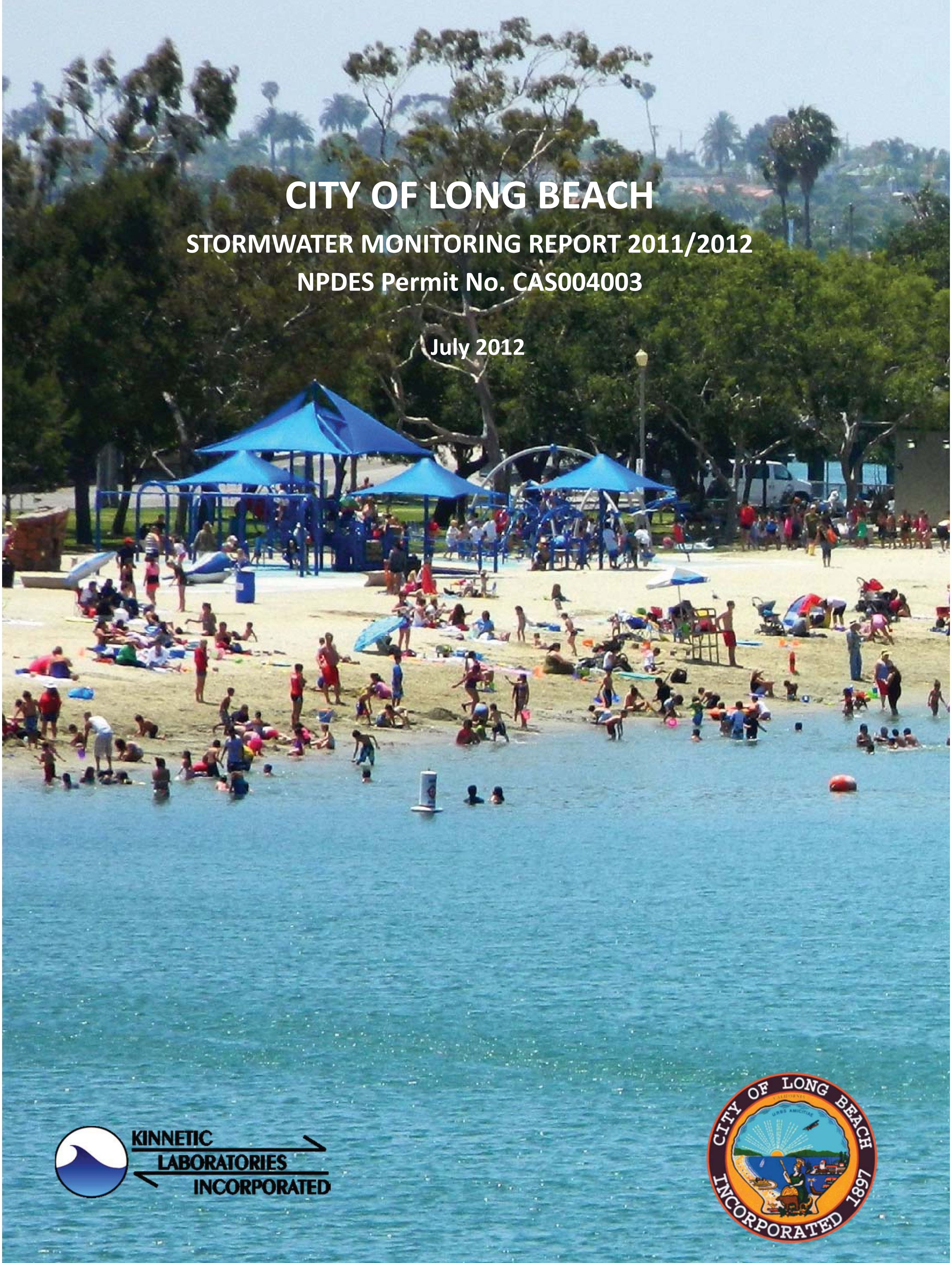
CITY OF LONG BEACH

STORMWATER MONITORING REPORT 2011/2012

NPDES Permit No. CAS004003

July 2012



KINNETIC LABORATORIES INCORPORATED

CITY OF LONG BEACH
DEPARTMENT OF PUBLIC WORKS

STORM WATER MANAGEMENT
CITY OF LONG BEACH

333 W. Ocean Blvd., 9th Floor | Long Beach, CA 90802 | (562) 570-6023 FAX: (562) 570-6501

STORM WATER/ENVIRONMENTAL COMPLIANCE DIVISION

July 12, 2012

The City of Long Beach is pleased to submit the twelfth annual, "Stormwater Monitoring Report, 2011/2012" in compliance with Order No. 99-060 of the Municipal National Pollutant Discharge Elimination System (NPDES) Permit No. CAS004003, (CI8052).

We have worked collaboratively with our contractor Kinnetic Laboratories, Inc., and their subcontractors to produce a report that we believe contains extremely useful information for the City and the Los Angeles Regional Water Quality Control Board/State Water Resources Control Board. As required in our permit, all analyses were conducted at laboratories certified for such analyses by the Department of Health Services or approved by the Executive Officer in accordance with US EPA guidelines procedures or as specified in this Monitoring Program.

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 evaluated 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 known violations.

Executed on the 12th of July, 2012
at Long Beach, California.

Anthony Arevalo
Storm Water/Environmental Compliance Officer

7-12-2012
Date

Cc: Michael Conway, Director of Public Works
Derek Wieske, Acting City Engineer

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CITY OF LONG BEACH

STORMWATER MONITORING REPORT 2011/2012

NPDES Permit No. CAS004003 (CI 8052)

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ACRONYMNS AND ABBREVIATIONS LIST

ASTM - American Society for Testing and Materials
BMP - Best Management Practice
BOD- Biological Oxygen Demand
CCC – Criterion Continuous Concentration
CD - Compact Disk
CFU - Colony Forming Units
CMC – Criterion Maximum Concentration
COD - Chemical Oxygen Demand
CRWQCB – California Regional Water Quality Control Board
CTR - California Toxics Rule
DDD - dichloro (p-chlorophenyl)ethane
DDE - dichloro (p-chlorophenyl)ethylene
DDT - dichlorodiphenyl trichloroethane
DF - dilution factor
DI - Deionized
DL - Detection Limit (considered the same as RL)
DO - Dissolved Oxygen
EC_{50} - Concentration causing effects to 50% of the test population
EDTA - ethylene diamine triacetic acid
EMC - Event mean concentration
GIS - Geographic Information System
IC_{25} - Concentration causing 25% inhibition in growth or reproduction
IC_{50} - Concentration causing 50% inhibition in growth or reproduction
ICID - Illegal Connection Illicit Discharge
ICP-MS - Inductively Coupled Plasma-Mass Spectrometry
KLASS - Kinnetic Laboratories Automated Sampling System
KLI - Kinnetic Laboratories, Inc.
LC_{50} - Bioassay concentration that produces 50% lethality
LDPE - Low Density Polyethylene
LOEC - Lowest Observed Effect Concentration
MBAS - methylene-blue-active substances
ML – Minimum level as defined in State Implementation Plan
MPN- Most Probable Number
MS4 - Multiple Separate Storm Sewer System
NPDES – National Pollutant Discharge Elimination System
NOEC - No observed effect concentration
NTU - nephelometric turbidity units
PCB - Polychlorinated biphenyls
PDF - Portable Document Format
PMSDs - Percent Minimum Significant Differences
ppb - Parts per Billion
ppt – Parts per Thousand
Q - Flow
QA/QC - Quality Assurance/Quality Control
RL - Reporting Limit (considered the same as DL)
RPD - Relative Percent Difference

sf - Square Feet
SIP – State Implementation Plan
SM- Standard Methods for the Examination of Water and Wastewater
SOP - Standard Operating Procedure
SRM - Standard Reference Material
STS - sodium tetradecyl sulfate
SWRCB-State Water Resource Control Board
TDS – Total Dissolved Solids
TIE – Toxicity Identification Evaluation
TKN - Total Kjeldahl Nitrogen
TOC - Total Organic Carbons
TPH - total petroleum hydrocarbons
TSS – Total Suspended Solids
TU - Toxicity Unit
TU_a – Acute Toxicity Unit (1/LC_{50} or EC_{50})
TU_c – Chronic Toxicity Unit (1/NOEC)
USEPA - U.S. Environmental Protection Agency
WQO - Water Quality Objective
WQS - Water Quality Standard

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EXECUTIVE SUMMARY

This report provides a summary of the results of the twelfth year of monitoring conducted under the terms of Order No. 99-060 National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052) for City of Long Beach. Included in this report is a synthesis of key elements of the data set as developed over the past 12 years. The following section provides a summary of the background and purpose of the monitoring program. This is followed by a summary of key findings based upon the full duration of monitoring starting in early 2000 and going through May, 2012.

BACKGROUND AND PURPOSE

Under the terms of Order No. 99-060, the City of Long Beach was required to conduct a water quality monitoring program for stormwater and dry weather discharges through the City's municipal separate storm sewer system (MS4) beginning in the 1999/2000 wet weather season. The permit was initially issued for the term of five years. At the end of the initial five years the City was directed by the Regional Board to continue operating under the 1999 permit until further notice. Current guidance from Regional Board staff indicates that a new permit is expected to be issued in the near future (2012 or 2013). The Regional Board is currently updating the Los Angeles County permit and reissuance of a new NPDES permit for the City of Long Beach is expected to follow shortly thereafter. It is expected that the new permit will be similar to the permit currently being negotiated with Los Angeles County but will not be as extensive due to the substantial differences in watersheds.

Major elements of the current monitoring and reporting program include 1) mass emission monitoring during storm events, 2) monitoring of dry weather discharges at each mass emission site, and 3) special studies. Special studies are intended to improve assessment of impacts on receiving water, identify sources and sinks for contaminants, and assess compliance with TMDL targets and water quality objectives. The City has been very proactive in the development of a variety of special studies that were identified as priority projects for addressing specific concerns. Data from the monitoring program is intended to support decisions necessary to refine BMPs for the reduction of pollutant loading and the protection and enhancement of beneficial use of the receiving waters.

Mass emission monitoring is specified to be conducted at four sites during four wet weather storm events each year. Monitoring sites specified in the permit are as follows:

- Dominguez Gap Pump Station
- Bouton Creek
- Belmont Pump Station
- Los Cerritos Channel

Mass emission monitoring program is intended to characterize stormwater discharges, identify contaminants of concern and develop pollutant load estimates for each major watershed. Monitoring is required to be conducted during the first significant rainfall event of the season. Flow-rated, whole storm composite samples are obtained at each site and analyzed for major constituents of concern which include conventional constituents, total and dissolved metals, organochlorine pesticides, organophosphate pesticides and, most recently, pyrethroid pesticides. Toxicity testing using sea urchin fertilization tests and water flea survival and reproduction is conducted on composite storm samples from three of the four mass emission sites. Phase 1 Toxicity Identification Evaluations (TIEs) are required to be performed on all samples that exhibit toxicity in excess of predetermined trigger values. The TIE process is used to determine the likely contaminants contributing to the observed toxicity.

Dry weather monitoring consists of inspections conducted at each mass emission site and the collection and analysis of dry weather discharges over 24-hour periods. Monitoring is required to be conducted twice during each dry season. Sampling is typically conducted in September just prior to the storm season and in May after several weeks of no rain. This element of the program is intended to identify pollutants of concern and associated toxicity at the mass emission sites during the dry season. Dry weather discharge samples are subjected to the same chemical analysis and toxicity testing procedures as used for stormwater monitoring.

The purpose of this report is to transmit the results of the monitoring conducted in accordance with the City of Long Beach's NPDES permit. Results are summarized for the current monitoring season (2011/2012) and compared with results from the full twelve years of monitoring.

SUMMARY OF RESULTS

The 2011/2012 season had below normal rainfall and considerably less rainfall than the 2010/2011 season. This season's cumulative rainfall of 7.53 inches at the airport is well below the normal wet season average of 12.27 inches and below the average of 10.32 inches since the inception of this program in 1999.

Two dry weather inspections/monitoring events were conducted during the 2011/2012 monitoring year. These surveys are conducted during the summer dry weather period at each of three mass emission stations. Dry weather sampling has not been conducted at the Belmont Pump Station since all dry weather flows were diverted to the sanitary system in 2009. Although the Dominguez Gap Pump Station was always inspected during dry weather surveys, discharges were never observed until completion of the wetland treatment system. This is only the third year that we have sampled dry weather discharges from the Dominguez Pump Station but it is important to note that dry weather flows consist predominantly of water that is drawn from the Los Angeles River and passed through the Dominguez Gap wetlands to provide both treatment and to enhance the constructed wetland habitat. Due to the methods of operation, dry weather monitoring was limited to the spring dry weather survey. No water was being discharged when the site was first visited for the fall dry weather monitoring effort.

The first dry weather survey was conducted on September 13-14, 2011 about two weeks prior to the first storm event of the year. The second dry weather survey was conducted on May 1-2, 2012 after more than two weeks of dry weather conditions.

Despite the low seasonal rainfall, the maximum number of storm events (four) was monitored at three of the four stations this season. Two monitoring events were captured at the Dominguez Gap Pump Station. A major objective for this site is to avoid discharges during storm events through better management of water levels within the wetlands such that a maximum amount of time is provided for infiltration and settling before actively lowering the level for subsequent storm events. It is likely that further improvements in water level management could have prevented or at least substantially minimized stormwater discharges during this past year. Water levels maintained in the sump and daily rainfall patterns were reviewed to allow examination of possible alternatives.

In addition to storm events sampled for the full suite of analyses, three events at Belmont Pump, three events at Bouton Creek, and two events at Los Cerritos Channel were sampled for total suspended solids (TSS) only. TSS events were conducted only when there was not sufficient rainfall and sample volume to conduct the majority of the analyses or after the required four events were completed that included the full suite of analyses.

For the purpose of this report, water quality criteria or objectives were used to provide reference points or benchmarks for assessing the relative importance of various stormwater contaminants. Specific receiving water studies would be necessary to quantify the presence and magnitude of any real impact on receiving water quality and beneficial uses. The 2005 California Ocean Plan (SWRCB, 2006), the Los Angeles Region Basin Plan (CRWQCB, Los Angeles Region, 1994), California Department of Fish and Game (Siepmann and Finlayson, 2002) criteria for chlorpyrifos and diazinon, and both saltwater and freshwater criteria from the California Toxics Rule (USEPA, 2000) were used as benchmarks as requested by Regional Board staff. In addition, National Recommended Water Quality Criteria (USEPA, 2009) were used as benchmarks for compounds such as malathion that are not considered to be priority pollutants. Additional benchmarks were included based upon recently proposed methodology for derivation of water quality criteria developed by the University of California at Davis (Fojut et al. 2012). Available toxicity reference data (Werner and Oram, 2008) were also used to provide comparisons of stormwater concentrations with contaminant concentrations shown to exert a toxic response. This evaluation is intended to provide a framework for evaluating constituents of concern and allow for identification of watersheds that could benefit from additional BMPs or source identification/reduction efforts.

Wet Weather Chemical and Bacterial Results

Benchmark reference values have been often exceeded for dissolved forms of copper, lead and zinc throughout the life of the permit (Kinnetic Laboratories, Inc., 2011). For stormwater discharges, the CTR freshwater acute criteria are the most applicable benchmarks for all sites. Copper and zinc have continued to exceed benchmark criteria on a frequent basis at all but the Dominguez Gap Pump Station site. Dissolved copper exceeded the CTR freshwater criteria in 71% of all stormwater samples this wet season. Stormwater discharged from the Dominguez Gap Pump Station slightly exceeded the CTR saltwater criterion during one of two monitored events. Concentrations of dissolved zinc exceeded the CTR freshwater acute criterion in 50% of the samples which included one event at the Belmont Pump Station, two during events at the Bouton Creek site and all four events in the Los Cerritos Channel. The acute lead criterion used as a benchmark for shorter term stormwater discharges was never exceeded.

Other than bacteria, few other constituents have exceeded benchmark values. MBAS minimally exceeded the Basin Plan criteria of 0.5 mg/L in the Los Cerritos Channel during the first storm event and pH was just above the upper limit (8.5) in samples taken from one event in Bouton Creek.

Chlorinated pesticides are typically not measured at high concentrations in stormwater due to both strong associations with sediment and the fact that most have been banned for over 20 years. Despite this fact, chlordane compounds are still detected in a large percentage of the samples. Discharges from the Belmont Pump Station have most commonly had the highest levels of these compounds. This year chlordane was again detected in a stormwater sample from the Belmont Pump but the concentration did not exceed the acute CTR criterion. The consistency of chlorinated compounds in discharges from this watershed remains a concern. The continued detection of low concentrations of chlordane compounds suggest that either some limited use of chlordane may be occurring or the degradation of legacy applications of chlordane has not occurred at rates that one would expect. These low levels may also be continuing to contribute loads to the receiving water sediments. One of the primary components of technical chlordane, alpha-chlordane, is one of the compounds that is incorporated into the chemical testing conducted for California's Sediment Quality Objectives. In addition, sediments within the estuary of the Los Cerritos Channel are currently listed.

This year was the first full year where pyrethroid pesticides were analyzed for all events. The highest concentrations of pyrethroid pesticides were encountered in stormwater from the Belmont Pump Station. This was consistent for all seven pyrethroid pesticides detected. Pyrethroids were also present at high levels in stormwater from the Los Cerritos Channel. Pyrethroids were detected in stormwater from both Bouton Creek and the Dominguez Gap Pump Station but at far lower concentrations.

Wet weather flows in the Los Cerritos Channel are subject to TMDL limits for total recoverable copper, lead and zinc. Lead remained well below TMDL limits but both copper and zinc exceeded TMDL limits during each of the four storm events. Copper loads were exceeded by a factor of 1.9 to 8 times the limit while zinc loads were by a factor of 1.4 to 5.9 times the limit.

Stormwater discharged to the Los Angeles River from the Dominguez Gap Pump Station continues to contain lower concentrations of most major constituents of concern. After the 2010/2011 season, total cadmium, dissolved and total copper, and dissolved and total zinc were all found to be significantly lower ($p<0.05$) than measured at the three other mass emission sites. In the case of lead, no significant differences were evident among stations for dissolved lead but stormwater discharges from both the Dominguez Gap Pump Station and Bouton Creek had significantly lower concentrations of total lead than measured at the Belmont Pump Station and the Los Cerritos Channel.

The concentrations of total recoverable copper, lead, and zinc measured in the two storm events at the Dominguez Gap Pump Station were low (19 and 20 ug/L for copper, 11 and 15 ug/L for lead; 95 and 110 ug/L for zinc) yet copper concentrations still exceeded the 17 ug/L TMDL wet weather target for Los Angeles River Reach 1. The total recoverable concentrations of lead and zinc were far below the respective TMDL target limitations of 62 ug/L for lead and the 159 ug/L for zinc. Although the total recoverable limit was exceeded for copper, neither storm event would have exceeded the limits if the corresponding dissolved criterion of 11 ug/L was used.

Although the Dominguez Gap Pump Station and associated wetlands have shown significant water quality benefits, the potential for further improvement water quality exist through better management of water levels to further reducing mass emissions of metals to the Los Angeles River. Water levels in the wetlands are preferably maintained at 7-8 feet during the wet season. This has been shown to provide capacity for at least one inch of runoff. After storm events, the benefits of retaining the stormwater as long as possible would ideally be balanced with the need to maintain capacity for subsequent storm events. We recommend allowing the stormwater to infiltrate and settle as long as possible. However, if another storm is predicted, water levels should be manually pumped down to a level of 7-8 feet in the sump to provide capacity for the following storm(s). We are continuing to work with the Los Angeles County Department of Public Works in order to reach a common ground as to maintenance practices that will balance both wetland and stormwater benefits and comply with the EIR.

Dry Weather Chemical and Bacterial Results

The City's NPDES Permit requires two dry weather inspections and sampling events to be conducted at each of the four mass emission stations during the summer dry weather period.

Site inspections are conducted at all sites to determine if water is present and whether water is flowing or just ponded. If flowing water is evident at any one of the mass emission sites, *in situ* water quality measurements, flow estimates, and composite water samples are taken along with general observations of site conditions.

For the past several seasons the Belmont Pump Station dry weather flows have been diverted to the sanitary sewer system either by means of a temporary pump or by the permanent low-flow diverter system completed in December 2009. During the same general time period, the Dominguez Gap infiltration basin has been modified into a wetland treatment system designed to provide a range of both environmental and recreational benefits. During dry weather periods, flow through the wetlands is intended to be maintained by a summer pump.

Dry weather flows in Bouton Creek and the Los Cerritos Channel notably declined in recent years. The dry weather flows at these sites appear to have stabilized at these lower levels. Prior to the 2009/2010 monitoring season, dry weather flows in Bouton Creek were not sufficient to flush seawater from the creek for three consecutive events. As a result, the location for dry weather monitoring was relocated 1,250 feet upstream from the primary site location at the LADPW Alamitos Yard. Field observations and measurements taken at the new site indicate that this new location will be permanently maintained for purposes of the dry season measurements. Outfalls located along the creek from Alamitos Yard to CSULB were observed to determine if any major dry weather discharges were missed by moving the site upstream. No discharges were identified from downstream storm drains during these tests.

Copper measured in dry weather flows from the Los Cerritos Channel were found to be well within the established dry weather TMDL limits. Although the concentration of total recoverable copper was near the TMDL limit, loads were far below the TMDL limitation due to the much reduced dry weather flows in the Los Cerritos Channel.

Overall, data continue to demonstrate consistent, high quality discharges from the Dominguez Gap Pump Station. Both the wetlands and detention provided by this site are credited with providing stormwater treatment that allows discharges to the Los Angeles River to meet acceptable water quality standards under most conditions. In fact, dry weather discharges from the Dominguez Gap Pump Station are consistently shown to improve water quality in the Los Angeles River water that is passed through the wetlands during the dry season. Metals in these discharges meet the receiving water quality criteria and are demonstratively better than water quality measurements taken at the Los Angeles River Wardlow monitoring site by the Coordinated Monitoring Program.

The treatment provided by the wetlands and detention of dry weather discharges has also resulted in water that has consistently met bacterial water quality standards. Although there was no discharge during the first dry weather survey, bacterial water quality during the second weather survey at the Dominguez Gap Pump Station remained within bacterial water quality standards for the receiving waters. The overall water quality met all applicable standards including trace metal concentrations required by the Los Angeles River metals TMDL.

Temporal Trends in Constituents of Concern

Most long-term trends tend to be obscured by factors that are not evident when exclusively looking at changes in concentrations. Unlike the abrupt decline in diazinon and chlorpyrifos that was occurred soon after removing these pesticides from the market, changes have been relatively gradual. In some cases, it has taken a full decade to observe clear visual trends based upon the long-term graphics in Appendix C.

- No trends are evident in the concentrations of total and dissolved copper measured at each site during either wet or dry weather.
- Concentrations of both total and dissolved lead have been decreasing slowly at all sites since the start of the stormwater program in 2000.
- Although changes are not as distinct, total and dissolved zinc show some signs of decreasing particularly in the Los Cerritos Channel.

- Malathion, another organophosphate pesticide, showed signs of increasing at the Belmont Pump Station but concentrations are now typically below the proposed acute criterion proposed by UC Davis.
- The frequent detection of elevated concentrations of malathion have predominately occurred in the Belmont Pump Station and, to a lesser degree, in the Los Cerritos Channel subwatersheds. This pesticide only elevated in a single sample from the Bouton Creek subwatershed and in three samples from the Dominguez Gap Pump Station subwatershed.
- Fecal indicator bacteria (FIB) typically exceed Basin Plan water quality criteria during wet season monitoring and show no evidence of increasing or decreasing contamination. Lower concentrations of fecal indicator bacteria are present in dry weather discharges (Appendix C). As a general rule, concentrations of FIBs measured in dry weather flows occasionally meet water quality criteria.
- Fecal indicator bacteria measured in dry weather flows at the Los Cerritos Channel site are now showing signs of decreasing. Total coliforms, fecal coliforms, and entercoccus are trending lower and are more frequently meeting water quality objectives during dry weather monitoring.
- In contrast, FIBs at the Bouton Creek site, particularly total and fecal coliform, are consistently exceeding water quality criteria compared to historical measurements that met objectives about 50% of the time.
- The changes in FIBs measured during dry weather surveys suggest that the lower flow rates in the Los Cerritos Channel are providing more time for exposure to the effects of UV light while the opposite is true in Bouton Creek. The new site is located at the point where flows are emerging from an enclosed conveyance and thus have less exposure to UV light.
- The first five dry weather monitoring events conducted at the Dominguez Gap Pump Station all had FIB concentrations that were below applicable water quality criteria.
- Long term trends at the Dominguez Gap Pump Station are currently difficult to assess. Over the first six to seven years of the monitoring effort stormwater discharges at the Dominguez Gap Pump Station were uncommon and, when they occurred, concentrations of TSS and metals were among the lowest encountered at the four mass emission sites. Some of the highest concentrations of TSS, metals and other contaminants occurred during storm events monitored when the wetland treatment system was under construction or not well developed. Since that time, water quality appears to be continually improving and further improvements are expected as operational aspects of the basin are improved.

Toxicity Results

A general trend of reduced toxicity had been observed in recent years at all sites. Although no significant daphnid mortality was observed at any of the three sites, toxicity was evident in 75% of the tests conducted using the sea urchin fertilization test. The magnitude of the toxicity was sufficient to trigger a Toxicity Identification Evaluation (TIE) on one sample from the Belmont Pump Station in association the fourth storm event. Baseline testing performed for the TIE indicated that a significant amount of toxicity was lost prior to the TIE. Although the toxicity of the sample decreased substantially, data still suggested a cationic metal as the most likely toxicant. The reason for the loss in toxicity could not be determined although rapid loss of toxicity if often attributed to loss of volatiles.

Comparisons of the actual toxicity versus expected toxicity calculated from the concentrations of key toxicants provided conflicting evidence. Concentrations of dissolved metals, particularly zinc, measured in stormwater samples during the first monitored event were present in concentrations that would be expected to cause toxicity. In contrast, dissolved metals present in the Belmont Pump TIE sample were not sufficient to have explained the observed toxicity.

Dry weather samples continue to show a lack of toxicity based upon both the daphnid and sea urchin fertilization test.

RECOMMENDED PROGRAMATIC CHANGES

A few adjustments to the NPDES monitoring program are recommended based upon the results of the 2011/2012 monitoring period as well as work conducted over the past twelve years.

- Pyrethroid pesticides are recommended for continued monitoring at all mass emission sites. Monitoring of these compounds was implemented midyear during the 2010/2011 season and continued through this past monitoring year. The results of this initial period indicated that pyrethroids were present in relatively high levels compared to other programs in Southern California. Concentrations measured are well within the ranges where one might expect toxicity to occur in the water column yet the mitigating effects of high concentrations of suspended sediment and dissolved organic carbon may effectively limit toxicity during storm events. We highly recommend maintaining this group of pesticides as part of the standard analytical suite.
- In addition to the pyrethroids, another emerging constituent of concern is fipronil and its metabolites. This broad use insecticide belongs to the phenylpyrazole chemical family. Fipronil is used to control ants, beetles, cockroaches, fleas, ticks, termites, mole crickets, thrips, rootworms, weevils, and other insects. Use of this pesticide for structural pest control has increased dramatically since 2001 and has been documented in stormwater runoff at concentrations well above those considered lethal for daphnids. Due to the concern that this pesticide has the potential to be the next major pollutant of concern and potential for increasing use if pyrethroids become limited, it would be valuable to incorporate this contaminant in routine screening. Recent studies by Ensminger and Kelley (2011) indicate that fipronil and its metabolites are now being frequently detected in urban stormwater.
- Install sensors to monitor run time for the sump pump at Dominguez Pump in order to estimate discharges through the dry season. A request has been submitted to the County to provide open contacts that can be integrated with the stormwater monitoring equipment at this site.
- Work should continue to coordinate with Los Angeles County Public Works to improve operation of the wetlands and pump station during the wet season to maximize retention, infiltration, and settling before any necessary pumped discharges to the Los Angeles River. This should include pursuit of a permit to monitor operation of the sump pump in order to better estimate long-term discharge volumes during dry weather. This effort should emphasize compliance with the Project's EIR.
- In addition it is recommended that the City focuses on the Belmont Pump Station subwatershed to encourage use of IPM (integrated pest management) to minimize use of pesticides. The City of Long Beach Stormwater Progam is already in the process of developing an educational program to inform the Public and Businesses in the area about the effects and consequences of the use of pesticides through mailers, additional flyers, in the new Storm Water Face Book page. They are also creating a City TV broadcast and developing information for schools in the area to get students to inform their parents.

With the expectation of a new NPDES permit being issued in the near future, we would also suggest that the Regional Board consider alternative approaches to the monitoring program to improve the overall efficacy. After 12 years of monitoring the mass emission sites for storm events four times a year and monitoring dry weather flows twice a year the program results are just starting to show evidence of relatively slow changes in the water quality of these discharges. Copper, one of the key contaminants of concern, is expected to take at least another decade before measureable responses to reductions in the copper content of brake pads can be documented. Many of the current constituents of concern are also persistent compounds that strongly associate with particulates and that have the potential to accumulate in the receiving water sediments. These analytes are often poorly quantified in stormwater using conventional analytical strategies.

Adjustment of routine mass emission monitoring efforts to alternate every permit cycle (5 years) would still allow these long-term changes to be documented. During cycles when routine mass emission monitoring efforts are not being conducted, efforts would be directed toward documenting the distribution of contaminants in the receiving water sediment and biota. These studies would be used to determine if stormwater discharges are having a detrimental effect and identify subwatersheds that are the most likely sources of the contaminants. If warranted, the results would be used to modify the mass emission monitoring efforts during the next cycle. Some mass emission monitoring would be necessary to address ongoing TMDLs but work would be limited to the specific analytes of concern.

INTRODUCTION

The City of Long Beach received an NPDES Permit issued by the California Regional Water Quality Control Board, Los Angeles Region on 30 June 1999 (Order No 99-060, NPDES No. CAS004003, [CI 8052]). This order defined Waste Discharge Requirements for Municipal Stormwater and Urban Runoff discharges within the City of Long Beach. Specifically, the permit regulates discharges of stormwater and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems, into receiving waters of the Los Angeles Basin.

The discharges from the MS4 system consist of surface runoff (non-stormwater and stormwater) from various land uses in the hydrologic drainage basins within the City. Approximately 44% of the land area discharges to the Los Angeles River, 7% to the San Gabriel River, and the remaining 49% drains directly to Long Beach Harbor and San Pedro Bay (City of Long Beach Municipal Stormwater Permit, CRWQCB, 1999). The quality and quantity of these discharges vary considerably and are affected by the hydrology, geology, and land use characteristics of the watersheds; seasonal weather patterns; and frequency and duration of storm events. Impairments or threatened impairments of beneficial uses of water bodies in Long Beach include the ocean beaches west of the Belmont Pier and the Los Angeles River estuary, Los Angeles River Reach 1 and Reach 2, Alamitos Bay, El Dorado Lake, San Gabriel River Estuary, San Gabriel River Reach 1, Coyote Creek, Colorado Lagoon, and the Los Cerritos Channel.

A number of TMDLs have been implemented or are under development in the 303(d) listed water bodies that receive runoff from the City of Long Beach (Table 1). Metals, bacteria and trash are the most common targets of these TMDLs although organochlorine pesticides, PCBs and PAHs are also a concern in some segments. The TMDLs listed in Table 1 are only those that currently impact the City or that will need to be addressed in the very near future.

ANNUAL PROGRAM ADJUSTMENTS

The 1999 NPDES permit requires the City of Long Beach to prepare, maintain, and update if necessary a monitoring plan. The original monitoring plan required the City to monitor three (Year 1) and four (Years 2 through 5) discharge sites draining representative urban watersheds (mass emission sites) during the program. Flow, chemical analysis of water quality, and toxicity were to be monitored at each of these sites for four representative storm events each year. During the dry season, inspections and monitoring of these same discharge sites were to be carried out, with the same water quality characterization and toxicity tests to be run. In addition, one receiving water body (Alamitos Bay) was to be monitored during the first two years of the program for bacteria and toxicity. Monitoring at the Alamitos Bay site was to be conducted during both the wet and the dry seasons and was to be used to document the effect of a dry weather diversion. In the early years of the program, the annual report was reviewed and adjustments made based upon discussions with Regional Board staff.

Although no recommended changes have been provided by the Regional Board staff in recent years, the City has continued to make improvements to the program in response to changing conditions. Pesticides use has changed substantially since this program was started in 2000. Organophosphate pesticides were identified to routinely exert toxicity in stormwater runoff. Diazinon and chlorpyrifos were the primary toxicants. The California Stormwater Quality Association (CASQA) led an effort to get these pesticides removed from use. In the mean time, pyrethroid pesticides have become the most common pesticides used in the urban environment and are also highly toxic in both the water column during storms and later in the benthic environment where they tend to bind to sediments. Evolution of the program is summarized in Table 2.

Table 1. Impaired Water Bodies with Existing or Developing TMDLs.

Water Body	Pollutant	Basin Plan Amendment/ Board Resolution	Approval or Effective Date
Los Angeles River	Metals Metals reconsideration	2007-14 R10-003	October 29, 2008 March 23, 2012
	Trash	2007-12	September 23, 2008
	Bacteria	2011-0056	March 23, 2012
Los Angeles River Estuary (Queensway Bay)	Sediment Only -Chlordane, DDT, Lead, PCBs, Zinc, Sediment Toxicity	303 (d) listed	TMDL action expected to be complete by 2019
Los Angeles River Reach 1	Cyanide, Diazinon	303 (d) listed	TMDL action expected to be complete by 2019
Alamitos Bay	Bacteria	303 (d) listed	TMDL action expected to be complete by 2019
El Dorado Lakes	Copper	TMDL Equivalent CAO No. R4-2012-003	TMDL applied as single regulatory action January 10, 2012
San Gabriel River	Metals and Selenium	2006-14	Effective March 26, 2007
San Gabriel River Estuary	Dioxins, nickel, dissolved oxygen	303 (d) listed	TMDL action expected to be complete by 2012
San Gabriel River Reach 1	Coliform bacteria	303 (d) listed	TMDL action expected to be complete by 2019
Coyote Creek	Coliform, diazinon, pH	303 (d) listed	TMDL action expected to be complete by 2019
Colorado Lagoon	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	R09-005	July 28, 2011
Los Angeles and Long Beach Harbors	Organochlorine Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals	R11-008	March 23, 2012
Los Cerritos Channel, freshwater portion	Metals	EPA TMDL 38254	March 17, 2010
Los Cerritos Channel	Ammonia, pH, trash, bis(2,ethylhexyl)phthalate, chlordane (sediment), coliform bacteria	303 (d) listed	TMDL action expected to be complete by 2019 Ammonia – 2015 pH -2021
City of Long Beach Coastal Beaches	Bacteria	EPA	March 26, 2012

1. EPA – U. S. Environmental Protection Agency, Region 9

Table 2. Summary of the City of Long Beach Stormwater NPDES Monitoring and Reporting Program with Annual Adjustments.

1999 Monitoring and Reporting Program

Mass Emission Site Monitoring

- Monitor 3 mass emission sites (Belmont Pump Station, Bouton Creek and Dominguez Gap Pump Station) during the 1st year of the permit. Add a 4th mass emission site (Los Cerritos Channel) during the 2nd and subsequent years. Flow-rated composites to be obtained during 4 storm events at each site and analyzed for:
  - ✓ conventionals, total and dissolved metals, semivolatile organic compounds, organochlorine pesticides, organophosphate pesticides, herbicides and MBTE.
  - ✓ toxicity testing using mysids, sea urchin and water flea.
  - ✓ Phase 1 Toxicity Identification Evaluations (TIEs) to be conducted when 3 consecutive wet weather or 2 consecutive dry weather samples from the same monitoring station show toxicity.
  - ✓ Grab samples for indicator bacteria and oil and grease.

  Dry season inspections and monitoring to be conducted at each mass emission site 2 times per year. Sampling of dry weather flows to be conducted over 24-hour periods to provide representative samples. Samples from each site to be tested consistent with stormwater monitoring.

Receiving Waters

- Conduct receiving water quality monitoring in Alamitos Bay for the first two years of the program to document effects of a dry weather diversion. Testing to consist of indicator bacteria and toxicity.

Special Studies

- Conduct a special study to examine characteristics of stormwater runoff from parking lots (one year only).

2001 - M&R Program Modifications

- List of constituents and reporting limits modified for consistency with minimum levels (MLs) listed in the State's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays and Estuaries of California* (SIP).
- TIE triggers altered to enhance opportunities for defining toxicity whenever it occurs.
- Use of the mysid toxicity test reduced to include only the first event of the season.

2002 - M&R Program Modifications

- Suspend toxicity monitoring at the Dominguez Pump Station monitoring site.
- Suspend monitoring of semivolatile organic compound.
- Conduct a pilot plume monitoring program in Alamitos Bay to document the horizontal and vertical extent of the stormwater plume in the receiving waters, measure the concentration of selected metals and organophosphate pesticides at four points in the plume and conduct sea urchin bioassay tests to document potential toxicity in the plume.
- Immediate upstream investigations were to be conducted if elevated pH was detected during dry weather surveys at mass emission monitoring sites in order to document the source or cause.

2003 - M&R Program Modifications

- Suspend analyses of parameters infrequently detected and/or typically detected at low levels.
- Continue the pilot plume monitoring program targeting the first storm of the season.
- Adjust TIE triggers – TIEs to be conducted using water flea when toxicity exceeds 2 toxicity units (TUs). TIEs to be conducted using sea urchins when toxicity exceeds 3 TUs.
- Change monitoring strategy to emphasize sampling during early season events.
- Monitor TSS and stormwater flow for all storm events at all four mass emission sites.

Table 2. Summary of the City of Long Beach Stormwater NPDES Monitoring and Reporting Program with Annual Adjustments. (continued)

2004 - M&R Program Modifications
• Recommended setting minimum of 7 days between monitored events. • Include daily records of rainfall for current and previous seasons in report. • Submit draft work plan for identification of PBT sources to Stormwater Monitoring Coalition (SMC) for input and participation.
2005 – 2006 M&R Program Modifications
• No changes; continue with current program.
2007 - M&R Program Modifications
• Completed PBT source study in the Colorado Lagoon storm drains and suspended Stormwater Runoff Plume Monitoring in Alamitos Bay.
2008 - M&R Program Modifications
• City independently implemented two Special Studies in the Los Cerritos Channel to investigate the source and fate of constituents of concern in the freshwater the watershed and the estuarine segments.
2009 - M&R Program Modifications
• No changes, continue with current program
2010 - M&R Program Modifications
• City independently implemented two Special Studies in the Los Cerritos Channel to investigate the source and fate of constituents of concern in the freshwater the watershed and the estuarine segments.
2011 - M&R Program Modifications
• Triazine pesticides were eliminated from the program per recommendations from the last three years. Pyrethroid pesticides were added to the analytical suite since these compounds have been shown to be frequently associated with sediment toxicity in streams and bays subject to stormwater runoff from urban and agricultural regions. • Long term, continuous measurement of pH and temperature was implemented in the Los Cerritos Channel to document seasonal and diurnal fluctuations as well as response to stormwater runoff..
2012 - M&R Program Modifications
• No additional modifications were made to the 2012 M&R program. Pyrethroid pesticides added to the analytical suite during the previous year were maintained as part of the base program due to the common occurrence of these analytes in stormwater discharges and known impacts that these compounds may have on both water column toxicity and sediment toxicity.

STUDY AREA DESCRIPTION

The following sections describe the regional setting. This includes the general geographic characteristic, the storm drain system, annual rainfall and climate as well as population trends experienced over the past 11 years.

GEOGRAPHY

The City of Long Beach is located in the center and southern part of the Los Angeles Basin (Figure 2) and is part of the highly urbanized Los Angeles region. In addition to residential and other uses, the City also encompasses heavy industrial and commercial areas and includes a major port facility, one of the largest in the United States. The City's waterfront is protected from the open Pacific Ocean by the extensive breakwater encircling the outer Harbor area of the Port of Los Angeles/Port of Long Beach complex. The waterfront includes port facilities along with a downtown commercial/residential area that includes small boat marinas, recreational areas, and convention facilities. Topography within the City boundaries can be generally characterized as low relief. The City of Long Beach completely surrounds Signal Hill which is the most prominent topographic feature (Figure 3) in the region. Signal Hill has a population of approximately 11,500 residents and is currently regulated under the Los Angeles County MS4 NPDES permit.

MAJOR WATERSHEDS

Major water bodies receiving stormwater discharges from the City of Long Beach include the Los Angeles River located near the western boundary of the City, the San Gabriel River located near the eastern boundary, and the outer Harbor of the Los Angeles/Long Beach area. The City of Long Beach has fifteen pump stations that discharge into the Los Angeles River, and one pump station that discharges into the San Gabriel River. Receiving water sub-areas of importance include the extensive Alamitos Bay, heavily developed for marina and recreational uses, and the inner Harbor areas of the City, heavily developed as port facilities. Other receiving water sub-areas include the Los Angeles River, El Dorado Lake, Los Angeles River Reach 1 and Reach 2, San Gabriel River Estuary, San Gabriel River Reach 1, Colorado Lagoon, and Los Cerritos Channel. These areas also include coastal shorelines, including Alamitos Bay Beaches, Belmont Shore Beach, Bluff Park Beach, and Long Beach Shore. The drainage from the City is characterized by major creeks or storm channels, usually diked and/or concrete lined such as the Los Cerritos Channel that originates in Long Beach, flows near the eastern City boundary, and discharges into the Marine Stadium and then into Alamitos Bay. Other such regional drains include:

- Coyote Creek, which passes through a small portion of Long Beach before it discharges to the San Gabriel River;
- Heather Channel and Los Cerritos Line E that both enter Long Beach from the City of Lakewood and discharge into the Los Cerritos Channel; and the
- Artesia-Norwalk Drain that enters Long Beach from Hawaiian Gardens and discharges into Coyote Creek.

The four City of Long Beach mass emission monitoring sites address runoff from 32% of entire City (Figure 4). The monitoring sites also capture stormwater runoff and dry weather flows from portions of Signal Hill and a number of other cities that are within the Los Cerritos Channel watershed. The total area of the watersheds monitored by the City of Long Beach program covers over 22,300 acres which is equivalent to 68% of the total area of the City of Long Beach.

ANNUAL RAINFALL AND CLIMATE

The City of Long Beach is located in the semi-arid Southern California coastal area and receives significant rainfall on a seasonal basis. The rain season generally extends from October through April, with the heavier rains more likely in the months of November through March (see Figure 11 for average rainfall by month and seasonal total rainfall as measured at the Long Beach Airport). The long-term average (1971-2000) rainfall for October through April (wet season) at the Long Beach Airport is 12.27 inches per year (http://mole.nacse.org/prism/nn/ - Prism Data Extractor accessed June 2010). Average annual rainfall for the entire year is 12.94 inches.

The City lies in the Los Angeles Plain, which is south of the Santa Monica and San Gabriel Mountains and west of the San Jose and the Puente Hills. The Los Angeles River is the largest river/stream on the Plain and it drains the San Fernando Valley and much of the San Gabriel Mountains (Miles and Goudey, 1998). The climate is mild, with a 30-year average temperature of 18.5 °C (65.3°F) at the Long Beach Daugherty Airport (NCDC/NOAA, 2004).

POPULATION AND LAND USE CHARACTERISTICS

The population of the City of Long Beach was estimated at 464,662 residents on January 1, 2012 (State of California Department of Finance, 2012[1]) and the total population of the County of Los Angeles, in which it resides, was estimated at 9,884,632 residents. These latest estimates are based upon the 2010 census. Prior to 2010, population estimates were still being based upon the 2000 census data with adjustments developed from driver's license applications. The apparent decline in population between 2009 and 2010 is simply the result of an improved data set (Figure 1). The City's population is estimated to have increased by 0.3 percent over each of the last two years which is consistent with estimated growth rates of 0.3 percent over the last decade.

The independent City of Signal Hill, located on a promontory, is surrounded by the City of Long Beach. In January of 2010, Signal Hill's population was estimated to be 11,022. The population was estimated to have increased to 11,121 by January 2012. Stormwater from the City of Signal Hill discharges both to the Los Angeles River and the Los Cerritos Channel.

The City of Long Beach has a total area of 32,865 acres (Table 3). Of that total 16,208 acres (49%) are classified as residential, 7,874 acres (24%) as commercial, 2,404 acres (7%) as industrial, 2,655 (8%) as mixed urban, and 2,937 acres (9%) as open space (SCAG, 2005). Open space is dominated by a number of golf courses and parks. Agriculture and water each represent roughly 1% of the City.

Land use within specific watersheds selected by the City of Long Beach for mass emission monitoring are described in more detail in the Monitoring Program section of this report.

Two years ago, the City of Sacramento surpassed current population estimates for the City of Long Beach. In 1999, the City of Long Beach had the fifth largest population of all cities in the California. As a result of this slow growth, the City of Long Beach was previously surpassed in total population by Fresno. Long Beach is now considered the seventh most populated city in the California.

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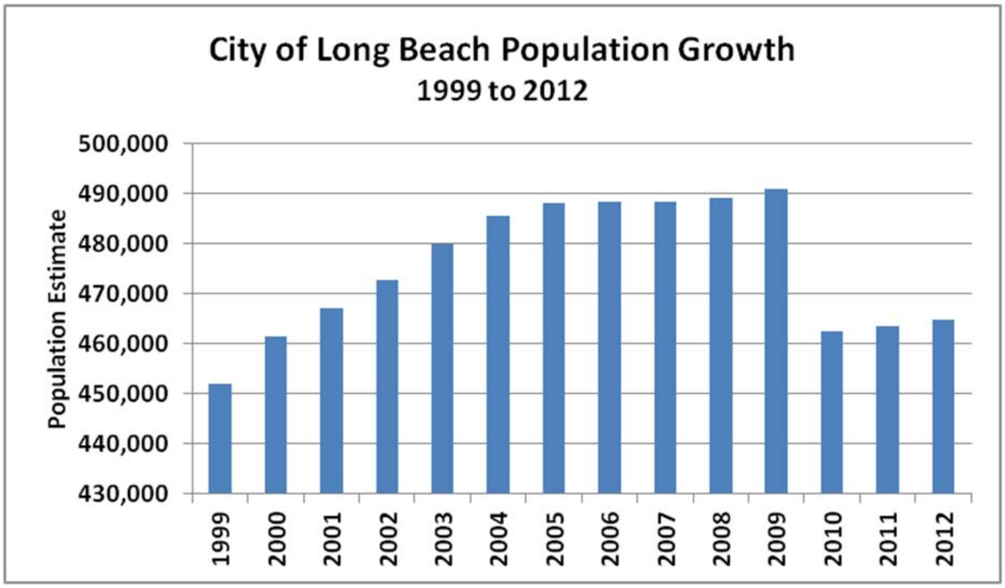
[1] *State of California, Department of Finance, E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 & 2010 Census Counts. Sacramento, California, August 2011.*



(Note: The apparent drop in the population estimate between2009 and 2010 reflects resetting to the 2010 census)

Figure 1. City of Long Beach Population Growth over the Past Twelve Years.

