grab samples taken for the chemical and biological analysis and toxicity analysis during the 2005-2006 monitoring season is included in Tables 4-2, 4-2a, and 4-3.

4.2.1 Mass Emission Analysis

This section provides a description of wet weather and dry weather mass emission results generated during the 2005-2006 monitoring season.

The County analyzes for an extensive number of individual water quality constituents, the results of which are included in Appendix B, along with a comparison to the applicable water quality standard. A comparison was made between mass emission water quality results and the water quality objectives outlined in the Ocean Plan, the Basin Plan, and the CTR. The freshwater final acute criteria set by the California Department of Fish and Game was also used to provide water quality standards for chlorpyrifos and diazinon. The Municipal Storm Water Permit specifically requires the County to assess the pollutant loading for the sampling events that are analyzed for the complete list of constituents following the 2005-2006 storm season. In addition, the Municipal Storm Water Permit requires the identification and analysis of any long-term trends in storm water or receiving water runoff. An analysis of the correlation between pollutants of concern (metals and PAHs) and TSS loadings for the sampling events was also performed.

4.2.1.1 Comparison Study

As required by the Municipal Storm Water Permit, a comparison to the applicable water quality standards from the Basin Plan, the Ocean Plan, or the CTR for mass emission monitoring was conducted. The lowest possible standard of the three documents was used for the comparison study. The California Department of Fish and Game provided freshwater final acute criteria water quality standards for chlorpyrifos and diazinon. The Basin Plan is designed to enhance water quality and protect the beneficial uses of all regional waters. The Ocean Plan is applicable to point source discharges to the ocean. The CTR promulgates criteria for priority toxic pollutants in the State of California for inland surface waters and enclosed bays and estuaries. Constituents that exceeded the applicable water quality standards are highlighted in Appendix B. Table C-7 shows the applicable water quality standards for both the mass emission and tributary monitoring programs. Table 4-4 and Figure 4-3 summarize this comparison analysis.

The following conclusions were drawn from the mass emission comparison study:

Wet Weather

At least four storms were monitored at each of the mass emission stations during the 2005-2006 season, meeting the Municipal Storm Water Permit requirement of monitoring a minimum of three storm events, including the first storm. One exception is the Coyote Creek station, where five storms were monitored. Results of concern were chosen to be those in which at least 75% of samples exceeded applicable water quality standards. This is similar to the pollutant investigation threshold of 3 exceedances of 4 sampling events in the Tributary Monitoring Program. A general overview of the results of concern are best presented using Table 1 below. (An x indicates constituents for which at least 75% of samples exceeded applicable water quality standards in each watershed.)

Table 1. Constituents for which at least 75% of samples exceeded applicable water quality standards for each watershed based on Mass Emission monitoring results.

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Constituents	Watershed						
	San Gabriel River	Coyote Creek	Los Angeles River	Dominguez Channel	Ballona Creek	Malibu Creek	Santa Clara River
Enterococcus	x	x	x	x	x	x	x
Fecal Coliform	x	x	x	x	x	x	x
Total Coliform	x	x	x	x	x	x	x
Total Aluminum					x		x
Total Copper		x	x	x	x	x	
Dissolved Copper			x	x			
Total Lead					x		
Total Zinc			x	x	x		
Sulfate						x	

The results confirm that bacteria is a persistent concern throughout all of the watersheds during wet weather. Except for San Gabriel River, one or more metals are also a concern amongst all watersheds. The results are in accord with the Constituents of Concern identified in the Department's 1994-2005 Integrated Receiving Water Impacts Report (Table 1, Executive Summary, page 5). The Constituents of Concern considered both wet and dry weather monitoring results, using yearly mean constituent values and applicable water quality standards to calculate the frequency and magnitude of exceedances. Notable differences between this year's results and the 1994-2005 list of Constituents of Concern are that Dissolved Copper was the only dissolved metal where significant exceedances were found in any of the watersheds during this monitoring season. It was found in Los Angeles River and Dominguez Channel. Dissolved metals are a Constituent of Concern in Coyote Creek, Los Angeles, River, Dominguez Channel, and Ballona Creek. There were no exceedances of the standard for Cyanide, whereas it is a Constituent of Concern across all watersheds. Diazinon is a Constituent of Concern in Dominguez Channel and Santa Clara River, but no exceedances were found in any watersheds during this monitoring year. Sulfate was not identified as Constituents of Concern in the 1994-2005 Integrated Receiving Water Impacts Report, but exceedances for Sulfate were found in all samples taken at Malibu Creek.

It should be noted that not all results required in the NPDES Municipal Permit were obtained during this season. Due to the light nature of the storm, some Semi-Volatile Organics (EPA 625) and Base/Neutral results were not obtained during the January 14, 2006 sampling event at Dominguez Channel. Also, alpha and gamma-Chlordane were not analyzed due to an oversight by the Los Angeles County Agricultural Commissioner/Weights & Measures Toxicology Lab. All Total Chlordane results were non-detects. However, particular vigilance will be given towards ensuring the receipt of results for the aforementioned constituents in the upcoming monitoring year.