Figure 2. **Los Angeles Basin. (Source: 3-D TopoQuads, Copyright 1999, Del Lorme, Yarmouth, ME 04096)**

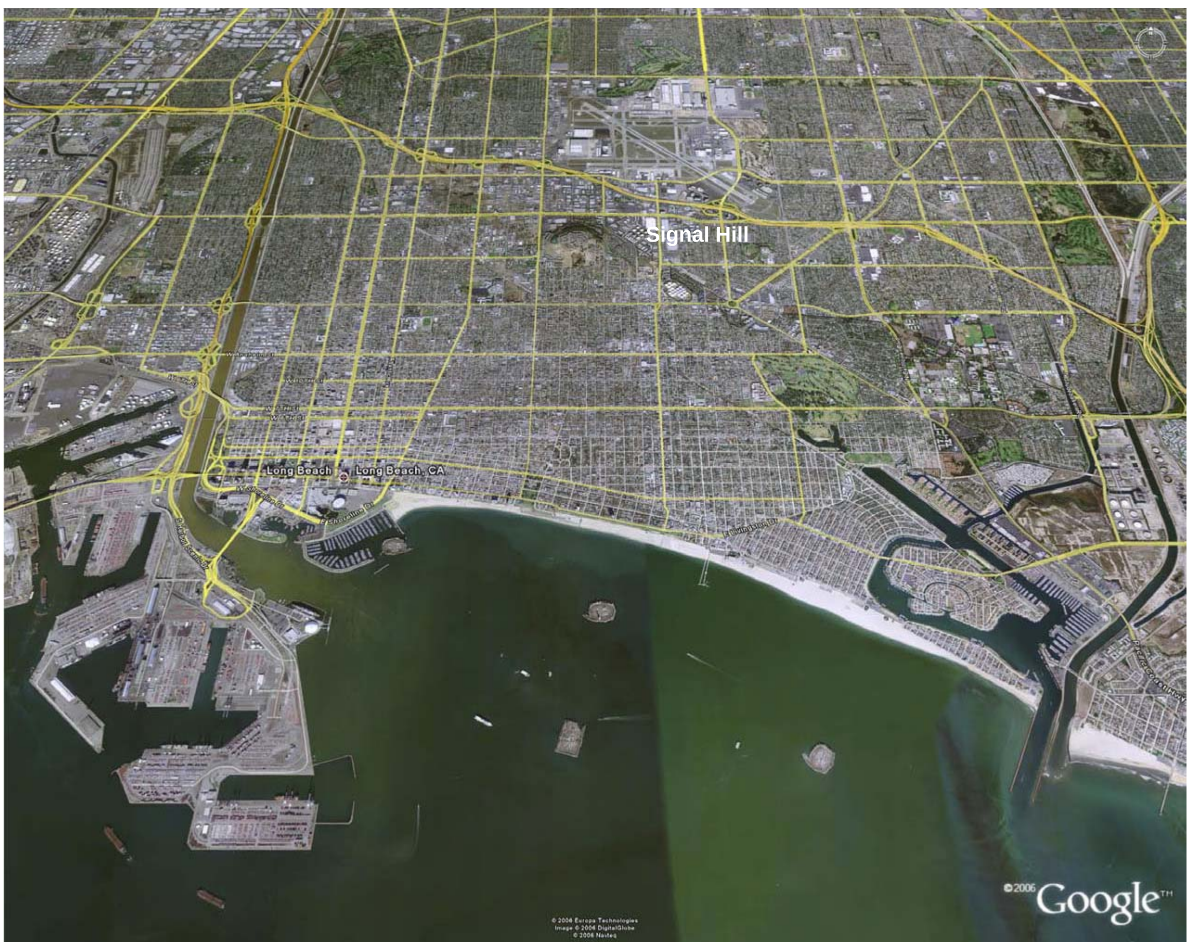


Figure 3. **City of Long Beach. (Source: Google Earth Pro, 2006)**

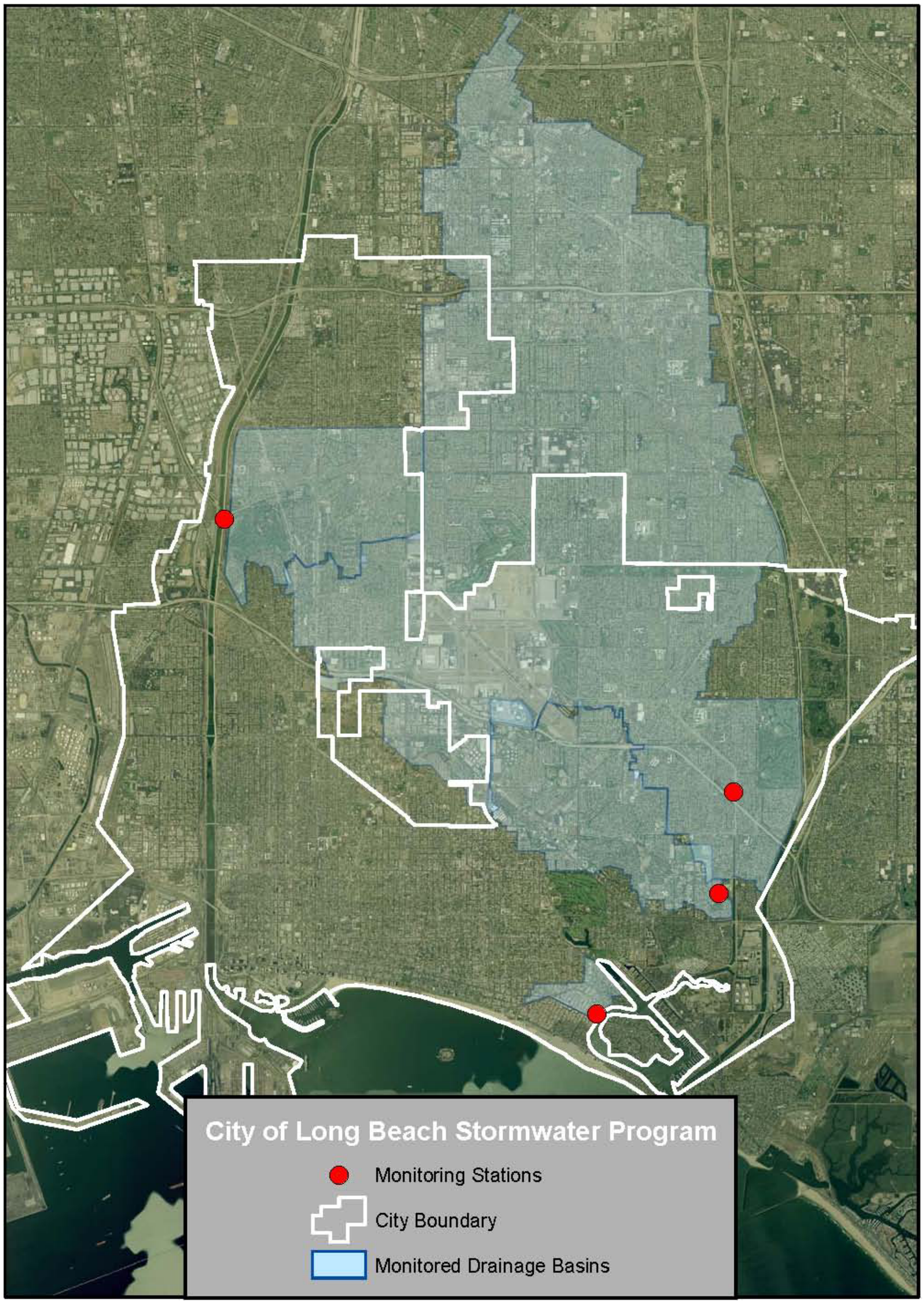


Figure 4. City of Long Beach and Drainage Basins Monitored by the Stormwater Program.

Table 3. Total Area and Land Use for the City of Long Beach and Monitored Watersheds within the City Limits.

Land Cover Type	Entire City	Belmont Pump Station	Bouton Creek	Los Cerritos Channel w/i City	Los Cerritos Channel Entire Watershed	Dominguez Gap
Agriculture	338	0	0	18	137	8
Commercial	7,874	29	824	1,987	2,669	240
High Density Residential	12,608	80	1,047	3,884	1,229	1,153
Low Density Residential	3,600	83	191	216	9,279	305
Industrial	2,404	0	19	672	1,620	6
Mix Urban	2,655	4	183	472	1,666	16
Open Space	2,937	7	62	717	1,098	354
Water	449	0	0	5	18.9	0
TOTAL	**32,865**	**203**	**2,326**	**7,972**	**17,716**	**2,082**

MONITORING PROGRAM

This section of the report provides a complete description of the basic monitoring program including detailed program objectives, details with respect to each monitoring site and monitoring equipment, monitoring procedures, analytical methods and toxicity testing methods.

MONITORING PROGRAM OBJECTIVES

The stated long-term objectives of the stormwater monitoring program were established in the 1999 NPDES permit. These include:

1. Estimate annual mass emissions of pollutants discharged to surface waters through the MS4;
2. Evaluate water column and sediment toxicity in receiving waters;
3. Evaluate impact of stormwater/urban runoff on marine life in receiving waters;
4. Determine and prioritize pollutants of concern in stormwater;
5. Identify pollutant sources on the basis of flow sampling, facility inspections, and ICID (Illegal Connection Illicit Discharge) investigations; and
6. Evaluate BMP effectiveness.

Since initiation of the Long Beach Stormwater Monitoring Study in 1999, the core of the program has been development of accurate measurements of pollutant loads from mass emission sites and determining the chemical and toxicological characteristics of these discharges during both storm events and dry weather periods. A number of special studies have been conducted to address individual elements of the long-term objectives. The primary objectives of monitoring conducted during the 2011/2012 monitoring period include:

1. Obtain monitoring data from four (4) storm events for each mass emission station.
2. Carry out dry weather inspections and obtain samples of dry weather flow at each of the three mass emission stations. Perform this dry weather work twice during the dry season that extends from May through October.
3. Perform chemical analyses for the specified suite of analytes at the appropriate detection limits for all stormwater samples collected.
4. Perform toxicity testing of the stormwater samples collected, and Toxicity Identification Evaluations (TIEs) if warranted by the toxicity results at a given site. No toxicity testing was required for water from the Dominguez Gap Pump Station monitoring site.
5. Report the above results and evaluate the monitoring data with respect to receiving water quality criteria.

MONITORING SITE DESCRIPTIONS

The four sites for mass emissions monitoring were originally selected by the City of Long Beach with the assistance of the Southern California Coastal Water Research Project (SCCWRP), with input from the Los Angeles Department of Public Works, the environmental community, and with the approval of the Regional Water Quality Control Board. These sites were then specified in the NPDES permit after an analysis of the drainage basins and receiving waters. They were selected to be representative of the stormwater discharges from the City's storm drain system, as well as to be practical sites to carry out stormwater and dry weather monitoring.

Four mass emission monitoring sites are routinely monitored as part of the City's stormwater program. The general locations of the drainage basins sampled by each of these sites and each monitoring location are shown in Figure 4. The latitude and longitude of each site are shown in Table 4. Brief descriptions of each drainage basin and land use are provided in the following sections.

Belmont Pump Station

This site collects water from Basin 23 that covers 213 acres. Land use in the basin is 80% residential, 14% commercial, 0% industrial, 2% mixed urban, and 3% open space (Figure 5). This basin is located in the southeastern portion of the City and is bounded on the north, south, east, and west by Colorado Street, Division Street, Ultimo Avenue and Belmont Avenue respectively. The Belmont Pump Station is located at 222 Claremont Avenue.

Changing Out Sample Bottles at the Belmont Pump Station

Water enters the forebay of the facility via a nine-foot diameter underground storm pipe. A trash rack catches debris before water drops four feet into the sump area. A small summer/sump pump exists at this facility. Prior to 2007, this pump turned on every evening at around 2300 hours and discharged approximately two feet of water that had accumulated in the sump due to dry weather flows. Starting in 2007, all summer dry weather flows were diverted to the sanitary system. Initially this was performed by a temporary pumping system but installation of a permanent dry weather diversion system was completed at this site in December, 2009.

Four main pumps are available to remove water during storm events. The summer/sump pump is operational during the winter to handle low flows and to lower the sump level once the main pumps are turned off. Water from these pumps is discharged into Alamitos Bay.

The storm monitoring equipment is interfaced with all five pumps to determine when each pump is activated. Water depth and pump discharge curves are then used to calculate discharges from this site for use in pacing the sampling equipment. An update of the monitoring equipment at this site was completed in 2009 along with improved stormwater monitoring software. Unexpected corrosion of the titanium pressure sensor and stainless steel strainer subsequent to installation of the permanent bypass system has necessitated replacement of both systems. The pressure sensor at this site was replaced with a bubbler for measuring water depth in the sump and the strainer was modified to eliminate metal parts that could be subject to electrolytic corrosion.

Bouton Creek

This site collects water from Basin 20 which encompasses 2,326 acres. Basin 20 is 53% residential, 35% commercial, 1% industrial, 8% mixed urban and 3% open space (Figure 6). Much of the commercial land within this drainage area consists of the California State University at Long Beach campus. This basin is located in the east central portion of the City and is bounded on the north, south, east, and west by Spring Street, 8th Avenue, the Los Cerritos Channel and Redondo Avenue, respectively. The sampling station is located a short way upstream from the point of discharge into Los Cerritos Channel, along side of the Alamitos Maintenance Yard of the Los Angeles County Public Works Department.

Stormwater Runoff at the Bouton Creek Monitoring Station

At the wet weather sampling station, Bouton Creek is a 35 ft wide, 8.5 ft deep open concrete box channel. The elevation of the channel bed is approximately one inch lower at the side than the center. About a quarter of a mile to the southeast, Bouton Creek flows into Los Cerritos Channel. Based on numerous observations of conductivity at various tides, this site has been documented to be subject to saltwater influence whenever tide levels exceed three feet and stream discharges are not sufficient to displace the saline waters. The automatic sampling equipment was therefore configured and programmed to measure directional flow (upstream or downstream) as well as the conductivity of the water at three elevations. This allows the sampler to obtain flow-composited samples of the freshwater discharges down the creek, avoiding tidal contributions by using real-time conductivity sensors. The upstream flow of freshwater is quantified and used to correct discharge calculations. An AVB velocity and depth sensor was mounted on the invert of the box channel near the center of flow. Two conductivity sensors were mounted on the wall of the channel near the bottom and 12 inches above the bottom. A third conductivity sensor and the sample intake were mounted on a floating arm that keeps them near the surface.

Location of Dry Weather Sampling Site in Bouton Creek

Refurbishment of most equipment at this site was mostly completed in 2009. A new CR-1000 datalogger/control module, along with an updated sampling program, was installed before the start of the 2009/1010 sampling season. The autosampler remains scheduled for replacement when sufficient funds are available.

Several years ago a secondary sampling site was selected for purposes of dry weather sampling in the Bouton Creek watershed. The dry weather sampling location was positioned 1,250 feet upstream at a point where the channel first daylights from under the California State University at Long Beach parking lot. This site was first sampled during the October 2009 dry weather sampling event. In recent years declining dry weather flows combined with increased algal growth in the channel has prevented complete flushing of saltwater from the channel before the flood tide would again inundate the site with saltwater. This was resulting in elevated conductivity in the dry weather samples due to residual saltwater that was excessive for both bioassay testing and chemical analysis for determination of dry weather loads. The elevated conductivity of water collected at the original site precluded collection and analysis of representative dry weather samples at this site for the two years prior to the October 2009 event. Based upon continued low flow conditions, this site has been designated as the permanent location for any further dry weather testing.

Los Cerritos Channel

The entire Los Cerritos Channel watershed is estimated at 17,716 acres (Figure 7). This watershed includes 7,972 acres of the City of Long Beach or approximately 45 percent of the entire watershed. Land use within the City of Long Beach's portion of the watershed consists of 52% residential, 25% commercial, 8% mixed urban and 3% open space (Figure 7). Aggregated data from the Southern California Association of Governments (SCAG) 2005 land use dataset indicates that the entire Los Cerritos Watershed is 93% urban (approximately 60% residential, 22% commercial, 4% mixed urban, and 6% industrial). Open space accounts for 6% of land use and agriculture is <1% of land use.

The stormwater monitoring station is installed in a steel utility box located on the west side of the channel south of Stearns Street. Flow sensors and sampling tubing are installed on the bottom of the large concrete lined channel. Flow rates based upon flow velocity and channel dimensions are used to control the composite sampler, and to calculate total flow at the end of the storm event.

Stormwater Runoff at the Los Cerritos Channel Monitoring Station

This site was the first to receive a new Campbell Scientific 1000 datalogger/control units along with an updated Kinnetic Laboratories, Inc. stormwater monitoring program. The only remaining major upgrade requirement at this site is replacement of the 10-year old autosampler and modem. These final upgrades are planned to occur as soon as budgets permit.

This sampling site is normally above tidewater on Los Cerritos Channel. During extreme tides that typically occur during the dry weather surveys, this site can be impacted by backwater conditions. This has been remedied in recent years by scheduling sampling for periods that have less extreme tidal ranges.

Dominguez Gap Pump Station

The sampling station located at the Dominguez Gap Pump Station is intended to monitor Basin 14. As part of the Dominguez Gap/DeForest Wetland project the drainage for Basin 14 was modified so that runoff from north of Market Street would be directed the Market Street Pump Station and DeForest Wetlands and runoff from the portion of Basin 14 located south of Market Street continued to drain to the Dominguez Gap Pump Station and Wetlands. The two areas were further separated by elimination of a previous connection between the two infitration basins at Del Amo. The Dominguez Gap Pump Station and Wetlands now has a contributing watershed of 2,082 acres (Figure 9). Land use in this watershed is 70% residential, 12 percent commercial, 17% open space and 1% mixed urban. Much of the open space is a golf course that borders the infiltration basin. The basin is located in the northwestern portion of Long Beach just east of the Los Angeles River and is bounded on the north, south, east, and west by Market Street, Roosevelt Road, the railroad, and the Los Angeles River respectively.

The Dominguez Gap Pump Station and adjacent infiltration/detention basin were undergoing major renovations during the summer of 2006 and through most of the 2007/2008 wet season. For the last four years of the monitoring program, wetland vegetation has been fully developed.

During dry weather periods, water is diverted from the Los Angeles River at the upper end of the wetlands. The system was designed for water to be siphoned across to the Eastern Basin of the Dominguez Gap system where further infiltration capacity was to be provided. From there it was to come back to the Dominguez Gap Pump Station where the summer pump is intended to discharge at a maximum rate of about five cubic feet per second (cfs) during dry weather periods. The Eastern Basin is not in use since it was providing the desired infiltration and has historically been the source of botulism.

View of Dominguez Gap Pump Station Intake Bay and Wetland Vegetation (2009)

The stormwater monitoring equipment at this site is located within the Dominguez Gap Pump Station. The refrigerated automatic sampler utilizes a peristaltic pump to collect water from the pump station's sump. All five major pumps have been individually instrumented to detect when each pump is activated and to measure the RPM while the pumps are being operated. Flow is calculated based upon pump curves and water elevations in the sump as measured with a pressure transducer to determine instantaneous head. Flow from each pump is summed to determine discharge rates at any one point in time. Under normal operation, it is highly unusual for the complement of pumps to be activated.

Constructed Wetlands North of the Dominguez Gap Pump Station (2009)

Major upgrades and modifications to the monitoring equipment at this site were completed in 2010. A new Campbell CR1000 datalogger/control module was installed at this site along with new autosampler head for the refrigeration unit. New stormwater monitoring software was developed to operate the site.

The summer pump still remains uninstrumented however we are in the process of submitting a request to the County to allow us to install noninvasive equipment to sense when the summer pump is running. A constant flow would be assumed whenever the summer pump is operating.

Management of water levels within the wetlands has been determined to play a critical role in attainment of TMDL requirements for Jurisdiction 1. Discussions with the County are currently underway in order to assure that this site is regulated consider the importance of both the wetland habitat and to minimize mass emissions of trace metals and other contaminants to the Los Angeles River.

MONITORING STATION DESIGN AND CONFIGURATION

Each of the four land use stations monitored in Long Beach is equipped with Kinnetic Laboratories Automatic Sampling System (KLASS). Figure 10 illustrates the configuration of a typical KLASS. This system consists of several commercially available components that Kinnetic Laboratories has integrated and programmed into an efficient flow-based stormwater compositing sampler.

The integral components of this system consist of an acoustic Doppler flow meter or a pressure transducer, a datalogger/controller module, cellular or landline telecommunications equipment, a rain gauge, and a peristaltic sampler. CR-1000 datalogger/control modules and updated monitoring software are now installed at each site. The system installed at Bouton Creek also incorporates several conductivity cells for distinguishing tidal flow from fresh water runoff. Equipment installed at pump stations incorporate a variety of sensors to monitor individual pump activity and head pressures.

All equipment is installed with intakes and sensors securely mounted, tubing and wires in conduits, and all above ground instruments protected within a security enclosure. The previous section described specific equipment configurations at each site.

All materials used in the collection of stormwater samples and in contact with the samples meet strict criteria in order to prevent any form of contamination of the sample. These materials allow both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only the highest grade of borosilicate glass is suitable for both trace metal and organic analyses from the same composite sample bottle. All intake hoses are constructed of Teflon® which provides both rigidity against collapse at high head differentials and is non-contaminating for both organics and inorganics.

All bottles and hoses are cleaned according to EPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983). These bottles and hoses are then evaluated through a blanking process to verify that the hoses and composite bottles were contamination-free and appropriately cleaned for analyses of both inorganic and organic constituents.

FIELD MONITORING PROCEDURES

The following sections provide a summary of the field methods and procedures used to collect and process data for both the wet and dry weather surveys.

Wet Weather Monitoring

Stormwater runoff is collected using two primary methods. Flow-weighted composite sampling is conducted to collect water is sufficient volumes to allow for both chemical analysis and toxicity testing. A few analytes such as bacteria and oil and grease are required to be sampled using grab sampling methods and thus reflect conditions only at the time of sampling.

Composite Sample Collection

A priority objective of the storm monitoring is to maximize the percent storm capture of the composite sample, while ensuring that the composite bottle collects enough water to support all the required analyses. The goal is to collect flow-weighted composite samples from 100% of the flow resulting from the rainfall. This monitoring program requires volumes of 20 to 30 liters of sample from each of the four mass emission sites to meet these analytical and toxicological needs. Approximately 40 liters is necessary for sites that are sampled in duplicate. Such high sample volumes require that the composite bottles be replaced multiple times over the course of an event.

The status of each monitoring site is continuously tracked from an office command and control center (Storm Control) located at our Santa Cruz laboratory. The Storm Control computer can be securely accessed from any location with internet access. The status of each station is monitored through telecommunication links to each site. Station data are downloaded, and the stations are controlled and reprogrammed remotely. Weather information, including Doppler displays of rainfall for each area being monitored, are also available on screen at the Storm Control center. Personnel monitoring the centralized Storm Control system are in contact by cellular phone with the field crews to provide guidance and updates on the status of each sampling site so that sites can be serviced and bottles changed as soon as possible after they fill.

When a storm is likely, all stations are made ready to sample. This preparation includes entering the correct volume of runoff required for each sample aliquot ("Volume to Sample"), setting the automatic sampler and the datalogger to sampling mode, pre-icing the composite sample bottles not associated with refrigerated samplers, and performing a general equipment inspection. A brief physical inspection of the equipment is made if possible to make certain that there were no obvious problems such as broken conduit, a kinked hose, or debris.

Once a storm event ended, the stations are shut down either on site or remotely by Storm Control. The station is left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. Data are retrieved remotely via telecommunications from the datalogger on a daily basis throughout the wet weather season. During storm events, data are downloaded either on demand or at intervals of 15 minutes to an hour.

All water samples are kept chilled (4°C) and transferred to the analytical laboratories within holding times. Prior to sample shipping, sub-sampling from the composite container into sample containers is accomplished using protocol cleaned Teflon® and silicone sub-sampling hoses and a peristaltic pump. Using a large, Teflon® coated magnetic stirrer, all composite water is first mixed together thoroughly and then continuously mixed while the sub-sampling takes place. All sub-sampling takes place at a staging area near Long Beach. Documentation accompanying samples to the laboratories includes Chain of Custody forms, and Analysis Request forms (complete with detection limits).

Grab Sampling

During each storm event, grab samples for oil and grease, total and fecal coliform, and enterococcus are collected. The timing of grab sampling efforts is often driven by the short holding times for the bacterial analyses. The ability to deliver samples to the microbiological laboratory within the 6-hour holding time is always a major consideration.

Except at the pump stations, all grab samples are taken as near to the center of flow as possible or at least in an area of sufficient velocity to ensure good mixing. At both the Dominguez Gap and Belmont Pump stations, grabs are taken from the sump. A specially constructed sampling pole is required to obtain samples at most sites. Poles used are fitted with special bottle holders to secure the sampling containers. Care is taken not to overfill the sample containers for some of the containers contain preservative.

Configuration of Grab Pole used for Oil & Grease and Fecal Indicator Bacteria Sampling

Dry Weather Monitoring

The City's NPDES Permit requires two dry weather inspections and sampling events be conducted at each of the four mass emission stations during the summer dry weather period.

Site inspections are conducted at all sites to determine if water is present and whether water is flowing or just ponded. If flowing water is evident at any one of the mass emission sites, *in situ* water quality measurements, flow estimates, and composite water samples are taken along with general observations of site conditions.

For the past several seasons the Belmont Pump Station dry weather flows have been diverted to the sanitary sewer system either by means of a temporary pump or by the permanent low-flow diverter system completed in December 2009. During the same general time period, the Dominguez Gap infiltration basin was modified into a wetland treatment system designed to provide a range of both environmental and recreational benefits. During dry weather periods, flow through the wetlands is intended to be maintained by a summer pump.

Dry weather sampling differs slightly at each monitoring site due to the unique characteristics and constraints at each location. Monitoring at the Los Cerritos Channel site is conducted by extending an intake hose to the low flow channel and setting the equipment to take a full 24-hour composite sample. The automatic peristaltic pump sampler is programmed to collect aliquots every half hour for the sampling period.

The Bouton Creek site experiences tidal influences which limit the times at which sampling can be performed. Dry weather sampling is conducted during time periods when extreme low tides allow the tidal water to drain from the channel such that flows are limited primarily to dry weather discharges. A composite sample is collected over a 30-minute period preceding tidal waters reentering the channel to isolate sampling to just the freshwater discharge down the creek. Salinity is monitored during a period of roughly two hours before tidal waters reenter the channel in order to determine when the dry weather (freshwater) flows comprise at least 90% of the flow.

Prior to the 2009/2010 monitoring season, dry weather flows in Bouton Creek were not sufficient to flush seawater from the creek for three consecutive events. The salinity remained at or above 10 ppt which would be toxic to one of the toxicity test species and could not be considered representative of dry weather discharges from the watershed. As of the 2009/2010 surveys, the sampling location was moved 1,250 feet upstream from the primary site location at the LADPW Alamitos Yard to the point where Bouton Creek emerges from under the California State University at Long Beach (CSULB) campus. Outfalls located along the creek from Alamitos Yard to CSULB are observed to insure that no major dry weather discharges are missed as a result of moving the site upstream. No dry weather discharges have been recorded downstream of the new sampling site ever since it was relocated.

Due to reconfiguration of the Dominguez Gap Treatment Wetlands, the 2009/2010 season was the first time that dry weather discharges were documented and sampled. Initially, the permanent sump pump was intended to maintain continuous flows through the wetlands but did not function as expected. Circulation through the system has often been augmented by periodic operation of the larger pumps. This year the sump pump was not in operation when the site was visited for the September 2011 event, but was operating for the May 2012 dry weather event

LABORATORY ANALYSES

The water quality constituents selected for this program were established based upon the requirements of the City of Long Beach NPDES permit for stormwater discharges as modified through the annual review process. All analyses were conducted at laboratories certified for such analyses by the Department of Health Services or approved by the Executive Officer and in accordance with current EPA guideline procedures or as specified in this Monitoring Program. Analytical methods are based upon approved USEPA methodology. The following sections detail laboratory methods for chemical and biological testing.

Analytical Suite and Methods

Conventional, bacteriological, and chemical constituents selected for inclusion in this stormwater quality program are presented in Table 5. Analytical method numbers, holding times, and reporting limits are also indicated for each analysis.

Laboratory QA/QC

Quality Assurance/Quality Control (QA/QC) activities associated with laboratory analyses are detailed in Appendix A.

The laboratory QA/QC activities provide information needed to assess potential laboratory contamination, analytical precision and accuracy, and representativeness. Analytical quality assurance for this program included the following:

- Employing analytical chemists trained in the procedures to be followed.
- Adherence to documented procedures, USEPA methods and written SOPs.
- Calibration of analytical instruments.
- Use of quality control samples, internal standards, surrogates and SRMs.
- Complete documentation of sample tracking and analysis.

Internal laboratory quality control checks included the use of internal standards, method blanks, matrix spike/spike duplicates, duplicates, laboratory control spikes and Standard Reference Materials (SRMs).

Data validation was performed in accordance with the USEPA Functional Guidelines for Low Level Concentration Organic Data Review (USEPA, 2001), USEPA Functional Guidelines for Inorganic Data Review (USEPA, 2002a), and Guidance on the Documentation and Evaluation of Trace Metals Data Collected for the Clean Water Act Compliance Monitoring-Draft (USEPA, 1996).

Toxicity Testing Procedures

Upon receipt in the laboratory, stormwater discharge and receiving water samples were stored at 4 °C, in the dark until used in toxicity testing. Toxicity testing commenced within 48 hours of sample collection for most samples. The relative toxicity of each discharge sample was evaluated using two chronic test methods: the water flea (*Ceriodaphnia dubia*) reproduction and survival test (freshwater) and the purple sea urchin (*Strongylocentrotus purpuratus*) fertilization test (marine). Each of the methods is recommended by the USEPA for the measurement of effluent and receiving water toxicity. Water samples were diluted with laboratory water to produce a concentration series using procedures specific to each test method.

Water Flea Reproduction and Survival Test

Toxicity tests using the water flea, *Ceriodaphnia dubia*, were conducted in accordance with methods recommended by USEPA (2002b). The test procedure consisted of exposing 10 *C. dubia* neonates (less than 24 hours old and 8 hour range in age) to the samples for approximately seven days. One animal was placed in each of 10 individual polystyrene cups containing approximately 20 mL of test solution. The test temperature was 25 ± 1 °C and the photoperiod consisted of a 16 hours light: 8 hours dark cycle. Daily water changes were accomplished by transferring each individual to a fresh cup of test solution; water quality measurements and observations of survival and reproduction (number of offspring) were made at this time also. Prior to transfer, each cup was inoculated with food (200 µL of a 1:1 mixture of *Selenastrum* culture, density of approximately 3.5 x 10^7 cells/mL, and YCT).

The test organisms for the *Ceriodaphnia dubia* tests were obtained from in-house cultures. The laboratory water used for cultures, controls, and preparation of sample dilutions was a moderately hard freshwater, prepared with diluted mineral water (8 parts Nanopure, 2 parts Perrier®). Test samples were poured through a 60 µm Nitex screen in order to remove indigenous organisms prior to preparation of the test concentrations. Serial dilutions of the test sample were prepared, resulting in test concentrations of 100, 50, 25, 12.5, and 6.25 %.

The quality assurance program for this test consists of two components. First, a negative control sample (laboratory water) was included in all tests, and this control is used for all sample comparisons and to meet test acceptability criteria. This control also helps document the overall health of the test organisms. Second, a positive control was conducted, which consisted of a reference toxicant test and a concentration series of copper chloride ($CuCl_2$). Since this organism is cultured in-house, EPA guidelines only require monthly reference toxicant tests to be conducted. These monthly tests are performed to monitor the overall test sensitivity and precision of the organisms. We compare the monthly survival and reproduction results to historical results, through the use of control charts which track the sensitivity of the organisms. Any significant difference in organism sensitivity to the historical mean is noted in the final report. Also, any deviations from the EPA protocols or performance criteria were noted in the final report.

Sea Urchin Fertilization Test

All discharge and receiving water samples of stormwater were also evaluated for toxicity using the purple sea urchin fertilization test (USEPA 1995). This test measures toxic effects on sea urchin sperm, which are expressed as a reduction in their ability to fertilize eggs. The test consisted of a 20-minute exposure of sperm to the samples. Eggs were then added and given 20 minutes for fertilization to occur. The eggs were then preserved and examined later with a microscope to assess the percentage of successful fertilization. Toxic effects are expressed as a reduction in fertilization percentage. Purple sea urchins (*Strongylocentrotus purpuratus*) that are used in the tests were field collected near Point Loma, San Diego, CA by Nautilus staff. The tests were conducted in glass shell vials containing 10 mL of solution at a temperature of 15 ± 1 °C. Five replicates were tested at each sample concentration.

All samples were adjusted to a salinity of 34‰ for the fertilization test. Previous experience has determined that many commercially available sea salt mixes are toxic to sea urchin sperm. Therefore, the salinity for the urchin test was adjusted by the addition of hypersaline brine. The brine was prepared by partially freezing natural seawater. Since the addition of brine dilutes the sample, the highest stormwater concentration that could be tested for the sperm cell test was usually between 60 and 70% sample. The adjusted samples were diluted with seawater to produce test concentrations of 60-70, 50, 25, 12.5, and 6.25%.

Seawater control (20 µm filtered natural seawater from Scripps Institution of Oceanography) and brine control samples (deionized water mixed with the same volume of brine as the high concentration of sample) were included in each test series for quality control purposes. Water quality parameters (temperature, dissolved oxygen, pH, and salinity) were measured on the test samples to ensure that the experimental conditions were within desired ranges and did not create unintended stress on the test organisms. In addition, since these urchins are caught in the wild, a reference toxicant test was included with each stormwater or dry weather event. The reference toxicant test is used to evaluate the overall health of the test organisms and to compare the sensitivity to historical control chart results. Each reference toxicant test consisted of a concentration series of copper chloride with five replicates tested per concentration.

Toxicity Identification Evaluations (TIEs)

If either stormwater or dry weather runoff samples exhibited substantial toxicity (> 2 TU_a for *Ceriodaphnia*, > 3 TU_a for sea urchins), Phase I TIEs were to be conducted in order to determine the characteristics of the toxicants present. Although no TIEs were triggered this year, the processes used in previous years are summarized below.

The TIE process involves an array of treatments designed to selectively remove or neutralize classes of compounds (e.g., metals, nonpolar organics) and thus the toxicity that may be associated with them. Treated samples are then tested to determine the change in toxicity.

Prior to evaluation of toxicity changes, an untreated aliquot of sample is tested to confirm persistence of the originally-noted toxicity. If toxicity in this “baseline” sample had decreased to levels below the original trigger point, further toxicity tests would not be performed and the TIE would be abandoned.

Four or five treatments have been typically applied to each sample. These treatments include particle removal, trace metal chelation, nonpolar organic extraction, organophosphate (OP) deactivation (except urchins) and chemical reduction. With the exception of the organics extraction, each treatment is applied independently on a salinity-adjusted sample. A control sample (lab dilution water) is included with each type of treatment to verify that the manipulation itself was not causing toxicity. If the TIE is not conducted concurrently with the initial testing of a sample, then a reduced set of concentrations of untreated sample is tested at the time of the TIE to determine the baseline toxicity and control for changes in toxicity attributable to sample storage.

Ethylene diamine tetraacetic acid (EDTA), a chelator of metals, is added at a concentration of 60 mg/L to the marine test samples. EDTA additions to the *Ceriodaphnia* samples are based upon sample hardness (USEPA 1991). Sodium thiosulfate (STS), a treatment that reduces oxidants such as chlorine and also decreases the toxicity of some metals is added to a concentration of 50 mg/L to separate portions of each marine sample. STS additions to the *Ceriodaphnia* samples are set at 500, 250 and 125 mg/L. The EDTA and sodium thiosulfate treatments are given one to three hours to interact with the sample prior to the start of toxicity testing. Piperonyl butoxide, which inhibits activation of OP pesticides is added to a concentration of 100 mg/L for mysids (mysids were tested only during the first few years of the program) and at four concentrations (125, 250, 500 and 750 mg/L) for *Ceriodaphnia.*

Samples are centrifuged for 30 min at 3000 X g if needed to remove particle-borne contaminants and tested for toxicity. A portion of the centrifuged sample is also passed through a 360 mg Sep-Pak™ C-18 solid phase extraction column in order to remove nonpolar organic compounds. C-18 columns have also been found to remove some metals from aqueous solutions.

DATA ANALYSES

A major focus of the data analysis is to develop a better understanding of long-term trends and the major factors that affect concentrations of key constituents of concern in discharges from the mass emission sites. Understanding these factors is an important step towards the design and implementation of optimal BMPs for controlling these loads. The following sections address procedures used to analyze both the chemical and toxicological data sets.

Chemical Data Analysis

For the past 12 years, data analysis has focused on visual examination of trends in the Event Mean Concentration (EMCs) for key metals, organophosphates and bacteria. Visual assessment has clearly illustrated the decline of diazinon and chlorpyrifos that resulted from removal of these pesticides from the market.

Further screening was conducted during the prior season to examine potential functional relationships between concentrations of primary metals of concern and factors expected to influence concentrations in stormwater. Predictor variables included total rain (inches), antecedent dry weather (days), antecedent rain (inches), peak rainfall intensity (inches/hour), rainfall duration (hours), and TSS. An initial Pearson correlation matrix was developed to further screen predictor variables.

Multiple linear regression was then applied using a stepwise process to identify statistically significant ($p < 0.05$) multivariate linear regression equations relating runoff quality to predictor parameters for each pollutant. Predictor variables were incorporated into the regression using a forward stepwise process using only those variables that were significantly ($p<0.05$) correlated with analyte concentrations. Regression equations were developed for constituents where a multiple linear regression could be derived with an overall r^2 value of 0.4 or higher.

Initially, it was assumed that data from all sites were combined in the regression analysis. This report examines trends of major constituents at individual monitoring sites. Independent variables of total flow, peak flow and flow duration were incorporated to assist in further understanding functional relationships of stormwater quality with environmental factors.

Application of the Mann-Kendall Trends test and Sen's method for estimation of slope were applied to the residuals from multiple linear regression for total lead, copper and zinc by site. Residuals were aggregated by monitoring years and tested for evidence of significant decreases or increases unrelated to other factors known to influence stormwater quality.

Multiple regression analysis was not repeated this year since the relatively small incremental increase in data would not be expected to substantially alter the results. This process will be repeated next year since that will likely represent the end of the permit cycle and the results will be useful in directing any potential changes in the program.

Toxicological Analysis

The toxicity test results were normalized to the control response in order to facilitate comparisons of toxicity between experiments. Normalization was accomplished by expressing the test responses as a percentage of the control value. Four statistical parameters (NOEC, LOEC, median effect, and TU_c) were calculated to describe the magnitude of stormwater toxicity. The NOEC (highest test concentration not producing a statistically significant reduction in fertilization or survival) and LOEC (lowest test concentration producing a statistically significant reduction in fertilization or survival) were calculated by comparing the response at each concentration to the dilution water control. Various statistical tests were used to make this comparison, depending upon the characteristics of the data. Water flea survival and reproduction data were usually tested against the control using Fisher's Exact and Steel's Many-One Rank test, respectively. Sea urchin fertilization and mysid survival data were evaluated for significant differences using Dunnett's multiple comparison test, provided that the data met criteria for homogeneity of variance and normal distribution. Data that did not meet these criteria were analyzed by the non-parametric Steel's Many-One Rank or Wilcoxon's tests.

Measures of median effect for each test were calculated as the LC_{50} (concentration producing a 50% reduction in survival) for water flea survival, the EC_{50} (concentration effective on 50% of eggs) for sea urchin fertilization, or the IC_{50} (concentration inhibitory to 50% of individuals) for water flea reproduction as well as the IC_{25}. The LC_{50} or EC_{50} was calculated using probit analysis, the trimmed Spearman-Karber method or linear interpolation (bootstrap). The IC_{25} and IC_{50} were calculated using probit or linear interpolation analysis. All procedures for calculation of median or percentile effects followed USEPA guidelines.

The toxicity results were also expressed as chronic Toxic Units (TU_c) and acute Toxic Units (TU_a). Chronic TUs were calculated as: 100/NOEC, while Acute TUs were calculated as 100/LC or EC_{50} for water fleas or 100/EC_{50} for urchins. Increased values of toxic units indicate relatively greater toxicity, whereas greater toxicity for the NOEC, LOEC, and median effect statistics is indicated by a lower value.

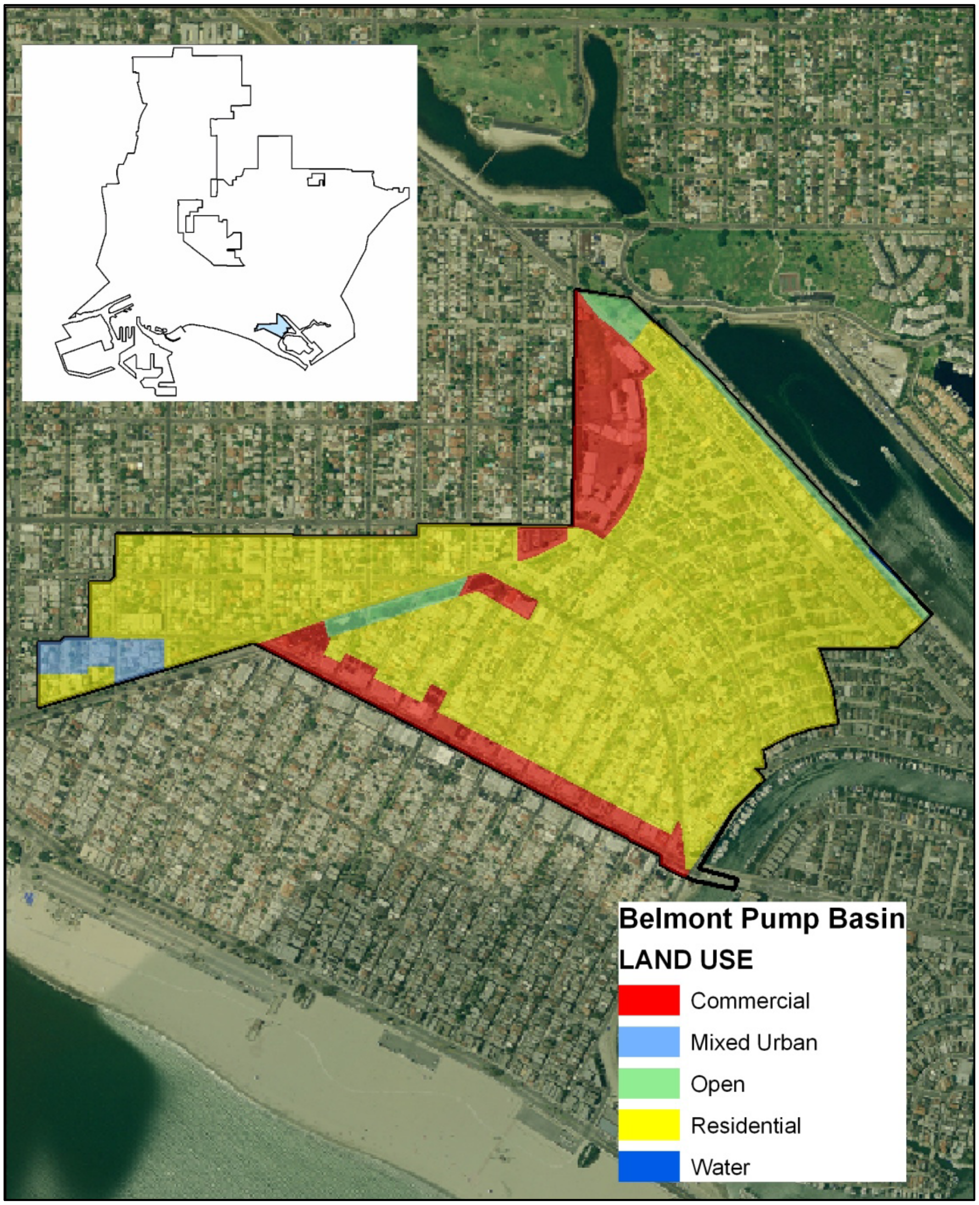


Figure 5. Land Use within the Belmont Pump Station Drainage Basin.