Dry Weather

The Municipal Storm Water Permit requires only two dry weather samples at each monitoring station. A general overview of the results of concern are best presented using Table 2 below. (An x indicates constituents for which at least 75% of samples (2 of 2 events) exceeded applicable water quality standards in each watershed.)

Table 2. Constituents for which at least 75% of samples exceeded applicable water quality standards for each watershed based on Mass Emission monitoring results.

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Constituents	Watershed						
	San Gabriel River	Coyote Creek	Los Angeles River	Dominguez Channel	Ballona Creek	Malibu Creek	Santa Clara River
Enterococcus	x	x	x	x	x		x
Fecal Coliform		x	x	x	x		
Total Coliform	x	x	x	x	x		x
Cyanide		x	x				
Chloride							x
Total Dissolved Solids		x		x	x		

The results show the persistence of Total Coliform and Enterococcus indicator bacteria exceedances in all watersheds during dry weather, except for Malibu Creek. Fecal Coliform was also an issue of concern amongst all watersheds, except for Malibu Creek and San Gabriel River. Malibu Creek had no exceedances of the water quality standards for Enterococcus and Fecal Coliform during dry weather during this season. As with the wet weather results, these results were in general agreement with those on the list of Constituents of Concern identified in the 1994-2005 Integrated Receiving Water Impacts Report. The strongest exceptions were that no dissolved metals or Diazinon exceedances were found. Total metals exceedances did not surpass the 75% exceedances threshold mentioned above. Cyanide exceedances crossed the 75% exceedances parameter only at the Coyote Creek and Los Angeles River, whereas it is a listed Constituent of Concern across all watersheds. Chloride and Total Dissolved Solids were not identified as Constituents of Concern. However, all dry weather samples exceeded the water quality objective guidelines at Santa Clara River for Chloride; and Ballona Creek, Coyote Creek, and Dominguez Channel for Total Dissolved Solids. Note that there are no waterbody specific objectives for Total Dissolved Solids at Ballona Creek, Coyote Creek, and Dominguez Channel. The effluent limit was based upon the guidelines in the Basin Plan, which would be protective of the potential MUN (Drinking Water Standards) Beneficial Use.

It should be noted that not all results required in the NPDES Municipal Permit were obtained during this season. Due to mechanical issues with the automated samplers, Chlorinated Pesticides and Polychlorinated Biphenyls were not obtained during the April 25, 2006 sampling event at Ballona Creek. New samplers will be purchased in the coming years to replace the old models in the Mass Emission stations. Also, alpha and gamma-Chlordane were not analyzed due to an oversight by the Los Angeles County Agricultural Commissioner/Weights & Measures Toxicology Lab. All Total Chlordane results were non-detects. However, particular vigilance will be given towards ensuring the receipt of results for the aforementioned constituents in the upcoming monitoring year.

4.2.1.2 Loading and Trend Analysis

An estimation of the total pollutant loads due to storm water and urban runoff for each mass emission station is shown on Table 4-9. As required by the Municipal Storm Water Permit, samples were collected and analyzed for TSS at all mass emission stations equipped with automated samplers for all storm events that resulted in at least 0.25 inches of rainfall. The concentrations for TSS for each storm is shown on Table 4-7 and the total pollutant loading for TSS for each mass emission station is shown on Table 4-8. By analyzing the pollutant loading at each mass emission station, it is possible to see if there is any correlation between storm events and the amount of pollutant loading. An analysis of trends in storm water or receiving water quality is represented in Figure 4-4. Some first flush phenomena are observed, primarily with pollutants associated with particulate matter, and storms with greater runoff volumes typically have larger pollutant loadings. Although an analysis of loading versus time yields little useful information, it may be possible to analyze the loading as it relates to total precipitation or precipitation intensity. Long term temporal trends cannot be found by analyzing one years worth of data and an analysis of historical long term temporal trends can be found in the 1994-2005 Integrated Receiving Water Impacts Report. Additional long term trend analysis will be conducted for the next Integrated Receiving Water Impacts Report.

The following conclusions were deduced from the loading analysis:

- The total runoff volume and pollutant loading at the Los Angeles River monitoring station was usually higher than at the other monitoring stations. Los Angeles River has approximately two to twenty five times the surface area of the other watersheds. This creates more potential for surface runoff pollution and likely explains, in part, the increased loading of constituents at the Los Angeles River monitoring station when compared to the other monitoring stations. However, it should be noted that differences in loading at different monitoring stations are not directly correlated with watershed surface area. For example, Total Aluminum loadings at Dominguez Channel for the 10/17/05 storm were approximately seven times less than at the Los Angeles River, while the Los Angeles River watershed is twenty five times larger than that of Dominguez Channel.

- The storm on February 27, 2006 produced the single largest TSS load of the season at the Los Angeles River with a load 17,750 tons. This storm was very similar in total precipitation to the December 31, but had approximately 3.5 times the runoff volume and 10 times the TSS load. Loading rates are highly variable even within the same watershed. The next highest TSS loads from a monitored storm occurred on October 17,2005, perhaps indicating a first flush phenomena. The Los Angeles River is the largest contributor of TSS out of the seven mass emission stations monitored.
- Four of the seven mass emissions stations exhibited first flush phenomena for TSS during the October 17, 2005 storm. The Los Angeles River would also have a first flush phenoma if the single loading event of February 27, 2006 is ignored. However, the last monitored event at the Los Angeles River on March 28, 2006 had almost the same TSS load as the first event, suggesting that TSS evolution or deposition is a continuous process or that discreet sources of TSS, such as exposed soil at construction sites, became available during the storm season.
- TSS concentrations were usually much higher during wet weather than during dry sampling events. However, the April 25, 2006 sampling event at Ballona Creek revealed a TSS concentration that was 1 to 2 orders of magnitude greater than any of the other TSS concentrations analyzed during the same event. This Ballona Creek TSS concentration was the third highest at that station during the storm season, less than only the presumed first flush of October 17, 2005 and the large storm on December 31, 2005. It is likely that this drastic increase in TSS concentration was due to a point source.
- High levels of aluminum, bacteria, copper, lead, nickel and zinc were observed at most mass emission stations during most events, and the metal s tended to decline through the storm season.
- MBAS loading, which indicates the presence of surfactants, was generally higher in the more urbanized watersheds. MBASs tended to exhibit first flush phenomena in more rural watersheds, but tended to be present at fairly constant levels in the more urbanized watersheds. This suggests a continuous source (perhaps industrial) in the urbanized areas, while the more rural watersheds may have periodic or seasonal sources.
- COD loads exceeded Dissolved Oxygen (DO) loads at all stations during all storms. BOD exceed DO at most locations during most storms. However, BOD was less than the DO load at Malibu Creek for 3 storms, at San Gabriel River for 2 storms and for 1 storm at both Coyote Creek and the Santa Clara River. This is most likely due to a combination of flow characteristics and watershed urbanization. It is not unusual for COD and BOD to exceed DO, and moving bodies of water rely upon gas exchange with the atmosphere to prevent anaerobic conditions from developing. Water from the MS4 system can be expected to become anaerobic if it is introduced to an environment where sufficient mixing does not occur, and therefore may not be suitable for impoundment or introduction into enclosed basins such as Oxford Basin.

- The highest Total Dissolved Solids (TDS) loadings occur at San Gabriel River during the October 17, 2005 storm and at Malibu Creek during the December 31, 2005 storm. In general, TDS loads increased during the storm season, most likely due to the presence of water in the watersheds after the first storm. This water collected dissolved materials and was then flushed into the MS4 system by additional rainfall. Malibu Creek has a lot of exposed geologic formations which may contribute to TDS loading, and the San Gabriel River receives imported waters which may contain elevated TDS levels.

Pollutant Loading Example

At the request of the RWQCB, below is an example of the pollutant loading calculation:

Site: Ballona Creek Mass Emission Station

Storm event: 12/25/2003

Constituent: Nitrate

Concentration: 4.75mg/L

Runoff Volume: 481.8 acre-ft (440 acre-ft Runoff + 41.8 acre-ft Base Flow)

1lb = 454 g

1g = 1,000 mg = $1\text{x}10^{6}$ µg

1L = 0.03531467 ft^3

1 ft^3 = 2.2957×10^{-5} acre-ft

Pollutant Loading = (Pollutant Concentration)(Runoff Volume)

Pollutant Load = (4.75 mg/L)(481.8 acre-ft)(1g/1,000 mg)(1 lb/454g)(1 ft^3/2.2957×10^{-5} acre-ft)(1L/0.03531467 ft^3)

Pollutant Load = 6223 lbs.

Conversion factors

4.1.2.3 Correlation Study

An analysis of the correlation between metals and TSS levels for the mass emission monitoring was performed. The study was only conducted on metals because the PAH samples at all of the monitoring stations were non-detects. In the 1994-2005 Integrated Receiving Water Impacts Report an analyses of the metals and TSS correlation was conducted. This report found that there was poor correlation between TSS and metals in all watersheds besides the Santa Clara River Watershed. It was suggested to remove the TSS correlation requirement from the permit in order to free up resources for increased tributary monitoring. These suggestions were included in the 2006 Report on Waste Discharge, and in anticipation of the Regional Water Quality Control Board’s agreement TSS correlation analysis was only conducted for the Santa Clara River Watershed, Ballona Creek Watershed and the Adams Drain Watershed. Ballona Creek and Adams Drain were chosen because of their inclusion in the tributary monitoring program.

A trend line was projected on each of the metals-versus-TSS plots and the coefficient of determination (R^2) was calculated to see if there was any correlation between the concentrations for each metal and TSS for the Santa Clara River, Ballona Creek and Adams Drain monitoring stations (Figure 4-5). The closer the value of R^2 is to the number one, the stronger the correlation of the two variables.