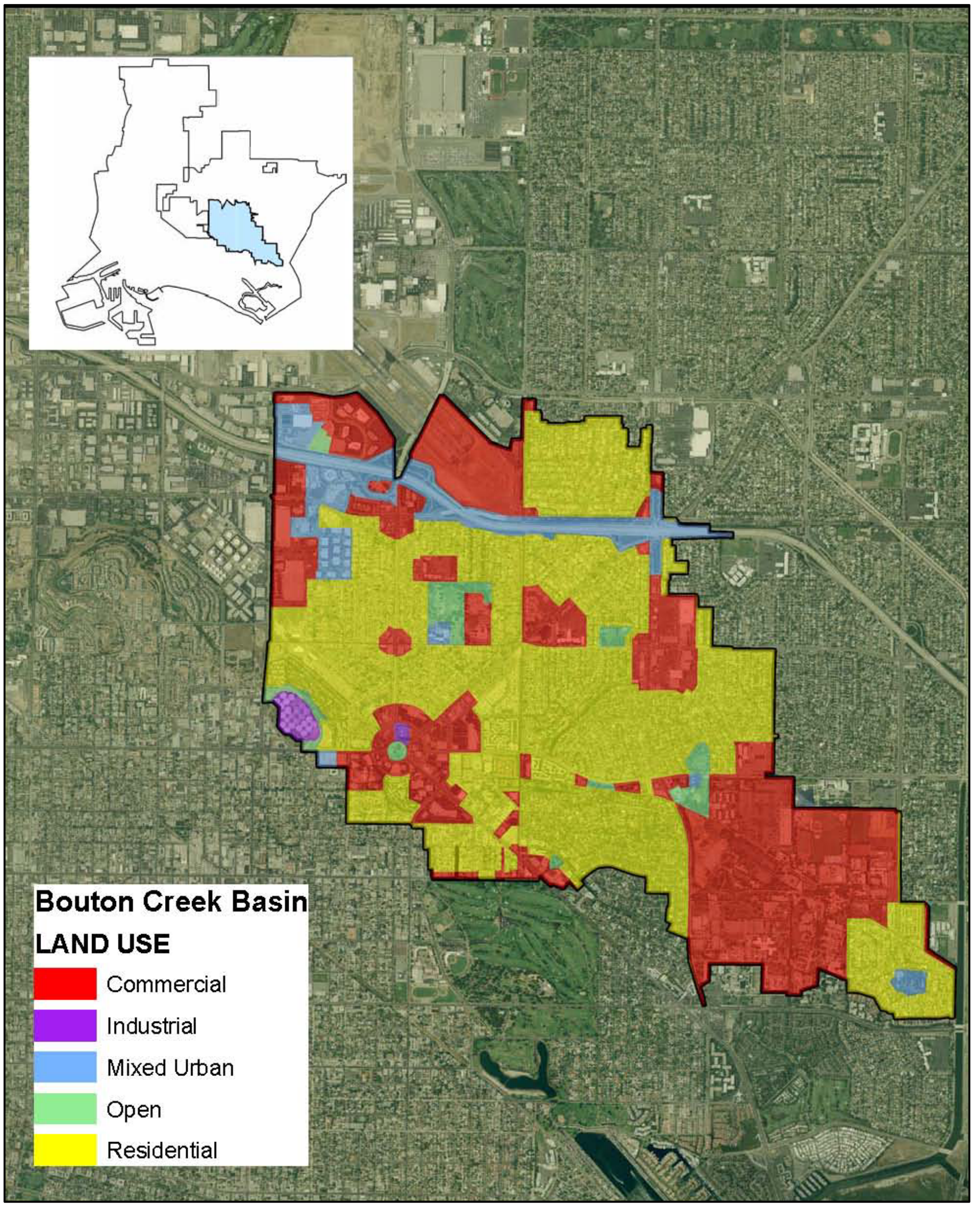


Figure 6. Land Use within the Bouton Creek Drainage Basin

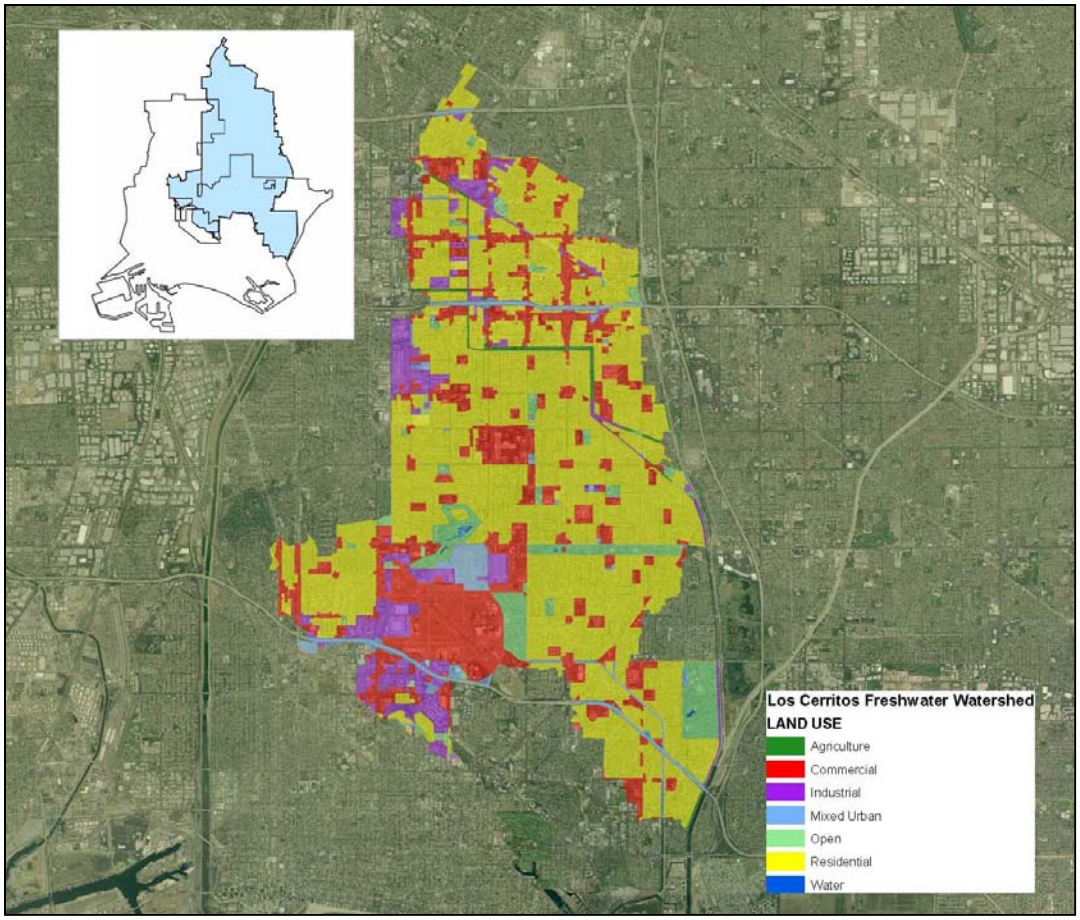


Figure 7. Land Use within the Entire Los Cerritos Channel Drainage Basin.

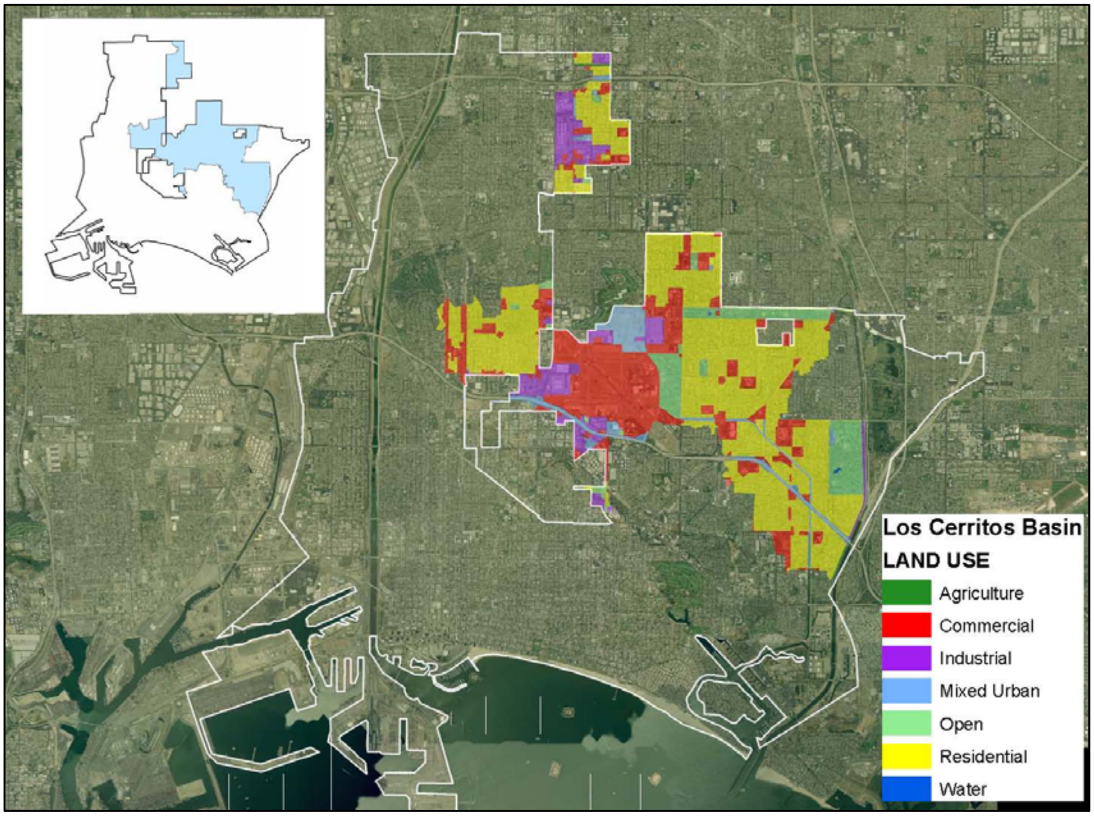


Figure 8. Land Use within the Portion of the Los Cerritos Channel Drainage Basin Located within the City of Long Beach.

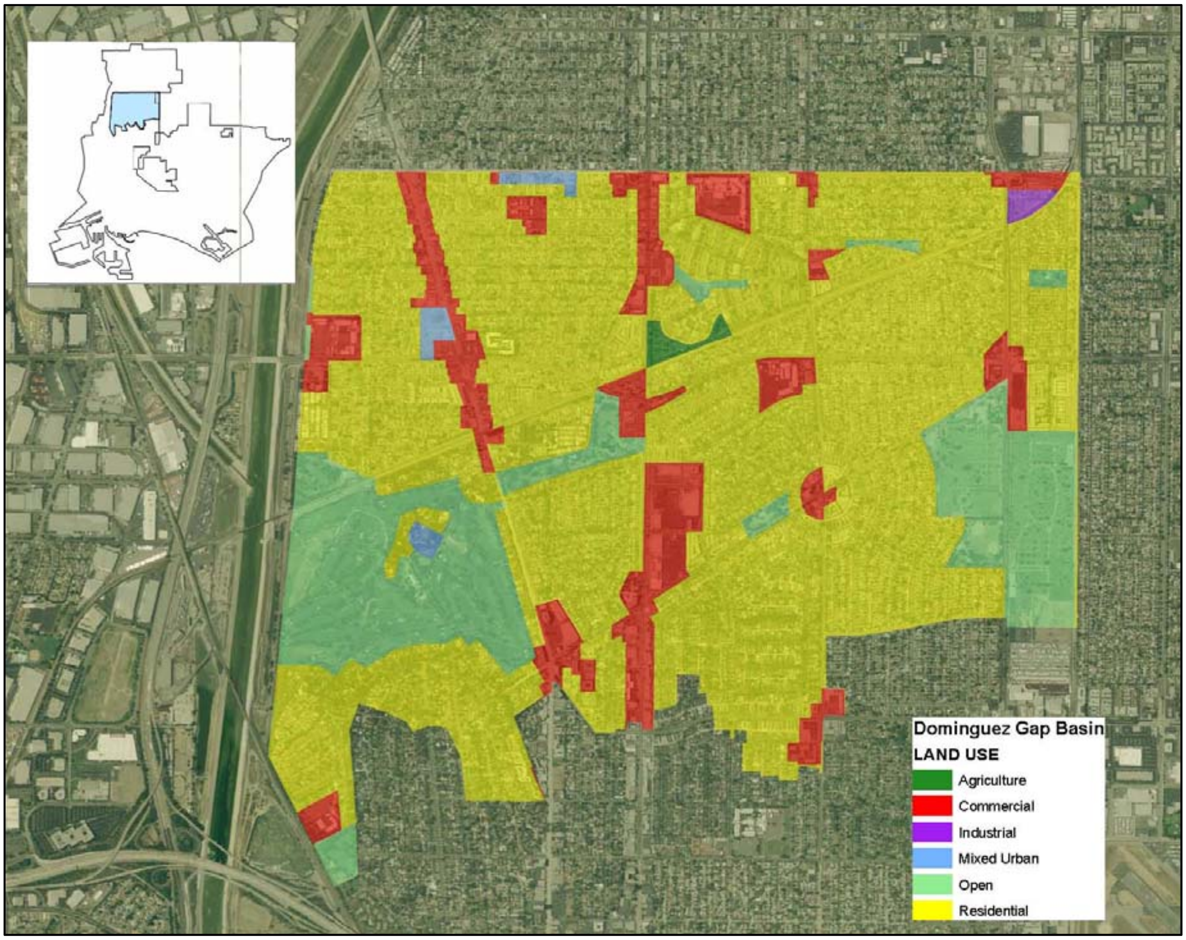


Figure 9. Land Use within the Dominguez Gap Drainage Basin.

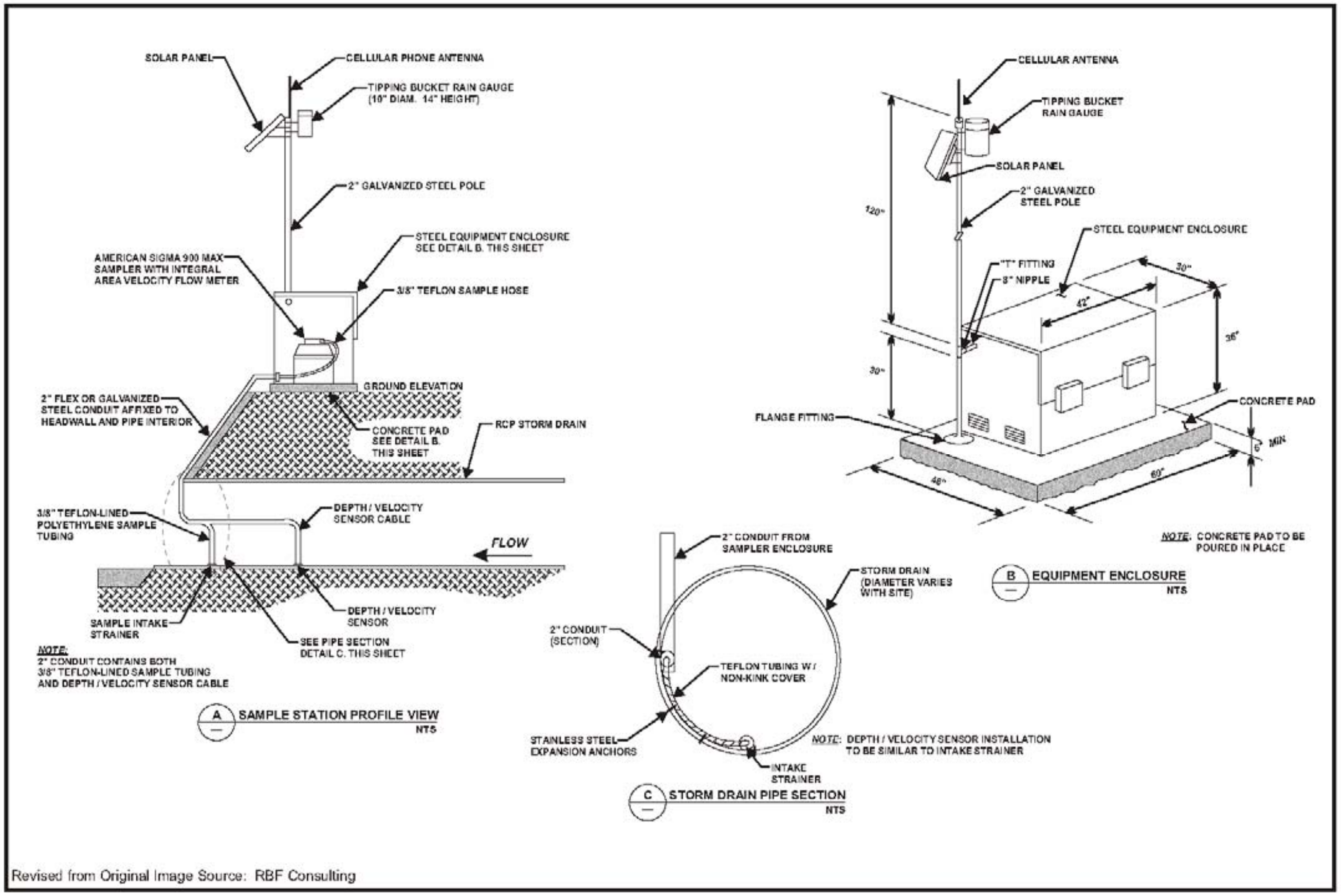


Figure 10. Typical KLASS Stormwater Monitoring Station.

Table 4. Location Coordinates of Monitoring Stations for the City of Long Beach Stormwater Monitoring Program.

Station Name	State Plane Coordinates: Zone 5		North American Datum (NAD) 83	
	Northing (ft)	Easting (ft)	Latitude	Longitude
Belmont Pump	1734835	6522091	33° 45' 36.6"N	118° 07' 48.7"W
Bouton Creek-wet[1]	1741961	6529305	33° 46' 44.3"N	118° 06' 23.4"W
Bouton Creek-dry[1]	1742580	6527993	33° 46' 50.4"N	118° 06' 35.9"W
Los Cerritos Channel	1747936	6530153	33° 47' 43.3"N	118° 06' 13.4"W
Dominguez Gap Pump	1764025	6500043	33° 50' 22.1"N	118° 12' 10.5"W

1. A separate upstream sampling location was established for Bouton Creek during dry weather due to decreases in dry weather flow that had proven insufficient to flush saltwater from the channel before the flood tide once again inundated the site with marine water.

Table 5. Analytical Methods, Holding Times, and Reporting Limits.

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit or ML
CONVENTIONAL PARAMETERS			
Oil and Grease (mg/L)	1664	28 days	5.0
Total Phenols (mg/L)	420.1	28 days	0.1
pH (units)	150.1	ASAP	0 – 14
Orthophosphate-P (mg/L)	365.2	48 hours	0.01
Total Phosphorus (mg/L)	365.2	28 days	0.05
Turbidity (NTU)	180.1	48 hours	1.0
Total Suspended Solids (mg/L)	160.2	7 days	1.0
Total Dissolved Solids (mg/L)	160.1	7 days	1.0
Volatile Suspended Solids (mg/L)	160.4	7 days	1.0
Total Organic Carbon (mg/L)	415.1	28 days	1.0
Biochemical Oxygen Demand (mg/L)	405.1	48 hours	4.0
Chemical Oxygen Demand (mg/L)	410.1	28 days	4.0
Total Ammonia-Nitrogen (mg/L)	350.1	28 days	0.1
Total Kjeldahl Nitrogen (mg/L)	351.1	28 days	0.1
Nitrite Nitrogen (mg/L)	300.0	48 hours	0.1
Nitrate Nitrogen (mg/L)	300.0	48 hours	0.1
Alkalinity, as CaCO3 (mg/L)	310.1	48 hours	5.0
Specific Conductance (umhos/cm)	120.1	48 hours	1.0
Total Hardness (mg/L)	130.2	180 days	1.0
MBAS (mg/L)	425.1	48 hours	0.025
Chloride (mg/L)	300.0	48 hours	1.0
Fluoride (mg/L)	300.0	48 hours	0.1
BACTERIA (MPN/100ml)			
Total Coliform	SM 9221B	6 hours	<20
Fecal Coliform	SM 9221E	6 hours	<20
Enterococcus	1600	6 hours	<10
TOTAL AND DISSOLVED METALS (µg/L)[1]			
Aluminum	200.8	180 days	100
Arsenic	200.8	180 days	0.5
Cadmium	200.8	180 days	0.25
Chromium	200.8	180 days	0.5
Copper	200.8	180 days	0.5
Iron	200.8	180 days	25
Lead	200.8	180 days	0.2
Nickel	200.8	180 days	0.5
Selenium	200.8	180 days	1.0
Silver	200.8	180 days	0.2
Zinc	200.8	180 days	1.0

1. Samples to be analyzed for dissolved metals are to be filtered within 48 hours.

Table 5. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
CHLORINATED PESTICIDES (µg/L)			
Aldrin	625m/608	7 days	0.005
alpha-BHC	625m/608	7 days	0.005
beta-BHC	625m/608	7 days	0.005
delta-BHC	625m/608	7 days	0.005
gamma-BHC (lindane)	625m/608	7 days	0.005
alpha-Chlordane	625m/608	7 days	0.005
gamma-Chlordane	625m/608	7 days	0.005
4,4'-DDD	625m/608	7 days	0.005
4,4'-DDE	625m/608	7 days	0.005
4,4'-DDT	625m/608	7 days	0.005
Dieldrin	625m/608	7 days	0.005
Endosulfan I	625m/608	7 days	0.005
Endosulfan II	625m/608	7 days	0.005
Endosulfan sulfate	625m/608	7 days	0.005
Endrin	625m/608	7 days	0.005
Endrin Aldehyde	625m/608	7 days	0.005
Heptachlor	625m/608	7 days	0.005
Heptachlor Epoxide	625m/608	7 days	0.005
Toxaphene	625m/608	7 days	0.005
PCBs (µg/L)			
Aroclor-1016	625m/608	7 days	0.02
Aroclor-1221	625m/608	7 days	0.02
Aroclor-1232	625m/608	7 days	0.02
Aroclor-1242	625m/608	7 days	0.02
Aroclor-1248	625m/608	7 days	0.02
Aroclor-1254	625m/608	7 days	0.02
Aroclor-1260	625m/608	7 days	0.02
Total PCBs	625m/608	7 days	0.02
ORGANOPHOSPHATE PESTICIDES (µg/L)			
Diazinon	625m/SW846 3510C	7 days	0.004
Chlorpyrifos (Dursban)	625m/SW846 3510C	7 days	0.002
Malathion	625m/614	7 days	0.006-0.050

Table 5. Analytical Methods, Holding Times, and Reporting Limits. (continued)

Analyte and Reporting Unit	EPA Method Number	Holding Time	Target Reporting Limit
PYRETHROID PESTICIDES (ng/L)			
Allethrin	SW846 3510C	7 Days/40 Days	1.5
Bifenthrin	SW846 3510C	7 Days/40 Days	1.5
Cyfluthrin	SW846 3510C	7 Days/40 Days	1.5
Cypermethrin	SW846 3510C	7 Days/40 Days	1.5
Deltamethrin:Tralomethrin	SW846 3510C	7 Days/40 Days	3
Esfenvalerate:Fenvalerate	SW846 3510C	7 Days/40 Days	1.5
Fenpropathrin	SW846 3510C	7 Days/40 Days	1.5
Lambda-Cyhalothrin	SW846 3510C	7 Days/40 Days	1.5
Permethrin	SW846 3510C	7 Days/40 Days	15
Tau-Fluvalinate	SW846 3510C	7 Days/40 Days	1.5
Tetramethrin	SW846 3510C	7 Days/40 Days	1.5

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RAINFALL AND HYDROLOGY

Except for the Dominguez Gap Pump Station, at least four storm events for each station were monitored this season despite below average rainfall for the season. Stormwater sampling was accomplished over the course of seven separate rainfall events, including the first significant rainfall of the season on October 5, 2011. Sufficient sample volume was collected during four events each at the Belmont Pump Station, Bouton Creek, and Los Cerritos Channel to complete the full required suite of analyses. Because of the lack of discharge during events that met antecedent rainfall criteria, only two events were sampled at the Dominguez Gap Pump Station for the full required suite of analyses. In addition to storm events sampled for the full suite of analyses, three events at the Belmont Pump Station and Bouton Creek and two events at Los Cerritos Channel were sampled for total suspended solids (TSS) only. TSS events were conducted only when there was not sufficient rainfall and sample volume to conduct the majority of the analyses or after the required four events for the full suite of analyses were completed.

A complete record of precipitation data exists for the 2011/2012 wet weather season, starting in early September, though some of the precipitation data were augmented with nearby precipitation data. All rain gauges were inspected prior to the first rain and subsequently during some servicing visits, yet there were a couple instances where the gauges malfunctioned as a result of spiders, birds and other fowling problems. In those cases, rain data were substituted with data from a nearby gauge. After inspection of data, the rain gauge at Dominguez Gap was discovered to have been partially clogged during the fourth through sixth monitored events (December 12, January 21 and March 17) and those data were substituted with data from the nearby Wardlow-LAR USACOE Station. The Bouton Creek rain gauge failed for the last event of the season (March 25 and 26) and data were replaced with Los Cerritos Channel data. Belmont Pump and Los Cerritos gauges operated throughout the season without any significant maintenance issues.

A complete record of discharge data also exists for the four monitoring stations. These data show no significant issues.

PRECIPITATION DURING THE 2011/2012 WET WEATHER SEASON

Table 6 through Table 9 summarize daily rainfall for each monitoring station during the 2011/2012 season along with daily rainfall from the previous 2010/2011 season (Oct – Apr). As these data show, the 2011/2012 season had below normal rainfall and considerably less rainfall than the 2010/2011 season. This is also evident in Figure 11 which shows the seasonal precipitation at Long Beach Airport for the past 13 years. This season's cumulative rainfall of 7.53 inches at the airport is well below the normal wet season average of 12.27 inches and below the average of 10.32 inches since the inception of this program in 1999.

Cumulative rainfall for each station is illustrated in Figure 12. As this figure shows, rainfall totals varied somewhat among the four monitoring stations as a result local orographic differences and the showery nature of some events. Season totals (October 1 through April 30) were 7.15 inches at the Belmont Pump Station, 7.59 inches at Los Cerritos Channel, 7.08 inches at Bouton Creek, and 8.06 inches at the Dominguez Gap Pump Station. The rainfall total at Long Beach Airport (7.53 inches) was similar to totals measured at each of the four monitoring stations.

Monthly Precipitation

Figure 13 shows monthly rainfall at the four monitoring sites and at the Long Beach Airport along with the normal average monthly rainfall at the airport. This season did not follow normal weather patterns. October, November and April had normal to above normal precipitation, while December through March had below normal precipitation. February, which is typically the wettest month of the season, was the driest month of the season. April ended up with about twice the normal precipitation.

Precipitation during Monitored Events

Precipitation during each storm event has been characterized by total rainfall, duration of rainfall, maximum intensity, days since last rainfall, and the magnitude of the event immediately preceding the monitored storm event (antecedent rainfall). Precipitation characteristics for each monitored event are summarized in Table 10. Descriptive statistics for all monitored events and for each station, including TSS only events are presented in Table 11.

Cumulative rainfall and intensity are summarized graphically for each monitored event at each station in Figure 14 through Figure 35.

For the 2011/2012 wet weather season, total rainfall for full testing events varied between 0.3 and 1.08 inches at the Belmont Pump Station, 0.39 and 0.78 inches at Bouton Creek, 0.34 and 0.77 inches at Los Cerritos Channel, and 0.49 and 1.01 inches at the Dominguez Gap Pump Station. For TSS-only storm events, total rainfall between monitored events ranged from 0.21 inches to 0.87 inches at the Belmont Pump Station, 0.21 inches to 0.69 inches at Bouton Creek, and 0.26 inches to 0.69 inches at Los Cerritos Channel.

Mean total rainfall between all testing events (Full and TSS only) during the 2011/2012 wet weather season ranged from 0.51 inches at Bouton Creek and Los Cerritos Channel to 0.75 inches at the Dominguez Gap Pump Station. Mean total rainfall between full suite storm events was not much different than mean total rainfall between all testing events. Mean total rainfall between full suite events ranged from 0.53 inches at Los Cerritos Channel and to 0.75 inches the Dominguez Gap Pump Station.

An important variable that directly affects water quality is maximum rainfall intensity during a rainfall event. Higher maximum rainfall intensities, especially over a sustained period, usually create higher flows that carry more particulates. Mean maximum rainfall intensities among monitored events (based on five minutes of data) ranged from 0.67 inches/hour at Bouton Creek to 1.08 inches/hour at the Dominguez Gap Pump Station. Maximum intensities during the 2011/2012 wet weather season monitored events reached as high as 1.08 inches/hour at Bouton Creek, 1.8 inches/hour at Los Cerritos channel, 1.01 inches/hour at the Dominguez Gap Pump Station, and a very brief but intense 3.72 inches/hour at the Belmont Pump Station. More intense rain probably fell at Bouton Creek during the March 25-26 event, but the rain gauge was inoperable during that event, thus the maximum intensity of 1.8 inches/hour observed for Los Cerritos Channel for that event cannot be verified at Bouton Creek.

Another important variable that directly affects water quality is antecedent rainfall. It can be expected that the longer the period of dry weather between rainfall events and the less amount of rainfall from the previous event, the greater the accumulation of pollutants on impervious surfaces. With this in mind, the Regional Water Quality Control Board stipulated a targeted period of dry conditions prior to monitoring events of at least seven days. Daily dry conditions for the purpose of monitoring are defined as a 24-hour period with less than 0.1 inches of rain. Dry periods prior to monitored events and the magnitude of the previous event are best illustrated by reviewing daily rainfall data in Table 6 through Table 9. These data and data summarized in Table 10 show that all but the first two monitored events during the 2011/2012 season met antecedent criteria. The “first flush” event on October 5 was preceded by 0.11 to 0.18 inches of rain the day before. Because of the importance of capturing the “first event” and the fact that the data showed minimal flow or discharge from the October 4 rain (no discharge from the Belmont Pump Station, 120 kcf from Bouton Creek, and 1,137 Kcf from Los Cerritos Channel), this deviation was considered minor. The second event on November 12 was preceded by 0.21 to 0.26 inches ending 5.6 days earlier. However, this event was sampled for only TSS. Besides the first two events, all other monitored events were preceded by at least eight days of dry conditions. A minor exception did occur for the January 21 Los Cerritos Channel event with 0.11 inches of rain occurring 5.2 days earlier. No measurable flow was recorded from this preceding event.

The mean period of dry conditions among all monitored events ranged from 7.5 days for Los Cerritos Channel to 14.4 days for the Belmont Pump Station. The mean antecedent rain prior to all monitored events ranged from 0.25 inches for the Los Cerritos Channel to 0.46 inches for the Belmont Pump Station.

STORMWATER RUNOFF DURING MONITORED EVENTS

In order to properly estimate Event Mean Concentrations (EMCs) and constituent loadings, monitoring was designed to quantify rainfall events in their entirety and the majority of runoff created by those events.

Table 11 provides flow based descriptive statistics for all monitored events during the 2011/2012 season. This information complements the calculated EMCs for each monitored analyte at these sites. Table 12 summarizes flow characteristics among monitored events at each station including the duration of discharge/flow, total discharge volume, and peak discharge/flow.

Figure 14 through 35 graphically depicts flow during each monitored event at each station in response to rainfall. These figures also show how the aliquoting of each composite sample was conducted and when grab samples were collected.

Flow duration or the period of discharge varied between stations and events. As is the usual case at these sites, flow duration was typically greatest at Bouton Creek due to tidal effects and at Los Cerritos Channel due to the large drainage area. During incoming tides at Bouton Creek, low flows are backed up and held back by the tide. As the tide recedes, stormwater is once again detected at the station using the conductivity sensors and sampling continues. In contrast, the period of discharge at the pump stations was much less.

The duration of discharge is reported in Table 12 for the 2011/2012 monitoring season. The Belmont and Dominguez Gap pump stations are often overestimated because of the on and off cycling of the pumps. Discharge durations reported in these tables represent the period between the times the first pump came on until all pumps became silent. One should refer to the hydrographs developed for the pump stations for a better estimate of the duration of discharge.

Mean total flow or discharge for monitored events during the 2011/2012 wet weather season ranged from 221 kilo-cubic feet (kcf) at the Belmont Pump Station to 8,176 kcf at Los Cerritos Channel. Excluding TSS only events, mean total flow did not change much (252 kcf at the Belmont Pump Station to 8,120 kcf at Los Cerritos Channel).

Percent storm captures (percentage of the total storm event volume effectively represented by the flow-weighted composite sample) met the optimal objective (>90%) in all but three station events. Reduced storm capture comes from a variety of reasons, but percent captures below 90% are usually due to delays in changing full composite bottles. Of the three station events with less than 90% capture, one was 76% (Belmont Pump, Event 1) and the other two were 85% and 87% (Los Cerritos, Events 2 and 5).

It can be expected that throughout a rain event, peak concentrations of pollutants occur at the start of an event and during peak flow/discharge. Therefore, it is important to be sampling during these segments of an event. These segments were sampled for most station events during the 2011/2012 wet weather season. Peak flow was sampled for all events but the very beginning of the storm was missed for the “first flush” event at all sites except the Dominguez Gap Pump Station that had no discharge. Hydrographs for Bouton Creek are misleading because early flows are often too salty to sample. Therefore, it is important to compare conductivity readings to the hydrographs when assessing when sampling occurred.

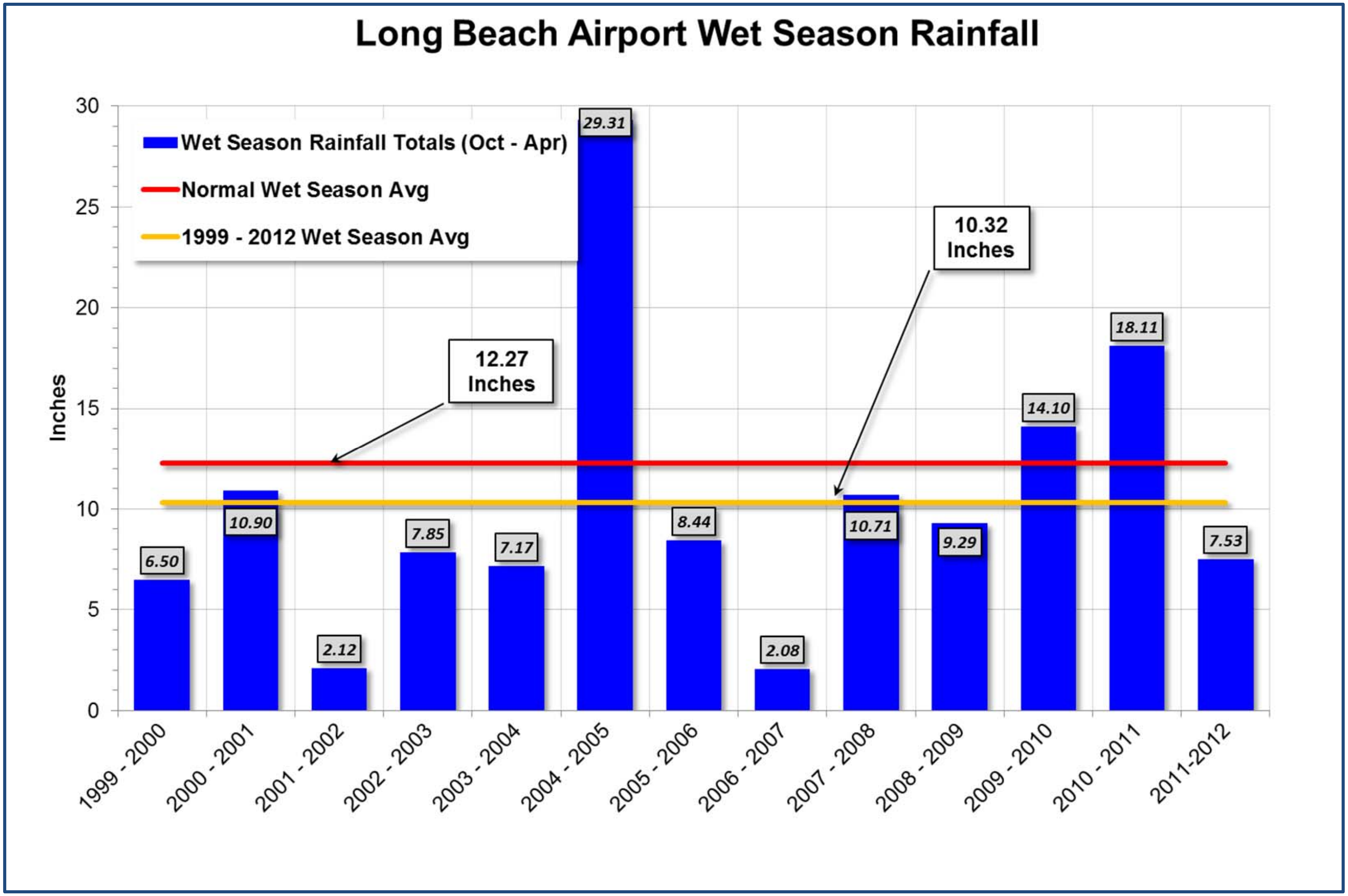


Figure 11. **Annual Rainfall (October –May) at Long Beach Daugherty Airport over Past Thirteen Years.**

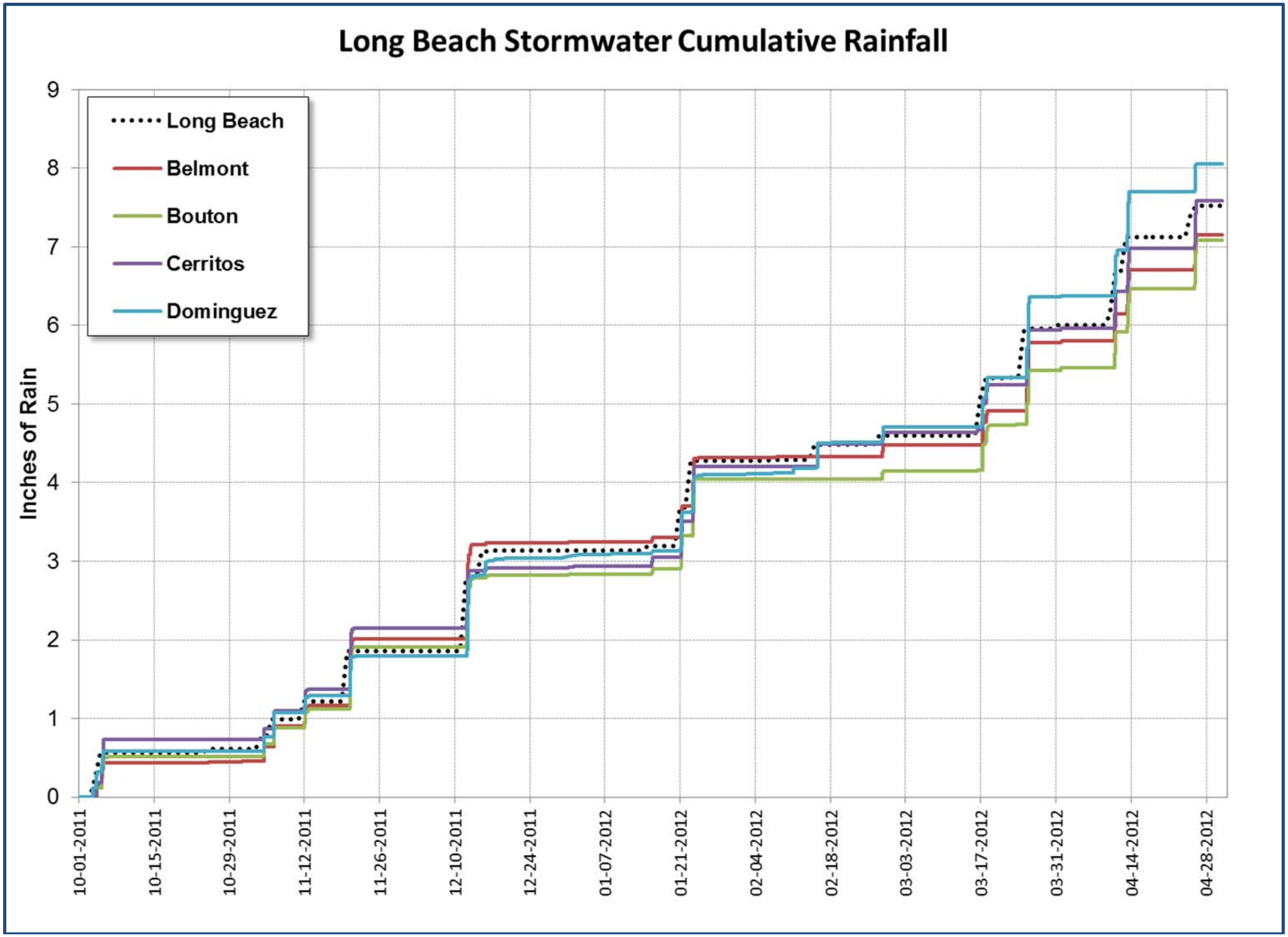
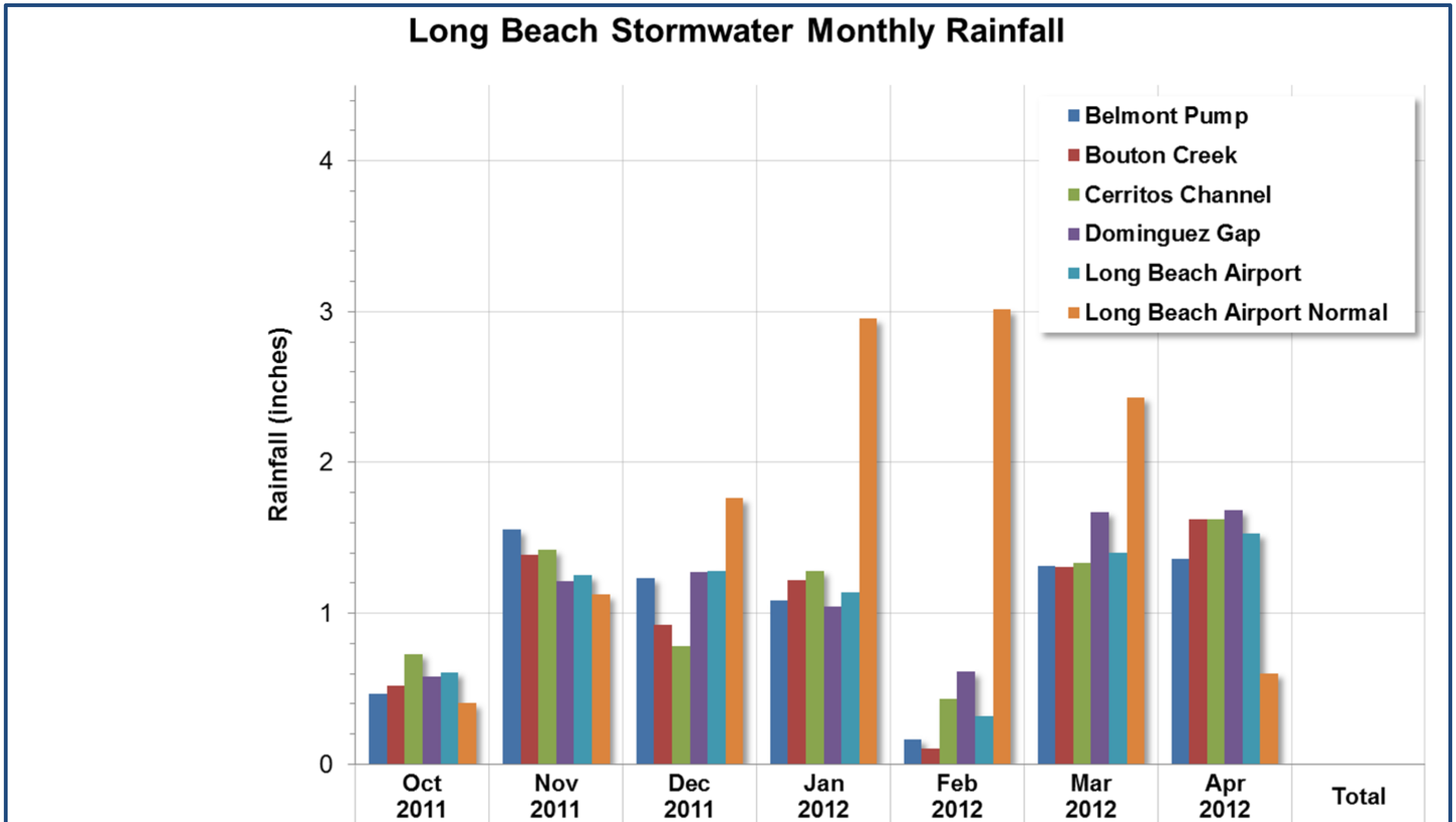


Figure 12. Cumulative Rainfall for the 2011/2012 Wet Weather Season.



	Oct 2011	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	Total
Belmont Pump	0.46	1.55	1.23	1.08	0.16	1.31	1.36	7.15
Bouton Creek	0.52	1.39	0.92	1.22	0.10	1.31	1.62	7.08
Cerritos Channel	0.73	1.42	0.78	1.28	0.43	1.33	1.62	7.59
Dominguez Gap	0.58	1.21	1.27	1.04	0.61	1.67	1.68	8.06
Long Beach Airport	0.61	1.25	1.28	1.14	0.32	1.40	1.53	7.53
Long Beach Airport Normal	0.40	1.12	1.76	2.95	3.01	2.43	0.60	12.27

Figure 13. Monthly Rainfall Totals for each Monitoring Site during the 2011/2012 Wet Weather Season and Normal Rainfall at Long Beach Daugherty Air Field.

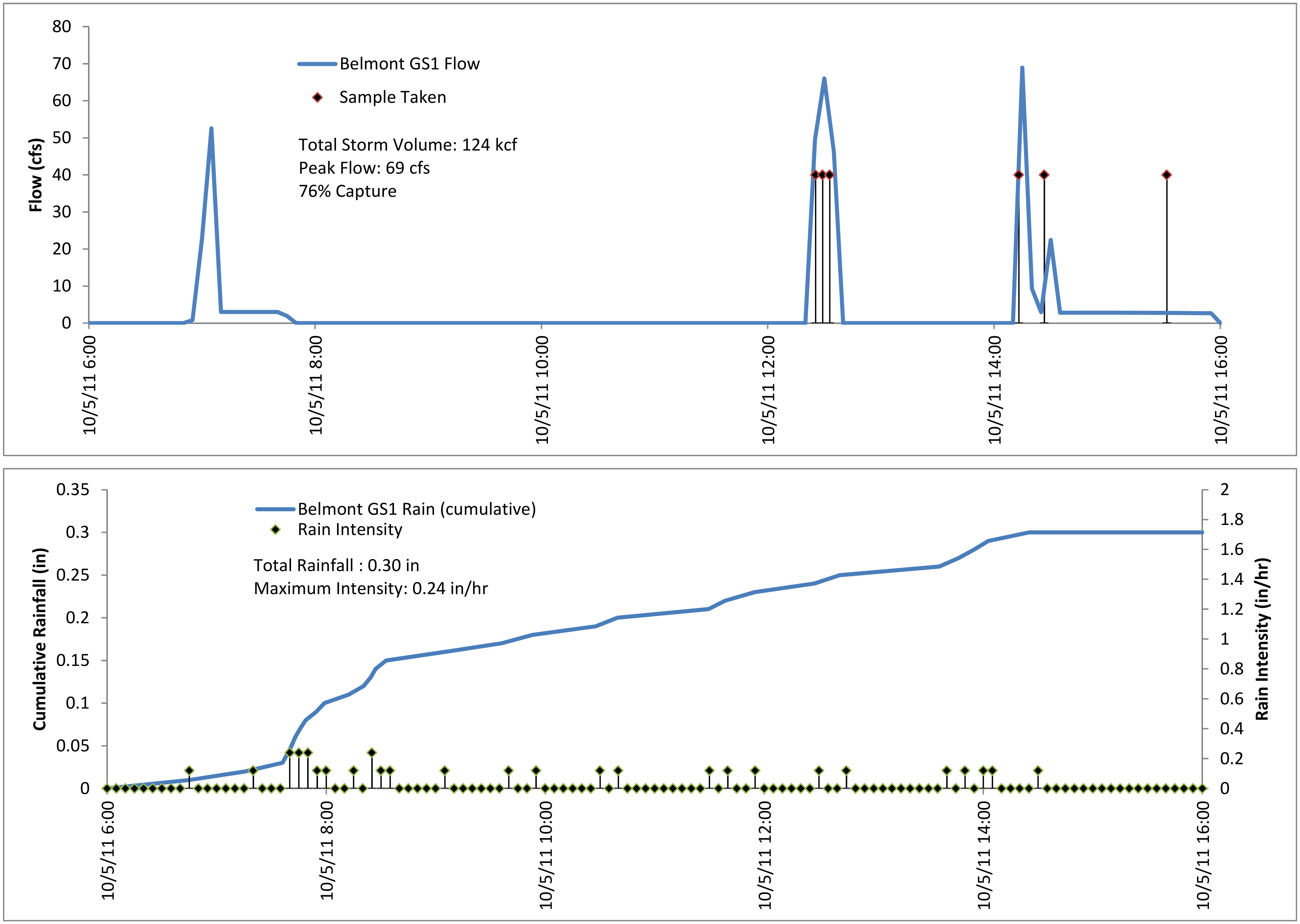


Figure 14. Rain and Discharge from the Belmont Pump Station for Station Event 1 (October 5, 2011– Global Event 1).