The following conclusions were deduced from the correlation study analysis:

- Few very strong correlations between TSS and metals concentrations were found. The highest R^2 value was for Dissolved Antimony (0.95) in the Adams Drain Watershed.
- 5 correlations with a R^2 value greater than 0.5 were found in the Santa Clara Watershed (Dissolved Aluminum, 0.80; Dissolved Barium, 0.64; Dissolved Iron, 0.68; Dissolved Nickel, 0.59; and Total Nickel, 0.59).
- No correlations with a R^2 value greater than 0.5 were found when examining the entire Ballona Creek Watershed. The highest R^2 value was 0.44 for Dissolved Barium.
- Adams Drain Watershed had 13 correlations with a R^2 value greater than 0.5 (Total Aluminum, 0.64; Dissolved Antimony, 0.95; Total Antimony, 0.74; Dissolved Arsenic, 0.60; Total Barium, 0.55; Total Chromium, 0.61; Total Copper, 0.53; Dissolved Iron, 0.51; Total Iron, 0.67; Dissolved Lead, 0.53; Total Lead, 0.65; Dissolved Nickel, 0.56; Total Zinc, 0.65).
- Correlation of TSS and metal concentrations is poor in large watersheds with multiple sources of metals. Correlations are better in smaller watersheds, most likely due to the relatively larger degree of homogeneity in metals sources. The Santa Clara Watershed exhibited more correlation between TSS and metals than the more urbanized Ballona Creek Watershed, but less than the much smaller Adams Drain Watershed. TSS correlation should be discontinued in the Mass Emissions Monitoring Program, but may prove to be a useful tool in the Tributary Monitoring Program.

4.2.2 Tributary Monitoring Analysis

This section provides a description and analysis of wet weather and dry weather tributary results generated during the 2005-2006 monitoring season.

Though only a requirement for the first storm of the season, tributary monitoring analysis included all of the water quality constituents monitored under the mass emission monitoring program, the results of which are included in Appendix B. Flow was also measured and is reported as hydrographs, which can be found in Appendix A. In order to identify the sub-watersheds where storm water discharges are causing or contributing to exceedances of water quality standards, a comparison was made between tributary water quality results and the water quality objectives outlined in the Ocean Plan, the Basin Plan, and the CTR. The lowest possible standard of the three documents was used for the comparison study. The freshwater final acute criteria set by the California Department of Fish and Game was also used to provide water quality standards for Chlorpyrifos and Diazinon.

Since the tributary monitoring stations collect samples from sub-watersheds within the Ballona Creek watershed, the results from the Ballona Creek Mass Emission station were also used in the analysis. However, it should be pointed out that two of the sites, Centinela Creek and Sepulveda

Channel, are situated below the Ballona Creek Mass Emission station. It was not possible to accurately identify any problems based on dry weather results as only two samples were taken at each tributary monitoring station in compliance with the Municipal Storm Water Permit as modified by the Los Angeles Regional Water Quality Control Board. Constituents that exceeded the applicable water quality standards are highlighted in Appendix B. Table 4-5 summarizes this comparison analysis. Tables 3 and 5 below provide a summary of findings based upon this monitoring year's results, using the 3 exceedances out of 4 sampling events (or 75% of samples) pollutant investigation threshold parameter in the NPDES Municipal Permit. Tables 4 and 6 provide a ranked list of sites for consideration of management actions based upon monitoring conducted at the tributary monitoring sites over the past two years. A ranking based upon loading rates per area was created for each of the Constituents of Concern identified for Ballona Creek in the 1994-2005 Integrated Receiving Water Impacts Report.

The following conclusions were drawn from the wet weather tributary comparison study:

Table 3. Constituents for which at least 75% of samples exceeded applicable water quality standards for each watershed based on Ballona Creek Tributary Site monitoring results.

Constituents	Watershed					
	Centinela Creek	Sepulveda Channel	Benedict Canyon	Adams Drain	Fairfax Drain	Cochran
Enterococcus	x	x	x	x	x	x
Fecal Coliform	x	x	x	x	x	x
Total Coliform	x	x	x	x	x	x
Total Copper	x	x	x	x	x	x
Dissolved Copper				x		
Cyanide				x		x
Total Zinc		x		x	x	x
Dissolved Zinc				x		
Oil & Grease				x		

These results align with the Constituents of Concern for Ballona Creek, identified in the 1994-2005 Integrate Receiving Water Impacts Report. The exceptions are that no exceedances were found for Dissolved Lead, one of the Constituents of Concern. Also, Total Zinc, and Oil & Grease exceedances in excess of the 75% parameter were found at some of the sites. Those constituents were not identified in the list of Constituents of Concern for Ballona Creek. Dissolved Copper and Dissolved Zinc are also not identified in the list of Constituents of Concern for Ballona Creek, yet significant exceedances were found in Adams Drain.

In order to help focus management actions in the Ballona Creek watershed, results from the last two years of monitoring were analyzed and a loading per metric area was used to prioritize pollutant reduction activities. Below are the results of that analysis for wet weather:

Table 4. Ranking of Ballona Creek Tributary Monitoring sites for management actions per Constituent of Concern identified for Ballona Creek in the 1994-2005 Integrated Receiving Water Impacts Report.