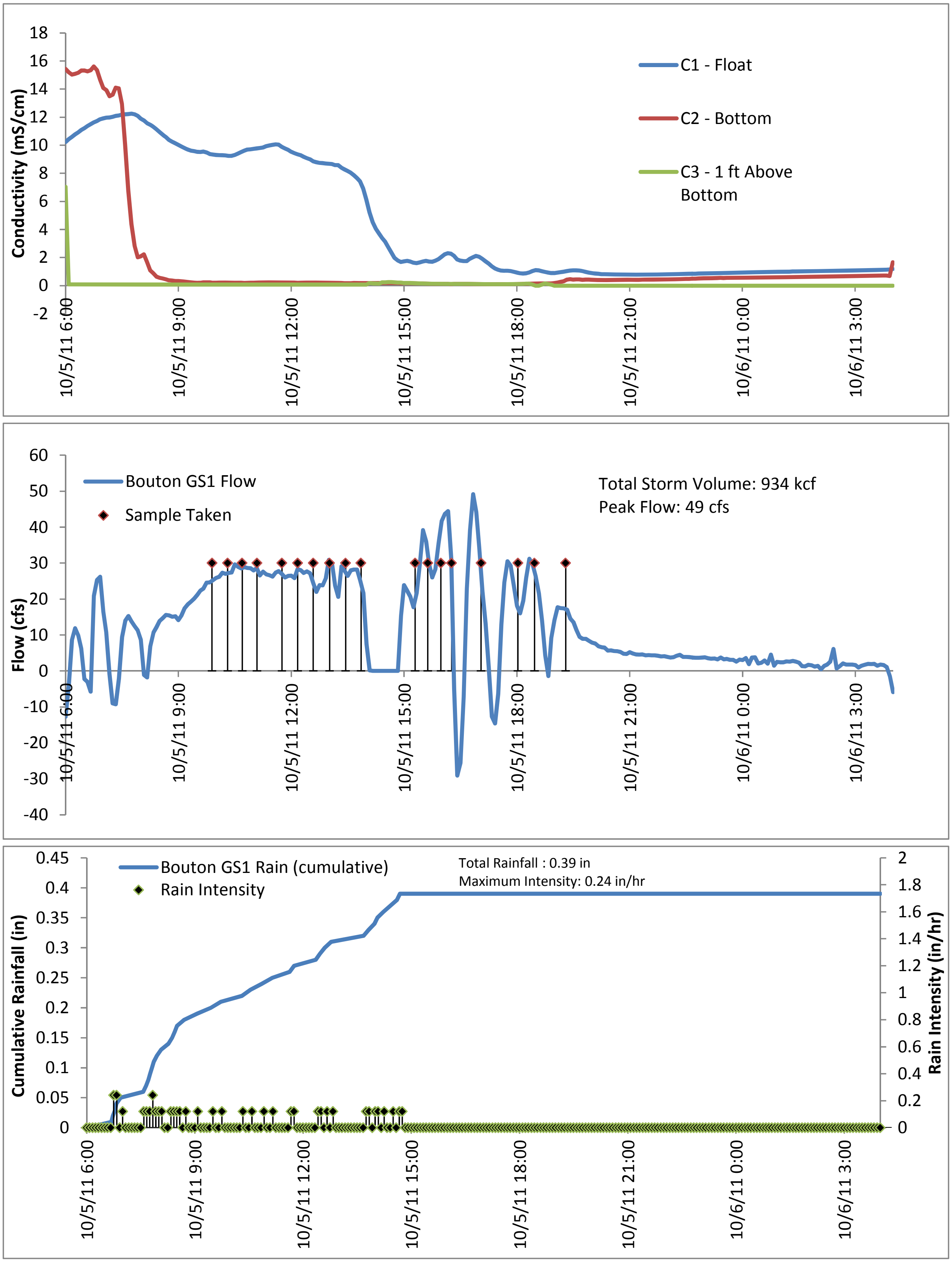


Figure 15. **Rain, Flow and Salinity from Bouton Creek for Station Event 1 (October 5, 2011– Global Event 1).**

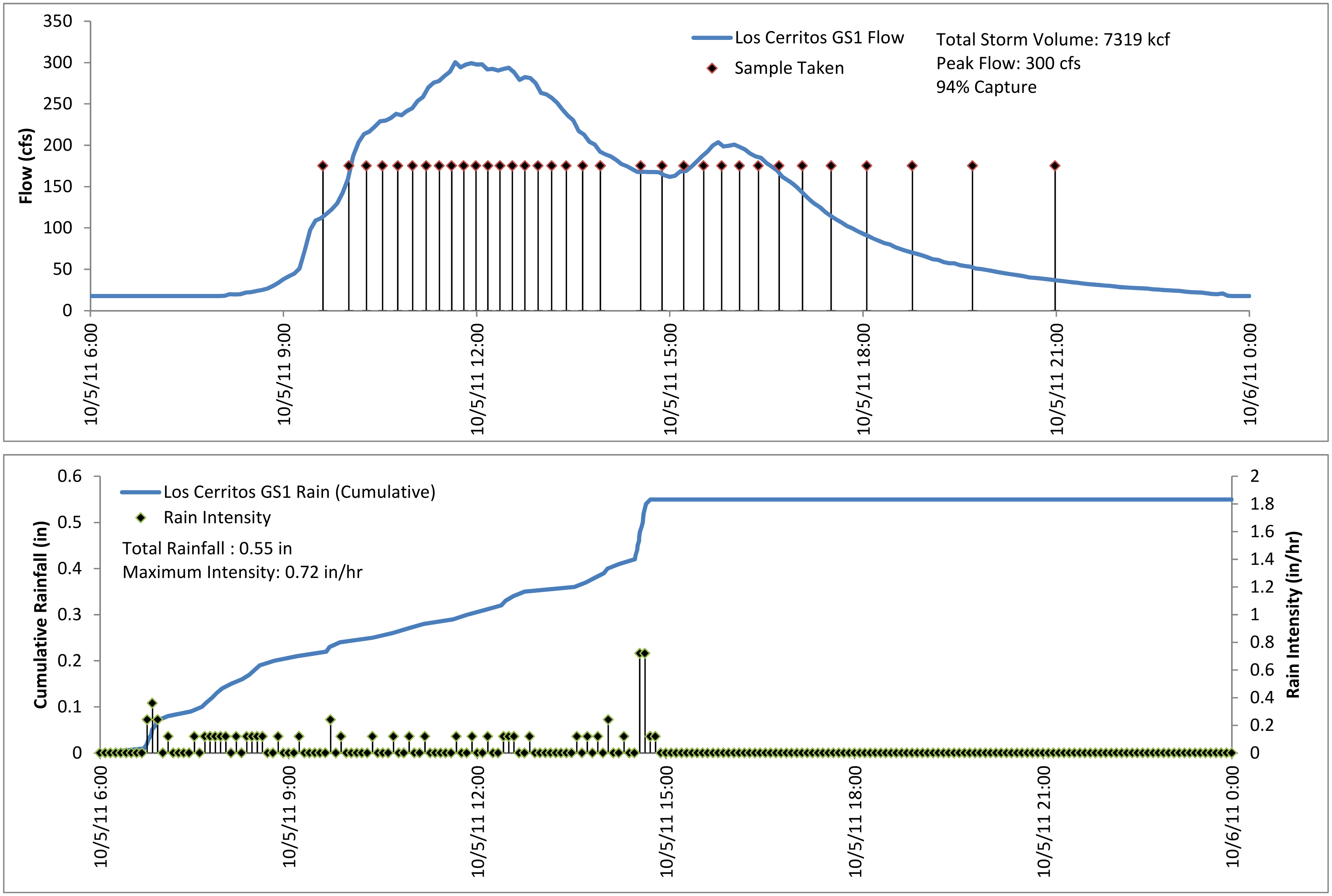


Figure 16. Rain and Flow from Los Cerritos Channel for Station Event 1 (October 5, 2011 – Global Event1).

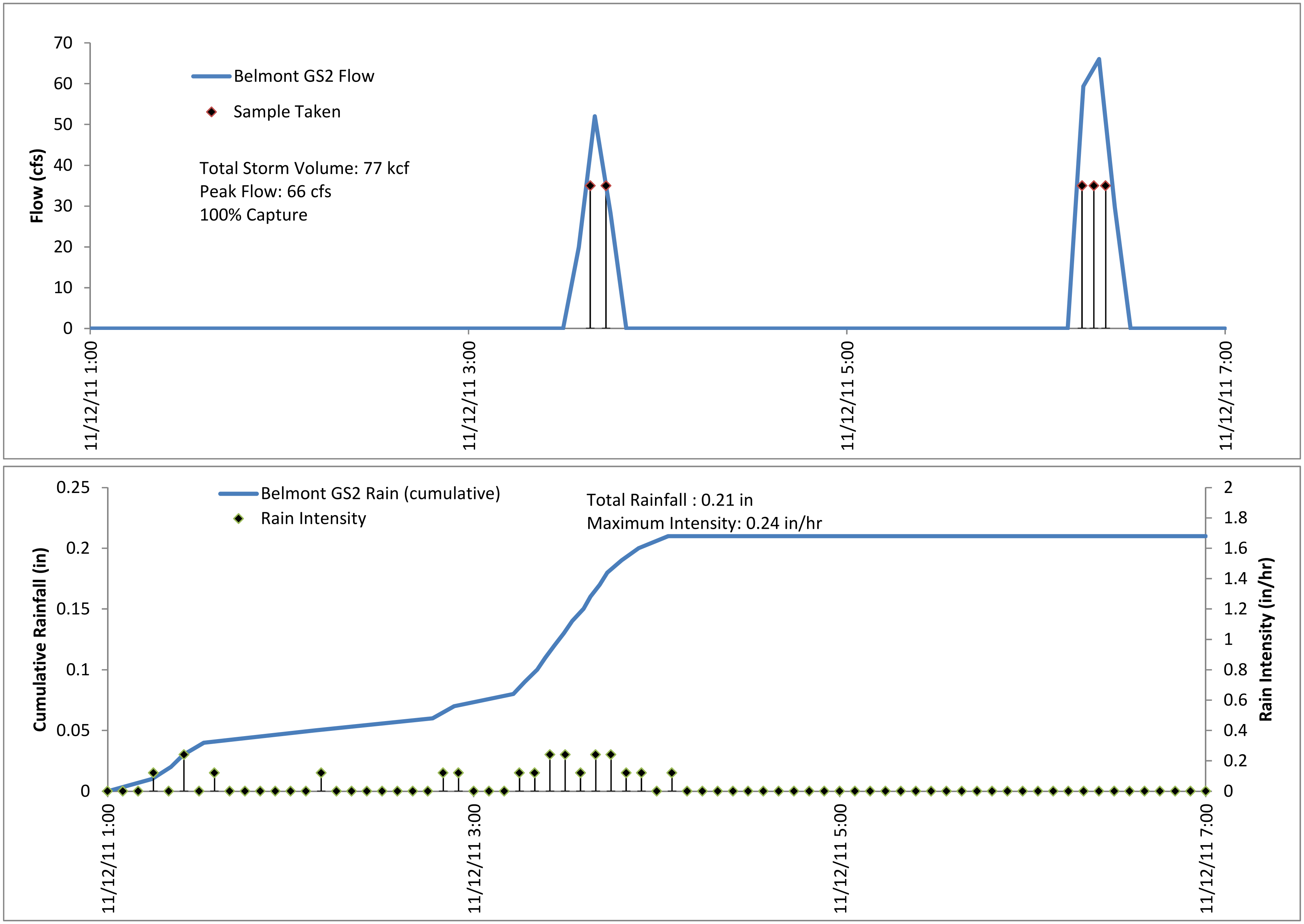


Figure 17. Rain and Flow from the Belmont Pump Station for Station Event 2 (November 12, 2011 – Global Event 2).

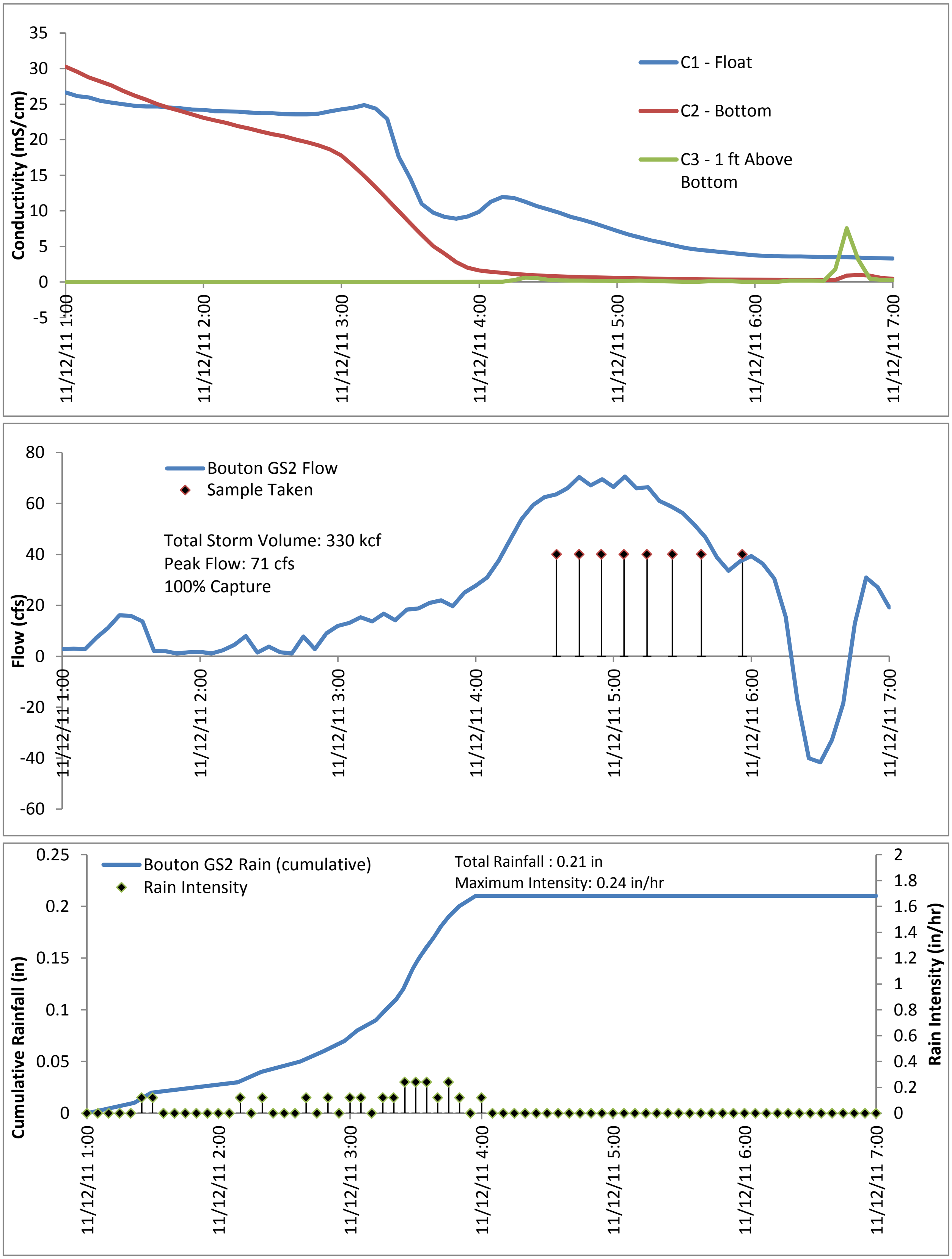


Figure 18. Rain, Flow and Conductivity from Bouton Creek for Station Event 2 (November 12, 2011–Global Event 2).

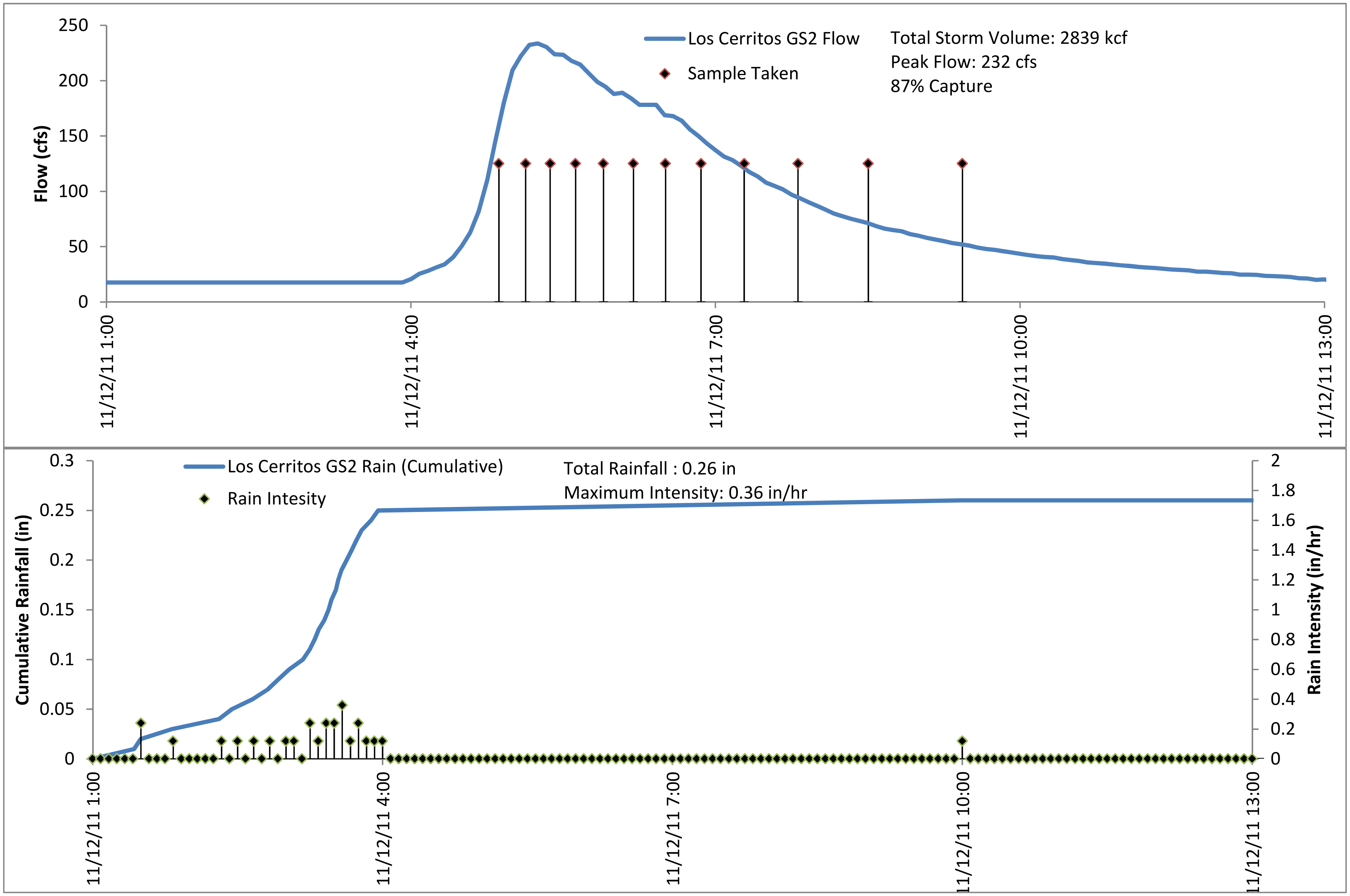


Figure 19. Rain and Flow from Los Cerritos Channel for Station Event 2 (November 12, 2011– Global Event 2).

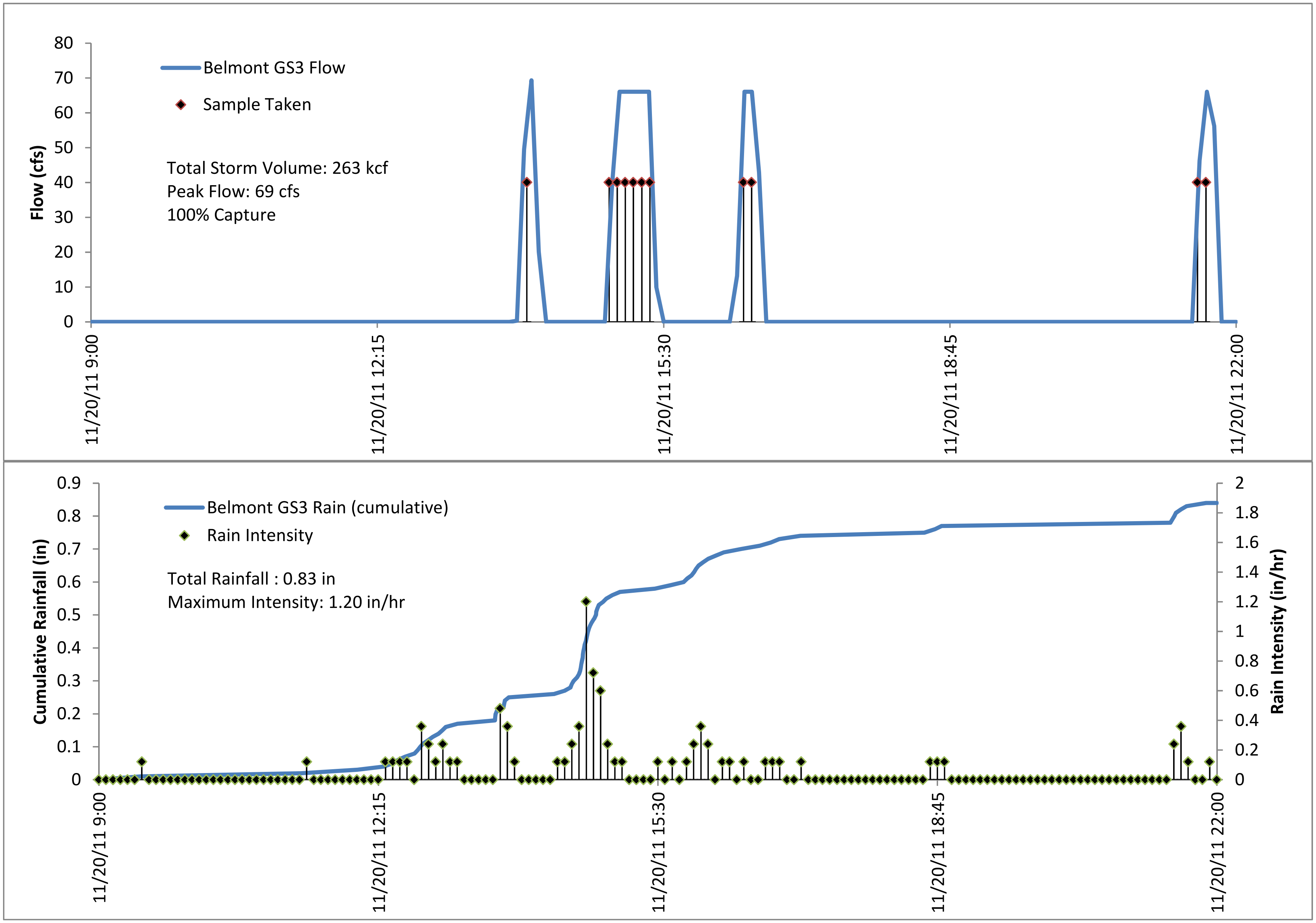


Figure 20. **Rain and Discharge from the Belmont Pump Station for Station Event 3 (November 20-21, 2011 – Global Event 3).**

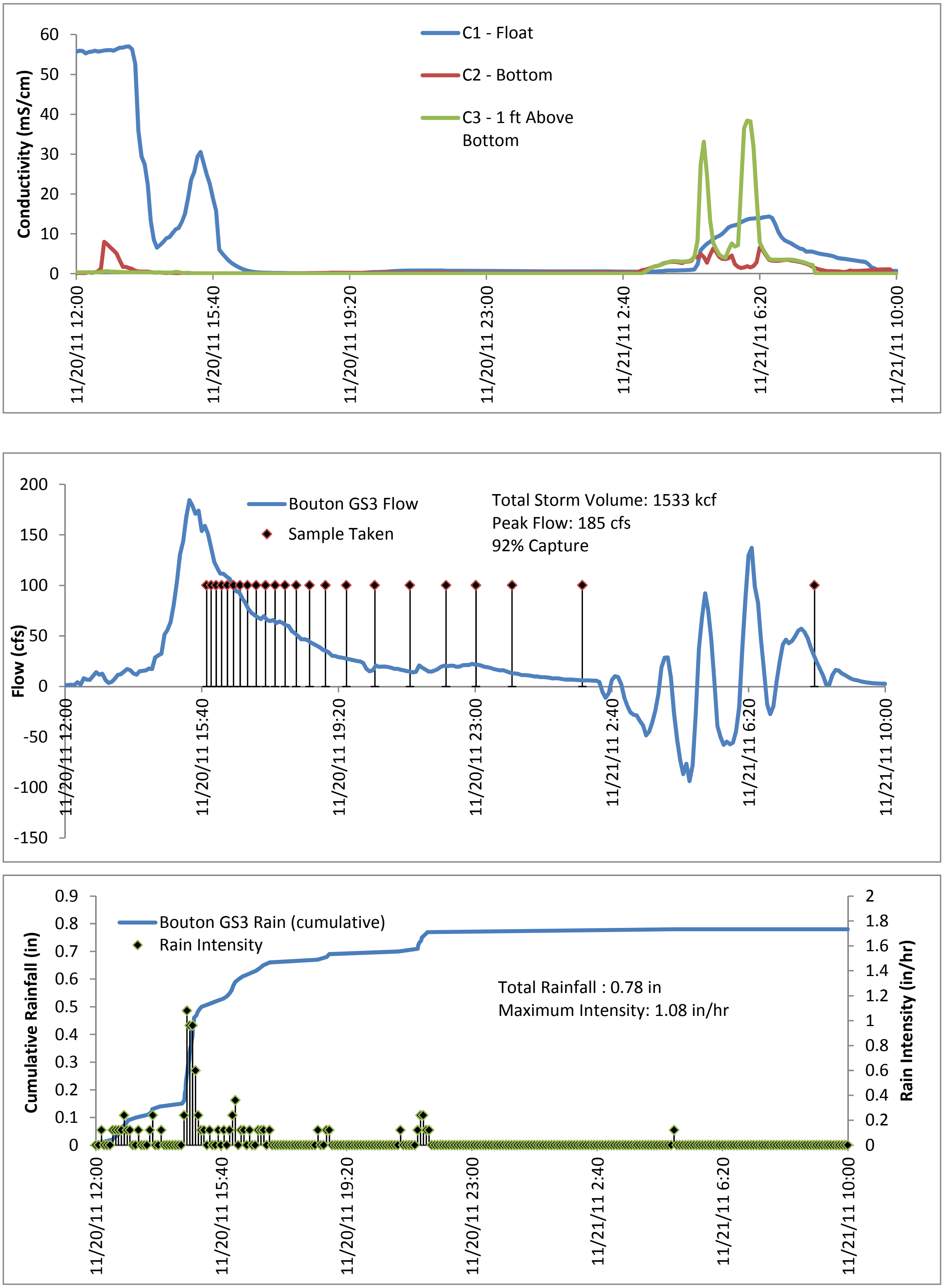


Figure 21. Rain, Flow and Conductivity from Bouton Creek for Station Event 3 (November 20-21, 2011 – Global Event 3).

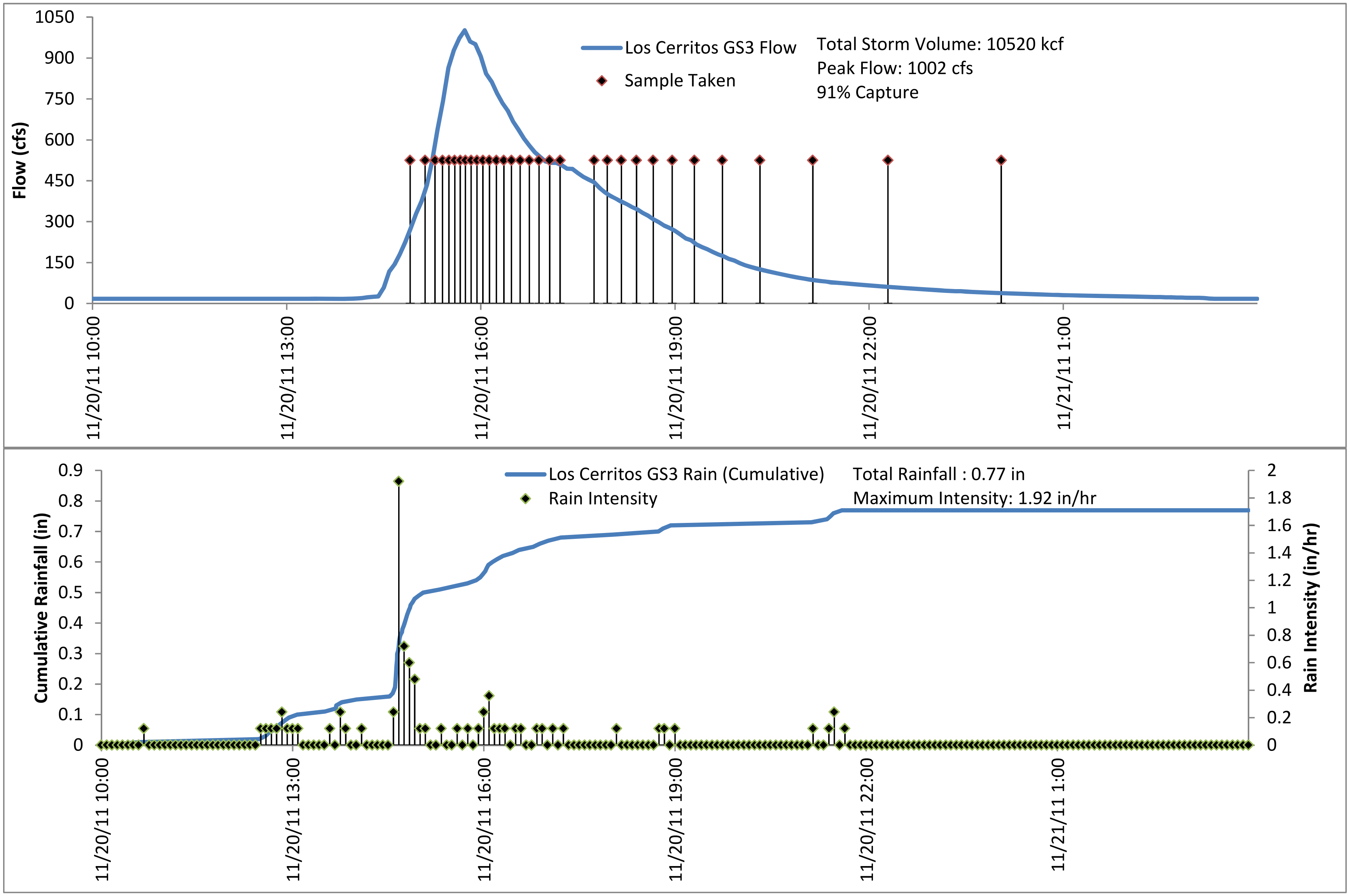


Figure 22. Rain and Flow from Los Cerritos Channel for Station Event 3 (November 20-21, 2011 – Global Event 3).

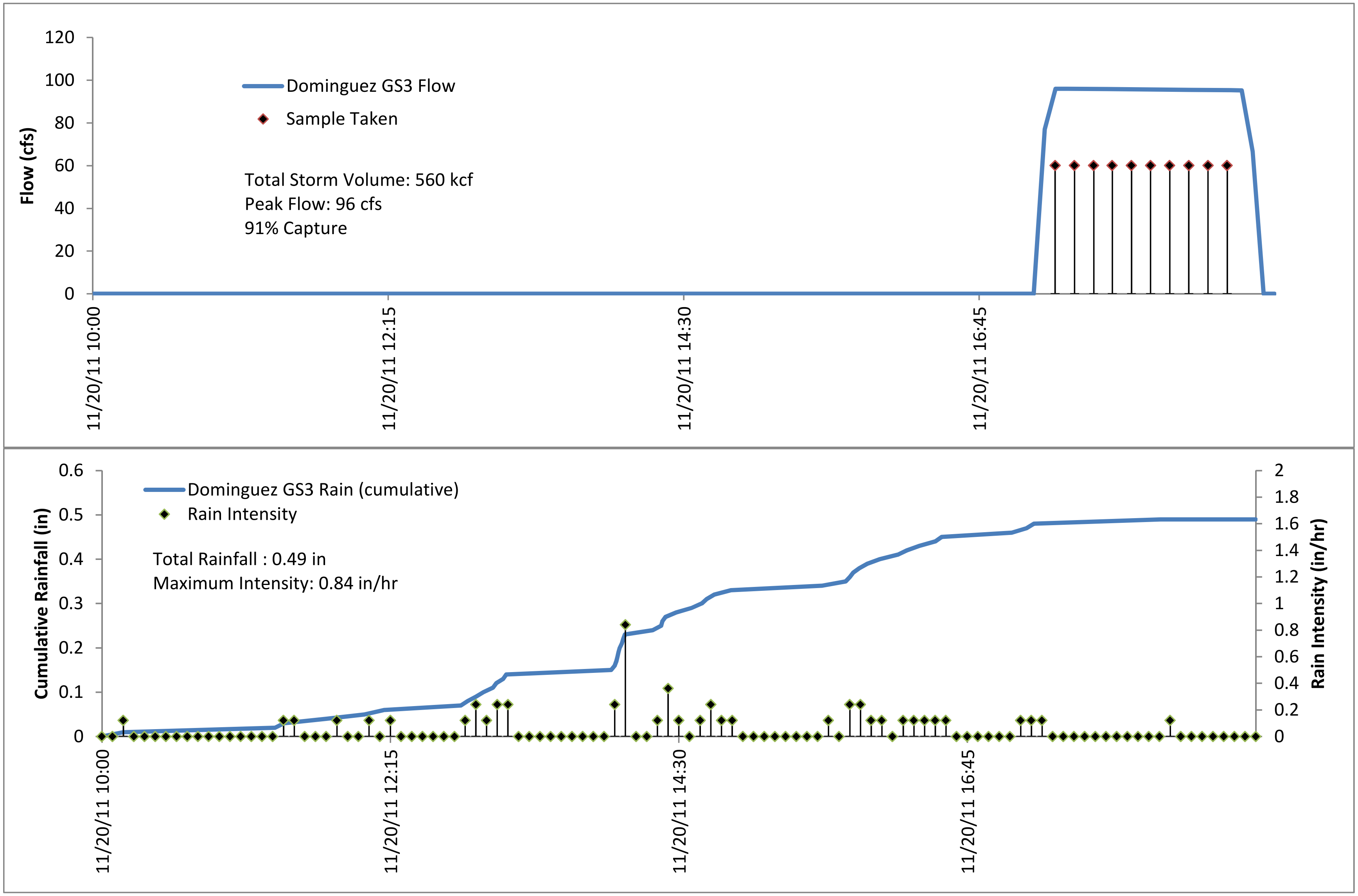


Figure 23. **Rain and Discharge from the Dominguez Gap Pump Station for Station Event 1 (November 20-21, 2011 – Global Event 3).**

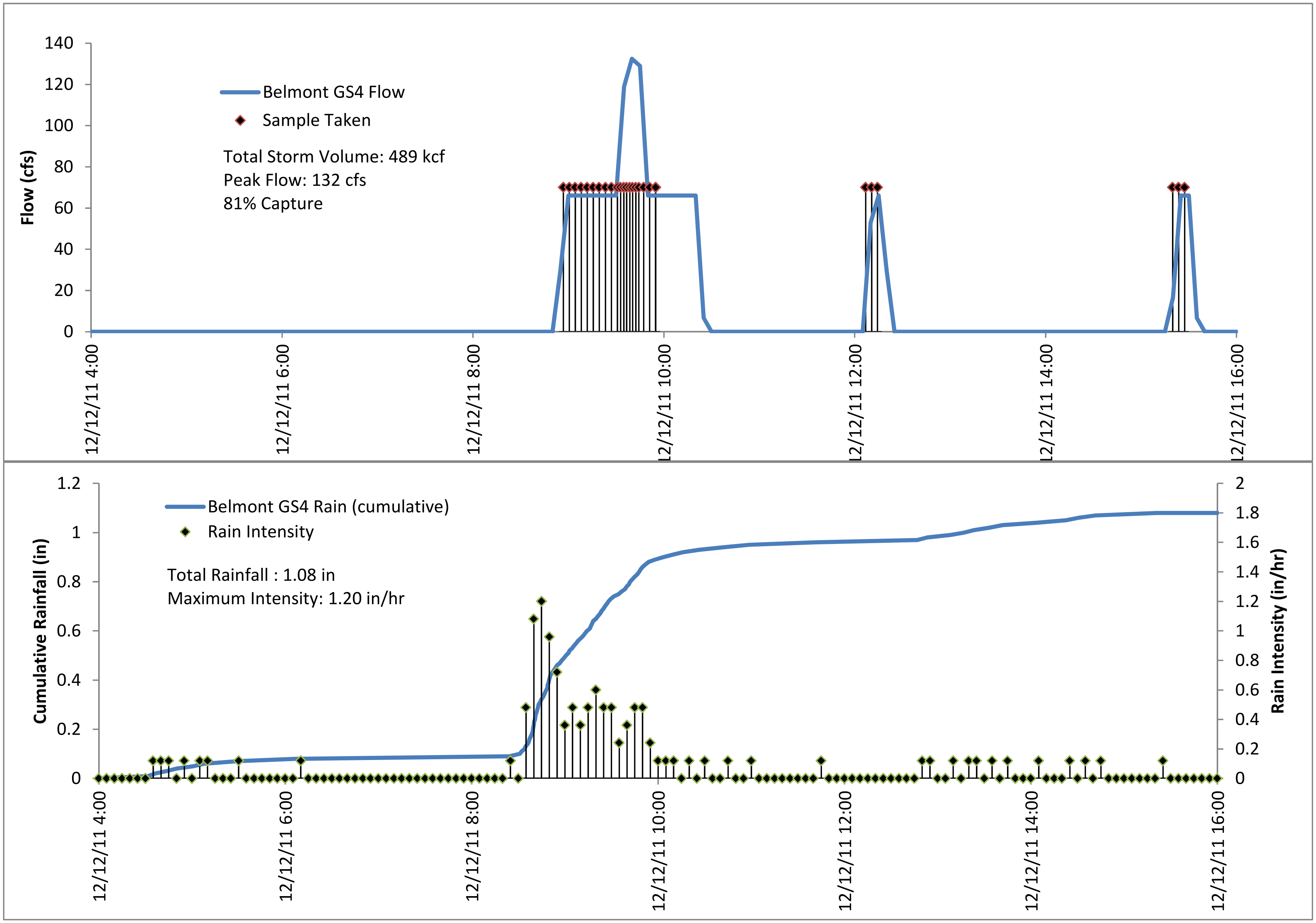


Figure 24. **Rain and Flow from the Belmont Pump Station for Station Event 4 (December 12, 2012 – Global Event 4).**

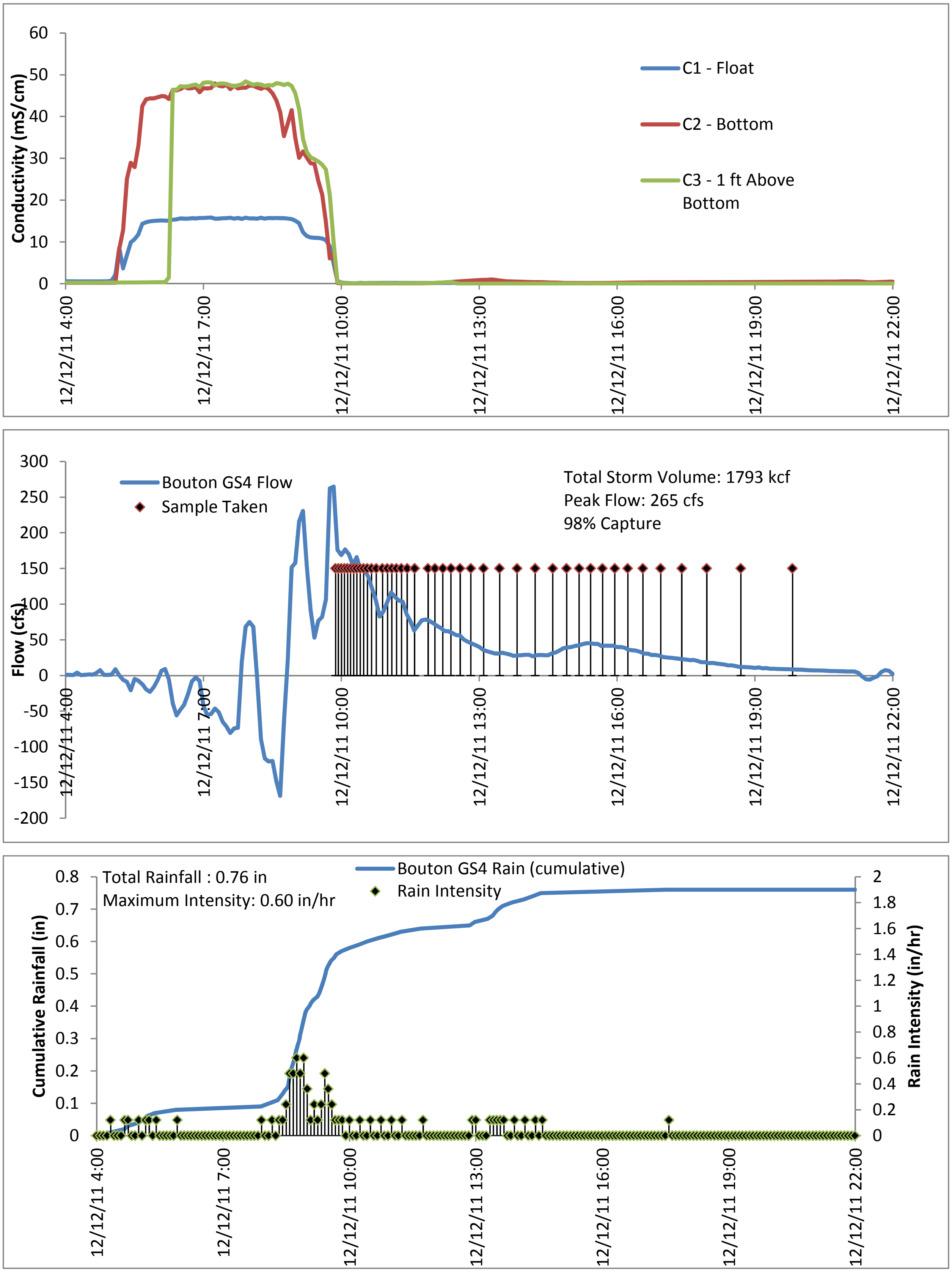


Figure 25. Rain, Flow and Conductivity from Bouton Creek for Station Event 4 (December 12, 2012 – Global Event 4).

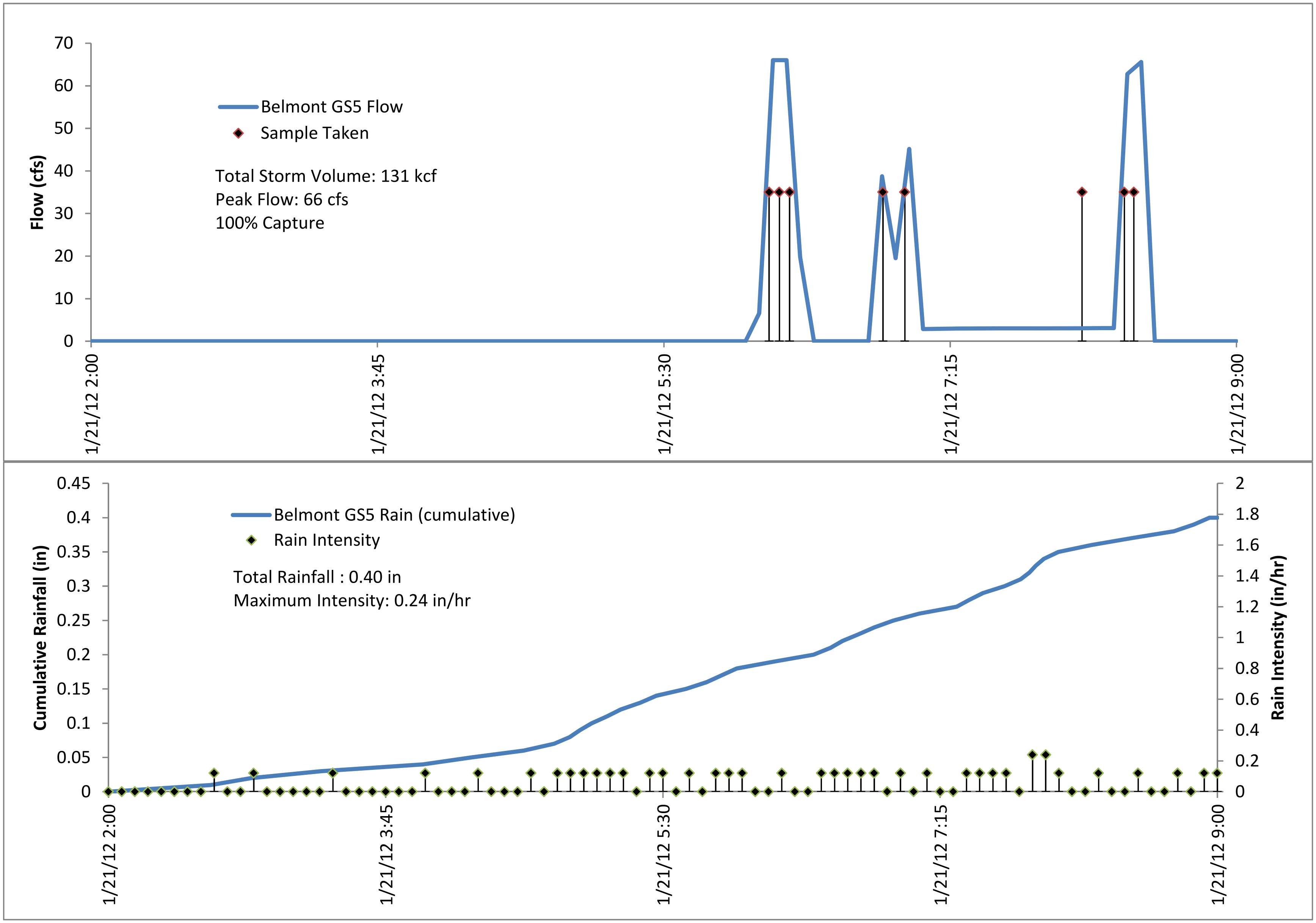


Figure 26. Rain and Discharge from the Belmont Pump Station for Station Event 5 (January 21, 2012 – Global Event 5).

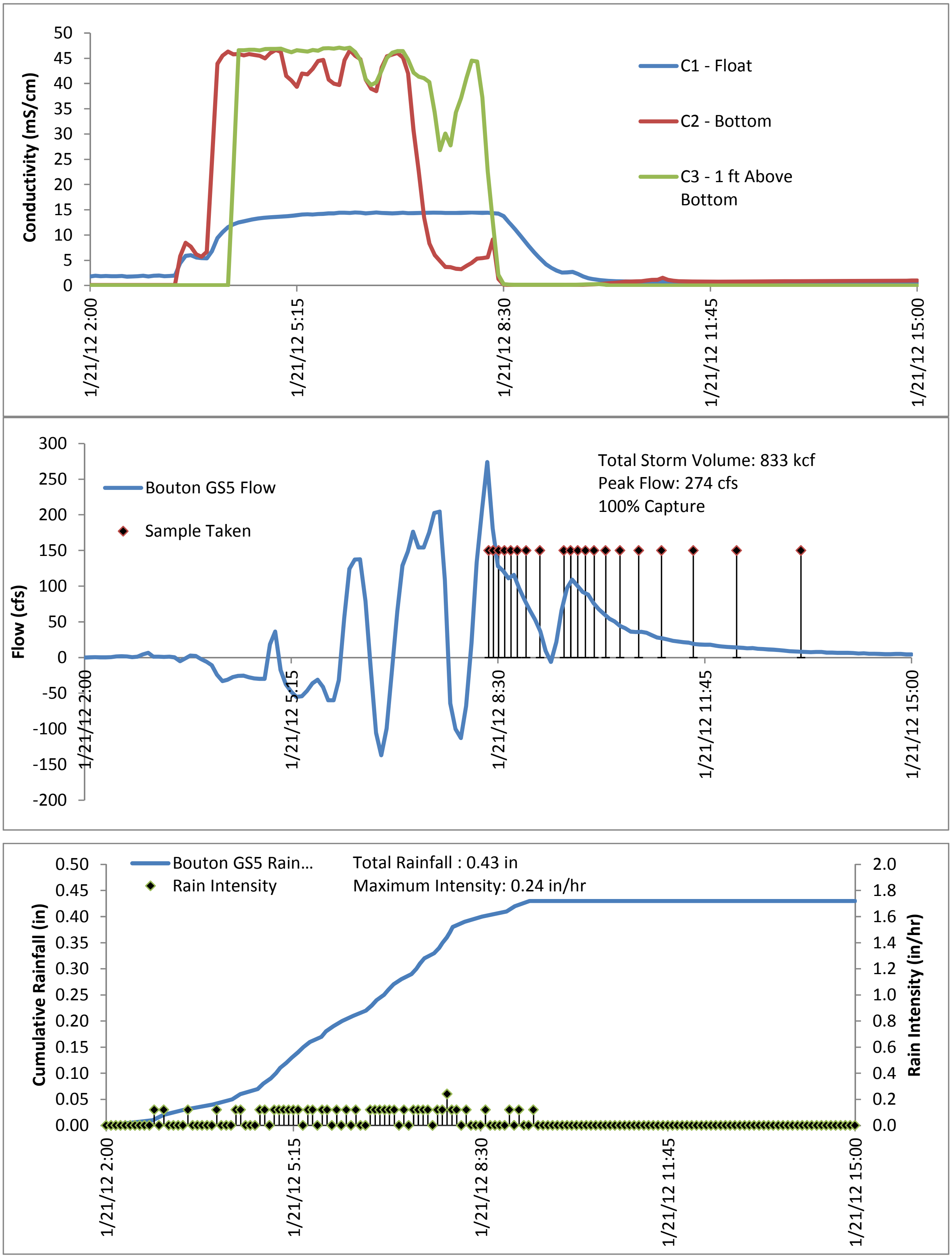


Figure 27. Rain, Flow, and Conductivity from Bouton Creek for Station Event 5 (January 21, 2012 – Global Event 5).

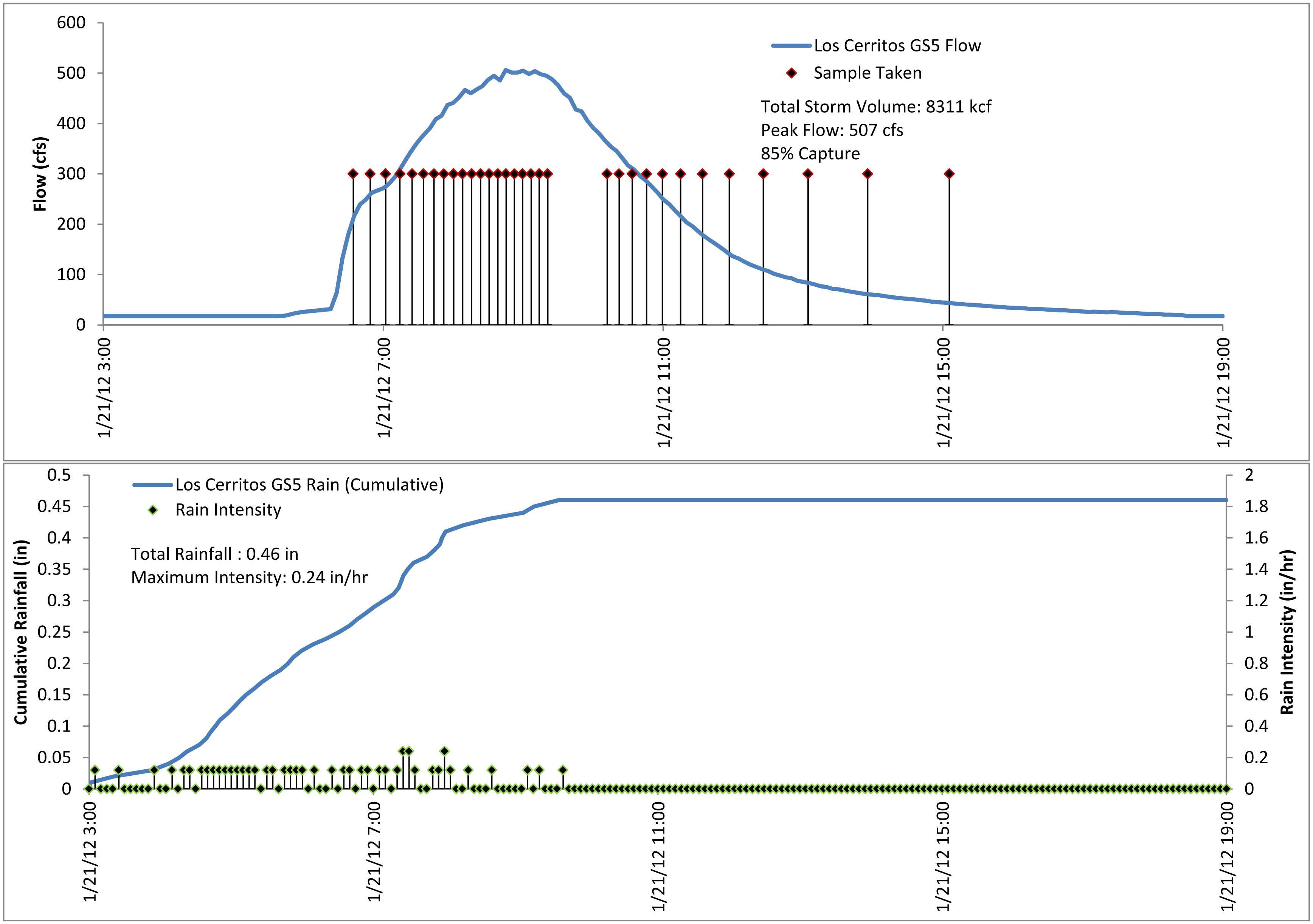


Figure 28. **Rain and Flow from Los Cerritos Channel for Station Event 4 (January 21, 2012 – Global Event 5).**

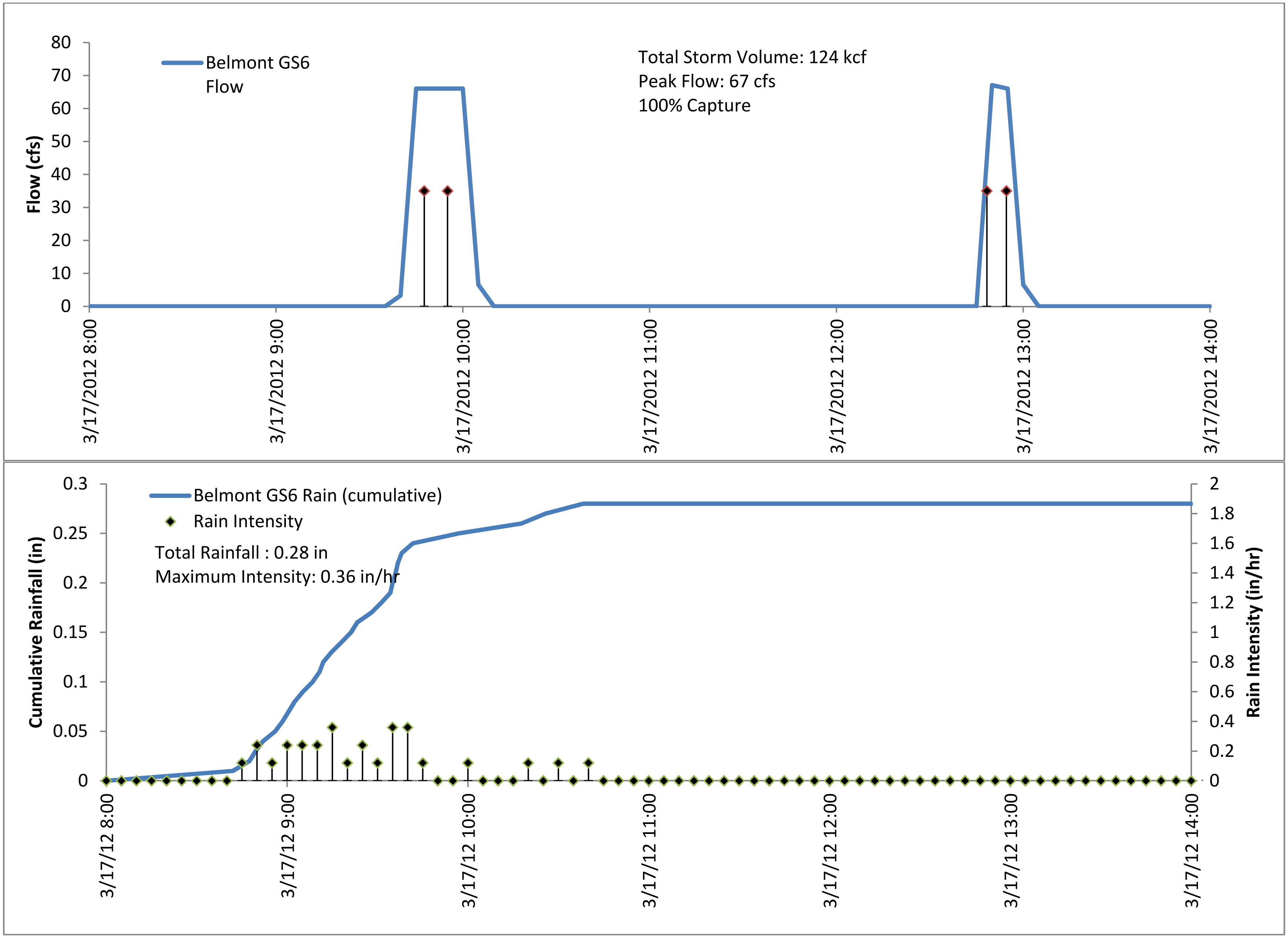


Figure 29. Rain and Discharge from the Belmont Pump Station for Station Event 6 (March 17, 2012 – Global Event 6).

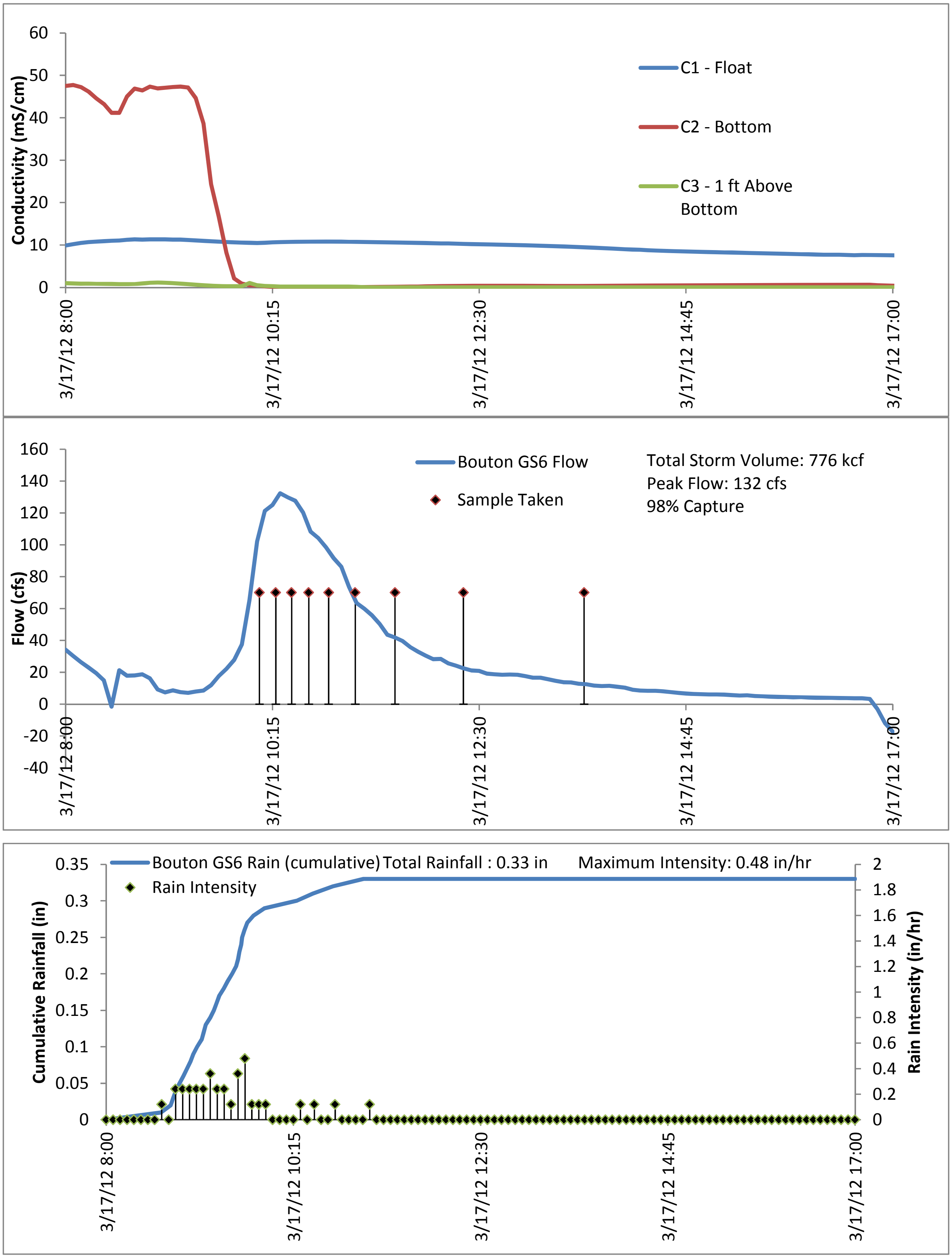


Figure 30. **Rain, Flow and Conductivity from Bouton Creek for Station Event 6 (March 17, 2012 – Global Event 6).**

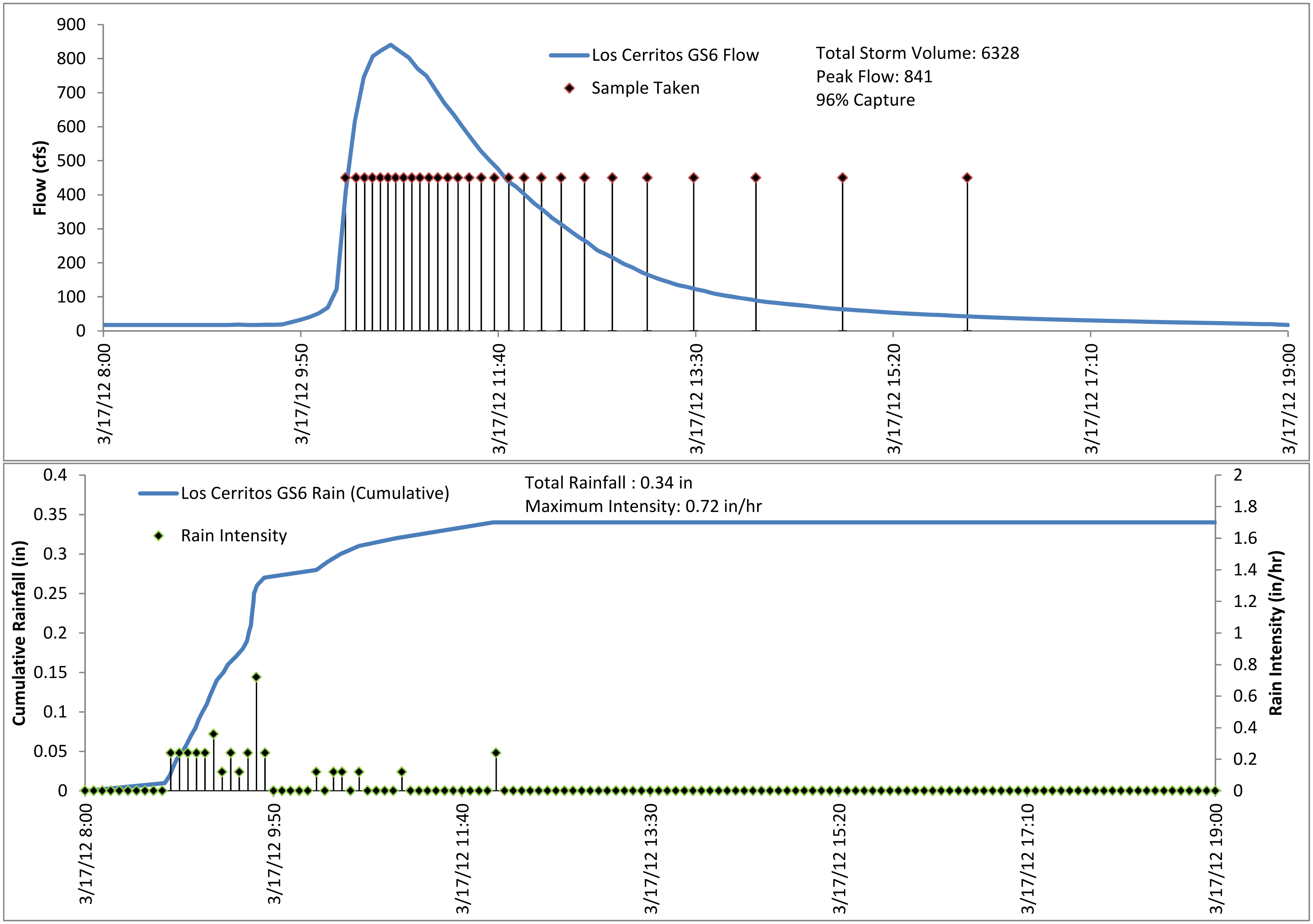


Figure 31. Rain and Flow from Los Cerritos Channel for Station Event 5 (March 17, 2012 – Global Event 6).

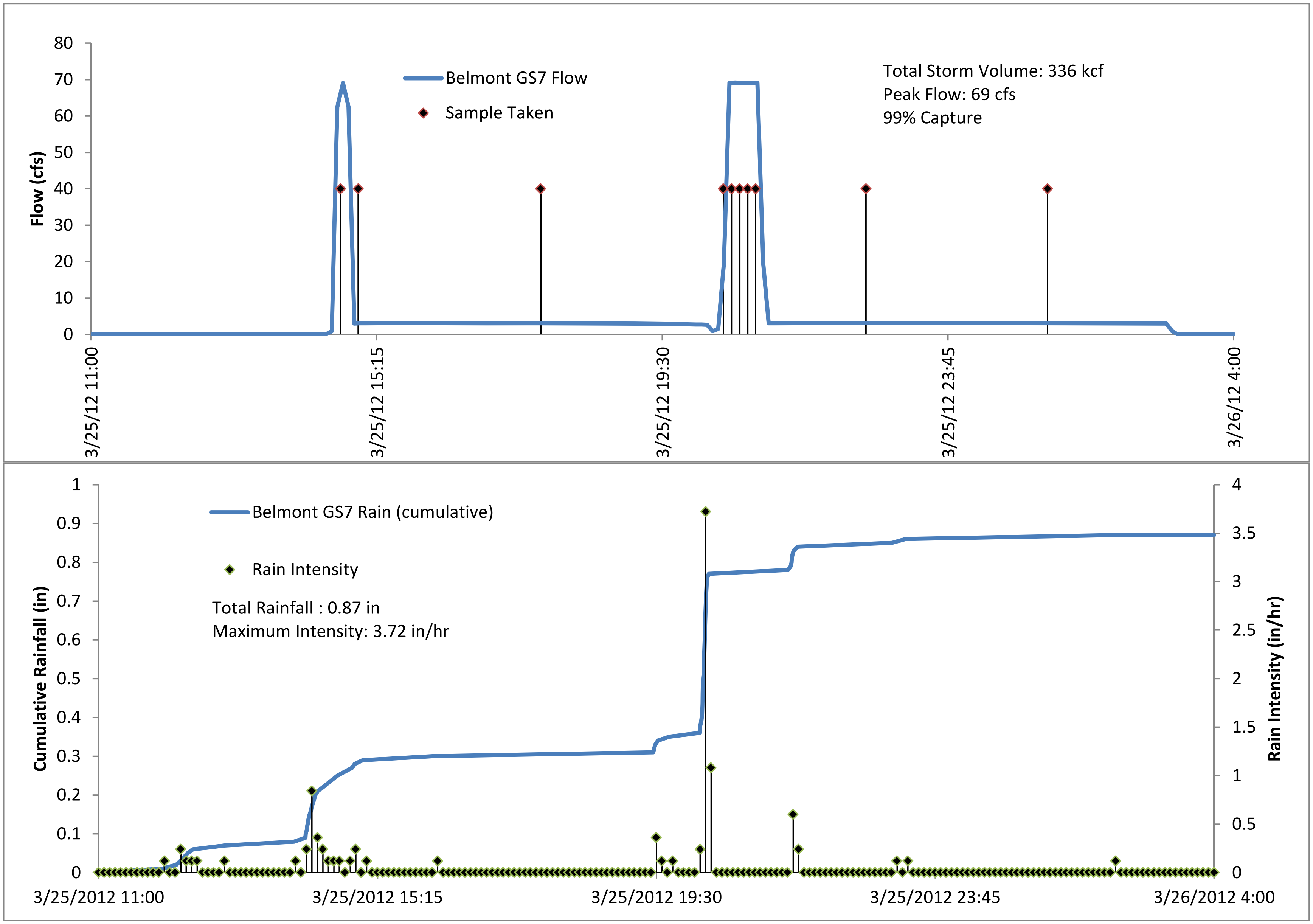


Figure 32. Rain and Discharge from the Belmont Pump Station for Station Event 7 (March 25-26, 2012 – Global Event 7).

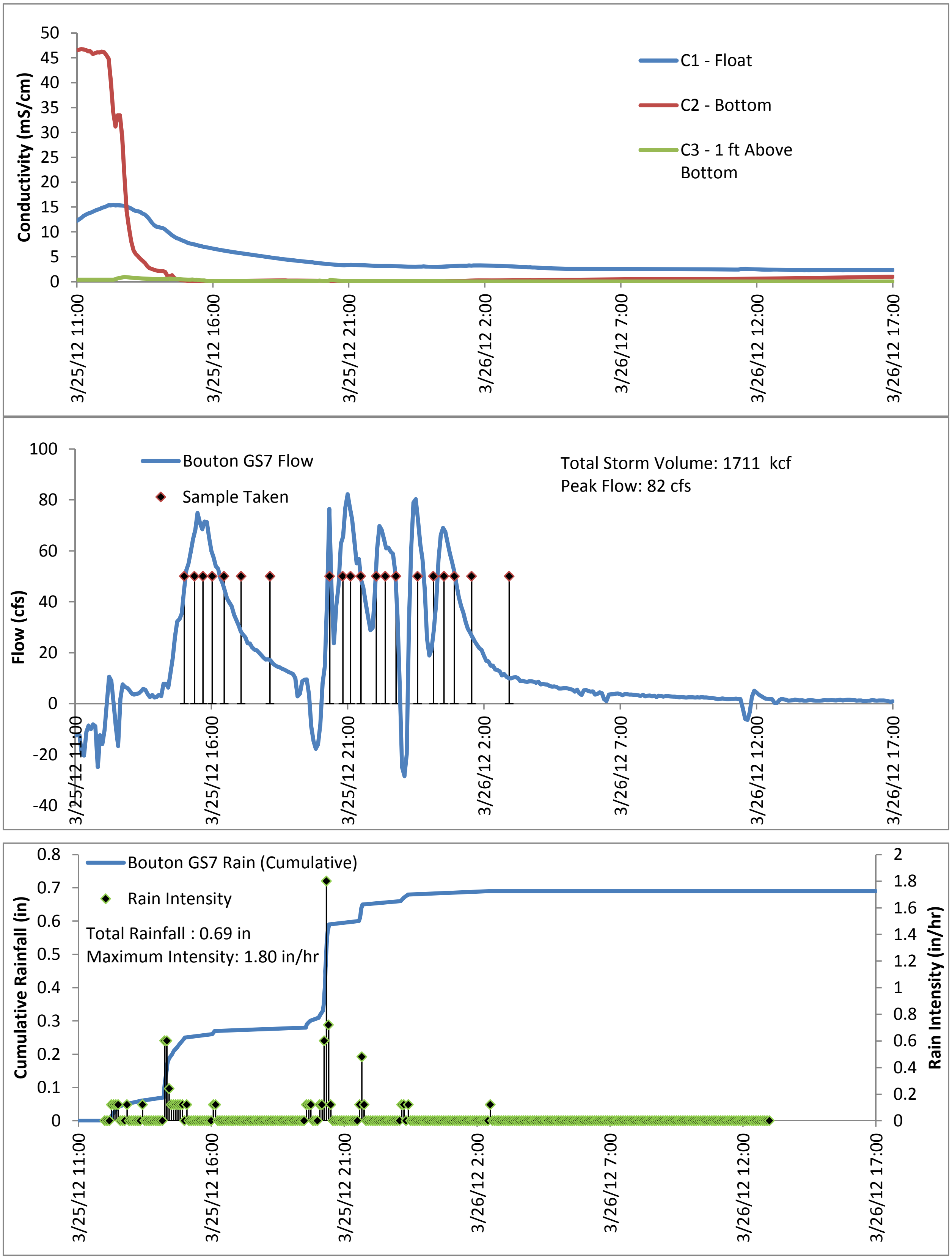


Figure 33. Rain, Flow and Conductivity from Bouton Creek for Station Event 7 (March 25-26, 2012 – Global Event 7).

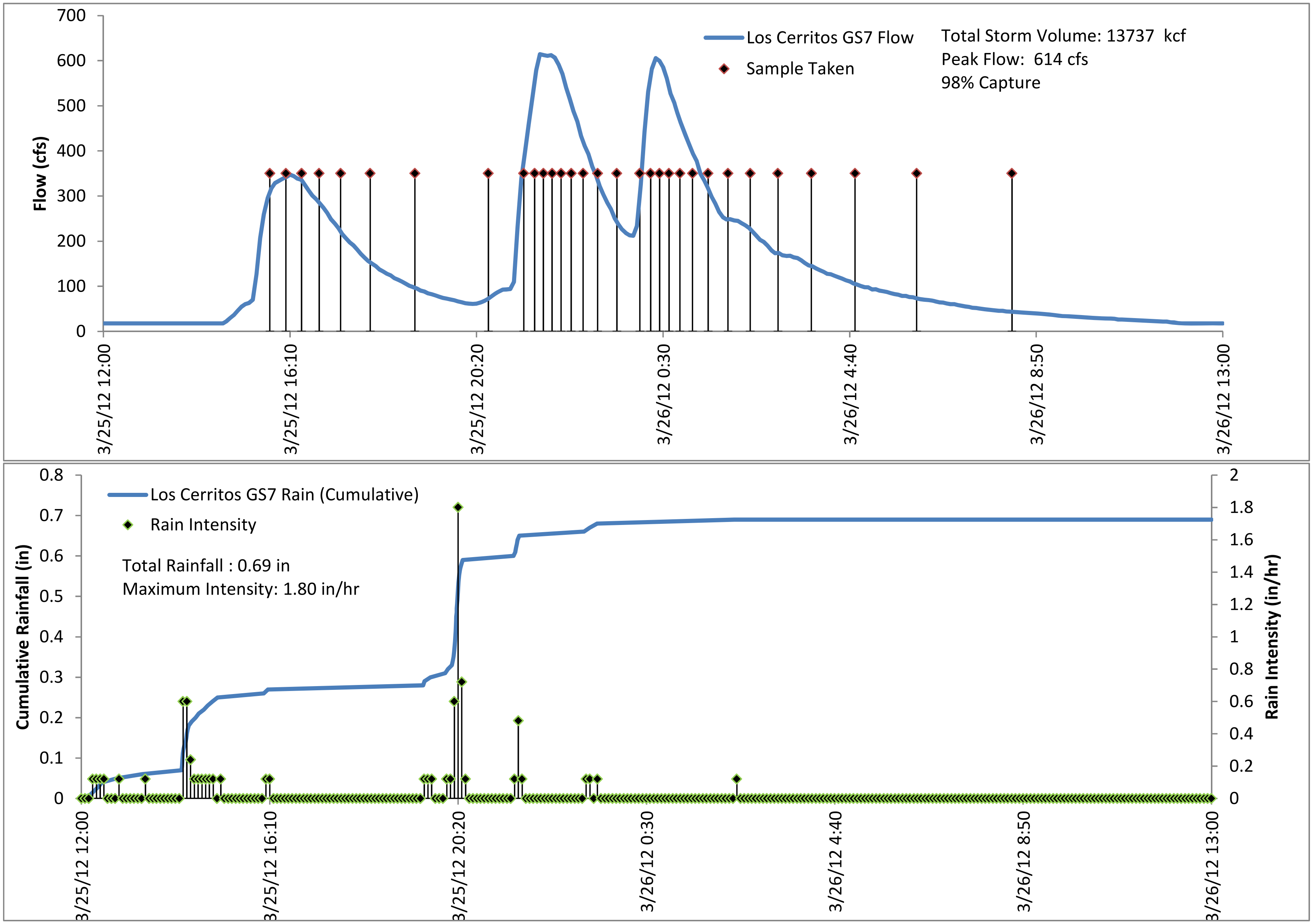


Figure 34. Rain and Flow from Los Cerritos Channel for Station Event 6 (March 25-26, 2012 – Global Event 7).

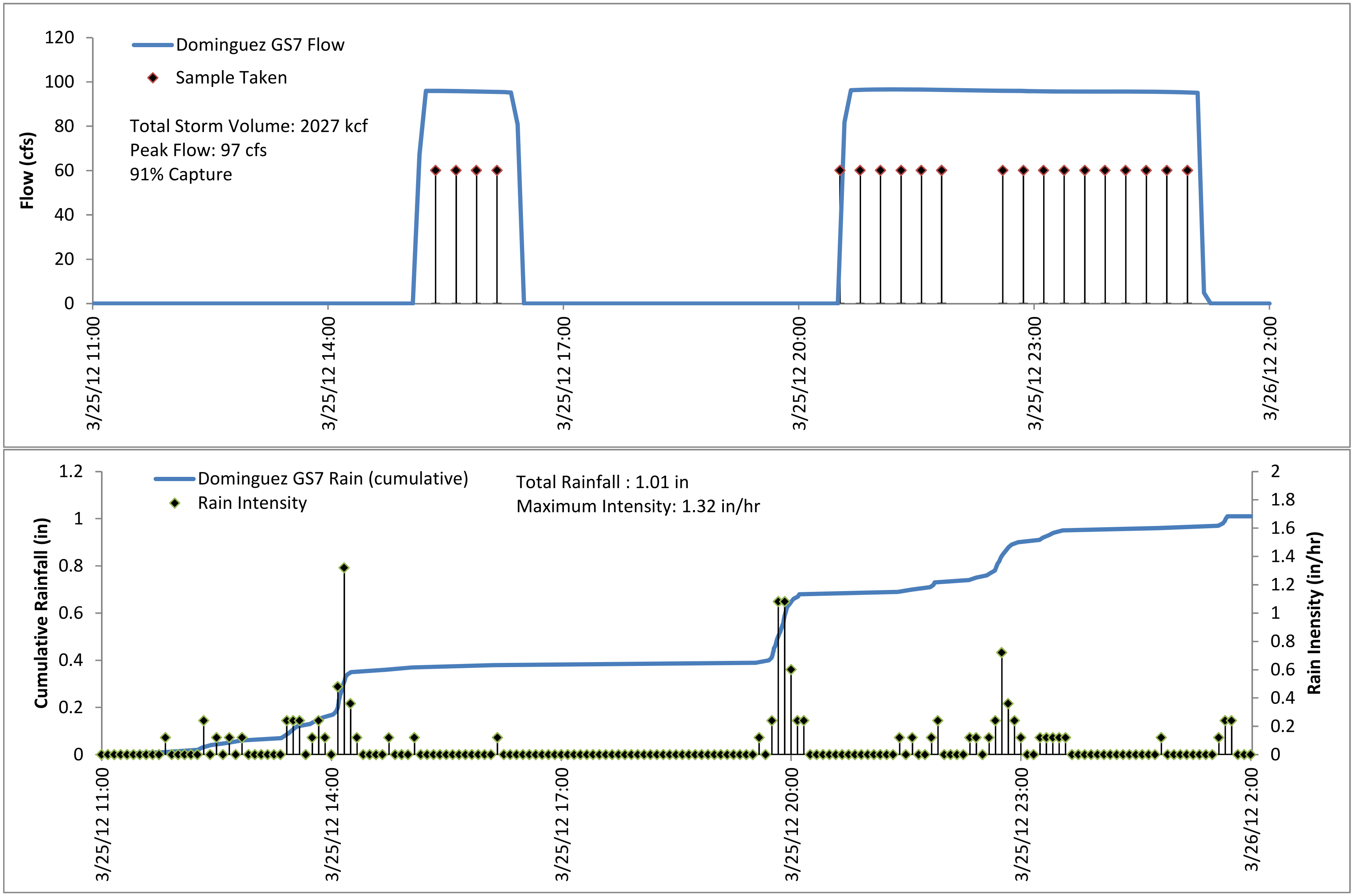


Figure 35. **Rain and Discharge from the Dominguez Gap Pump Station for Station Event 2 (March 25-26, 2012 – Global Event 7).**

Table 6. Daily Rainfall Data at the Belmont Pump Station during the 2010/2011 and 2011/2012 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2010	2011	2010	2011	2010	2011	2011	2012	2011	2012	2011	2012	2011	2012	2010/2011	2011/2012
1	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.01		
2	0	0	0	0	0	0	0.91	0	0	0	0.06	0	0	0		
3	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0		
4	00.01	0.14	0	0.18	0	0	0	0	0	0	0	0	0	0		
5	00.05	0.3	0	0	0.44	0	0	0	0	0	0	0	0	0		
6	00.43	0	0	0	0.05	0	0	0	0	0	0	0	0	0		
7	0	0	0	0.26	0.01	0	0	0	0	0.01	0.07	0	0	0		
8	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16		
11	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0.19		
12	0	0	0	0.27	0	1.12	0	0	0	0	0	0	0	0		
13	0	0	0	0	0	0.08	0	0	0	0	0	0	0	0.56		
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0.02	0.02	0	0.05	0.02	0	0	0	0	0		
16	0	0	0	0	0.03	0	0	0	0.12	0	0	0	0	0		
17	0	0	0	0	1.04	0	0	0	0	0	0	0.3	0	0		
18	0.04	0	0	0	0.82	0	0	0	0.71	0	0	0.13	0	0		
19	1.01	0	0	0	1.84	0	0	0	0.29	0	0	0	0	0		
20	0.12	0	0.45	0.83	1.14	0	0.02	0	0.11	0	0.98	0	0	0		
21	0.01	0	0.1	0.01	1.01	0	0	0.4	0	0	0.42	0	0	0		
22	0	0	0	0	1.22	0	0	0	0	0	0	0	0	0		
23	0.08	0	0.02	0	0.02	0	0	0.61	0	0	0.67	0	0	0		
24	0.07	0	0	0	0	0	0	0.01	0	0	0.02	0	0.07	0		
25	0.02	0.01	0	0	0.5	0	0	0	0.25	0	0.2	0.86	0	0.23		
26	0	0	0	0	0.13	0	0	0	0.41	0	0	0.01	0	0.21		
27	0	0	0.12	0	0	0	0	0	0	0.15	0.22	0	0	0		
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
29	0	0	0	0	0.88	0	0	0		0	0	0	0	0		
30	0.2	0	0	0	0	0	0.02	0			0	0	0	0		
31	0	0.01			0	0.01	0	0			0	0.01				
Total	**2.04**	**0.46**	**0.72**	**1.55**	**9.16**	**1.23**	**1.15**	**1.08**	**1.91**	**0.16**	**2.64**	**1.31**	**0.07**	**1.36**	**17.69**	**7.15**

Darker shading depicts days water quality monitoring took place

Table 7. Daily Rainfall Data at Bouton Creek during the 2010/2011 and 2011/2012 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2010	2011	2010	2011	2010	2011	2011	2012	2011	2012	2011	2012	2011	2012	2010/2011	2011/2012
1	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0		
2	0	0	0	0	0	0	0.66	0	0	0	0.04	0	0	0		
3	0	0	0	0	0	0	0.14	0	0	0	0.01	0	0	0		
4	0.01	0.11	0	0.15	0	0	0	0	0	0	0	0	0	0		
5	0.05	0.39	0	0	0.4	0	0	0	0	0	0	0	0	0		
6	0.28	0.01	0	0.21	0.05	0	0	0	0	0	0	0	0	0		
7	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0		
8	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14		
11	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0.32		
12	0	0	0	0.24	0	0.84	0	0	0	0	0	0	0	0		
13	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0.55		
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0.02	0	0.06	0.01	0	0	0	0	0		
16	0	0	0	0	0.04	0.01	0	0	0.13	0	0	0.01	0	0		
17	0.01	0	0	0	0.88	0	0	0	0	0	0	0.36	0	0		
18	0.04	0	0	0	0.73	0	0	0	0.51	0	0	0.21	0	0		
19	0.98	0	0	0	2	0	0	0	0.16	0	0	0	0	0		
20	0.03	0	0.36	0.78	1.33	0	0	0	0.08	0	1.02	0	0	0		
21	0.02	0	0.09	0.01	0.94	0	0	0.43	0	0	0.47	0	0	0		
22	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0		
23	0.05	0	0.04	0	0.01	0	0	0.71	0	0	0.53	0.01	0	0		
24	0.08	0	0	0	0	0	0	0.01	0	0	0.04	0	0.05	0		
25	0.05	0	0	0	0.51	0	0	0	0.29	0	0.16	0.68	0	0.31		
26	0	0	0	0	0.11	0	0	0	0.32	0	0	0.01	0	0.3		
27	0	0	0.14	0	0	0	0	0	0	0.1	0.18	0	0	0		
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
29	0	0	0	0	0.79	0	0	0		0	0	0	0	0		
30	0.18	0	0	0	0	0	0.04	0			0	0	0	0		
31	0	0.01			0	0.01	0	0			0	0.03	0	0		
Total	**1.78**	**0.52**	**0.67**	**1.39**	**8.72**	**0.92**	**0.84**	**1.22**	**1.5**	**0.1**	**2.49**	**1.31**	**0.05**	**1.62**	**16.05**	**7.08**

Darker shading depicts days water quality monitoring took place

Table 8. Daily Rainfall Data at Los Cerritos Channel during the 2010/2011 and 2011/2012 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	2010	2011	2010	2011	2010	2011	2011	2012	2011	2012	2011	2012	2011	2012	2010/2011	2011/2012
1	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0		
2	0	0	0	0	0	0	0.66	0	0	0	0	0	0	0		
3	0	0	0	0	0	0	0.14	0	0	0	0	0	0	0		
4	0	0.18	0	0.14	0	0	0	0	0	0	0.05	0	0	0		
5	0.03	0.55	0	0	0.45	0	0	0	0	0	0	0	0	0		
6	0.25	0	0	0.23	0.09	0	0	0	0	0	0	0	0	0		
7	0	0	0	0	0	0	0	0	0	0	0.05	0	0	0		
8	0	0	0.04	0	0	0	0	0	0	0	0	0	0.01	0		
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0.14		
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0.32		
12	0	0	0	0.27	0	0.73	0	0	0	0	0	0	0	0		
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0.55		
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
15	0	0	0	0	0.01	0.04	0	0.11	0.01	0.28	0	0	0	0		
16	0	0	0	0	0.05	0	0	0	0.12	0	0	0.03	0	0		
17	0.14	0	0	0	0.86	0	0	0	0	0	0	0.38	0	0		
18	0.05	0	0	0	0.78	0	0	0	0.12	0	0	0.19	0	0		
19	0.76	0	0.04	0	1.97	0	0	0	0.05	0	0	0	0	0		
20	0.03	0	0.37	0.77	1.01	0	0	0	0.01	0	1.2	0	0	0		
21	0.03	0	0.11	0.01	0.77	0	0	0.46	0	0	0.4	0	0	0		
22	0	0	0	0	1.19	0	0	0	0	0	0	0	0	0		
23	0.04	0	0.02	0	0.01	0	0	0.69	0	0	0.63	0.01	0	0		
24	0.07	0	0.01	0	0	0	0	0.01	0	0	0.05	0	0.02	0		
25	0.09	0	0	0	0.51	0	0	0	0.3	0	0.17	0.68	0	0.31		
26	0	0	0	0	0.11	0	0	0	0.32	0	0	0.01	0	0.3		
27	0	0	0.12	0	0	0	0	0	0	0.15	0.1	0	0	0		
28	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0		
29	0	0	0	0	0.79	0	0	0		0	0	0	0	0		
30	0.25	0	0	0	0	0	0.17	0			0	0	0	0		
31	0	0			0	0.01	0	0			0	0.03		0		
Total	**1.74**	**0.73**	**0.73**	**1.42**	**8.6**	**0.78**	**0.97**	**1.28**	**0.93**	**0.43**	**2.65**	**1.33**	**0.03**	**1.62**	**15.65**	**7.59**

Darker shading depicts days water quality monitoring took place.

Table 9. Daily Rainfall Data at the Dominguez Gap Pump Station during the 2010/2011and 2011/2012 Wet Weather Seasons.

	October		November		December		January		February		March		April		Seasonal Totals	
Day	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**	**2010/2011**	**2011/2012**
1	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0		
2	0	0	0	0	0	0	0.63	0.01	0	0.01	0.12	0	0	0		
3	0	0.12	0	0	0	0	0.2	0	0	0	0.02	0	0	0		
4	0	0.2	0	0.19	0	0	0	0	0	0	0	0	0	0		
5	0	0.26	0	0	0.35	0	0	0	0	0	0	0	0	0		
6	0.39	0	0	0.3	0	0	0	0	0	0	0	0	0	0		
7	0	0	0	0	0	0	0	0	0	0.02	0.03	0	0	0		
8	0	0	0.04	0	0	0	0	0.01	0	0	0	0	0	0		
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12		
11	0	0	0	0	0.04	0	0	0	0	0.05	0	0	0	0.46		
12	0	0	0	0.22	0	0.98	0	0	0	0	0	0	0	0		
13	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0.74		
14	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0		
15	0	0	0	0	0	0.18	0	0.03	0.01	0.32	0	0	0	0		
16	0	0	0	0	0.04	0.01	0	0	0.07	0	0	0	0	0		
17	0	0	0	0	0.4	0.02	0	0	0	0	0	0.42	0	0		
18	0	0	0	0	0.43	0	0	0	0.16	0.01	0	0.21	0	0		
19	0.44	0	0	0	1.22	0.01	0	0	0.09	0	0.01	0	0	0		
20	0.04	0	0.23	0.49	1.89	0	0	0	0.05	0	0.74	0	0	0		
21	0	0	0.04	0.01	0.98	0	0	0.49	0	0	0.42	0	0	0		
22	0	0	0	0	1.34	0	0	0	0	0	0	0	0	0		
23	0.07	0	0.08	0	0.04	0	0	0.46	0	0	0.46	0	0	0		
24	0.08	0	0	0	0	0	0	0.01	0	0	0.09	0	0.03	0		
25	0.08	0	0	0	0.51	0	0	0.01	0.26	0	0.1	0.95	0	0.24		
26	0	0	0	0	0.08	0	0	0	0.28	0	0	0.07	0	0.12		
27	0	0	0.12	0	0	0	0	0	0	0.2	0.15	0	0	0		
28	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0		
29	0	0	0	0	0.71	0	0	0		0	0	0	0	0		
30	0.24	0	0	0	0	0.01	0.08	0			0	0	0	0		
31	0	0			0	0.01	0	0			0	0.02				
Total	**1.34**	**0.58**	**0.51**	**1.21**	**8.07**	**1.27**	**0.91**	**1.04**	**0.92**	**0.61**	**2.14**	**1.67**	**0.03**	**1.68**	**13.92**	**8.06**

Darker shading depicts days water quality monitoring took place.

Table 10. Rainfall for Monitored Events during the 2011/2012 Wet-Weather Season.

Site/Event	Start Rain		End Rain		Duration Rain (hours:minutes)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)	Sampling Code
	Date	Time	Date	Time						
Event 1										
BELMONT PUMP ST.	10/5/2011	6:45	10/5/2011	14:30	7:45:00	0.3	0.24	1.0	0.14	Full
BOUTON CREEK	10/5/2011	6:41	10/5/2011	14:45	8:04:00	0.39	0.24	0.8	0.11	Full
LOS CERRITOS	10/5/2011	6:42	10/5/2011	14:50	8:08:00	0.55	0.72	0.9	0.18	Full
DOMINGUEZ PUMP ST	10/5/2011	6:35	10/5/2011	14:15	7:40:00	0.26	0.24	0.9	0.20	ND
Event 2										
BELMONT PUMP ST.	11/12/2011	1:14	11/12/2011	4:05	2:51:00	0.21	0.24	5.6	0.26	TSS
BOUTON CREEK	11/12/2011	1:21	11/12/2011	4:00	2:39:00	0.21	0.24	5.6	0.21	TSS
LOS CERRITOS	11/12/2011	1:25	11/12/2011	10:00	8:35:00	0.26	0.36	5.6	0.22	TSS
DOMINGUEZ PUMP ST	11/12/2011	1:25	11/12/2011	3:50	2:25:00	0.20	0.24	5.6	0.30	ND
Event 3										
BELMONT PUMP ST.	11/20/2011	9:29	11/20/2011	21:52	12:23	0.83	1.2	7.7	0.21	Full
BOUTON CREEK	11/20/2011	12:09	11/21/2011	4:53	16:44	0.78	1.08	8.3	0.21	Full
LOS CERRITOS	11/20/2011	10:36	11/20/2011	21:37	11:01	0.77	1.92	8.0	0.26	Full
DOMINGUEZ PUMP ST	11/20/2011	10:10	11/20/2011	18:15	8:05	0.49	0.84	8.3	0.20	Full
Event 4										
BELMONT PUMP ST.	12/12/2011	4:31	12/12/2011	15:25	10:54	1.08	1.2	21.3	0.83	Full
BOUTON CREEK	12/12/2011	4:19	12/12/2011	17:35	13:16	0.76	0.60	21.0	0.78	Full
LOS CERRITOS	12/12/2011	4:10	12/12/2011	16:00	11:50	0.73	0.60	21.3	0.77	NS
DOMINGUEZ PUMP ST*	12/12/2011	5:42	12/13/2011	1:27	19:45	1.02	0.62	21.5	0.49	ND
Event 5										
BELMONT PUMP ST.	1/21/2012	2:38	1/21/2012	8:57	6:19	0.40	0.24	39.1	1.20	Full
BOUTON CREEK	1/21/2012	2:48	1/21/2012	9:25	6:37	0.43	0.24	38.7	0.88	Full
LOS CERRITOS	1/21/2012	3:00	1/21/2012	9:36	6:36	0.46	0.24	5.2	0.11	Full
DOMINGUEZ PUMP ST*	1/21/2012	2:28	1/21/2012	8:16	5:48	0.49	0.38	36.3	0.19	ND
Event 6										
BELMONT PUMP ST.	3/17/2012	8:42	3/17/2012	10:40	1:58	0.28	0.36	18.5	0.15	TSS
BOUTON CREEK	3/17/2012	8:39	3/17/2012	11:10	2:31	0.33	0.48	18.6	0.10	TSS
LOS CERRITOS	3/17/2012	8:46	3/17/2012	12:00	3:14	0.34	0.72	18.4	0.15	Full
DOMINGUEZ PUMP ST*	3/17/2012	4:11	3/17/2012	11:40	7:29	0.36	3.43	18.4	0.20	ND

Table 10. Rainfall for Monitored Events during the 2011/2012 Wet-Weather Season. (continued)

Site/Event	Start Rain		End Rain		Duration Rain (hours:minutes)	Total Rain (inches)	Max Intensity (Inches/hr)	Antecedent Rain (days)	Antecedent Rain (inches)	Sampling Code
	Date	Time	Date	Time						
Event 7										
BELMONT PUMP ST.	3/25/2012	11:58	3/26/2012	2:28	14:30	0.87	3.72	7.3	0.42	TSS
BOUTON CREEK**	3/25/2012	11:49	3/26/2012	2:26	14:37	0.69	1.80	7.0	0.57	TSS
LOS CERRITOS	3/25/2012	12:12	3/26/2012	2:26	14:14	0.69	1.80	7.2	0.57	TSS
DOMINGUEZ PUMP ST	3/25/2012	11:47	3/26/2012	2:08	14:21	1.01	1.32	7.3	0.63	Full

*Based on Data from Wardlow

** Based on data from Los Cerritos Channel

Sampling Codes

Full = Sampled for full suite of chemical constituents and toxicity tests

Partial = Sampled for a reduced set of chemical constituents plus toxicity tests

TSS = Sampled for TSS only

ND = No Discharge

NS = No samples collected by autosampler

Table 11. Descriptive Statistics - Rainfall and Flow Data for All Monitored Events (2011/2012).