Management Action Rank Order	Constituent of Concern						
	Entero-coccus (MPN/hectare)	Fecal Coliform (MPN/hectare)	Total Coliform (MPN/Hectare)	Total Copper (kg/hectare)	Total Lead (kg/hectare)	Dissolved Lead (kg/hectare)	Cyanide (kg/hectare)
1	Adams Drain (2.31E+14)	Cochran (1.42E+14)	Adams Drain (4.53E+14)	Adams Drain (2.26E-2)	Adams Drain (1.65E-2)	Centinela Creek (6.36E-4)	Cochran (4.71E-2)
2	Cochran (8.71E+13)	Adams Drain (1.11E+14)	Cochran (2.03E+14)	Centinela Creek (1.58E-2)	Centinela Creek (9.76E-3)	Adams Drain (6.04E-4)	Adams Drain (3.96E-2)
3	Centinela Creek (5.80E+13)	Fairfax Drain (3.82E+13)	Centinela Creek (1.11E+14)	Cochran (1.26E-2)	Cochran (9.69E-3)	Cochran (4.24E-4)	Centinela Creek (1.73E-2)
4	Fairfax Drain (5.40E+13)	Centinela Creek (2.52E+13)	Fairfax Drain (4.76E+13)	Fairfax Drain (5.11E-3)	Fairfax Drain (3.16E-3)	Fairfax Drain (2.07E-4)	Fairfax Drain (9.86E-4)
5	Sepulveda Channel (4.61E+12)	Sepulveda Channel (4.61E+12)	Benedict Canyon (9.56E+12)	Sepulveda Channel (1.87E-3)	Sepulveda Channel (7.03E-4)	Sepulveda Channel (5.06E-5)	Sepulveda Channel (1.64E-4)
6	Benedict Canyon (3.44E+12)	Benedict Canyon (1.34E+12)	Sepulveda Channel (8.24E+12)	Benedict Canyon (5.57E-4)	Benedict Canyon (2.24E-4)	Benedict Canyon (1.61E-5)	Benedict Canyon (5.70E-5)

To prudently plan for future activities, only the top three sites are recommended for management actions. The results in Table 4 indicate that it would benefit the Ballona Creek watershed to focus management actions upon Adams Drain, Cochran, and Centinela Creek for all of the above Constituents of Concern.

It should be noted that not all results required in the NPDES Municipal Permit were obtained during this season. Due to the light nature of the storm, Ammonia (NH_3) was not obtained during the January 14, 2006 sampling event at Sepulveda Channel. For the same reason, results for some Herbicides were not obtained for the November 9, 2005 event at Fairfax Drain and

Cochran. Only results for constituents obtained by grab sample were obtained for the October 17, 2005 storm at Benedict Canyon due to mechanical issues with the automated sampler at that station. New monitoring protocols were instituted to ensure that necessary grab sampling to create flow-weighted composites will be instituted should mechanical repairs not suffice to collect samples. This was particularly emphasized for the first storm of the season. A complete set of grab and composite sample results was obtained for one additional storm beyond the NPDES Municipal Permit’s minimum requirement at the Benedict Canyon site. Also, alpha and gamma-Chlordane were not analyzed due to an oversight by the Los Angeles County Agricultural Commissioner/Weights & Measures Toxicology Lab. All Total Chlordane results were non-detects. However, particular vigilance will be given towards ensuring the receipt of results for the aforementioned constituents in the upcoming monitoring year.

The following conclusions were drawn from the dry weather tributary comparison study:

Table 5. Constituents for which at least 75% of samples exceeded applicable water quality standards for each watershed based on Ballona Creek Tributary Site monitoring results.

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Constituents	Watershed					
	Centinela Creek	Sepulveda Channel	Benedict Canyon	Adams Drain	Fairfax Drain	Cochran
Enterococcus	x	x	x	x	x	x
Fecal Coliform	x	x	x		x	x
Total Coliform	x	x	x	x	x	x
Total Copper	x			x		x
Total Zinc				x		
Total Dissolved Solids		x	x	x	x	x

These results align with the Constituents of Concern for Ballona Creek mentioned above. The exceptions are that no exceedances were found for Dissolved Lead and Cyanide. Total Lead exceedances did not surpass the 75% threshold at any of the sites. Also, Total Zinc exceedances in excess of the 75% threshold were found at Adams Drain. That pollutant is not on the list of Constituents of Concern for Ballona Creek as mentioned above. All dry weather samples exceeded the water quality objective guidelines for Total Dissolved Solids at all watersheds, except Centinela Creek. Note that there are no waterbody specific objectives for Total Dissolved Solids in the Ballona Creek watershed. The effluent limit was based upon the guidelines in the Basin Plan, which would be protective of the potential MUN (Drinking Water Standards) Beneficial Use.

In order to help focus management actions in the Ballona Creek watershed, results from the last two years of monitoring were analyzed and a loading per metric area was used to prioritize pollutant reduction activities. Below are the results of that analysis for dry weather:

Table 6. Ranking of Ballona Creek Tributary Monitoring sites for management actions per Constituent of Concern identified for Ballona Creek in the 1994-2005 Integrated Receiving Water Impacts Report.