Site Parameter	n	Missing Values	Min	Max	Mean	Standard Deviation	1st Quartile	Median	3rd Quartile
BELMONT PUMP ST.									
Duration Flow (days)	7	0	0.10	0.74	0.30	0.22	0.13	0.28	0.35
Total Flow (kcf)	7	0	76.6	489	220	150	124	131	299
Duration Rain (days)	7	0	0.08	0.60	0.34	0.20	0.19	0.32	0.49
Total Rain (inches)	7	0	0.21	1.08	0.57	0.35	0.29	0.40	0.85
Max Intensity (in/hr)	7	0	0.24	3.72	1.03	1.27	0.24	0.36	1.20
Antecedent Dry (days)	7	0	1.00	39.05	14.36	13.06	6.47	7.72	19.90
Antecedent Rain (inches)	7	0	0.14	1.20	0.46	0.41	0.18	0.26	0.63
BOUTON CREEK									
Duration Flow (days)	7	0	0.20	0.83	0.44	0.28	0.24	0.29	0.65
Total Flow (kcf)	7	0	330	1793	1133	555	805	934	1632
Duration Rain (days)	7	0	0.10	0.70	0.38	0.24	0.19	0.34	0.58
Total Rain (inches)	7	0	0.21	0.78	0.51	0.23	0.36	0.43	0.73
Max Intensity (in/hr)	7	0	0.24	1.80	0.67	0.58	0.24	0.48	0.84
Antecedent Dry (days)	7	0	0.81	38.72	14.29	12.95	6.31	8.34	19.77
Antecedent Rain (inches)	7	0	0.10	0.88	0.41	0.33	0.16	0.21	0.68
LOS CERRITOS CHANNEL									
Duration Flow (days)	6	1	0.38	0.89	0.57	0.19	0.43	0.55	0.63
Total Flow (kcf)	6	1	2839	13737	8176	3717	6576	7815	9968
Duration Rain (days)	6	1	0.13	0.90	0.43	0.27	0.29	0.35	0.53
Total Rain (inches)	6	1	0.26	0.77	0.51	0.20	0.37	0.51	0.66
Max Intensity (in/hr)	6	1	0.24	1.92	0.96	0.72	0.45	0.72	1.53
Antecedent Dry (days)	6	1	0.90	18.39	7.55	5.85	5.30	6.39	7.81
Antecedent Rain (inches)	6	1	0.11	0.57	0.25	0.17	0.16	0.20	0.25
DOMINGUEZ GAP PUMP ST.									
Duration Flow (days)	2	5	0.07	0.42	0.24	0.25	0.16	0.24	0.33
Total Flow (kcf)	2	5	560	2027	1294	1037	927	1294	1660
Duration Rain (days)	2	5	0.34	0.60	0.47	0.18	0.40	0.47	0.53
Total Rain (inches)	2	5	0.49	1.01	0.75	0.37	0.62	0.75	0.88
Max Intensity (in/hr)	2	5	0.84	1.32	1.08	0.34	0.96	1.08	1.20
Antecedent Dry (days)	2	5	7.27	8.26	7.77	0.70	7.52	7.77	8.02
Antecedent Rain (inches)	2	5	0.20	0.63	0.42	0.30	0.31	0.42	0.52

Table 12. Rainfall and Flow Data for all Monitored Events during the 2011/2012 wet season.

Site/Event	Start Flow		End Flow		Flow or Discharge Duration (hrs:mins)	Total Flow (kilo- cubic feet)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
	Date	Time	Date	Time							
Event 1											
BELMONT PUMP ST.	10/5/2011	6:55	10/5/2011	16:00	9:05	124	6	69	76%	Yes	Full
BOUTON CREEK	10/5/2011	6:55	10/6/2011	3:50	20:55	934	18	49	90%	Yes	Full
LOS CERRITOS	10/5/2011	8:05	10/5/2011	23:45	15:40	7319	34	300	94%	Yes	Full
DOMINGUEZ PUMP ST											ND
Event 2											
BELMONT PUMP ST.	11/12/2011	3:35	11/12/2011	6:30	2:55	77	5	66	100%	Yes	TSS
BOUTON CREEK	11/12/2011	3:30	11/12/2011	8:25	4:55	330	8	71	100%	Yes	Full
LOS CERRITOS	11/12/2011	3:55	11/12/2011	13:05	9:10	2839	12	232	87%	Yes	TSS
DOMINGUEZ PUMP ST											ND
Event 3											
BELMONT PUMP ST.	11/20/2011	13:50	11/20/2011	21:45	7:55	263	11	69	100%	Yes	Full
BOUTON CREEK	11/20/2011	14:05	11/21/2011	10:00	19:55	1553	24	185	92%	Yes	Full
LOS CERRITOS	11/20/2011	14:05	11/21/2011	3:20	13:15	10520	32	1002	91%	Yes	Full
DOMINGUEZ PUMP ST	11/20/2011	17:15	11/20/2011	18:55	1:40	560	10	96	91%	Yes	Full
Event 4											
BELMONT PUMP ST.	12/12/2011	8:55	12/12/2011	15:40	6:45	489	26	132	81%	Yes	Full
BOUTON CREEK	12/12/2011	9:50	12/12/2011	21:15	11:25	1793	43	265	98%	Yes	Full
LOS CERRITOS	12/12/2011	8:50	12/13/2011	10:00	1:10	12242	0	809	0%	No	NS
DOMINGUEZ PUMP ST											ND
Event 5											
BELMONT PUMP ST.	1/21/2012	6:05	1/21/2012	8:25	2:20	131	8	66	100%	Yes	Full
BOUTON CREEK	1/21/2012	8:20	1/21/2012	14:45	6:25	833	20	274	100%	Yes	Full
LOS CERRITOS	1/21/2012	5:35	1/21/2012	18:30	12:55	8311	32	507	85%	Yes	Full
DOMINGUEZ PUMP ST											ND
Event 6											
BELMONT PUMP ST.	3/17/2012	9:40	3/17/2012	13:00	3:20	124	4	67	100%	Yes	TSS
BOUTON CREEK	3/17/2012	9:45	3/17/2012	16:45	7:00	776	9	132	98%	Yes	TSS
LOS CERRITOS	3/17/2012	9:30	3/17/2012	19:00	9:30	6328	38	841	96%	Yes	Full
DOMINGUEZ PUMP ST											ND

Table 12. Rainfall and Flow Data for all Monitored Events during the 2011/2012 wet season.

Site/Event	Start Flow		End Flow		Flow or Discharge Duration (hrs:mins)	Total Flow (kilo- cubic feet)	No. of Sample Aliquots Collected	Peak Flow (cfs)	% Storm Capture	Peak Capture	Sampling Code
	Date	Time	Date	Time							
Event 7											
BELMONT PUMP ST.	3/25/2012	14:35	3/26/2012	8:15	17:40	336	11	69	99%	Yes	TSS
BOUTON CREEK	3/25/2012	12:55	3/26/2012	8:55	20:00	1711	20	82	95%	Yes	TSS
LOS CERRITOS	3/25/2012	14:40	3/26/2012	12:00	21:20	13737	31	614	98%	Yes	TSS
DOMINGUEZ PUMP ST	3/25/2012	15:10	3/26/2012	1:10	10:00	2027	20	97	91%	Yes	Full

Sampling Codes

Full = Sampled for full suite of chemical constituents and toxicity tests
Partial = Sampled for a reduced set of chemical constituents plus toxicity tests
TSS = Sampled for TSS only
NS = No samples collected by autosampler.

CHEMISTRY RESULTS

The following sections separately summarize the results of wet weather and dry weather monitoring efforts.

WET WEATHER CHEMISTRY RESULTS

A total of seven storm events were monitored during the 2011/2012 season (Table 13). Four full storm events were monitored at each of the Belmont Pump, Bouton Creek, and Los Cerritos Channel mass emission stations. Two full storm events were successfully monitored at the Dominguez Gap Pump Station. In addition, three TSS events were monitored at the Bouton Creek and Belmont Pump Station mass emission sites, and two at the Los Cerritos Channel site

The results of the chemical analysis of these composite and grab stormwater samples are summarized in Table 14 through Table 17. Data from events monitored only for TSS are summarized in Table 18. Any values exceeding benchmarks are highlighted and footnoted to indicate which of the benchmarks are exceeded. Toxicity results for the composite samples from these monitored events are presented separately in the following section (**Toxicity Results**).

Pyrethroid pesticides were incorporated into the program during the middle of the 2009/2010. storm season when CRG Marine Laboratories, who had conducted the organic analyses since the early part of the program, suddenly was not accepting samples. CalTest was selected to conduct the organic testing for the remainder of the year. In order to achieve detection limits necessary for the two key organophosphate compounds, diazinon and chlorpyrifos, the laboratory needed to run the tests using NCI-GCMS which also is the analytical method for pyrethroid pesticides. As the pyrethoid pesticides were rapidly emerging as some of the most important contaminants of concern, we chose to incorporate this analytical method to provide an initial evaluation of the presence and concentrations of these compounds in stormwater runoff from the City of Long Beach. This year pyrethroid pesticides were analyzed during all storm events. Together with data from two events the previous year, we are able to get our first substantial look the distribution of these pesticides in the watersheds monitored for the Long Beach program.

WET WEATHER LOAD CALCULATIONS

Estimates of total pollutant loads associated with stormwater runoff during each storm event are provided in Table 19 through 23. Constituents included in these tables are limited to those that had measureable loads during at least one event at one of the four monitoring sites.

Load calculations were made by multiplying the measured concentrations by the total stormwater discharge volume along with the appropriate unit conversion factors. As of the 2010/2011 season, all load calculations are provided kilograms. Reports prior to the 2010/2011 annual report had presented loads in terms of pounds. The database is in the process of conversion to metric in order to provide standard units for all data. The following calculation is an example of the process used for analytes such as TSS that are measured in mg/L. The specific example is for the first storm event at the Los Cerritos Channel mass emission monitoring station.

(260 mg/L) x [(7319 kcf)(28317 L/kcf)] x (1 kg/10^6 mg) = 53,886 kilograms

Consistent with sound scientific practice, total pollutant loads are reported to two significant figures since all chemical data are also reported to two significant figures. Thus the TSS load for the first monitored event at the Los Cerritos Channel is reported as 54,000 kilograms or 27 metric tons of sediment.

As one would expect, pollutant loads are largely controlled by the size of the watershed. Over the past 12 years, the Los Cerritos Channel (Table 21) has consistently produced the highest overall loads of solids and total metals simply due to the large size of the watershed and limited infiltration capacity.

Pollutant loads are consistently lowest at the Belmont Pump Station (Table 19) which has the smallest catchment area. This site was estimated to discharge 293 to 1,939 kilograms of solids in association with the four events. The load of total copper discharged from the Belmont Pump Station during these monitored events ranged from 0.11 to 0.47 kilograms.

Historically, loading estimates for solids from the Dominguez Gap Pump Station were substantially lower than all other sites. Since reconfiguration of this site total solid loading have increased and are often similar to or even exceed loadings of suspended solids at the Belmont Pump Station. Solids loading associated with the two storm events monitored at the Dominguez Gap Pump Station were 840 and 4,707 kilograms (Table 22).

Historically, estimated loads of total recoverable metals such as copper and lead from the Dominguez Gap Pump Station were also the lowest encountered at all mass emission sites but since the reconfiguration of the Pump Station to accommodate development of the wetlands, metal loads estimated for the Dominguez Gap have also increased to levels similar or higher than those measured at the Belmont Pump Stations. As part of that change, the area of the watershed served by this pump station was approximately halved. In both the case of suspended solids and metals, the major increases in loads occurred in association with the latter two storm events when water levels within the forebay were relatively high (9.6 to10.6 feet) before the storms started.

DRY WEATHER CHEMISTRY RESULTS

The NPDES Permit requires that two dry weather inspections and sampling events be conducted each year. These surveys are scheduled during the summer dry weather period at each of the four mass emission stations. A total of 26 dry weather surveys have been conducted since issuance of the permit (Table 24). Events 25 and 26, which were conducted during the 2011/2012 season, are shaded in Table 24. Field measurements are provided in Table 25 for the 2011/2012 season. Chemical analyses performed in the laboratory are summarized in Table 26 through Table 28 for the 2011/2012 season.

Dry weather flow at the Belmont Pump Station continues to be pumped into the sanitary sewer system for treatment. For several seasons this diversion was accomplished by use of a temporary pump, which was in place during the dry weather season. In December, 2009 a permanent low-flow diversion system was installed to divert all low flow, not just dry weather flow, to the sanitary system. Since this site no longer discharges dry weather flow to the receiving waters, no water samples or field measurements were taken. The site was still visited during each of the dry weather events to verify that the bypass was operational.

Bouton Creek Monitoring Site

Bouton Creek was inspected during both of the 2011/2012 dry weather events. The inspections occurred 2-3 hours after the low-low tide of the day when the salt water had receded and the channel had been mostly flushed by fresher, low flow discharges. During these periods, flow in the creek was not impeded by seawater backing into the creek. In early years the flow was usually freshwater flowing downstream and the volume of fresh flow had been sufficient to flush all residual saltwater from the channel.

During the May and July, 2008 and the May, 2009 inspections no samples were collected. Flow was very low during those inspections. Portions of the crown of the channel bottom were exposed, and there was extensive algae growth across the entire bottom. The salinity of the flow never fell below 10.8 ppt before the incoming tidal flows reached the site. The overall decrease in dry weather discharges eventually necessitated that we temporarily deploy sampling equipment about 1000 yards upstream from the primary monitoring location in order to decrease impacts of the tidal swings.

The dry weather sampling location was changed for the 2009/2010 through the 2011/2012 inspections. Previously the dry weather samples were collected at the LADPW Alamitos Maintenance Yard at the same location as the wet weather samples are collected. Starting in October of 2009 the dry weather samples were collected just east of where Bouton Creek emerges from under the California State University Long Beach parking lot. The low flows were found to be much less saline there. This is thought to be due to the lack of sea water soaked algae in the channel below the parking lot. None of The outfalls located between the Alamitos Yard and the Cal State parking lot had discharges at the time of the inspection/sampling. The 20 liter grab samples were collected on September 13, 2011 and May 1, 2012

Los Cerritos Channel Monitoring Site

Time-weighted samples are taken at 30-minute intervals covering a period of 24 hours during each dry weather event. Sampling was initiated for the first event on September 13, 2011 and was completed by September 14, 2011. Sampling for the second event began on May 1, 2012 and ended on May 2th. All 48 samples were collected during both events.

Samples were taken from the middle of the channel using the automated sampler installed on the bank of the channel. Dry weather flows consisted of a shallow, narrow stream located near the middle of the channel. To reach the water, the sampling hose used for sampling stormwater was extended an additional 33 feet using protocol cleaned and blanked intake hose to reach the low flow channel. The composite bottles were changed every 12 hours and chilled to 4°C with ice during both the 24-hour sampling effort and during transportation. Following completion of the sampling, the bottles of water were combined into a single composite sample, mixed and then sub-sampled. Grab samples were manually collected for oil and grease and bacteria during the 24-hour sampling on September 13th and at the end of the 24-hour sampling on May 2nd.

Dominguez Gap Monitoring Site

Inspections for dry weather flow were conducted at the Dominguez Gap Pump Station on September 13, 2011, and on May 1-2, 2012. During the September 2011 survey the sump pump was not in operation; no discharge was occurring, and no samples were collected. During the May, 2012 survey the sump pump was on and remained in continuous operation during the 24-hour sampling effort.

Accurate discharge rates cannot be assessed at this site due to the configuration of the pump and the use of a valve to restrict the rate of discharge. The LADPW Engineering Department has indicated that the design level of the wet basin is 7 feet, and at this level the objective was to maintain a discharge of 3 cfs. Various Public Works personnel encountered at the pump station have indicated that they have been instructed to maintain water levels of either 8 or 9 feet. During dry weather periods, the water level in the basin is dependent upon a combination of manual adjustment of the gate valve that allows water to flow into it from the Los Angeles River and the capacity of the pump to discharge it back to the river. Public Works personnel make adjustments of the gate setting to maintain a level or, alternatively, use the larger pumps to periodically draw down the water level in the basin.

Table 13. Monitored Storm Events, 2011/2012.

Global Event	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6	Event 7
Date	10/5-6/11	11/12/11	11/20-21/11	12/12/11	1/21/12	3/17/12	3/26/12
Belmont Pump	S1	TSS1	S2	S3	S4	TSS2	TSS3
Bouton Creek	S1	TSS1	S2	S3	S4	TSS2	TSS3
Los Cerritos Channel	S1	TSS1	S2		S3	S4	TSS2
Dominguez Gap			S1				S2

Sx=Full Storm Composites – "x" indicates sequential monitored event at each site
TSS=Storm Events monitored for TSS only

Table 14. Belmont Pump Stormwater Chemistry Results, 2011/2012.

Analyte	10/5/2011	11/20/2011	12/12/2011	1/21/2012
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	7.05	7.75	7.87	8.04
Alkalinity as CaCO3	53	37	38	130
Biochemical Oxygen Demand	22	13	11	18
Chemical Oxygen Demand	170	89	81	92
Chloride	58	37	43	160
Conductivity *(uS/cm)*	370	220	250	890
Fluoride	0.36	0.16	0.18	0.46
Hardness as CaCO3	60	29	30	88
MBAS	**0.57**[2]	0.24	0.17	0.15
Nitrate (as N)	1.2	0.51	0.49	0.68
Nitrite (as N)	0.13	0.1U	0.1U	0.073J
Oil and Grease	5U	2.8J	5U	4.9J
Total Ammonia (as N)	0.39	0.64	0.64	0.65
Total Dissolved Solids	230	130	120	490
Total Kjeldahl Nitrogen	4.6	2.1	2.1	2.6
Total Organic Carbon	35	15	12	14
Orthophosphate (as P)	0.52	0.37	0.28	0.46
Total Phosphorus	0.94	0.61	0.61	0.78
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	130	110	140	79
Volatile Suspended Solids	48	38	48	33
Turbidity *(NTU)*	84	53	54	46
Dissolved Metals (ug/L)				
Aluminum	34	13J	17J	8.8J
Arsenic	2	1.1	0.83	1.8
Cadmium	0.22	0.051J	0.064J	0.16J
Chromium	0.96	0.66	0.62	0.32J
Copper	**16** [2,6]	**7.8** [2,6]	**6.8** [2,6]	**7** [6]
Iron	120	40	32	46
Lead	1.1	0.6	0.53	0.28
Nickel	8.3	1.8	1.3	2
Selenium	1U	0.27J	1U	1U
Silver	0.2U	0.2U	0.016J	0.2U
Zinc	**120** [2,6]	37	29	26
Total Metals (ug/L)				
Aluminum	**2500** [1]	**2200** [1]	**2300** [1]	**1700** [1]
Arsenic	3.8	2.1	2.2	2.7
Cadmium	0.74	0.36	0.4	0.34
Chromium	8	5.9	5.5	3.9
Copper	**83** [5]	**39** [5]	**34** [5]	**30** [5]
Iron	3800	3500	3300	2500
Lead	**31** [5]	**24** [5]	**26** [5]	**13** [5]
Nickel	15	6.4	5.8	4.8
Selenium	1U	0.24J	0.16J	0.23J
Silver	0.091J	0.075J	0.074J	0.049J
Zinc	**420** [5]	**230** [5]	**200** [5]	**140** [5]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 14. Belmont Pump Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/5/2011	11/20/2011	12/12/2011	1/21/2012
Microbiology				
Enterococcus *(CFU/100 ml)*	**17000**[1,2]	**12000**[1,2]	**4600**[1,2]	**2900**[1,2]
Fecal Coliform *(MPN/100 ml)*	**920000**[1,2]	**240000**[1,2]	**10000**[1,2]	**4900**[1,2]
Total Coliform *(MPN/100 ml)*	**>1600000**[1,2]	**350000**[1,2]	**12000**[1,2]	**7000**[1,2]
Aroclors (ug/L)				
Aroclor 1016	0.1U	0.13U	0.1U	0.11U
Aroclor 1221	0.1U	0.13U	0.1U	0.11U
Aroclor 1232	0.1U	0.13U	0.1U	0.11U
Aroclor 1242	0.1U	0.13U	0.1U	0.11U
Aroclor 1248	0.1U	0.13U	0.1U	0.11U
Aroclor 1254	0.1U	0.13U	0.1U	0.11U
Aroclor 1260	0.1U	0.13U	0.1U	0.11U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.005U	0.0063U	0.005U	0.0057U
2,4'-DDE	0.005U	0.0063U	0.005U	0.0057U
2,4'-DDT	0.01U	0.013U	0.01U	0.011U
4,4'-DDD	0.005U	0.006U	0.005U	0.006U
4,4'-DDE	0.005U	0.006U	0.005U	0.006U
4,4'-DDT	0.005U	0.006U	0.005U	0.006U
Total DDT	0	0	0	0
Aldrin	0.005U	0.006U	0.005U	0.006U
Dieldrin	0.005U	0.006U	0.005U	0.006U
Endrin	0.005U	0.006U	0.005U	0.006U
Endrin aldehyde	0.005U	0.006U	0.005U	0.006U
Endrin ketone	0.005U	0.006U	0.005U	0.006U
alpha-BHC	0.005U	0.006U	0.005U	0.006U
beta-BHC	0.005U	0.006U	0.005U	0.006U
delta-BHC	0.005U	0.006U	0.005U	0.006U
gamma-BHC (Lindane)	0.005U	0.006U	0.005U	0.006U
Endosulfan I	0.005U		0.005U	0.006U
Endosulfan II	0.005U	0.006U	0.005U	0.006U
Endosulfan sulfate	0.005U	0.006U	0.005U	0.006U
Heptachlor	0.005U	0.006U	0.005U	0.006U
Heptachlor epoxide	0.005U	0.006U	0.005U	0.006U
alpha-Chlordane	0.005U	0.01	0.005U	0.006U
gamma-Chlordane	0.005U	0.021	0.005U	0.006U
Oxychlordane	0.005U	0.0063U	0.005U	0.0057U
cis-Nonachlor	0.005U	0.0063U	0.005U	0.0057U
trans-Nonachlor	0.0097J	0.013U	0.01U	0.011U
Total Chlordane	0.0097J	0.031	0	0
Methoxychlor	0.005U	0.006U	0.005U	0.006U
Toxaphene	0.5U	0.6U	0.5U	0.6U
Trichloronate	0.005U	0.0063U	0.005U	0.0057U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 14. Belmont Pump Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/5/2011	11/20/2011	12/12/2011	1/21/2012
Organophosphates (ug/L)				
Chlorpyrifos	0.0042	0.002U	0.008	**0.055** [3,7]
Demeton	0.5U	0.5U	0.5U	0.5U
Diazinon	0.0015U	0.0015U	0.0015U	0.0015U
Disulfoton	0.1U	0.1U	0.1U	0.1U
Malathion	0.05U	0.06U	0.05U	**0.49** [3,7]
Methyl Parathion	0.1U	0.1U	0.1U	0.1U
Pyrethroids (ug/L)				
Bifenthrin	**42** [4]	**64** [4]	**104** [4]	**39J+** [4]
Cyfluthrin	**16J** [4]	**26** [4]	**55** [4]	**36** [4]
Cypermethrin	**6.8J** [4]	**6.7** [4]	**20** [4]	**5.6** [4]
Fenpropathrin	1.5U	1.5U	1.5U	1.5U
L-Cyhalothrin	**1.8** [4]	**13** [4]	**3.1** [4]	**7.3** [4]
Permethrin	**70J+** [4]	**52** [4]	**204** [4]	**51J** [4]
Total Deltamethrin/Tralomethrin	13	15	47	38
Total Esfenvalerate/Fenvalerate	5	3.1	1.8	0.7J

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 15. Bouton Creek Stormwater Chemistry Results, 2011/2012.

Analyte	10/5/2011	11/21/2011	12/12/2011	1/21/2012
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	6.98	7.44	7.27	8.04
Alkalinity as CaCO3	29	21	18	23
Biochemical Oxygen Demand	21	9.5	12	12
Chemical Oxygen Demand	140	66	73	84
Chloride	41	33	68	240
Conductivity *(uS/cm)*	260	170	290	920
Fluoride	0.36	0.15	0.16	0.2
Hardness as CaCO3	48	26	35	82
MBAS	0.46	0.25	0.22	0.13
Nitrate (as N)	1.1	0.51	0.48	0.55
Nitrite (as N)	0.1U	0.1U	0.1U	0.1U
Oil and Grease	5U	3.2J	5U	1.8J
Total Ammonia (as N)	0.75	0.46	0.6	0.55
Total Dissolved Solids	180	110	160	490
Total Kjeldahl Nitrogen	3.5	1.3	1.8	2.2
Total Organic Carbon	38	13	15	13
Orthophosphate (as P)	0.38	0.21	0.18	0.15
Total Phosphorus	0.61	0.37	0.41	0.42
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	50	51	64	61
Volatile Suspended Solids	23	18	25	14
Turbidity *(NTU)*	58	36	48	38
Dissolved Metals (ug/L)				
Aluminum	42	17J	26	15J
Arsenic	1.7	0.88	0.71	0.85
Cadmium	0.26	0.058J	0.13J	0.17J
Chromium	1.6	0.99	1.1	0.61
Copper	**25** [2,6]	**9.3** [2,6]	**11** [2,6]	**8.2** [6]
Iron	79	31	35	30
Lead	1.8	0.86	0.71	0.5
Nickel	5.8	1.5	1.5	1.2
Selenium	1U	0.35J	1U	1U
Silver	0.2U	0.2U	0.019J	0.2U
Zinc	**140** [2,6]	**43** [2]	43	36
Total Metals (ug/L)				
Aluminum	1000	**1300** [1]	**1300** [1]	930
Arsenic	2.1	1.6	1.5	1.7
Cadmium	0.58	0.22	0.28	0.29
Chromium	4.5	4.2	4.2	5.4
Copper	**48** [5]	**26** [5]	**29** [5]	**22** [5]
Iron	1500	2000	1800	1400
Lead	**11** [5]	**12** [5]	**9.9** [5]	7.2
Nickel	8.9	4	4.3	3.1
Selenium	1U	0.36J	1U	1U
Silver	0.047J	0.043J	0.047J	0.018J
Zinc	**250** [5]	**130** [5]	**130** [5]	**110** [5]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

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Table 15. Bouton Creek Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/5/2011	11/21/2011	12/12/2011	1/21/2012
Microbiology				
Enterococcus *(CFU/100 ml)*	**17000**[1,2]	**8700**[1,2]	**8200**[1,2]	**4900**[1,2]
Fecal Coliform *(MPN/100 ml)*	**>1600000**[1,2]	**130000**[1,2]	**23000**[1,2]	**2400**[1,2]
Total Coliform *(MPN/100 ml)*	**>1600000**[1,2]	**130000**[1,2]	**23000**[1,2]	**4000**[1,2]
Aroclors (ug/L)				
Aroclor 1016	0.1U	0.1U	0.1U	0.1U
Aroclor 1221	0.1U	0.1U	0.1U	0.1U
Aroclor 1232	0.1U	0.1U	0.1U	0.1U
Aroclor 1242	0.1U	0.1U	0.1U	0.1U
Aroclor 1248	0.1U	0.1U	0.1U	0.1U
Aroclor 1254	0.1U	0.1U	0.1U	0.1U
Aroclor 1260	0.1U	0.1U	0.1U	0.1U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.005U	0.005U	0.005U	0.005U
2,4'-DDE	0.005U	0.005U	0.005U	0.005U
2,4'-DDT	0.01U	0.01U	0.01U	0.01U
4,4'-DDD	0.005U	0.005U	0.005U	0.005U
4,4'-DDE	0.005U	0.005U	0.005U	0.005U
4,4'-DDT	0.005U	0.005U	0.005U	0.005U
Total DDT	0	0	0	0
Aldrin	0.005U	0.005U	0.005U	0.005U
Dieldrin	0.005U	0.005U	0.005U	0.005U
Endrin	0.005U	0.005U	0.005U	0.005U
Endrin aldehyde	0.005U	0.005U	0.005U	0.005U
Endrin ketone	0.005U	0.005U	0.005U	0.005U
alpha-BHC	0.005U	0.005U	0.005U	0.005U
beta-BHC	0.005U	0.005U	0.005U	0.005U
delta-BHC	0.005U	0.005U	0.005U	0.005U
gamma-BHC (Lindane)	0.005U	0.005U	0.005U	0.005U
Endosulfan I	0.005U	0.005U	0.005U	0.005U
Endosulfan II	0.005U	0.005U	0.005U	0.005U
Endosulfan sulfate	0.005U	0.005U	0.005U	0.005U
Heptachlor	0.005U	0.005U	0.005U	0.005U
Heptachlor epoxide	0.005U	0.005U	0.005U	0.005U
alpha-Chlordane	0.005U	0.005U	0.005U	0.005U
gamma-Chlordane	0.005U	0.005U	0.005U	0.005U
Oxychlordane	0.005U	0.005U	0.005U	0.005U
cis-Nonachlor	0.005U	0.005U	0.005U	0.005U
trans-Nonachlor	0.01U	0.01U	0.01U	0.01U
Total Chlordane	0	0	0	0
Methoxychlor	0.005U	0.005U	0.005U	0.005U
Toxaphene	0.5U	0.5U	0.5U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 15. Bouton Creek Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/5/2011	11/21/2011	12/12/2011	1/21/2012
Organophosphates (ug/L)				
Chlorpyrifos	0.01U	0.002U	0.01U	0.0007J
Demeton	0.5U	0.5U	0.5U	0.5U
Diazinon	0.02U	0.0018	0.02U	0.0015U
Disulfoton	0.1U	0.1U	0.1U	0.1U
Malathion	0.05U	0.05U	0.05U	0.05U
Methyl Parathion	0.1U	0.1U	0.1U	0.1U
Pyrethroids				
Bifenthrin	**12** [4]	**19** [4]	**20** [4]	**24J+** [4]
Cyfluthrin	**2.8J** [4]	**8.4** [4]	**14** [4]	**9.2** [4]
Cypermethrin	**3.7J** [4]	**4.3** [4]	**6.9** [4]	**4.3** [4]
Fenpropathrin	1.5U	1.5U	1.5U	1.5U
L-Cyhalothrin	0.7J	**1.4J** [4]	**2.7** [4]	**1.1J** [4]
Permethrin	**20J+** [4]	**18** [4]	**45J** [4]	**22J** [4]
Total Deltamethrin/Tralomethrin	1.3J	1.3J	6.3	1.2J
Total Esfenvalerate/Fenvalerate	1.5U	0.3J	0.6J	0.4J

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2011/2012.

Analyte	10/6/2011	11/21/2011	1/21/2012	3/17/2012
Conventionals (mg/L unless otherwise noted)				
pH *(pH units)*	7.14	7.5	7.61	7.4
Alkalinity as CaCO3	39	21	22	30
Biochemical Oxygen Demand	32	12	12	23
Chemical Oxygen Demand	220	95	50	180
Chloride	11	4	3.9	5.4
Conductivity *(uS/cm)*	150	64	77	88
Fluoride	0.31	0.13	0.18	0.2
Hardness as CaCO3	47	17	17	22
MBAS	**0.58**[2]	0.21	0.22	0.24
Nitrate (as N)	1.3	0.47	0.59	0.54
Nitrite (as N)	0.1U	0.1U	0.1U	0.1U
Oil and Grease	5U	3.5J	2.8J	1.4J
Total Ammonia (as N)	0.77	0.47	0.66	0.53
Total Dissolved Solids	120	54	51	62
Total Kjeldahl Nitrogen	6.8	1.8	1.7	3.4
Total Organic Carbon	41	14	12	23
Orthophosphate (as P)	0.35	0.18	0.17	0.17
Total Phosphorus	1.3	0.59	0.39	0.91
Total Recoverable Phenolics	0.1U	0.1U	0.1U	0.1U
Total Suspended Solids	260	160	53	370J
Volatile Suspended Solids	88	48	8.3	83
Turbidity *(NTU)*	110	73	34	100
Dissolved Metals (ug/L)				
Aluminum	29	16J	18J	7.8J
Arsenic	1.5	0.99	0.98	1
Cadmium	0.18J	0.064J	0.12J	0.2U
Chromium	1.1	0.64	0.74	1.2
Copper	**13**[2,6]	**7.1**[2,6]	**7.4**[2,6]	**8.6**[2,6]
Iron	83	31	28	49
Lead	1.6	0.57	0.39	0.63
Nickel	5.7	1.6	1.3	3.2
Selenium	1U	0.25J	1U	1U
Silver	0.2U	0.2U	0.2U	0.2U
Zinc	**64**[2]	**37**[2]	**44**[2]	**41**[2]
Total Metals (ug/L)				
Aluminum	**3600**[1]	**3900**[1]	**1100**[1]	**6200**[1]
Arsenic	4.6	2.9	1.5	4.2
Cadmium	1.4	0.68	0.35	0.78
Chromium	10	9.5	3	13
Copper	**78**[5]	**39**[5]	**19**[5]	**58**[5]
Iron	5100	5600	1500	8200
Lead	**37**[5]	**26**[5]	**9.3**[5]	**43**[5]
Nickel	15	11	3.5	16
Selenium	1U	0.44J	1U	0.27J
Silver	0.17J	0.088J	0.028J	0.69
Zinc	**560**[5]	**290**[5]	**130**[5]	**390**[5]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/6/2011	11/21/2011	1/21/2012	3/17/2012
Microbiology				
Enterococcus *(CFU/100 ml)*	**14000**[1,2]	**5500**[1,2]	**4100**[1,2]	**9200**[1,2]
Fecal Coliform *(MPN/100 ml)*	**140000**[1,2]	**220000**[1,2]	**3300**[1,2]	**160000**[1,2]
Total Coliform *(MPN/100 ml)*	**>1600000**[1,2]	**220000**[1,2]	**35000**[1,2]	**>160000**[1,2]
Aroclors (ug/L)				
Aroclor 1016	0.1U	0.1U	0.12U	0.1U
Aroclor 1221	0.1U	0.1U	0.12U	0.1U
Aroclor 1232	0.1U	0.1U	0.12U	0.1U
Aroclor 1242	0.1U	0.1U	0.12U	0.1U
Aroclor 1248	0.1U	0.1U	0.12U	0.1U
Aroclor 1254	0.1U	0.1U	0.12U	0.1U
Aroclor 1260	0.1U	0.1U	0.12U	0.1U
Total Aroclors	0	0	0	0
Chlorinated Pesticides (ug/L)				
2,4'-DDD	0.005U	0.005U	0.0059U	0.005U
2,4'-DDE	0.005U	0.005U	0.0059U	0.005U
2,4'-DDT	0.01U	0.01U	0.012U	0.01U
4,4'-DDD	0.005U	0.005U	0.006U	0.005U
4,4'-DDE	0.005U	0.005U	0.006U	0.005U
4,4'-DDT	0.005U	0.005U	0.006U	0.005U
Total DDT	0	0	0	0
Aldrin	0.005U	0.005U	0.006U	0.005U
Dieldrin	0.005U	0.005U	0.006U	0.005U
Endrin	0.005U	0.005U	0.006U	0.005U
Endrin aldehyde	0.005U	0.005U	0.006U	0.005U
Endrin ketone	0.005U	0.005U	0.006U	0.005U
alpha-BHC	0.005U	0.005U	0.006U	0.005U
beta-BHC	0.005U	0.005U	0.006U	0.005U
delta-BHC	0.005U	0.005U	0.006U	0.005U
gamma-BHC (Lindane)	0.005U	0.005U	0.006U	0.005U
Endosulfan I	0.005U	0.005U	0.006U	0.005U
Endosulfan II	0.005U	0.005U	0.006U	0.005U
Endosulfan sulfate	0.005U	0.005U	0.006U	0.005U
Heptachlor	0.005U	0.005U	0.006U	0.005U
Heptachlor epoxide	0.005U	0.005U	0.006U	0.005U
alpha-Chlordane	0.005U	0.005U	0.006U	0.005U
gamma-Chlordane	0.005U	0.005U	0.006U	0.005U
Oxychlordane	0.005U	0.005U	0.0059U	0.005U
cis-Nonachlor	0.005U	0.005U	0.0059U	0.005U
trans-Nonachlor	0.01U	0.01U	0.012U	0.01U
Total Chlordane	0	0	0	0
Methoxychlor	0.005U	0.005U	0.006U	0.005U
Toxaphene	0.5U	0.5U	0.6U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 16. Los Cerritos Channel Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	10/6/2011	11/21/2011	1/21/2012	3/17/2012
Organophosphates (ug/L)				
Chlorpyrifos	0.01U	0.002U	0.0014J	0.0051
Demeton	0.5U	0.5U	0.5U	0.5U
Diazinon	0.02U	0.0014J	0.0015U	0.0015U
Disulfoton	0.1U	0.1U	0.1U	0.1U
Malathion	0.05U	0.05U	0.06U	0.05U
Methyl Parathion	0.1U	0.1U	0.1U	0.1U
Pyrethroids				
Bifenthrin	**38** [4]	**26** [4]	**21J+** [4]	**78** [4]
Cyfluthrin	**24J** [4]	**26** [4]	**12** [4]	**40** [4]
Cypermethrin	**11J** [4]	**7.8** [4]	**5.3** [4]	**27** [4]
Fenpropathrin	1.5U	1.5U	1.5U	1.5U
L-Cyhalothrin	**2.9** [4]	**4** [4]	**1.5** [4]	**11** [4]
Permethrin	**69J+** [4]	**48** [4]	**50J** [4]	**143** [4]
Total Deltamethrin/Tralomethrin	4	2.9J	2.6J	25
Total Esfenvalerate/Fenvalerate	0.8J	2.2	0.4J	1.2J

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 17. Dominguez Gap Stormwater Chemistry Results, 2011/2012.

Analyte	Nov 20-21 2011	Mar 26, 2012
Conventionals (mg/L unless otherwise noted)		
pH *(pH units)*	7.77	7.49
Alkalinity as CaCO3	50	46
Biochemical Oxygen Demand	12	8.2
Chemical Oxygen Demand	49	73
Chloride	26	26
Conductivity *(uS/cm)*	260	260
Fluoride	0.32	0.15
Hardness as CaCO3	63	59
MBAS	0.22	0.16
Nitrate (as N)	1.2	0.48
Nitrite (as N)	0.1U	0.1U
Oil and Grease	1.5J	5U
Total Ammonia (as N)	0.53	0.46
Total Dissolved Solids	160	180
Total Kjeldahl Nitrogen	1.5	1.8
Total Organic Carbon	16	16
Orthophosphate (as P)	0.3	0.17
Total Phosphorus	0.5	0.44
Total Recoverable Phenolics	0.1U	0.1U
Total Suspended Solids	53	82
Volatile Suspended Solids	16	23
Turbidity *(NTU)*	49	70
Dissolved Metals (ug/L)		
Aluminum	15J	19J
Arsenic	1.1	0.96
Cadmium	0.092J	0.12J
Chromium	0.54	0.35J
Copper	**6.4** [6]	4.2
Iron	35	46
Lead	0.91	0.7
Nickel	2.1	1.9
Selenium	0.46J	0.2J
Silver	0.2U	0.2U
Zinc	32	25
Total Metals (ug/L)		
Aluminum	**1600** [1]	**3100** [1]
Arsenic	1.7	2.2
Cadmium	0.15J	0.32
Chromium	3.7	5.1
Copper	**19** [5]	**20** [5]
Iron	2300	3500
Lead	**11** [5]	**15** [5]
Nickel	4.7	5.7
Selenium	0.56J	0.38J
Silver	0.04J	0.043J
Zinc	**95** [5]	**110** [5]

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 17. Dominguez Gap Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	Nov 20-21 2011	Mar 26, 2012
Microbiology		
Enterococcus *(CFU/100 ml)*	**20000**[1,2]	**1800**[1,2]
Fecal Coliform *(MPN/100 ml)*	**140000**[1,2]	**7900**[1,2]
Total Coliform *(MPN/100 ml)*	**140000**[1,2]	**43000**[1,2]
Aroclors (ug/L)		
Aroclor 1016	0.1U	0.1U
Aroclor 1221	0.1U	0.1U
Aroclor 1232	0.1U	0.1U
Aroclor 1242	0.1U	0.1U
Aroclor 1248	0.1U	0.1U
Aroclor 1254	0.1U	0.1U
Aroclor 1260	0.1U	0.1U
Total Aroclors	0	
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.005U	0.005U
2,4'-DDE	0.005U	0.005U
2,4'-DDT	0.01U	0.01U
4,4'-DDD	0.005U	0.005U
4,4'-DDE	0.005U	0.005U
4,4'-DDT	0.005U	0.005U
Total DDT	0	0
Aldrin	0.005U	0.005U
Dieldrin	0.005U	0.005U
Endrin	0.005U	0.005U
Endrin aldehyde	0.005U	0.005U
Endrin ketone	0.005U	0.005U
alpha-BHC	0.005U	0.005U
beta-BHC	0.005U	0.005U
delta-BHC	0.005U	0.005U
gamma-BHC (Lindane)	0.005U	0.005U
Endosulfan I	0.005U	0.005U
Endosulfan II	0.005U	0.005U
Endosulfan sulfate	0.005U	0.005U
Heptachlor	0.005U	0.005U
Heptachlor epoxide	0.005U	0.005U
alpha-Chlordane	0.005U	0.005U
gamma-Chlordane	0.005U	0.005U
Oxychlordane	0.005U	0.005U
cis-Nonachlor	0.005U	0.005U
trans-Nonachlor	0.01U	0.01U
Total Chlordane	0	0
Methoxychlor	0.005U	0.005U
Toxaphene	0.5U	0.5U

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

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Table 17. Dominguez Gap Stormwater Chemistry Results, 2011/2012. (Continued).

Analyte	Nov 20-21 2011	Mar 26, 2012
Organophosphates (ug/L)		
Chlorpyrifos	0.002U	0.0007J
Demeton	0.5U	0.5U
Diazinon	0.0015U	0.0015U
Disulfoton	0.1U	0.1U
Malathion	0.13	0.05U
Methyl Parathion	0.1U	0.1U
Pyrethroids		
Bifenthrin	**15**[4]	**17**[4]
Cyfluthrin	**5.9**[4]	**6.3**[4]
Cypermethrin	**7.1**[4]	**5.5**[4]
Fenpropathrin	1.5U	1.5U
L-Cyhalothrin	**1.4J**[4]	0.8J
Permethrin	**57**[4]	**34**[4]
Total Deltamethrin/Tralomethrin	4.2	8
Total Esfenvalerate/Fenvalerate	4.6	0.4J

Bolded values with superscripts exceed criteria 1=LA Basin Plan, 2=California Toxic Rule Fresh Water CMC, 3= Cal. Fish and Game Fresh Water CMC, 4=UC Davis CMC, 5=Ocean Plan Daily Max or Inst. Max, 6=California Toxic Rule Salt Water CMC.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 18. Summary of Data from Additional Events Monitored for TSS (mg/L), 2011/2012.

Site/Event Date	Nov 12 2011	Mar 17 2012	Mar 26 2012
Belmont Pump	75	120	160
Bouton Creek	112	190	82
Los Cerritos Channel	68		120

Table 19. Total Load in Kilograms at the Belmont Pump Station for 2011/2012 Storm Events

Analyte Group	10/5/2011	11/20/2011	12/12/2011	1/21/2012
Conventionals				
Alkalinity as CaCO3	186.1	276	526	482
Biochemical Oxygen Demand	77.2	97	152	67
Chemical Oxygen Demand	596.9	663	1122	341
Chloride	203.7	276	595	594
Fluoride	1.3	1.2	2.5	1.7
Hardness as CaCO3	210.7	216	415	326
MBAS	2.0	1.8	2.4	0.6
Nitrate (as N)	4.2	3.8	6.8	2.5
Nitrite (as N)	0.5	0.0	0.0	0.3
Oil and Grease	0.0	20.9	0.0	18
Orthophosphate (as P)	1.8	2.8	3.9	1.7
Total Ammonia (as N)	1.4	4.8	8.9	2.4
Total Dissolved Solids	807.6	968	1662	1818
Total Kjeldahl Nitrogen	16.2	15.6	29	9.6
Total Organic Carbon	122.9	112	166	52
Total Phosphorus	3.3	4.5	8.4	2.9
Total Recoverable Phenolics	0.0	0.0	0	0
Total Suspended Solids	457	819	1939	293
Volatile Suspended Solids	168.5	283	665	122
Dissolved Metals				
Aluminum	0.12	0.097	0.235	0.033
Arsenic	0.007	0.008	0.011	0.007
Cadmium	0.0008	0.0004	0.001	0.001
Chromium	0.0034	0.005	0.009	0.001
Copper	0.056	0.058	0.094	0.026
Iron	0.42	0.30	0.44	0.17
Lead	0.004	0.0045	0.007	0.001
Nickel	0.029	0.013	0.018	0.007
Selenium	0	0.0020	0	0
Silver	0	0	0.0002	0
Zinc	0.42	0.28	0.40	0.096
Total Metals				
Aluminum	8.8	16.4	32	6.3
Arsenic	0.013	0.016	0.030	0.010
Cadmium	0.003	0.0027	0.0055	0.0013
Chromium	0.028	0.044	0.076	0.014
Copper	0.29	0.29	0.47	0.11
Iron	13.3	26	45.7	9.3
Lead	0.109	0.18	0.36	0.05
Nickel	0.053	0.048	0.080	0.018
Selenium	0	0.0018	0.0022	0.0009
Silver	0.0003	0.00056	0.0010	0.0002
Zinc	1.5	1.7	2.8	0.5

Table 19. Total Load in Kilograms at Belmont Pump Station for 2011/2012 Storm Events. (continued)

Analyte Group	10/5/2011	11/20/2011	12/12/2011	1/21/2012
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
alpha-Chlordane	0	0.000074	0	0
gamma-Chlordane	0	0.00016	0	0
Trans-nonachlor	0.000034	0	0	0
Total Chlordane	0	0.00023	0	0
Organophosphates				
Chlorpyrifos	0	0	0.00011	0.00020
Diazinon	0	0	0	0
Malathion	0	0	0	0
Pyrethroids				
Bifenthrin	0.00015	0.00048	0.0014	0.00014
Cyfluthrin	0.000056	0.00019	0.00076	0.00013
Cypermethrin	0.00002	0.000050	0.00028	0.00002
L-Cyhalothrin	0.000006	0.00010	0.000058	0.000003
Permethrin	0.00025	0.00039	0.000043	0.000027
Total Deltamethrin/Tralomethrin	0.000046	0.00011	0.0028	0.00019
Total Esfenvalerate/Fenvalerate	0.000018	0.000023	0.00065	0.00014

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 20. Total Load in Kilograms at the Bouton Creek Stations for 2011/2012 Storm Events.

Analyte	10/5/2011	11/21/2011	12/12/2011	1/21/2012
Conventionals				
Alkalinity as CaCO3	767	923	914	543
Biochemical Oxygen Demand	555	418	609	283
Chemical Oxygen Demand	3703	2902	3706	1981
Chloride	1084	1451	3453	5661
Fluoride	10	6.6	8.1	4.7
Hardness as CaCO3	1270	1143	1777	1934
MBAS	12	11.0	11.2	3.1
Nitrate (as N)	29	22.4	24	13
Nitrite (as N)	0	0.0	0.0	0.0
Oil and Grease	0	141	0.0	42
Orthophosphate (as P)	10	9.2	9.1	3.5
Total Ammonia (as N)	20	20.2	30.5	13
Total Dissolved Solids	4761	4837	8124	11558
Total Kjeldahl Nitrogen	93	57.2	91	52
Total Organic Carbon	1005	572	762	307
Total Phosphorus	16	16.3	20.8	9.9
Total Recoverable Phenolics	0	0	0	0
Total Suspended Solids	1322	2243	3249	1439
Volatile Suspended Solids	608	792	1269	330
Dissolved Metals				
Aluminum	1.11	0.748	1.320	0.354
Arsenic	0.045	0.039	0.036	0.020
Cadmium	0.0069	0.0026	0.007	0.004
Chromium	0.042	0.044	0.056	0.014
Copper	0.66	0.41	0.56	0.19
Iron	2.1	1.36	1.78	0.71
Lead	0.048	0.038	0.036	0.012
Nickel	0.15	0.066	0.076	0.028
Selenium	0	0.015	0	0
Silver	0	0	0.0010	0
Zinc	3.7	1.9	2.2	0.85
Total Metals				
Aluminum	26	57	66	22
Arsenic	0.056	0.070	0.076	0.040
Cadmium	0.015	0.0097	0.0142	0.0068
Chromium	0.12	0.18	0.213	0.127
Copper	1.3	1.1	1.47	0.52
Iron	39.7	88	91.4	33.0
Lead	0.291	0.53	0.50	0.17
Nickel	0.24	0.18	0.22	0.073
Selenium	0	0.016	0.0000	0
Silver	0.0012	0.0019	0.0024	0.0004
Zinc	6.6	5.7	6.6	2.6

Table 20. Total Load in Kilograms at Bouton Creek Station for 2011/2012 Storm Events. (continued)

Analyte	10/5/2011	11/21/2011	12/12/2011	1/21/2012
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
alpha-Chlordane	0	0	0	0
Total Chlordane	0	0	0	0
Chlordane	0	0	0	0
trans-Nonachlor	0	0	0	0
Organophosphates				
Chlorpyrifos	0	0	0.00006	0.00002
Diazinon	0	0	0.00029	0
Malathion	0	0	0	0
Pyrethroids				
Bifenthrin	0.00032	0.00084	0.0010	0.00057
Cyfluthrin	0.000074	0.00037	0.00071	0.00022
Cypermethrin	0.00010	0.00019	0.00035	0.00010
L-Cyhalothrin	0.000019	0.000062	0.00014	0.000026
Permethrin	0.00053	0.00079	0.0023	0.00052
Total Deltamethrin/Tralomethrin	0.000034	0.000057	0.00032	0.000028
Total Esfenvalerate/Fenvalerate	0	0.000013	0.000030	0.000009

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 21. Total Load in Kilograms at the Los Cerritos Channel Station for 2011/2012 Events.

Analyte Group	10/6/2011	11/21/2011	1/21/2012	3/17/2012
Conventionals				
Alkalinity as CaCO3	8083	6256	5178	5376
Biochemical Oxygen Demand	6632	3575	2824	4121
Chemical Oxygen Demand	45595	28300	11767	32254
Chloride	2280	1192	918	968
Fluoride	64	38.7	42.4	36
Hardness as CaCO3	9741	5064	4001	3942
MBAS	120	63	52	43
Nitrate (as N)	269	140	139	97
Nitrite (as N)	0	0.0	0.0	0
Oil and Grease	0	1043	659	251
Orthophosphate (as P)	73	53.6	40.0	30
Total Ammonia (as N)	160	140.0	155	95
Total Dissolved Solids	24870	16086	12002	11110
Total Kjeldahl Nitrogen	1409	536.2	400	609
Total Organic Carbon	8497	4171	2824	4121
Total Phosphorus	269	175.8	91.8	163
Total Recoverable Phenolics	0	0.0	0.0	0.0
Total Suspended Solids	53885	47663	12473	66300
Volatile Suspended Solids	18238	14299	1953	14873
Dissolved Metals				
Aluminum	6.0	4.8	4.2	1.4
Arsenic	0.31	0.30	0.23	0.18
Cadmium	0.037	0.019	0.028	0
Chromium	0.23	0.19	0.17	0.22
Copper	2.7	2.1	1.7	1.5
Iron	17	9.2	6.6	8.8
Lead	0.33	0.17	0.092	0.11
Nickel	1.2	0.48	0.31	0.57
Selenium	0	0.074	0	0
Silver	0	0	0	0
Zinc	13	11	10	7.3
Total Metals				
Aluminum	746	1162	259	1111
Arsenic	0.95	0.86	0.35	0.75
Cadmium	0.29	0.20	0.082	0.14
Chromium	2.1	2.8	0.71	2.3
Copper	16.2	11.6	4.5	10.4
Iron	1057	1668	353.0	1469
Lead	7.7	7.8	2.2	7.7
Nickel	3.1	3.3	0.82	2.9
Selenium	0	0.13	0	0.048
Silver	0.035	0.026	0.0066	0.12
Zinc	116	86	31	70

Table 21. Total Load in Kilograms at the Los Cerritos Channel Station for 2011/2012 Events. (continued)

Analyte Group	10/6/2011	11/21/2011	1/21/2012	3/17/2012
Aroclors				
Aroclor 1016 - 1260	0	0	0	0
Chlorinated Pesticides				
alpha-Chlordane	0	0	0	0
gamma-Chlordane	0	0	0	0
Total Chlordane	0	0	0	0
trans-Nonachlor	0	0	0	0
Organophosphates				
Chlorpyrifos	0	0	0.00033	0.00091
Diazinon	0	0	0	0
Malathion	0	0	0	0
Pyrethroids				
Bifenthrin	0.00788	0.00775	0.0049	0.014
Cyfluthrin	0.00497	0.00775	0.0028	0.0072
Cypermethrin	0.00228	0.0023	0.0012	0.0048
L-Cyhalothrin	0.00060	0.0012	0.00035	0.0020
Permethrin	0.01430	0.0143	0.01177	0.0256
Total Deltamethrin/Tralomethrin	0.00083	0.00086	0.00061	0.0045
Total Esfenvalerate/Fenvalerate	0.00017	0.00066	0.000094	0.00022

ND indicates that an analysis was performed but the analyte was not detected.
A blank cell (-) indicates that the analysis was not performed.

Table 22. Total Load in Kilograms at the Dominguez Gap Station for 2011/2012 Events.

Analyte	Nov 20-21 2011	Mar 26, 2012
Conventionals		
Alkalinity as CaCO3	793	2640
Biochemical Oxygen Demand	190	471
Chemical Oxygen Demand	777	4190
Chloride	412	1492
Fluoride	5.1	8.6
Hardness as CaCO3	999	3386
MBAS	3.5	9.2
Nitrate (as N)	19.0	27.6
Nitrite (as N)	0.0	0.0
Oil and Grease	23.8	0.0
Orthophosphate (as P)	4.8	9.8
Total Ammonia (as N)	8.4	26
Total Dissolved Solids	2537	10332
Total Kjeldahl Nitrogen	23.8	103
Total Organic Carbon	254	918
Total Phosphorus	7.9	25
Total Recoverable Phenolics	0.0	0.0
Total Suspended Solids	840	4707
Volatile Suspended Solids	254	1320
Dissolved Metals		
Aluminum	0.238	1.09
Arsenic	0.017	0.055
Cadmium	0.001	0.007
Chromium	0.009	0.020
Copper	0.101	0.24
Iron	0.56	2.64
Lead	0.014	0.040
Nickel	0.033	0.109
Selenium	0.007	0.011
Silver	0	0
Zinc	0.51	1.4
Total Metals		
Aluminum	25	178
Arsenic	0.027	0.13
Cadmium	0.0024	0.018
Chromium	0.059	0.29
Copper	0.30	1.1
Iron	36	201
Lead	0.17	0.86
Nickel	0.075	0.33
Selenium	0.0089	0.022
Silver	0.00063	0.002
Zinc	1.5	6.3

Table 22. Total Load in Kilograms at the Dominguez Gap Stations for 2011/2012 Events. (continued)

Analyte Group	Feb 25-26, 2011	March 20-21, 2011
Aroclors		
Aroclor 1016 - 1260	0	0
Chlorinated Pesticides		
Alpha-chlordane		
Gamma-chlordane		
Chordane		
Organophosphates		
Chlorpyrifos		0.000040
Diazinon		
Malathion	0.0021	
Pyrethroids		
Bifenthrin	0.00024	0.00098
Cyfluthrin	0.000094	0.00036
Cypermethrin	0.00011	0.00032
L-Cyhalothrin	0.000022	0.000046
Permethrin	0.00090	0.00195
Total Deltamethrin/Tralomethrin	0.000067	0.000459
Total Esfenvalerate/Fenvalerate	0.000073	0.000023

ND indicates that an analysis was performed but the analyte was not detected.
NS indicates indicates that the analysis was not performed.

Table 23. Total Load in Kilograms for TSS-only events for 2010/2011 Storm Events

	Nov 12 2011	Mar 17 2012	Mar 26 2012
Belmont Pump	163	421	1522
Bouton Creek	1047	4175	3973
Los Cerritos Channel	5467		46679

Table 24. Monitored Dry Weather Events, 1999-2012.

Station	1 - 10/4/00	2 - 6/21/00	3 - 6/29/00	4 - 6/5/01	5 - 8/16/01	6 - 5/9,14/02	7 - 9/5/02	8 - 5/20/03	9 - 9/ll/03	10 - 5/4/04	11 – 8/4/04	12 – 5/4/05	13 -8/18/05	14 -5/11/06	15 -9/7/06	16 -5/17/07	17 – 9/27/07	18 – 5/7/08	19 - 7/2/2008	20 – 5/7/2009	21-10/12/2009	22-5/11/2010	23-9/23/10	24-5/10/11	25- 9/14/11	26- 5/1/12
Bouton Creek		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•[3]	•[3]	•[3]	•[5]	•[5]	•[5]	•[5]	•[5]	•[5]
Belmont Pump[5]		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•										
Los Cerritos Channel				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Dominguez Gap		•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[1]	•[2]	•	•[1]	•[1]	•	•	•	•	•[6]	•

1. The intake to the sump was observed to be dry. Therefore, no samples were collected.
2. The pump station was inoperative during renovation of the pumps and the wet basin behind the pump house. No samples were collected.
3. There was very low flow along both sides of the channel during each event. In each case flow was insufficient to flush the salt water out of the channel. Salinity never dropped below 17 ppt during Event 19 and 10.8 during Event 20 before the channel was flooded by the incoming tide. No samples were collected.
4. The Belmont Pump Station dry weather flow has been continually diverted to the sanitary sewer system since prior to the 17th dry weather survey.
5. Due to the continued presence of brackish water in Bouton Creek during low flow, the sampling location for dry weather was relocated upstream to where Bouton Creek emergences from under the parking lot of California State University Long Beach.
6. The sump pump was not in operation, therefore; no discharge was taking place. No samples were collected.

Shading indicates 2011/2012 Dry Weather Surveys included in this report.

Table 25. Field Measurements for Dry Weather Surveys.

	Bouton Creek		Los Cerritos Channel		Dominguez Gap Pump	
Date	**13-Sept-11**	**1-May-12**	**14-Sept-11**	**2-May-12**	**14-Sept-11**	**2-May-12**
Time	[4]	**1300**	[4]	**0810**	[3]	**0926**
Temperature (^{0}C)	n/a	18.8	n/a	17.3		19.8
pH	n/a	8.66	n/a	8.69		7.06
Specific Conductivity (mS/cm)	n/a	0.44	n/a	0.0006		0.78
Flow (cfs)	n/a	0.68[1]	n/a	0.34[1]	[3]	[2]
Dissolved Oxygen (mg/L)	n/a	14.4	n/a	17.1		4.5

n/a = not available

1. Flow was calculated from measurements of the depth and width of the water stream, as well as the velocity of a floating object in the water.
2. The exact flow is not known. The Los Angeles County Department of Public Works estimates flow at 3 cfs when the stage is at 7.0 feet. The stage was at 7.8 feet at the time of this visit.
3 The sump pump was not in operation, therefore; no discharge was taking place. No field measurements were performed.
4 Field measurements were performed, however, the log books along with other field equipment were stolen when the truck was broken into while parked overnight.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2011/2012.

Analyte	Sep 14, 2011	April 30-May 1 2012,
Conventionals (mg/L unless otherwise noted)		
pH (pH Units)	**8.56**[2]	**8.53**[2]
Alkalinity as CaCO3	120	140
Biochemical Oxygen Demand	3.1	4.6
Chemical Oxygen Demand	96	42
Chloride	730	120
Conductivity (uS/cm)	2700	780
Fluoride	0.89	0.82
Hardness as CaCO3	260	99
MBAS	0.045J	0.1U
Nitrate (as N)	0.15	0.26
Nitrite (as N)	0.1U	0.1U
Oil and Grease	5U	5U
Total Ammonia (as N)	0.26	0.21
Total Dissolved Solids	1600	460
Total Kjeldahl Nitrogen	1.8	1.8
Total Organic Carbon	25	8.4
Orthophosphate (as P)	0.027	0.033
Total Phosphorus	0.17	0.22
Total Recoverable Phenolics	0.1U	0.1U
Total Suspended Solids	16	8.7
Volatile Suspended Solids	2.4	2.4U
Turbidity (NTU)	5.9	52
Dissolved Metals (ug/L)		
Aluminum	51	25U
Arsenic	2.3	1.1
Cadmium	0.33	0.2U
Chromium	0.18J	0.5U
Copper	**7.8**[6]	**5.1**[6]
Iron	13	21
Lead	0.34	0.2U
Nickel	1.5	1
Selenium	1U	1U
Silver	0.2U	0.2U
Zinc	12	12
Total Metals (ug/L)		
Aluminum	260	2800
Arsenic	2.6	1.8
Cadmium	0.33	0.2U
Chromium	0.97	4.1
Copper	11	8.4
Iron	180	2900
Lead	1.1J	2.5
Nickel	2.1	3.6
Selenium	1U	1U
Silver	0.2U	0.2U
Zinc	18	27

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	Sep 14, 2011	April 30-May 1 2012,
Microbiology		
Enterococcus (CFU/100 ml)	**1200** [1,2]	**650** [1,2]
Fecal Coliform (MPN/100 ml)	**8000** [1,2]	**2200J** [1,2]
Total Coliform (MPN/100 ml)	**13000** [1,2]	**130000** [1,2]
Aroclors (ug/L)		
Aroclor 1016	0.1U	0.1U
Aroclor 1221	0.1U	0.1U
Aroclor 1232	0.1U	0.1U
Aroclor 1242	0.1U	0.1U
Aroclor 1248	0.1U	0.1U
Aroclor 1254	0.1U	0.1U
Aroclor 1260	0.1U	0.1U
Total Aroclors	0	0
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.005U	0.005U
2,4'-DDE	0.005U	0.005U
2,4'-DDT	0.01U	0.01U
4,4'-DDD	0.005U	0.005U
4,4'-DDE	0.005U	0.005U
4,4'-DDT	0.005U	0.005U
Total DDT	0	0
Aldrin	0.005U	0.005U
Dieldrin	0.005U	0.005U
Endrin	0.005U	0.005U
Endrin aldehyde	0.005U	0.005U
Endrin ketone	0.005U	0.005U
alpha-BHC	0.005U	0.005U
beta-BHC	0.005U	0.005U
delta-BHC	0.005U	0.005U
gamma-BHC (Lindane)	0.005U	0.005U
Endosulfan I	0.005U	0.005U
Endosulfan II	0.005U	0.005U
Endosulfan sulfate	0.005U	0.005U
Heptachlor	0.005U	0.005U
Heptachlor epoxide	0.005U	0.005U
alpha-Chlordane	0.005U	0.005U
gamma-Chlordane	0.005U	0.005U
Oxychlordane	0.005U	0.005U
cis-Nonachlor	0.005U	0.005U
trans-Nonachlor	0.01U	0.01U
Total Chlordane	0	0
Methoxychlor	0.005U	0.005U
Toxaphene	0.5U	0.5U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 26. Summary of Bouton Creek Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	Sep 14, 2011	April 30-May 1 2012,
Organophosphates (ug/L)		
Chlorpyrifos	0.002U	0.005U
Demeton	0.5U	0.5U
Diazinon	0.0015U	0.0025U
Disulfoton	0.1U	0.1U
Malathion	0.05U	0.05U
Methyl Parathion	0.1U	0.1U
Pyrethroids (ug/L)		
Bifenthrin	**1.6** [4]	2.5U
Cyfluthrin	1.5U	2.5U
Cypermethrin	1.5U	2.5U
Fenpropathrin	1.5U	2.5U
L-Cyhalothrin	1.5U	2.5U
Permethrin	15U	50U
Total Deltamethrin/Tralomethrin	3U	5U
Total Esfenvalerate/Fenvalerate	1.5U	5U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2011/2012.

Analyte	Sep 14, 2011	April 30-May 1 2011
Conventionals (mg/L unless otherwise noted)		
pH (pH Units)	**9.15**[2]	**9.7**[2]
Alkalinity as CaCO3	120	93
Biochemical Oxygen Demand	10	17
Chemical Oxygen Demand	100	100
Chloride	110	120
Conductivity (uS/cm)	760	750
Fluoride	0.92	0.61
Hardness as CaCO3	150	110
MBAS	0.11	0.1U
Nitrate (as N)	0.1U	0.19
Nitrite (as N)	0.1U	0.1U
Oil and Grease	5U	5U
Total Ammonia (as N)	0.3	0.24
Total Dissolved Solids	510	480
Total Kjeldahl Nitrogen	3.1	2.7
Total Organic Carbon	48	32
Orthophosphate (as P)	0.038	0.01U
Total Phosphorus	0.19	0.14
Total Recoverable Phenolics	0.1U	0.1U
Total Suspended Solids	10	8.4
Volatile Suspended Solids	4.1	5.4
Turbidity (NTU)	19	11
Dissolved Metals (ug/L)		
Aluminum	64	25U
Arsenic	4.6	3.8
Cadmium	0.34	0.3
Chromium	0.57	0.5U
Copper	**13** [2,6]	**18** [2,6]
Iron	16	14
Lead	0.34	0.73
Nickel	4.9	3.1
Selenium	1U	1U
Silver	0.2U	0.2U
Zinc	5.7	12
Total Metals (ug/L)		
Aluminum	290	25U
Arsenic	5.3	4.4
Cadmium	0.47	0.31
Chromium	0.96	0.91
Copper	**18** [5]	**20** [5]
Iron	310	58
Lead	1.3J	1.1
Nickel	6.1	3.6
Selenium	1U	1U
Silver	0.021J	0.2U
Zinc	15	16

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	Sep 14, 2011	April 30-May 1 2011,
Microbiology		
Enterococcus (CFU/100 ml)	**280** [1,5]	**210** [1,5]
Fecal Coliform (MPN/100 ml)	**2300** [1,5]	<18J
Total Coliform (MPN/100 ml)	1700	<18
Aroclors (ug/L)		
Aroclor 1016	0.1U	0.1U
Aroclor 1221	0.1U	0.1U
Aroclor 1232	0.1U	0.1U
Aroclor 1242	0.1U	0.1U
Aroclor 1248	0.1U	0.1U
Aroclor 1254	0.1U	0.1U
Aroclor 1260	0.1U	0.1U
Total Aroclors	0	0
Chlorinated Pesticides (ug/L)		
2,4'-DDD	0.005U	0.005U
2,4'-DDE	0.005U	0.005U
2,4'-DDT	0.01U	0.01U
4,4'-DDD	0.005U	0.005U
4,4'-DDE	0.005U	0.005U
4,4'-DDT	0.005U	0.005U
Total DDT	0	0
Aldrin	0.005U	0.005U
Dieldrin	0.005U	0.005U
Endrin	0.005U	0.005U
Endrin aldehyde	0.005U	0.005U
Endrin ketone	0.005U	0.005U
alpha-BHC	0.005U	0.005U
beta-BHC	0.005U	0.005U
delta-BHC	0.005U	0.005U
gamma-BHC (Lindane)	0.005U	0.005U
Endosulfan I	0.005U	0.005U
Endosulfan II	0.005U	0.005U
Endosulfan sulfate	0.005U	0.005U
Heptachlor	0.005U	0.005U
Heptachlor epoxide	0.005U	0.005U
alpha-Chlordane	0.005U	0.005U
gamma-Chlordane	0.005U	0.005U
Oxychlordane	0.005U	0.005U
cis-Nonachlor	0.005U	0.005U
trans-Nonachlor	0.01U	0.01U
Total Chlordane	0	0
Methoxychlor	0.005U	0.005U
Toxaphene	0.5U	0.5U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 27. Summary of Los Cerritos Channel Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	Sep 14, 2011	April 30-May 1 2012
Organophosphates (ug/L)		
Chlorpyrifos	0.002U	0.01U
Demeton	0.5U	0.5U
Diazinon	0.0015U	0.02U
Disulfoton	0.1U	0.1U
Malathion	0.05U	0.05U
Methyl Parathion	0.1U	0.1U
Pyrethroids (ug/L)		
Bifenthrin	**3.4** [4]	**4.1** [4]
Cyfluthrin	**0.3J** [4]	2.5U
Cypermethrin	**0.4J** [4]	2.5U
Fenpropathrin	1.5U	2.5U
L-Cyhalothrin	1.5U	2.5U
Permethrin	15U	50U
Total Deltamethrin/Tralomethrin	3U	5U
Total Esfenvalerate/Fenvalerate	1.5U	5U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2011/2012.

Analyte	April 30-May 1 2012
Conventionals (mg/L unless otherwise noted)	
pH (pH Units)	7.36
Alkalinity as CaCO3	120
Biochemical Oxygen Demand	11
Chemical Oxygen Demand	53
Chloride	87
Conductivity (uS/cm)	760
Fluoride	0.46
Hardness as CaCO3	200
MBAS	0.1U
Nitrate (as N)	0.11
Nitrite (as N)	0.1U
Oil and Grease	5U
Total Ammonia (as N)	0.21
Total Dissolved Solids	430
Total Kjeldahl Nitrogen	2
Total Organic Carbon	14
Orthophosphate (as P)	0.068
Total Phosphorus	0.27
Total Recoverable Phenolics	0.1U
Total Suspended Solids	22
Volatile Suspended Solids	9.2
Turbidity (NTU)	18
Dissolved Metals (ug/L)	
Aluminum	25U
Arsenic	1.7
Cadmium	0.2U
Chromium	0.5U
Copper	2
Iron	32
Lead	0.39
Nickel	3.4
Selenium	1U
Silver	0.2U
Zinc	11
Total Metals (ug/L)	
Aluminum	360
Arsenic	1.9
Cadmium	0.2U
Chromium	0.79
Copper	4.4
Iron	510
Lead	2.5
Nickel	3.5
Selenium	1U
Silver	0.2U
Zinc	21

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	April 30-May 1 2012
Microbiology	
Enterococcus (CFU/100 ml)	63
Fecal Coliform (MPN/100 ml)	230J
Total Coliform (MPN/100 ml)	1700
Aroclors (ug/L)	
Aroclor 1016	0.1U
Aroclor 1221	0.1U
Aroclor 1232	0.1U
Aroclor 1242	0.1U
Aroclor 1248	0.1U
Aroclor 1254	0.1U
Aroclor 1260	0.1U
Total Aroclors	0
Chlorinated Pesticides (ug/L)	
2,4'-DDD	0.005U
2,4'-DDE	0.005U
2,4'-DDT	0.01U
4,4'-DDD	0.005U
4,4'-DDE	0.005U
4,4'-DDT	0.005U
Total DDT	0
Aldrin	0.005U
Dieldrin	0.005U
Endrin	0.005U
Endrin aldehyde	0.005U
Endrin ketone	0.005U
alpha-BHC	0.005U
beta-BHC	0.005U
delta-BHC	0.005U
gamma-BHC (Lindane)	0.005U
Endosulfan I	0.005U
Endosulfan II	0.005U
Endosulfan sulfate	0.005U
Heptachlor	0.005U
Heptachlor epoxide	0.005U
alpha-Chlordane	0.005U
gamma-Chlordane	0.005U
Oxychlordane	0.005U
cis-Nonachlor	0.005U
trans-Nonachlor	0.01U
Total Chlordane	0
Methoxychlor	0.005U
Toxaphene	0.5U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater. U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

Table 28. Summary of Dominguez Gap Dry Weather Chemistry Results, 2011/2012. (continued)

Analyte	April 30-May 1 2012
Organophosphates (ug/L)	
Chlorpyrifos	0.01U
Demeton	0.5U
Diazinon	0.02U
Disulfoton	0.1U
Malathion	0.05U
Methyl Parathion	0.1U
Pyrethroids (ug/L)	
Bifenthrin	**2.6J** [4]
Cyfluthrin	2.9U
Cypermethrin	2.9U
Fenpropathrin	2.9U
L-Cyhalothrin	2.9U
Permethrin	59U
Total Deltamethrin/Tralomethrin	5.9U
Total Esfenvalerate/Fenvalerate	5.9U

Bolded values with superscripts exceed criteria 1-LA Basin Plan, 2-Cal. Toxics Rule Freshwater, 3-Cal. Fish&Game Freshwater, 4-UC Davis, 5-Ocean Plan, 6-Cal. Toxics Rule Saltwater, 7-Cal. Fish&Game Saltwater.

U=not detected at the detection limit, J=value is considered an estimate, J- = value is considered to be a low estimate, J+=value is considered to be a high estimate.

TOXICITY RESULTS

Toxicity testing is required to be conducted at all sites except the Dominguez Gap Pump Station. Toxicity tests were conducted on subsamples of the composites collected for chemical analysis. Wet weather samples were collected from five storm events. Composite samples were collected during each of the storm events and tested with two species, the water flea (freshwater crustacean) and the sea urchin (marine echinoderm). All three stations were sampled during three of the five storm events, two stations were sampled during one event and one station was sampled as part of the fifth and final stormwater monitoring effort.

Dry weather sampling was conducted during two events in accordance with NPDES requirements. Both Bouton Creek and the Los Cerritos Channel had sufficient flow to be sampled in both dry weather periods. With installation of a permanent dry weather diversion system at the Belmont Pump Station this site no longer discharges to receiving waters and is not included in the two dry weather surveys.

WET WEATHER DISCHARGE

Wet weather toxicity testing is conducted in association with full analytical chemical testing at the Belmont Pump Station, Bouton Creek and Los Cerritos Channel mass emission sites. Concurrent chemical testing is critical for interpretation of any toxicity. Toxicity testing was eliminated at the Dominguez Gap Pump Station in 2002 due to infrequent discharges and lack of toxicity whenever discharges occurred.

Wet weather samples were collected from five storm events: October 5-6 2011, November 20-21 2011, December 12 2011, January 21 2012 and March 17 2012. Samples could not be collected from Los Cerritos Channel from the third storm event due to an equipment failure. Results of tests from all three stations are presented in Table 29 through Table 31 and Figure 36 through Figure 38. Complete toxicity test reports with CETIS summaries are included in Appendix B (CD only).

Ceriodaphnia Bioassays

There was no measurable toxicity at any of the three stations during any of the five storms for the water flea (*Ceriodaphnia*) bioassay tests. Stormwater runoff collected during 2011/2012 showed no impacts on mortality or reproduction with all NOECs equaling 100% and all LC_{50}s being >100%. Over the entire storm season, less than 1 acute toxicity unit (TU_a) was measured in all tests conducted at each of the three stations, and no TIEs were triggered.

All daphnid bioassays met all test acceptability criteria (TAC) and all reference toxicant test results were within laboratory control chart limits.

Strongylocentrotus Bioassays

Sea urchin (*Strongylocentrotus*) fertilization tests showed statistically significant toxicity in almost every toxicity test run for the wet weather season yet the magnitude of toxicity required only a single TIE be performed at Belmont Pump on 10/5/11. Tests that did not show significant toxicity were the 12/12/11 event at Belmont Pump (NOEC = 62.7%), the 1/21/12 event at Bouton Creek (NOEC = 63%) and the 11/20/11 event at Los Cerritos Channel (NOEC = 63.7%). This chronic toxicity was 1.6 TU_c for each sample and all acute toxicity results were less than 1.6 acute toxicity units (TU_a).

Stormwater from the Belmont Pump Station showed decreased fertilization in association with both the October 2011 storm (NOEC = 12.5%, EC_{50} >58.8%) and the November 2011 storm (NOEC = 12.5%, EC_{50} >63.7%). The January 2012 event for this station triggered a TIE with an EC_{50} = 28.3% and a TU_a of 3.5. Bouton Creek samples had a decreased fertilization in the October 2011 storm (NOEC = 6.25%, EC_{50} = 54.2%), the November 2011 event (NOEC = 25%, EC_{50} = 56.8%) and the December 2011 storm (NOEC = 25%, EC_{50} >63.2%). Samples taken at Los Cerritos Channel showed decreased fertilization in the October 2011 storm (NOEC = 6.25%, EC_{50} >58.7%), the January 2012 event (NOEC = 25%, EC_{50} >58.0%) and the March 2012 storm (NOEC = 6.25%, EC_{50} >54.5%).

With this test, the highest concentration that can be tested is 64%-66% of the original sample. This is due to the need to use brine to bring the salinity up to appropriate levels. The lowest measureable chronic toxicity is therefore limited to approximately 1.6 TU_c.

All sea urchin bioassays met all test acceptability criteria (TAC) and all concurrent reference toxicant test results were within laboratory control chart limits.

DRY WEATHER DISCHARGES

Toxicity results from the dry weather samples are presented in Table 32 and Figure 39. Toxicity tests were conducted on samples from dry weather sampling events on September 13-14, 2011 and May 1-2, 2012. As with the wet weather monitoring, dry weather discharges from the Dominguez Gap Pump Station are not required to be tested for toxicity. This has not been an issue since dry weather discharges were not observed at the Dominguez Gap Pump Station from the start of the program eleven years ago until the recent completion of the wetlands project. The reconfiguration of this site now results in discharges during dry weather periods but the source of the water is the Los Angeles River which is diverted to provide infiltration and maintain the recently constructed Dominguez Gap wetlands system.

Since completion of the wetland project, water has sporadically been discharged to the Los Angeles River. The 2005 Environmental Impact Report (CH2MHill, 2005) indicated that diversions from the Los Angeles River were expected to average about 1.75 cfs on a year round basis, with up to 5 cfs in the summer months. Due to problems with the summer pump, discharges to the River during dry weather have often been controlled by periodic manual control of the larger, natural gas pumps. More recently, water levels in the basin have been maintained at a relatively constant level of 9-10 feet.

Los Cerritos Channel and Bouton Creek

No toxicity was found in either of the two dry weather events from both the Los Cerritos Channel and Bouton Creek mass emission monitoring sites. The NOECs for both survival and reproduction in the *Ceriodaphnia* bioassay tests were 100% sample concentration and the EC_{50s} were >100%. The acute toxicity units (TU_a) were measured as less than 1 in all tests conducted, and no TIEs were triggered.

The sea urchin fertilization tests showed no measurable toxicity at either site for both dry weather events. NOECs ranged from 64% to 66% which was the highest concentration tested due to the upper range that can be achieved using brines to adjust salinity. All acute toxicity units were <1.5 to <1.6. No TIEs were triggered by these dry weather samples.

Toxicity Identification Evaluations (TIEs)

The trigger for TIE initiation in this program is the occurrence of an LC_{50} of ≤50% (equivalent to ≥2 TU_a) for water flea survival or an EC_{50} of ≤33% (≥3 TU_a) for the sea urchin fertilization test. This year two TIEs were conducted although only one fully met the established criteria.

The first of these was conducted on stormwater from Bouton Creek December 12, 2011 storm event. An abbreviated TIE was conducted in association with this event even though the magnitude of the initial response did not meet the established criteria. The abbreviated TIE was limited to EDTA treatments. The baseline sample indicated that toxicity had declined between the original test and the baseline testing for the TIE. Percent fertilization increased from 51.8% in the original sample to 69.6% in the baseline. All concentrations of EDTA resulted in fertilization success greater than 96%. The source of the toxicity was therefore attributed to an unidentified heavy metal. The limited toxic response associated with this sample did not warrant further TIE testing.

The second TIE was conducted on stormwater collected at the Belmont Pump Station during the January 21, 2012 event. The Belmont Pump sample showed a statistically significant difference in fertilization in the four highest concentrations tested. This sample showed an 83 percent decrease in fertilization in the highest concentration tested compared to the control. This initial test met the criteria of >3 TU_a that was established to provided a high likelihood of a successful TIE.

During the TIE phase, the baseline sample exhibited 88 percent fertilization, only 7 percent below the laboratory control (Table 33). Due to the lack of a toxic signal in the baseline sample, information on the contaminant responsible for toxicity in the original screen could not be determined. Percent fertilization in the TIE treatments ranged from 63 to 94 percent. A reduction in the mean percent fertilization of the STS TIE treatment was observed relative to the remaining treatments. It is difficult to determine the reason for this, as the method controls for these two STS concentrations were 94 and 95 percent. Fertilization among all lab and method controls, ranging from 88 to 97 percent, was within the acceptable range.

It is unsure what caused the loss of toxicity in the Belmont Pump Station sample. We saw 17 percent fertilization in the high concentration during the initial screen, but this increased to 88 percent fertilization during the TIE phase. It is unsure whether the loss of toxicity was due to a volatile toxicant or just the changing nature of stormwater that will sometimes occur. Sometimes, the ions and different components within the stormwater will naturally alter over time and move towards a point of equilibrium. However, it should be noted that the sample was held in cold storage, in a tightly-sealed container with no head-space, minimizing any loss of volatile toxicants and met the criteria for proceeding with a TIE for sea urchin fertilization at the Belmont Pump Station.

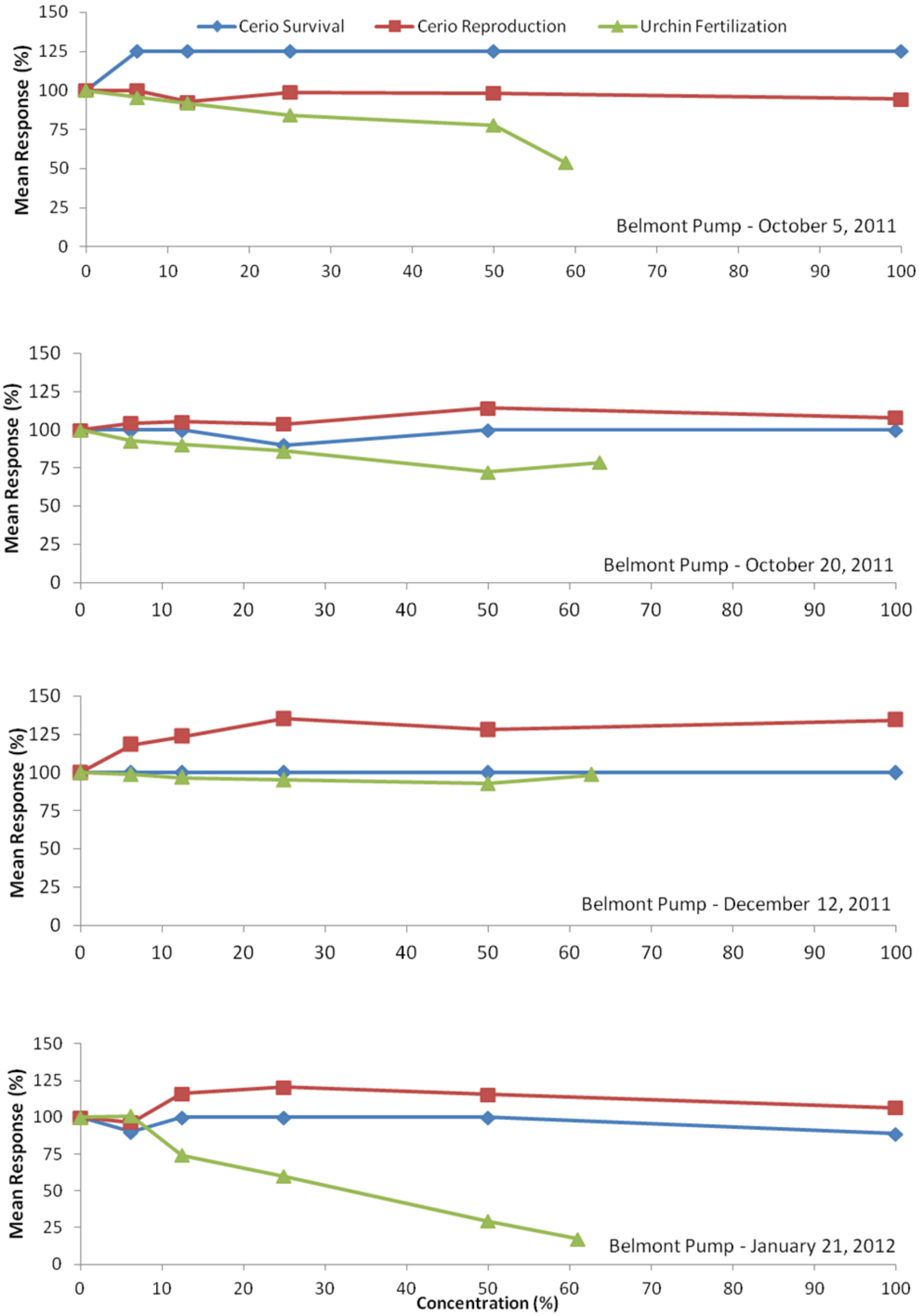

Figure 36. Toxicity Dose Response Plots for Stormwater Samples Collected at Belmont Pump during the 2011/2012 Season.

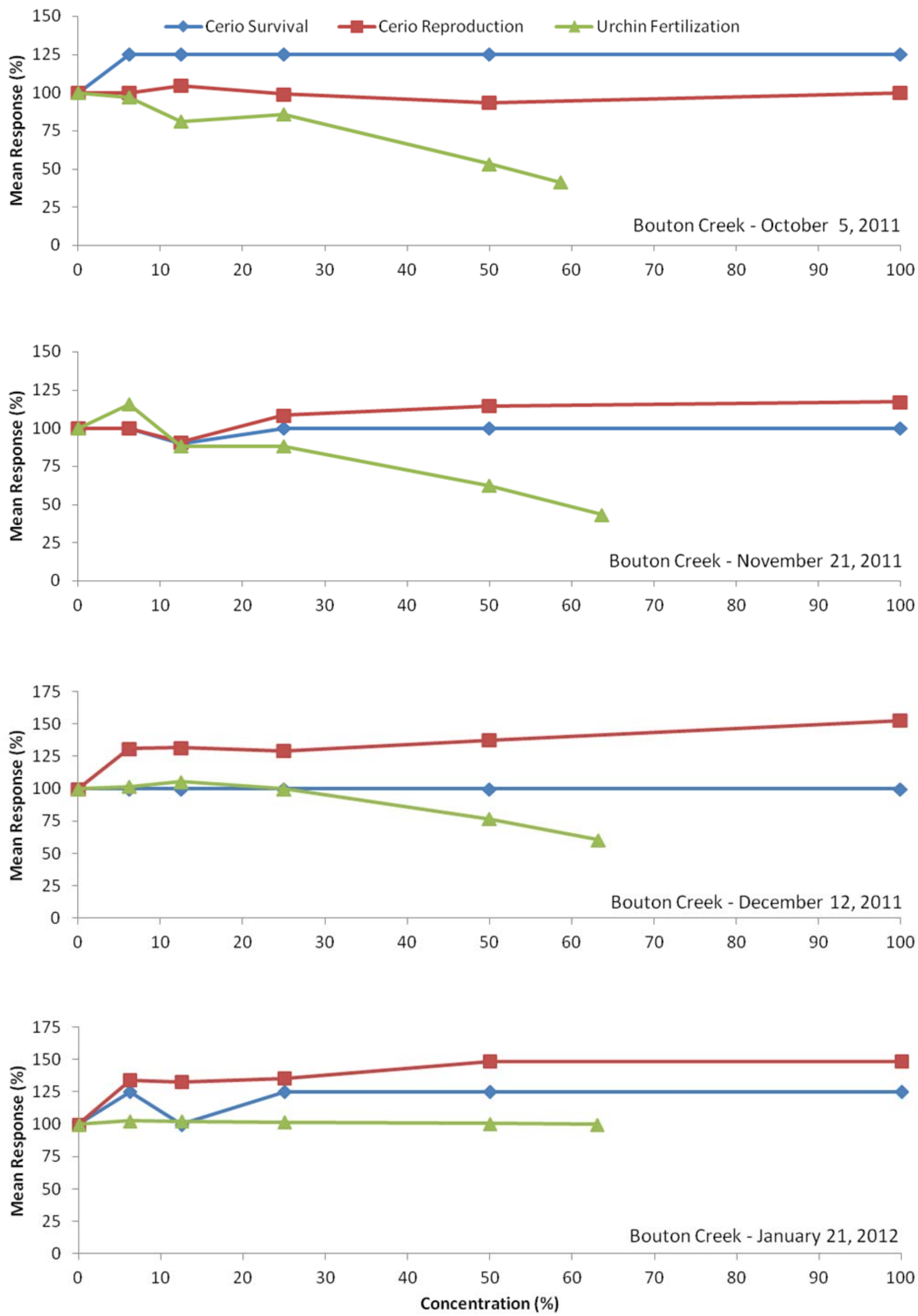

Figure 37. Toxicity Dose Response Plots for Stormwater Samples Collected at Bouton Creek during the 2011/2012 Season.

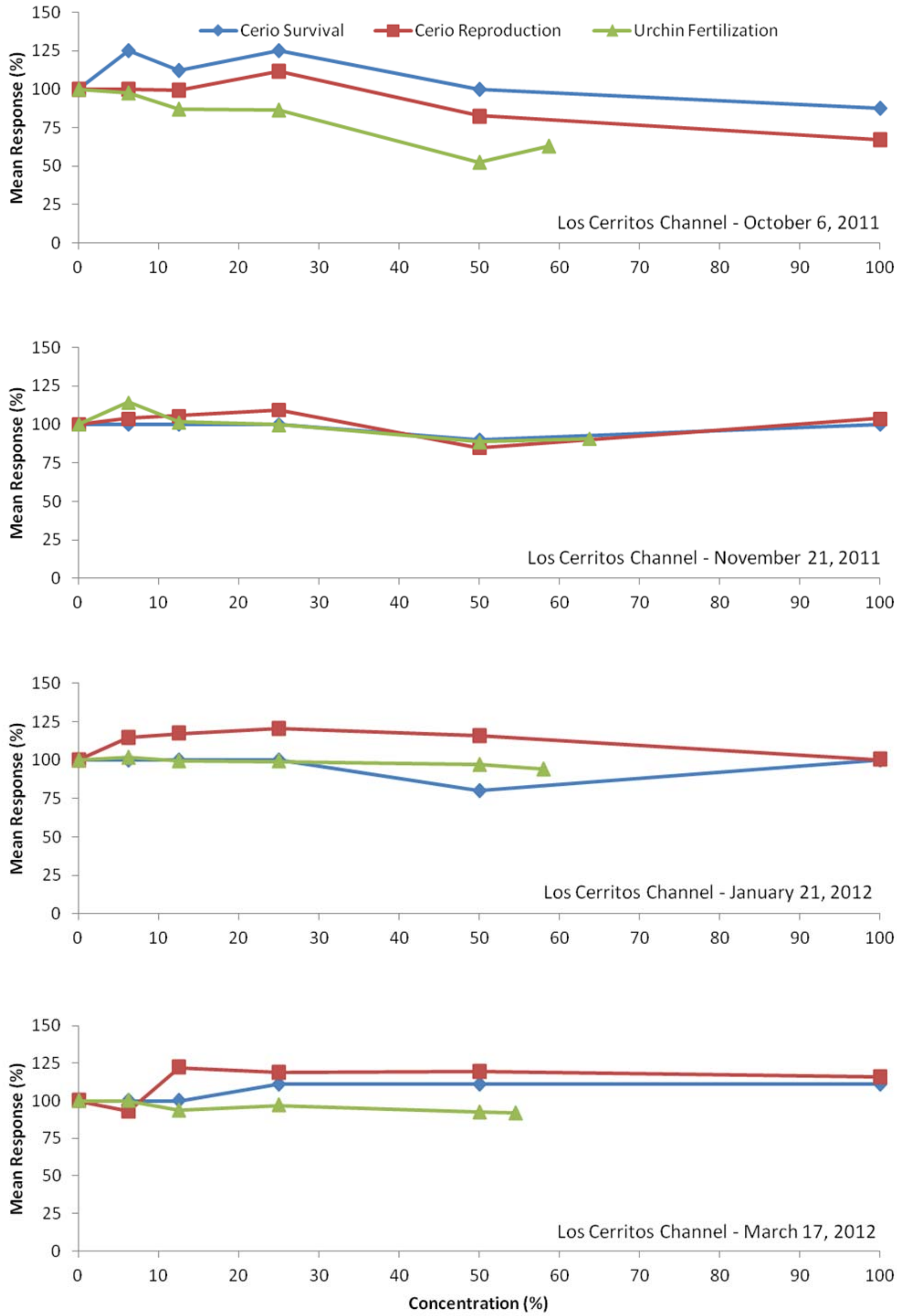

Figure 38. Toxicity Dose Response Plots for Stormwater Samples Collected at Los Cerritos Channel during the 2011/2012 Season.