Management Action Rank Order	Constituent of Concern						
	Entero-coccus (MPN/ hectare)	Fecal Coliform (MPN/ hectare)	Total Coliform (MPN/ Hectare)	Total Copper (kg/ hectare)	Total Lead (kg/ hectare)	Dissolved Lead (kg/ hectare)	Cyanide (kg/ hectare)
1	Adams Drain (4.08E+10)	Fairfax Drain (1.24E+11)	Adams Drain (2.31E+12)	Cochran (6.05E-4)	Cochran (7.11E-5)	Cochran (1.07E-4)	Cochran (2.13E-4)
2	Cochran (3.66E+10)	Sepulveda Channel (1.10E+11)	Cochran (7.35E+11)	Adams Drain (3.06E-4)	Adams Drain (2.86E-5)	Fairfax Drain (5.00E-5)	Fairfax Drain (1.00E-4)
3	Fairfax Drain (2.58E+10)	Cochran (7.28E+10)	Fairfax Drain (5.60E+11)	Fairfax Drain (2.74E-4)	Fairfax Drain (2.54E-5)	Adams Drain (1.02E-5)	Adams Drain (5.60E-5)
4	Sepulveda Channel (1.48E+10)	Adams Drain (2.02E+10)	Benedict Canyon (4.54E+11)	Sepulveda Channel (4.44E-5)	Sepulveda Channel (7.61E-6)	Benedict Canyon (8.36E-6)	Sepulveda Channel (2.96E-5)
5	Benedict Canyon (8.60E+9)	Benedict Canyon (8.98E+9)	Sepulveda Channel (3.73E+11)	Benedict Canyon (4.06E-5)	Centinela Creek (4.32E-6)	Sepulveda Channel (5.98E-6)	Benedict Canyon (1.67E-5)
6	Centinela Creek (3.04E+8)	Centinela Creek (1.01E+9)	Centinela Creek (4.63E+10)	Centinela Creek (1.59E-5)	Benedict Canyon (3.74E-6)	Centinela Creek (1.15E-6)	Centinela Creek (2.31E-6)

The results above indicate that it would be beneficial to focus management actions upon Cochran, Fairfax Drain, and Adams Drain for all of the above Constituents of Concern.

It should be noted that not all results required in the NPDES Municipal Permit were obtained during this season. Due to light flows over a 24-hour period, Chlorinated Pesticides and Polychlorinated Biphenyls results were not obtained during the April 25, 2006 sampling event at the Adams Drain and Fairfax Drain sites. Calibration efforts will be improved to allow for sampling a sufficient quantity of water to conduct all required tests. Also, alpha and gamma-Chlordane were not analyzed due to an oversight by the Los Angeles County Agricultural Commissioner/Weights & Measures Toxicology Lab. All Total Chlordane results were non-detects. However, particular vigilance will be given towards ensuring the receipt of results for the aforementioned constituents in the upcoming monitoring year.

4.2.3 Water Column Toxicity Analysis

This section describes the water column toxicity results generated during the 2005-2006 storm season. Water column toxicity monitoring was performed at all mass emission sites in accordance with the Municipal Storm Water Permit. In total, four samples were analyzed for toxicity at each site. Dry weather samples were collected on November 29, 2005 (at Ballona Creek and Santa Clara River mass emission sites), on January 24, 2006 (at Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, and Dominguez Channel mass emission sites), and on April 25, 2006 (at all 7 mass emission sites). The results obtained from these samples are found in Table 4-6a. Wet weather samples were collected during the first rain event of the season on October 17, 2005 (at all 7 mass emission sites), on November 9, 2005 (at Ballona Creek and Malibu Creek mass emission sites), on December 31, 2005 (at Los Angeles River, Coyote Creek, San Gabriel River, and Santa Clara River mass emission sites), and also on January 3, 2006 (at the Dominguez Channel mass emission site). The results obtained from these samples are found in Table 4-6b.

A minimum of one freshwater and one marine species was used for toxicity testing, specifically Ceriodaphnia dubia (water flea) 7-day reproduction/survival and Strongylocentrotus purpuratus (sea urchin) fertilization. Results calculated from the Ceriodaphnia dubia and Strongylocentrotus purpuratus tests included the No Observed Effect Concentration (NOEC), 50% Effective Concentration (EC50), 50% Lethal Concentration (LC50), and toxicity unit (TU). NOEC is the highest concentration of toxicant that would cause no observable adverse effects on the test organisms, which means the values for the observed responses statistically are insignificantly different from the controls. EC50 is the toxicant concentration that would cause an observable adverse effect on a quantal response (such as death, fertilization, germination, or development) in 50% of the test population. A quantal response is an all-or-none response. For example, death is a quantal response because a test organism can only be either dead or alive after being exposed to the toxicant concentration in the test sample. When the observable effect is death or immobility, the term Lethal Concentration or LC is used in place of the term Effective Concentration or EC. Therefore, LC50 is the concentration that produces a 50% reduction in survival. TU is defined in the permit as 100/(LC50 or EC50). A TU value greater than or equal to 1.00 is considered substantially toxic and requires a toxicity identification evaluation (TIE).

The following conclusions were deduced from the water column toxicity testing:

- Ceriodaphnia dubia survival and reproduction were only significantly affected by exposure to the wet weather sample collected from the Dominguez Channel mass emission station on October 17, 2005. This sample had a TU value of 1.23 for the survival test and that of 1.10 for the reproduction test. In accordance with the Permit, the "baseline" test was conducted and toxicity was not observed in this sample, indicating that further TIE manipulations were not necessary. The fact that a slight amount of toxicity was observed in the initial chronic tests indicated that the toxicant was most likely associated with volatile compound(s). The compound(s) apparently dissipated to non-toxic levels between the time of the initial toxicity tests and initiation of the "baseline" toxicity testing.

- Sea urchin fertilization was significantly affected by exposure to the wet weather samples collected from the Ballona Creek, Los Angeles River, and Dominguez Channel mass emission stations on October 17, 2005. These samples had TU values equal to 1.31, 1.29, and 1.30, respectively. The wet weather sample collected from Ballona Creek on November 09, 2005 also had a TU value of 1.34 for the fertilization test. These TU values triggered a TIE study in accordance with the Permit. The "baseline" tests conducted on these samples did not detect any toxicity, indicating no purpose to continue with further TIE manipulations. The fact that a slight amount of toxicity was observed in the initial chronic tests indicated that the toxicant was most likely associated with volatile compound(s). The compound(s) apparently dissipated to non-toxic levels between the time of the initial toxicity tests and initiation of the "baseline" toxicity testing.

- Ceriodaphnia dubia survival and reproduction were only significantly affected by exposure to the dry weather sample collected from the Malibu Creek mass emission station on April 25, 2006. This sample had a TU value of 1.60 for the survival test and that of 2.01 for the reproduction test, which triggered a TIE study in accordance with the Permit. The initial component of the TIE study was to conduct a "baseline" test to determine the final TIE test dilutions. The "baseline" test was conducted and toxicity was not observed in this sample, indicating no purpose in continuing with the TIE analysis. The fact that a slight amount of toxicity was observed in the initial chronic tests indicated that the toxicant was most likely associated with volatile compound(s). The compound(s) apparently dissipated to non-toxic levels between the time of the initial toxicity tests and initiation of the "baseline" toxicity testing.

- Sea urchin fertilization was only significantly affected by exposure to the dry weather sample collected from the Los Angeles River mass emission station on January 24, 2006. This sample had a TU value equal to 1.42. In accordance with the Permit, a TIE was attempted on this sample and toxicity was not observed during the "baseline" toxicity testing, indicating no purpose for furtherance of the TIE analysis. The fact that a slight amount of toxicity was observed in the initial chronic tests indicated that the toxicant was most likely associated with volatile compound(s). The compound(s) apparently dissipated to non-toxic levels between the time of the initial toxicity tests and initiation of the "baseline" toxicity testing.

4.2.4 Trash Monitoring Analysis

This section describes the trash monitoring results generated during the 2005-06 storm season. At least 600 catch basin inserts and four Continuous Deflective System (CDS) units have been installed in various land uses, including commercial, high density single family residential, industrial, low density single family residential, and open space/parks, across the Los Angeles River and Ballona Creek watersheds for monitoring trash discharge rates. The trash collected from each device was separated into two categories: Anthropogenic and Sediment/Vegetation. After separating into these categories, the trash collected was then weighed and recorded. Five cleaning events were conducted at each watershed during this storm season. Table 4-10a and Table 4-10b summarize the trash collection results for each cleaning event per land use. The Municipal Storm Water Permit requires a minimum of one photograph at each mass emission station after the first storm event and three additional storm events per year. Pictures can be found in Appendix C.

The following conclusions were drawn from the trash monitoring results for anthropogenic trash in Los Angeles River and Ballona Creek watersheds:

Los Angeles River Watershed

- The rate of collected trash to tributary area in the Los Angeles River Watershed from five cleaning events for 2005-06 storm season was 3.3 lbs/acre. The largest amount of trash collected from a single event occurred after the third storm event.

- The Industrial land use was the largest trash contributor of the entire storm season with a rate of 8.5 lbs/acre. The second highest contributor was the Commercial land use with a rate of 5.3 lbs/acre. It was followed by the High Density Single Family Residential, the Open Space and then the Low Density Single Family Residential land uses with rates of 2.6 lbs/acre, 1.2 lbs/acre, and 0.1 lbs/acre, respectively.

Ballona Creek Watershed

- The rate of collected trash to tributary area in the Ballona Creek Watershed from five cleaning events for 2005-06 storm season was 5.3 lbs/acre. The largest amount of trash collected from a single event occurred after the first storm event.

- The Commercial land use was the largest contributor of the entire storm season with a rate of 21.5 lbs/acre. The second largest trash generated rate was from the Open Space/Park land use with 4.8 lbs/acre. It was followed by a tie between Industrial and Low Density Single Family Residential with 2.5 lbs/acre. Finally, the lowest contributor was the High Density Single Family Residential land use with 1.6 lbs/acre.

4.2.5 Identification of Possible Sources

This section describes the possible sources of the constituents that did not meet the water quality standards during the 2005-2006 monitoring season in all or most of the watersheds, as discussed above in Section 4.2.1 and 4.2.2.

The source of bacteria is hard to pinpoint. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* published on November 8, 2001 by the California Regional Water Quality Control Board, Los Angeles Region, urban runoff from the storm drain system may have elevated levels of bacterial indicators due to 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 malfunctioning septic tanks among other things. Fecal matter from animals and birds can also elevate bacteria levels.

An article titled *Residential Sources of Contamination* on EPA's website states that elevated levels of chloride may be a result of fertilizers, animal sewage, industrial wastes, minerals, or seawater. It also shows that many metals, such as aluminum, silver, iron, and zinc, could be a result of natural deposits.

According to the report *Regulating Copper in Urban Stormwater Runoff* by G. Fred Lee, PhD and Anne Jones-Lee, PhD, copper can come from brake pads or industrial (such as 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* by A.P. Davis, M. Shokouhian, and S. Ni. The study concludes that significant 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. Atmospheric deposition was also identified as an important source of cadmium, copper, and lead.

The Agency for Toxic Substances and Disease Registry, Division of Toxicology, in Atlanta, Georgia prepared a *Public Health Statement, Cyanide*. In it, a few of the major sources of cyanides included vehicle exhaust and cyanide-containing pesticides.

Internet research on the Santa Monica Mountains range, *Geology of the Santa Monica Mountain Range (http://members.aol.com/OnDaNose/Geology2/SMMGeo.html)*, indicates that the geology of the Malibu Creek watershed is composed of sedimentary rock, a source of minerals like gypsum, containing sulfate. As Malibu Creek is still large natural, the Sulfate exceedances at Malibu Creek may be attributable to natural soil conditions.

Sources of Oil & Grease included oil and other lubricating agents leaking from vehicles and being washed during storms from roads, parking lots, gasoline stations and other areas of intense automobile use as reported in an article on Pollutants and Stormwater Runoff by J. A. Arnold, S.W. Coffey, D.E. Line, J. Spooner, Extension Biological & Agricultural Engineer Specialists, and D.W. Moody, U.S. Geological Survey, included in a paper titled *Urban Integrated Pest Management* for the North Carolina Cooperative Extension Service, College of Agriculture and Life Sciences, North Carolina State University.

As mentioned in the Basin Plan, the watersheds with excessive Total Dissolved Solids exceedances are often impaired (by high levels of minerals) and there is not sufficient historic data to designate objectives based on natural background conditions. The effluent limits applied in those watersheds were based upon guidelines in the Basin Plan that are intended to be protective of the MUN (Drinking Water Standards) Beneficial Use. Site-specific objectives have not yet been determined.

4.2.6 Recommendations

Monitoring components conducted during the 2005-2006 monitoring season included collecting two dry weather samples at each of the tributary monitoring stations as recommended in the 2002-2003 monitoring report. In addition, all required samples were taken, including dry weather and toxicity samples. The only exception was the lack of capture of composite samples at the Benedict Canyon Tributary Monitoring site due to mechanical issues. Below are some recommendations that were identified based on results of monitoring in the 2005-2006 monitoring season.

Many of the polychlorinated biphenyls, SVOCs (Semi Volatile Organic Compunds), and chlorinated pesticides cannot be compared to the water quality standards because there are no standards listed in the Basin Plan, Ocean Plan, or CTR. However, even if there were water quality standards, all of these constituents were not detected at any of the mass emission or tributary monitoring stations. We recommend discontinuing sampling for these constituents, except during the first storm event of every year.

Some constituents sampled at the tributary stations, particularly Total Copper and Total Zinc continued to show exceedances of water quality standards during this second year of monitoring. The Municipal Storm Water Permit requires the initiation of a focused effort to identify sources of pollutant within that sub-watershed when a constituent exceeds a water quality standard in three out of four samples. To identify the possible sources of these pollutants, LACDPW compared them with the water quality data collected from the land-use monitoring stations. The land-use of all tributary monitoring stations is predominantly high density single family residential. The land-use monitoring water quality data indicate that Total Copper and Total Zinc were also typically found from the same land-use, high density single family residential. Based upon two-years of monitoring at the Ballona Creek Tributary Monitoring sites, it is recommended that management actions be focused upon the Constituents of Concern in the Adams Drain, Cochran, and Centinela Creek watersheds for wet weather. For dry weather, it is recommended that management actions be focused upon the Constituents of Concern in the Adams Drain, Cochran, and Fairfax Drain watersheds.

As two seasons have been spent gathering data at Ballona Creek tributary monitoring sites, verifying results, it is recommended that tributary monitoring be moved to San Gabriel River tributaries for the 2006-2007 season.

In order to identify and better understand the source(s) of pollution, mass emission monitoring, toxicity monitoring, trash monitoring, and tributary monitoring will be continued in the future in addition to the regional monitoring and special studies, as required by the Municipal Storm Water Permit.