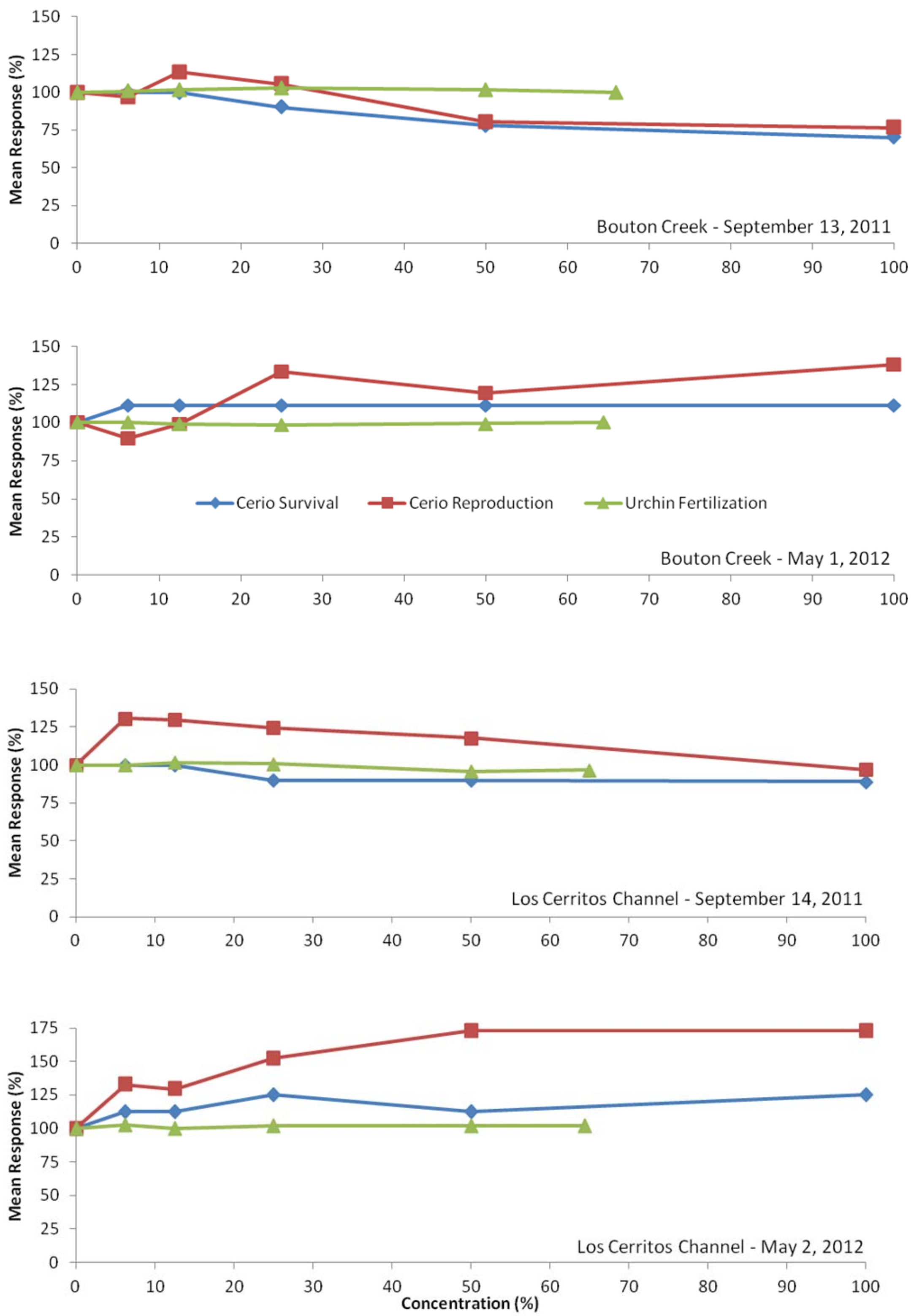

Figure 39. Toxicity Dose Response Plots for Dry Weather Samples Collected at the Bouton Creek and Los Cerritos Channel sites during the 2011/2012 Season.

Table 29. Toxicity of Wet Weather Samples Collected from the City of Long Beach Belmont Pump Station during the 2011/2012 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU_a [d]	TU_c [e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/5/11	Water Flea Survival	100	>100	>100	<1	1
10/5/11	Water Flea Reproduction	100	>100	>100	<1	1
10/5/11	**Sea Urchin Fertilization**	**12.5**	**25**	**>58.8**	**<1.7**	**8**
11/20/11	Water Flea Survival	100	>100	>100	<1	1
11/20/11	Water Flea Reproduction	100	>100	>100	<1	1
11/20/11	**Sea Urchin Fertilization**	**12.5**	**25**	**>63.7**	**<1.6**	**8**
12/12/11	Water Flea Survival	100	>100	>100	<1	1
12/12/11	Water Flea Reproduction	100	>100	>100	<1	1
12/12/11	Sea Urchin Fertilization	62.7	>62.7	>62.7	<1.6	1.6
1/21/12	Water Flea Survival	100	>100	>100	<1	1
1/21/12	Water Flea Reproduction	100	>100	>100	<1	1
1/21/12	**Sea Urchin Fertilization**	**6.25**	**12.5**	**28.3**	**3.5**	**16**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.

[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).

[d] Acute toxicity units = 100/LC_{50} or EC_{50}.

[e] Chronic toxicity units = 100/NOEC.

Table 30. Toxicity of Wet Weather Samples Collected from the City of Long Beach Bouton Creek Station during the 2011/2012 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/5/11	Water Flea Survival	100	>100	>100	<1	1
10/5/11	Water Flea Reproduction	100	>100	>100	<1	1
10/5/11	**Sea Urchin Fertilization**	**6.25**	**12.5**	**54.2**	**1.8**	**16**
11/20/11	Water Flea Survival	100	>100	>100	<1	1
11/20/11	Water Flea Reproduction	100	>100	>100	<1	1
11/20/11	**Sea Urchin Fertilization**	**25**	**50**	**56.8**	**1.8**	**4**
12/12/11	Water Flea Survival	100	>100	>100	<1	1
12/12/11	Water Flea Reproduction	100	>100	>100	<1	1
12/12/11	**Sea Urchin Fertilization**	**25**	**50**	**>63.2**	**<1.6**	**4**
1/21/12	Water Flea Survival	100	>100	>100	<1	1
1/21/12	Water Flea Reproduction	100	>100	>100	<1	1
1/21/12	Sea Urchin Fertilization	63	>63	>63	<1.6	1.6

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.

[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).

[d] Acute toxicity units = 100/LC_{50} or EC_{50}.

[e] Chronic toxicity units = 100/NOEC.

Table 31. Toxicity of Wet Weather Samples Collected from the City of Long Beach Los Cerritos Channel Station during the 2011/2012 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Date	Test	Test Response (% sample)			TU$_a$[d]	TU$_c$[e]
		NOEC[a]	LOEC[b]	Median Response[c]		
10/6/11	Water Flea Survival	100	>100	>100	<1	1
10/6/11	Water Flea Reproduction	100	>100	>100	<1	1
10/6/11	**Sea Urchin Fertilization**	**6.25**	**12.5**	**>58.7**	**<1.7**	**16**
11/20/11	Water Flea Survival	100	>100	>100	<1	1
11/20/11	Water Flea Reproduction	100	100	>100	<1	1
11/20/11	Sea Urchin Fertilization	63.7	>63.7	>63.7	<1.6	1.6
1/21/12	Water Flea Survival	100	>100	>100	<1	1
1/21/12	Water Flea Reproduction	100	>100	>100	<1	1
1/21/12	**Sea Urchin Fertilization**	**25**	**50**	**>58.0**	**<1.7**	**4**
3/17/12	Water Flea Survival	100	>100	>100	<1	1
3/17/12	Water Flea Reproduction	100	>100	>100	<1	1
3/17/12	**Sea Urchin Fertilization**	**<6.25**	**6.25**	**>54.5**	<1.8	**>16**

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.

[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).

[d] Acute toxicity units = 100/LC_{50} or EC_{50}.

[e] Chronic toxicity units = 100/NOEC.

Table 32. Toxicity of Dry Weather Samples from the City of Long Beach Mass Emission Monitoring Sites during the 2011/2012 Monitoring Season.

Test results indicating toxicity are shown in bold type.

Station	Date	Test	Test Response (% sample)			TU_a[d]	TU_c[e]
			NOEC[a]	LOEC[b]	Median Response[c]		
Bouton Creek	9/13/11	Water Flea Survival	100	>100	>100	<1	1
Bouton Creek	9/13/11	Water Flea Reproduction	100	>100	>100	<1	1
Bouton Creek	9/13/11	Sea Urchin Fertilization	66	>66	>66	<1.5	1.5
Los Cerritos	9/14/11	Water Flea Survival	100	>100	>100	<1	1
Los Cerritos	9/14/11	Water Flea Reproduction	100	>100	>100	<1	1
Los Cerritos	9/14/11	Sea Urchin Fertilization	65	>65	>65	<1.5	<1.5
Bouton Creek	5/1/12	Water Flea Survival	100	>100	>100	<1	1
Bouton Creek	5/1/12	Water Flea Reproduction	100	>100	>100	<1	1
Bouton Creek	5/1/12	Sea Urchin Fertilization	64	>64	>64	<1.6	<1.6
Los Cerritos	5/2/12	Water Flea Survival	100	>100	>100	<1	1
Los Cerritos	5/2/12	Water Flea Reproduction	100	>100	>100	<1	1
Los Cerritos	5/2/12	Sea Urchin Fertilization	64	>64	>64	<1.6	<1.6

[a] No Observed Effect Concentration: the highest concentration with a test response not significantly different from the control.

[b] Lowest Observed Effect concentration: the lowest concentration producing a test response that was significantly different from the control.

[c] Concentration causing 50% mortality to water fleas (LC_{50}), 50% inhibition in water flea reproduction (IC_{50}), or 50% reduction in sea urchin fertilization (EC_{50}).

[d] Acute toxicity units = $100/LC_{50}$ or EC_{50}.

[e] Chronic toxicity units = 100/NOEC.

Table 33. Summary of Belmont Pump Station TIE using sea urchin fertilization.

TIE Treatment	Mean Fertilization (%)
Lab Control	95
Baseline Sample	88
25 mg/L EDTA	93
50 mg/L EDTA	94
25 mg/L STS	63
50 mg/L STS	67
Centrifugation	89
C18 Column	92

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DISCUSSION

The following sections discuss the quality of stormwater and dry weather discharges from the mass emission monitoring sites. Concentrations of contaminants measured in both stormwater and dry weather discharges are compared with various receiving water quality criteria. Temporal trends over the past 12 years are examined for principal contaminants of concern. The toxicity of both stormwater and dry weather discharges is evaluated for the current year and general trends are examined over the duration of this permit.

COMPARISON TO WATER QUALITY CRITERIA

Numeric standards are not available for stormwater discharges. For the purpose of this report, water quality criteria or objectives were used to provide reference points for assessing the relative importance of various stormwater contaminants, though specific receiving water studies are necessary to quantify the presence and magnitude of any actual water quality impacts. Ultimately, specific beneficial uses of the receiving water body should be considered when selecting the appropriate benchmarks. Existing, potential and intermittent beneficial uses are provided for the receiving waters associated with each discharge point (Table 34).

Water quality criteria used as benchmarks in freshwater environments are summarized in Table 35. Criteria applicable to saline conditions are summarized separately in Table 36. These reference water quality criteria are useful for screening Event Mean Concentrations (EMCs) generated for most of the major constituents measured as part of this program. The results summary tables (Table 14 through Table 17) also identify various benchmarks that are exceeded for each storm event. Most importantly, these benchmarks are only intended to serve as a tool to assist with the interpretation of the stormwater quality data. Exceedances of these receiving water quality benchmarks do not necessarily indicate impairment. Other factors such as dilution, duration and transformation in the receiving waters must also be considered. Nevertheless they can be extremely useful in screening for analytes that might have greater potential to impact receiving waters and/or warrant more consideration in development of BMPs and implementation of source control strategies.

For comparative purposes, an EMC was considered to be an exceedance if the value was higher than any of the reference or benchmark values. In using these benchmarks, it is important that the source of the specific criterion is considered. For instance, metals concentrations derived from California Toxics Rule (CTR) freshwater criteria for protection of aquatic life are based upon dissolved concentrations and are often a function of hardness. Values listed in Table 35 are based upon a default hardness of 100 mg/L which is consistent with tabulated values provided in the CTR. Evaluation of any possible exceedance of hardness-dependant criterion is based upon the actual hardness EMC for that site and event therefore the criterion will change. Hardness measured during wet weather events is typically far less than 100 mg/L while hardness associated with dry weather events will be substantially higher. For metals with criteria dependent upon hardness, CTR criteria tend to be much higher for dry weather discharges since elevated hardness encountered during the dry season tends to mitigate potential toxicity of these metals. Saltwater objectives listed for metals under the CTR are also based upon dissolved concentrations while those listed under the California Ocean Plan are based upon total recoverable measurements. Although Ocean Plan numbers are used for comparative purposes, the marine and estuarine receiving waters in the vicinity of Long Beach would only be subject to the CTR saltwater values since both Alamitos Bay and San Pedro Bay are considered enclosed bays and estuaries. Water quality criteria provided in the Los Angeles Basin Plan are primarily based upon Title 22 drinking water standards. For two of the key organophosphate pesticides, the only available water quality criteria are those proposed by the California Department of Fish and Game (Siepmann and Finlayson, 2002). UC Davis (Faria et al. 2010; Fojut et al. 2012) has recently provided a series of reports that suggest new acute and chronic water quality criteria for a series of pesticides that include various pyrethroids and organophosphate pesticides. USEPA (2009) National Recommended Water Quality Criteria provide an additional reference for many of the nonpriority pollutants included in the monitoring program.

Both acute and chronic water quality criteria are used in this evaluation. Due to the limited period of discharge, the acute criteria are considered most applicable to stormwater. Dry weather discharges are most appropriately compared against chronic criteria (CCCs or daily maxima).

Wet Season Water Quality

In previous years, the pH of stormwater runoff was noted to be slightly acidic on many occasions. This is mostly due to dissolved carbon dioxide that the rain "scrubs" from the atmosphere. Other gases such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x) can cause further acidification of the rainfall.

The water quality criteria for pH included in the Los Angeles Basin Plan (CRWQCB, Los Angeles, 1994) indicate that surface waters should be maintained in the range of 6.5 to 8.5. During the 2011/2012 wet season, the pH of all stormwater discharges met Basin Plan criteria (Table 14 through Table 17). Although pH measurements in stormwater met the Basin Plan criteria at all sites, this was not always the case. In earlier years of the program about 25% of the stormwater samples had measured pH values that were below the lower Basin Plan limits of 6.5. Due to the acid nature of rainfall, it is unusual to have stormwater with measured pH values greater than the upper Basin Plan limit of 8.5 but a small percentage of stormwater samples (2-5 percent of all events) have exceeded the upper standard of 8.5. Runoff with pH concentrations in excess of 8.5 are attributed to the low buffering capacity (alkalinity) in most stormwater runoff and could reflect inaccuracies that can result from measuring pH in water with low ionic strength. These exceedences have only happened during a few small volume storm events and have not been unique to any one monitoring site.

Although care is taken to get accurate pH measurements, it is well-known that accurate measurements in water with low ionic strength are difficult to obtain due to instability and slow response times. Nevertheless, it is possible that some historical measurements were impacted by this problem. Sensors and measurement techniques for addressing water with low ionic strength have improved over the past decade.

The total coliform, fecal coliform and enterococcus single sample criteria are commonly exceeded at all sites during wet weather sampling events. Grab samples taken for bacteria during storm events most often exceed Basin Plan water quality criteria but also have shown a tremendous degree of variability of time. This can be attributed to both extreme variability that can occur over the course of a storm event and even extreme short term variability that is common when taking field duplicates. A graphical comparison of bacterial concentrations measured at each site during all storm events through the course of the season (Figure 40) shows high variability and concentrations that generally decrease through the storm season. Although the variation is substantial, overall concentrations of FIBs in stormwater average about 10^4 mpn/100 ml for both *Enterococcus* and fecal coliform. Total coliform concentrations average roughly an order of magnitude higher or 10^5 mpn/100 ml.

Over the past 12 years, five total recoverable metals including aluminum, copper, iron, lead and zinc have frequently exceeded benchmark reference values. One of these five metals, iron, is only listed as a ***chronic*** criterion on the National Non Priority Pollutant list for freshwater. Criteria for total recoverable aluminum exist for drinking water (Basin Plan criteria) and aquatic life as a nonpriority pollutant (Table

35). Both total recoverable aluminum and iron are abundant in soils and often used to normalize other metals data to better evaluate enrichment from anthropogenic activities. Elevated levels of both iron and aluminum are normal during storm events with increased loads of sediment and are not typically considered to be a major concern.

Concentrations of total recoverable copper, lead, and zinc measured in runoff from the mass emission sites exceeded Ocean Plan criteria in nearly 100% of the storm events. Total recoverable concentrations of three metals (copper, lead and zinc) have frequently exceeded Ocean Plan criteria over the past ten years of the stormwater monitoring program. Only one of these metals, total lead, was measured below Ocean Plan criteria during the fourth storm event monitored in Bouton Creek. Previous reports have shown very strong relationships between TSS concentrations and all three of these total metals. Total recoverable lead concentrations have always shown the strongest association with TSS concentrations.

Among the conventional pollutants, Methylene Blue Active Substances (MBAS) was found to slightly exceed the Basin Plan criterion of 0.50 mg/L during the first storm event of the season at both the Belmont Pump Station and the Los Cerritos Channel. This indicator of detergents generally declined through the storm season. Car washing and illicit disposal of washwaters in stormdrains are the most likely sources of these contaminants.

In 1993 (USEPA, 1993) EPA recognized that, in most cases, measurement of metals in the dissolved form provided the most accurate assessment of potential stress to aquatic ecosystems. As a result water quality criteria promulgated by EPA as the “California Toxics Rule” (CTR; USEPA, 2000) were based upon the dissolved fraction for both freshwater and saltwater. In the case of freshwater, criteria for six of the eight metals included in the monitoring are functions of hardness. Low concentrations of hardness lead to low water quality criteria. With increasing hardness, toxicity decreases and the water quality criteria for these six metals increase. The saltwater criteria included in the CTR are applicable in bays and estuaries of California.

Dissolved copper exceeded the CTR acute freshwater criteria in 72% of the stormwater samples this wet season. The fourth storm events at the Belmont Pump Station and Bouton Creek and both storm events at the Dominguez Gap monitoring site were the only cases where dissolved copper concentrations were below the CTR acute freshwater criteria. Discharges from the two Dominguez Gap stormwater monitoring events were again found to have the best water quality associated with any of the sites. All metals were below CTR acute freshwater criteria and copper was the only metal to exceed CTR acute saltwater criteria at this location. As with many other constituents, dissolved zinc concentrations were highest during the first one or two storm events. This was most evident at the Belmont Pump Station and Bouton Creek sites where later season events met both the freshwater and saltwater criteria.

The Los Cerritos Channel monitoring site is subject to a wet weather TMDL based upon total recoverable copper, lead and zinc. The TMDL established concentration limits at 9.8 µg/L copper, 55.8 µg/L lead and 95.6 µg/L zinc (Table 37). Lead remained well below TMDL limits but both copper and zinc exceeded TMDL limits during each of the four storm events. Copper loads were exceeded by a factor of 1.9 to 8 times the limit while zinc loads were by a factor of 1.4 to 5.9 times the limit.

Chlorinated pesticides continue to be uncommon in stormwater runoff from the mass emission sites. When detected, concentrations of detected compounds have typically been low (less than 10 times the reporting limit). Although largely banned or restricted throughout the industrialized nations, these legacy pesticides persist in the environment. Chlorinated pesticides are hydrophobic, lipophilic and very stable. Due to the hydrophobic nature of these compounds, chlorinated pesticides strongly associate with suspended solids which settle and accumulate in bottom sediments. Throughout the program organochlorine pesticides most often detected in stormwater runoff have been DDT compounds, primarily 4,4'-DDE, and chlordane compounds. This year the organochlorine pesticides were limited to low concentrations of alpha-chlordane and gamma-chlordane detected in runoff from the second storm event at the Belmont Pump Station and a detection of trans-nonachlor at levels between the MDL and RL during the first Belmont Pump Station storm event. Each of these compounds are components of technical chlordane that has commonly been detected at this location

Technical chlordane, another organochlorine compound, is a complex mixture of approximately 140 compounds but NOAA considers seven compounds as representative of the major components of technical chlordane. These include alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, heptachlor, heptachlor epoxide and oxychlordane. During the 2008/2009 storm season, chlordane was detected in 70% of the stormwater composites including all three monitored events at the Belmont Pump Station. Despite being completely banned for over 20 years, chlordane was detected at 0.336 µg/L during the first monitored event of the2008/2009 monitoring season at the Belmont Pump Station. This was the highest concentration measured at any monitoring station since the program was initiated 12 years ago. During the 2009/2010 season, the highest concentrations of chlordane compounds (0.308 µg/L) were once again measured in runoff from the Belmont Pump Station. The low levels of chlordane or chlordane compounds (0.031 µg/L of alpha-chlordane and gamma-chlordane) measured in just one of four stormwater samples from this site suggests that residuals or residual uses of these compounds in the watershed are on the decline.

The banning of residential, nonprofessional use of diazinon and chlorpyrifos resulted in these contaminants no longer being measureable in most stormwater samples from City of Long Beach stormwater monitoring program. Lower detection limits were implemented in the middle of the 2010/2011 monitoring season. The detection limits for chlorpyrifos dropped from 0.05 µg/L to 0.002 µg/L and the detection limits for diazinon dropped from 0.01 µg/L to 0.0015 µg/L. This has resulted in increased numbers of detections but still very few cases where either compound exceeded the benchmark concentrations. Chlorpyriphos was detected in two of four samples from the Los Cerritos Channel, one of four samples from Bouton Creek and two of four samples from the Belmont Pump Station. One of the samples from the Belmont Pump Station had a chlorpyrifos concentration of 0.055 µg/L which exceeded the acute criterion suggested by the California Department of Fish and Game (0.012 ug/l; Siepmann and Finlayson, 2002). This sample exhibited significant initial toxicity using the sea urchin fertilization test. This toxicity later diminished during baseline testing for the TIE. Diazinon was detected in only two of the 14 stormwater samples from the 2011/2012 season. Diazinon was present below the detection limit in one of these samples and was measured at 0.018 µg/L in the other. Both measurements remained well below available criterion (0.08 µg/L; Siepmann and Finlayson, 2002). As will be discussed further below, the near elimination of these pesticides in stormwater discharges has resulted in substantial decreases in toxicity to *Ceriodaphnia* but pesticides being used in lieu of the organophosphates have introduced alternative problems.

Malathion, another organophosphate pesticide used as a residential pesticide, continues to be common in stormwater samples. Malathion is far less toxic to daphnids with reported LC_{50}s ranging from 1.14 to 3.18 µg/L (TDC, 2003). With both diazinon and chorpyrifos being taken off the shelves, detection of malathion in stormwater samples initially became more common. Since the 2006/2007 season, malathion has also tended to occur in fewer samples. This season, just two of the samples had detectable quantities of malathion. The highest concentration of malathion was encountered in the January 21, 2012 sample from the Belmont Pump Station (0.49 µg/L). This exceeded the California Department of Fish and Game suggested chronic criterion of 0.43 µg/L but, more importantly, this sample exceeded the UC Davis (Faria et al. 2010) proposed new acute criterion of 0.17 ug/L and chronic criterion of 0.028ug/L. Malathion was detected at the Dominguez Gap pump station during the first storm event but the measured values (0.13 µg/L) was below the new acute standard proposed by UC Davis. In most prior years, concentrations were highest during early season events with concentrations decreasing substantially later in the season. It was unusual to encounter a single elevated value during the final monitored event of the year. None of the reported concentrations were high enough to be expected to exert a toxic response in the *Ceriodaphnia* (waterflea) bioassay tests.

Pyrethroid pesticides have largely replaced diazinon and chorpyrifos for pest control in the urban environment. These pesticides are known to be highly toxic with several compounds causing a toxic response to *Hyalella* at levels as low as 0.002 µg/L. Pyrethroids were not added to the analytical suite until mid season during the 2010/2011 season. Many of the pyrethroids were measured at concentrations that would be expected to cause toxicity to *Hyalella* or *Americamysis* but generally low enough that *Ceriodaphnia* would not be expected to show impacts (Table 38). In addition, Yang et al. (2006) have shown that suspended solids can inhibit toxicity since pyrethroids would tend to partition with the solids and not be bioavailable. Since these compounds are highly hydrophobic, they are best known for the toxicity that they exert on the benthos. These compounds are more known for toxicity in sediments. Although they typically have a half-life in water that ranges from days to months, it is expected that they may persist much longer in the sediments. Recently, Lao et al. (2010) identified the presence of pyrethroid pesticides in sediment sampled in the Ballona Creek Estuary. Levels measured in the sediments were considered sufficient to have caused observed toxicity to *Eohaustorius* which is an amphipod common in marine and estuarine environments.

Dry Season Water Quality

With the exception of organophosphate pesticides, water quality of dry weather discharges has not changed substantially since the start of the program in early 2000. Dry season water quality has not tended to vary greatly between sites or sampling dates. The most significant changes continue to be decreases in the volume of dry weather discharges including the elimination of dry weather flow at the Belmont Pump Station. The location for monitoring dry weather discharges in Bouton Creek site was relocated 1,250 feet upstream due to low flows making sampling impossible for a period of two years. Flows at this site reached a point where they were not sufficient to clear the saltwater from the channel such that samples could be taken that accurately represented the dry weather flow.

All pH measurement taken at the Bouton Creek and Los Cerritos Channel sites exceeded the upper limit of 8.5 established in the Basin. Extensive testing was conducted in the Los Cerritos Channel last year that demonstrated natural cycling of pH in any shallow, low flow channel with the presence of algae. The only practical ways to control these fluctuations would be to enclose the channel or eliminate flow during the dry seasons. Enclosure of the channels would impact bacterial concentrations by eliminating the sanitizing effects of sunlight that help to control bacteria concentrations.

This is the third year of dry weather monitoring at the Dominguez Gap Pump Station. Although dry weather discharges now occur at the Dominguez Gap Pump Station, the water originates from the Los Angeles River. Discharges were observed only during the second dry weather survey conducted on April 30-May 1, 2012.

It is notable that, since reconfiguration of the wetland system, very few of the constituents measured in dry weather discharges at the Dominguez Gap Pump Station, including bacteria, were found to exceed any of the available water quality benchmarks in all four surveys. With the exception of pyrethroid pesticides, all organic constituents (aroclors, chlorinated pesticides, and organophosphate pesticides) were below detection limits. Most pyrethroid pesticides, which were monitored for the first full season this year, were below very low project detection limits but bifenthrin was detected at low levels (less than three time the reporting limit) in both Los Cerritos Channel dry weather samples and in one of the Bouton Creek samples. Bifenthrin was present in the dry weather sample from the Dominguez Gap Pump Station but concentrations were below the reporting limit. Cyfluthrin and cypermethrin were only detected in one of the Los Cerritos Channel samples and both were below quantification limits.

Attainment of dry weather TMDL objectives were reviewed in both the Los Cerritos Channel and the Los Angeles River. The copper dry-weather loading capacity (TMDL) for Los Cerritos Channel was established based upon the following calculation: 19.1 µg/L X 2.35 cfs X 0.00539 (conversion factor) = 0.242 lbs/day or 109.7 grams/day. The TMDL objectives are expressed as total recoverable metals.

Dry weather flows have dramatically declined in recent years presumably due to better water conservation efforts. Flow measurements associated with the first dry weather storm event were lost due to vandals breaking into our field truck. A significant amount of equipment was removed from the vehicle along with all of the log books. The average flow measured during the last five visitations (0.36 cfs) to this site was used in order to assist in estimation of loads for the September event. Measured flows during May survey were 0.34 cfs. Total concentrations of copper were 18 µg/L during the September survey and 20 ug/L during the May survey. Although both values were near the concentration limit of 19.1 µg/L, the substantial and sustained decreases in dry weather flows resulted in loads of 21 and 23 grams/day or just 17-18% of the TMDL.

The Los Angeles River Metals TMDL established concentration-based targets at 23 µg/L for total recoverable copper and 12 µg/L for total recoverable lead at the downstream Wardlow monitoring site during dry weather. A summary of all dry weather monitoring data from the Dominguez Gap Pump Station for these metals (Figure 41) shows consistently low concentrations of copper, lead and zinc in both the total recoverable and dissolved forms. Concentrations of these metals in Dominguez Gap Pump Stations dry weather discharges have also remained lower than measurements made within the Los Angeles River by the Coordinated Monitoring Program. This indicates that the wetland system is has very effective in removing these metals.

Low concentrations of suspended solids are the primary characteristic of dry weather discharges. Discharges sampled during all dry weather surveys had TSS concentrations ranging from 8.4 to 22 mg/L. In general, these low concentrations of suspended particulates result in total recoverable metal concentrations that meet all water quality criteria. Trace metals associated with dry weather discharge have predominantly been in the dissolved form largely due to lower concentrations of suspended solids. Total recoverable copper is the only metal typically found to exceed Ocean Plan water quality criteria that are based upon total metals. This year the Ocean Plan criterion for copper was only exceeded in Los Cerritos Channel dry weather discharges. This year the CTR chronic saltwater criterion was exceeded during all dry weather surveys at Bouton Creek and in the Los Cerritos Channel.

Another important characteristic of dry weather discharges is the hardness of these discharges. Hardness as $CaCO_3$ is consistently elevated in dry weather flows from the mass emission sites. Hardness concentrations measured in dry weather samples this season ranged from 99 to 260 mg/L. Both the lowest and highest hardness values occurred in water from Bouton Creek. Hardness tends to mitigate the effects of the dissolved metals (Table 26 through Table 28) resulting in very few water quality exceedances for most metals. Dissolved copper is the only metal that commonly exceeds water quality criteria during dry weather periods. These exceedences are limited to Bouton Creek and the Los Cerritos Channel.

The pH of dry weather flows exceeded the upper Basin Plan criterion of 8.5 during one survey at both the Los Cerritos Channel and Bouton Creek. Occurrences of elevated pH in dry weather discharges within shallow open concrete channels appear to be both common and part of a natural process associated with photosynthetic activity (Kinnetic Laboratories, Inc., 2005 – Appendix B; Kinnetic Laboratories, Inc., 2011 – Appendix D). Evidence suggests that pH initially increases during the day. Algae, that are very abundant in the channels, during the summer, consume carbon dioxide (CO_2) while undergoing photosynthesis. High photosynthetic activity is typically evident in the form of the high concentrations of dissolved oxygen in the water as well as visual evidence of bubbles being generated as the water becomes oversaturated from oxygen. The removal of CO_2 from the water causes bicarbonate and carbonate ions to react with hydrogen ions (H^+) to form more CO_2. The loss of H^+ from the water causes the pH to increase during daylight hours. During the night, respiration of the algae and bacteria in the channel cause CO_2 to be released and oxygen to be consumed. This causes a corresponding drop in pH during the night. This diurnal cycling of pH is a common occurrence in open waterways with shallow, sluggish flow. The process is further influenced by the alkalinity or buffering capacity of the water such that high alkalinity water should be expected experience less extreme diurnal changes in pH.

As in all previous years, copper remains the primary constituent of concern in dry weather discharges although it has been uncommon for dissolved copper to exceed the CTR freshwater criterion at most stations due to the elevated hardness of dry weather discharges. Dissolved copper in dry weather discharges from the Los Cerritos Channel exceeded the CTR freshwater criterion during both dry weather surveys. The CTR saltwater criterion of 3.1 µg/L was exceeded during all surveys in Bouton Creek and the Los Cerritos Channel (Table 26, Table 27).

The recent TMDL for metals in the freshwater portion of the Los Cerritos Channel (USEPA 2010) set a dry weather target of 19.1 µg/L for total copper. This was exceeded only during the May, 2012 survey when total copper was reported as 20 µg/L.

The 30-day average ammonia-N criterion was not exceeded during both of the dry weather surveys conducted this year at all three sites. For the Dominguez Gap Pump Station, calculation of the criterion was based upon use of instantaneous temperature and pH measurement taken at the site during daylight hours. For Bouton Creek, a 30-day average temperature derived from an in-situ thermistor was used along with a single point measure of pH. Calculations of the ammonia-N criteria at the Los Cerritos Channels used data from a point measurement for pH and temperature.

Most pyrethroids were not detected in dry flows. None were detected at the Dominguez Gap Pump Station. Bifenthrin was the only pesticide in this group that was detected above the reporting limits. Bifenthrin was detected at 1.6 ng/L during the first Bouton Creek survey only. Bifenthrin was present in both dry weather surveys in the Los Cerritos Channel (3.4 and 4.1 ng/L). Two other pyrethroid compounds were identified present in water from the Los Cerritos Channel at levels between the Method Detection Limit (MDL) and the reporting limit.

TEMPORAL TRENDS OF STORMWATER POLLUTANTS

Temporal trends in concentrations of selected trace metals, one organophosphate pesticides, TSS and bacteria have been tracked since the first dry weather surveys conducted in 2000. Time series plots of these contaminants are provided in Appendix C. Separate time series are presented for dry and wet weather. The metals and organic compounds included in this assessment are those that are 1) often detected in both stormwater and dry weather discharges and/or 2) are suspected to be primary sources of toxicity. Time series graphics were developed for total and dissolved concentrations of three trace metals: copper, lead and zinc. Due to the typically large differences between total and dissolved concentrations, separate graphics are included to detail changes in dissolved forms over time. In addition, graphics were developed for malathion during the wet season. Malathion started to show up in higher concentrations soon after diazinon and chlorpyrifos were no longer available in local home and garden shops.

In previous reports, diazinon and chlorpyrifos were among the few data to clearly show significant decreases in concentration over time. The highest concentration of diazinon measured this past year was 0.0058 µg/L from one event at Bouton Creek. All measured concentrations were well below the CDF&G aquatic life criterion of 0.08 µg/L. Chlorpyrifos was detected at a concentration of 0.055 µg/L in one stormwater sample from the Belmont Pump Station but all other detections were less than 0.008 µg/L. Long-term graphics were discontinued for these two compounds this year since both have demonstrated such significant declines. These two organic compounds are still detected on occasions indicating that they are still being used in some residential areas but even these occasional hits are expected to further decrease as stored products become depleted. Furthermore, when detected, these two organophosphate pesticides are typically not present in concentrations expected to exert toxic responses to bioassay test species.

Most long-term trends tend to be obscured by factors that are not evident when exclusively looking at changes in concentrations. Unlike the abrupt decline in diazinon and chlorpyrifos that was occurred soon after removing these pesticides from the market, changes have been relatively gradual. In some cases, it has taken a full decade to observe clear visual trends based upon the long-term graphics in Appendix C.

- No trends are evident in the concentrations of total and dissolved copper measured at each site during either wet or dry weather.
- Concentrations of both total and dissolved lead have decreasing slowly at all sites since the start of the stormwater program in 2000.
- Although changes are not as distinct, total and dissolved zinc show some signs of decreasing particularly in the Los Cerritos Channel.
- Malathion, another organophosphate pesticide, showed signs of increasing at the Belmont Pump Station but concentrations are now typically below the proposed acute criterion proposed by UC Davis.
- The frequent detection of elevated concentrations of malathion have predominately occurred in the Belmont Pump Station and, to a lesser degree, in the Los Cerritos Channel subwatersheds. This pesticide was only elevated in a single sample from the Bouton Creek subwatershed and in three samples from the Dominguez Gap Pump Station subwatershed.
- Fecal indicator bacteria (FIB) typically exceed Basin Plan water quality criteria during wet season monitoring and show no evidence of increasing or decreasing contamination. Lower concentrations of fecal indicator bacteria are present in dry weather discharges (Appendix C). As a general rule, concentrations of FIBs measured in dry weather flows occasionally meet water quality criteria.
- Fecal indicator bacteria measured in dry weather flows at the Los Cerritos Channel site are now showing signs of decreasing. Total coliforms, fecal coliforms, and entercoccus are trending lower are more frequently meeting water quality objectives during dry weather monitoring.
- In contrast, FIBs at the Bouton Creek site, particularly total and fecal coliform, are consistently exceeding water quality criteria compared to historical measurements that met objectives about 50% of the time.

- The changes in FIBs measured during dry weather surveys suggest that the lower flow rates in the Los Cerritos Channel are providing more time for exposure to the effects of UV light while the opposite is true in Bouton Creek. The new site is located at the point where flows are emerging from an enclosed conveyance and thus have less exposure to UV light.
- The first five dry weather monitoring events conducted at the Dominguez Gap Pump Station all had FIB concentration that were below applicable water quality criteria.
- Long term trends at the Dominguez Gap Pump Station are currently difficult to assess. Over the first six to seven years of the monitoring effort stormwater discharges at the Dominguez Gap Pump Station were uncommon and, when they occurred, concentrations of TSS and metals were among the lowest encountered at the four mass emission sites. Some of the highest concentrations of TSS, metals and other contaminants occurred during storm events monitored when the wetland treatment system was under construction or not well developed. Since that time, water quality appears to be continually improving and further improvements are expected as operational aspects of the basin are improved.

Although the Dominguez Gap Pump Station and associated wetlands have shown significant Improvement the potential exists to further improve water quality and have fewer discharges (Figure 42 through Figure 44). Water levels in the wetlands during the early part of the season were largely controlled to prevent discharges during storm events. Water levels were slowly being brought down to just of 7 feet in late October prior to a few small storm events. By mid-November, water levels in the sump had slowly increased until reaching 9 feet. At that level, a rainfall event of only 0.5 inches caused water levels to increase to the level necessary to trigger the main pumps. After this event water levels in the basin were slowly dropped to approximately 6.5 feet at which time a storm event occurred that yielded 1.02 inches. This storm event was fully contained but another small storm occurred several days later yielding 0.21-0.30 inches was nearly enough to automatically trigger the pumps. The water level was manually pumped down before triggering the main pumps. Over a period of several weeks in late December and early January, water levels were brought down to 7 feet before slowly being allowed to increase to nearly 8.5 feet. Two storm events occurred in rapid succession that yielded approximately an inch of rain but the system was again able to contain the discharge. By approximately February 20th, 2012, water level within the sump again reached 7 feet. During the next 30 days, water levels slowly rose to a depth of roughly 8.5 feet before another storm event caused levels in the sump to reach 10.8 feet. Ideally the basin would have been pumped down toward a level of 7 feet after a period of four the five days. This would have been sufficient to provide capacity for the following storm event that yielded over an inch. Several pump downs occurred after the late March storm but they were not sufficient to prevent discharges from the second of two closely spaced storm events. The ultimate objective for this site is to continue to improve the capacity available for stormwater during the wet season, maximize retention time for both infiltration and settling while still assuring that the wetland habitat is maintained. We are continuing to work with the Los Angeles County Department of Public Works in order to reach a common ground as to maintenance practices that will balance both wetland and stormwater benefits in accordance with the EIR.

SPATIAL DIFFERENCES IN CONCENTRATIONS OF FIBS, TSS AND TRACE METALS

Box plots were used to visually compare the distribution of fecal indicator bacteria, total suspended solids, and both total recoverable and dissolved forms of key trace metals (Figure 45 through Figure 47). The water quality associated with discharges from the Dominguez Gap Pump Station has remained consistently better than all other mass emission sites. Statistical tests conducted in association with last year's annual report provided the first solid evidence that the quality of water discharged during storm events from the Dominguez Gap Pump Station is significantly better than all other sites with one exception. Lead in Bouton Creek stormwater discharges was also low and found to be similar to that achieved at the Dominguez Gap Pump Station.

Box plots were also used to compare the relative distribution of pyrethroid pesticides among stations (Figure 48). All data from both the 2010/2011 and 2011/2012 seasons were combined. The results show all seven pyrethroids to be most abundant in the Belmont Pump Station subwatershed and, to a lesser degree, in the Los Cerritos Channel subwatershed. Both Bouton Creek and Dominguez Gap had measurable concentrations but were consistently far less than other two sites.

TOXICITY

The following sections address toxicity as expressed during both dry and wet weather periods, examine long-term (between years) and short-term (within seasons) trends, provide a comparison with toxicity in other Southern California areas, and examine sources of toxicity.

Stormwater Toxicity

Four wet weather samples from the Belmont Pump, Bouton Creek and Los Cerritos Channel stations were analyzed for toxicity during the monitoring period. Five storms were collected over a period of six months. The first storm of the season occurred in October 2011 and the fifth storm was sampled in March of 2012. All three stations were sampled during the first, second and the fourth storms. Belmont Pump and Bouton Creek were sampled during the third storm and only Los Cerritos Channel was sampled during the fifth storm. All twelve of those samples were tested with water fleas and sea urchins (24 total bioassays).

None of the samples tested exhibited measurable toxicity to water flea survival or reproduction. NOECs for all stations were 100% sample (1 TU_c) and LC_{50}s/IC_{50}s were >100% sample (<1 TU_a). Urchin tests exhibited toxicity that was significantly higher than the controls in three of four storms at each station but only one met the criteria for performing a TIE. The single TIE was performed on water from the January 2012 storm event at the Belmont Pump station.

Dry Weather Toxicity

Dry weather toxicity tests are limited to the Bouton Creek and Los Cerritos Channel sites. Testing of discharges from the Belmont Pump station has not been conducted since 2009 when a low flow diversion system was first installed to direct dry weather flows to the sanitary sewer.

Neither the September 2011 nor the May 2012 dry weather samples from Bouton Creek and the Los Cerritos Channel produced measurable lethal toxic responses based upon water flea survival or reproduction. Similarly, there was no measureable decrease in sea urchin fertilization associated with any of the four dry weather samples. NOECs ranged from 64% to 66% (<1.5 to 1.6 TU_c) indicating that no decreased fertilization was observed at the highest concentrations that can be tested.

Historical Toxicity Trend

Historical trends are summarized in Figure 49 through Figure 52. Figure 50 and Figure 52 summarize chronic toxicity of stormwater to sea urchin fertilization and water flea reproduction, respectively, throughout the twelve years of the City's monitoring program. Figure 49 and Figure 51 provide similar summaries of dry weather chronic toxicity for urchins and water fleas, respectively.

Sea urchins have shown more instances of moderate to high (>8 TUc) wet weather toxicity than have water fleas (Figure 50 and Figure 52). Episodes of high urchin toxicity have occurred with approximately equal frequency at all three stations, beginning with the 2000/2001 monitoring program and continuing through 2008/2009 and again in the 2011/2012 season. No such episodes occurred during either the (2010/2011) or the (2009/2010) monitoring programs.

Figure 52 shows a virtual absence of wet weather water flea toxicity after the 2001/2002 storm season at all three stations, except for sporadic episodes of minor to moderate reproductive effects in 2004/2005 and 2006/2007. In the 2008/2009 program, instances of elevated reproductive toxicity were attributed to statistical artifacts due to very low within-test variability. Data from the 2009/2010 and continuing into the 2011/2012 monitoring programs continues to show that water flea toxicity is almost undetectable in wet weather samples.

Dry weather samples were negligibly toxic to both species (Figure 49 and Figure 51) in water collected from Belmont Pump in all study years. With the exception of the 2002/2003 program, sea urchins have shown little dry weather toxicity at the Bouton Creek site. Some of the *Ceriodaphnia* toxicity observed in Bouton Creek dry weather samples between 2003 and 2005 can probably be attributed to elevated sample salinity since dry weather flows have been declining and contribute to tidal exchanges having greater influence on the samples. The relocation of the Bouton Creek site to a site 1000 feet further upstream was designed to decrease the influence of marine waters on dry weather discharges. Water from the Los Cerritos Channel exhibited elevated toxicity in spring and fall samples of the 2007/2008 program and in the spring of 2008/2009. Minor inhibition of fertilization was observed in the dry weather discharges from Bouton Creek taken in the fall of 2009/2010 and during dry weather sampling during the fall of 2010/2011 at both the Bouton Creek site and in the Los Cerritos Channel.

Temporal Toxicity Patterns

There was some suggestion in the toxicity data from early monitoring periods that seasonal flushing may have been a factor affecting the variability in stormwater toxicity. Early years of the program suggested that *Ceriodaphnia* toxicity was usually somewhat elevated in early versus late storms, but this pattern has not been evident in recent years. Toxicity to sea urchins has varied widely over the storm seasons at each of the three stations. Figure 50 shows that stormwater samples exhibiting urchin toxicity of 16 TU_c or more have been encountered throughout the storm season. There has been little toxicity to either species over the past two storm seasons.

Thus the initial suggestions that seasonal flushing significantly affects stormwater toxicity is not strongly supported by more recent water flea and sea urchin data test data. Although early season toxicity was not evident in the bioassays, the concentrations of dissolved metals are clearly elevated and would have been expected to cause toxicity (Figure 53 and Figure 54). This suggests that toxicity may be mitigated by unknown factors.

Comparison of Relative Toxicity of Stormwater in Southern California

Table 40 compares the frequency and magnitude of toxicity to sea urchin fertilization from the Long Beach stations in 2011/2012 with that of stormwater samples from Long Beach in previous years and with toxicity in other southern California watersheds (Los Angeles and San Gabriel Rivers, Ballona and

Cholla Creeks). Current data disrupts the recent trend towards decreasing frequency and magnitude of Long Beach stormwater toxicity to sea urchins with a 75% of the stormwater samples having some measurable toxicity.

A decreasing trend is evident in the frequency of toxicity to water fleas (Table 39) with no toxicity seen in the 2011/2012 season. In 2010/2011 toxicity associated with the water flea tests was only slightly elevated from the low level seen in the 2009/2010 season, opposing the trend towards higher frequency of toxicity seen in the 2007/2008 and 2009/2009 monitoring years. The magnitude of toxic response was low continuing the trend toward reduction in magnitude seen in the previous six monitoring periods. The spike in magnitude seen in December of 2008 was judged to be artificial, due to unusually high test sensitivity during that test episode.

We might expect results from the Chollas Creek and Ballona Creek to be similar to Long Beach results, as these samples were obtained from smaller highly urbanized watersheds, relative to the samples from the Los Angeles and San Gabriel Rivers. The Chollas/Ballona Creek sea urchin data (Table 40) show frequency of toxicity ranging from 85-100%, suggesting comparability for Long Beach samples from the first two monitoring periods. Sea urchin toxicity data from similar studies in the Los Angeles River, San Gabriel River and Ballona Creek indicated an absence of toxicity during the period of 2009 through 2011. Data from the 2011/2012 season are not available for comparison at this time. Samples taken from the Long Beach monitoring sites during the 2009 to 2011 time period indicated similar trends of decreasing frequency and magnitude of toxicity.

Table 40 summarizes Long Beach water flea toxicity data from the past 11 years as well as similar data from monitoring conducted in the Los Angeles and San Gabriel Rivers, Ballona Creek and Chollas Creek. All Southern California sites have shown a general decrease in both the frequency and magnitude of reproductive toxicity over time. This has been clearly associated with elimination of diazinon and chlorpyrifos as pesticides for use in residential applications.

Toxicity Characterization

During the current monitoring period, the sea urchin fertilization test indicated toxicity in one of the Belmont Pump Station at a level that warranted further testing with a TIE. The acute TU was 3.5 with an EC_{50} of 28.3%. The results of the TIE were inconclusive but implicated metals as the primary toxicant

One method used to evaluate the importance of key toxicants is the comparison of the measured and predicted toxic units of the samples. This comparison was performed on all samples for both the water flea and sea urchin fertilization test regardless of whether a TIE was required. Expected water flea toxicity was calculated based upon LC_{50}s for zinc, chlorpyrifos and diazinon (Figure 53). Earlier testing implicated these analytes as the primary toxicants contributing to mortality and reproduction. Expected toxicity for sea urchins was calculated based upon EC_{50} data for zinc and copper (Figure 54). Similarly, these two metals are often implicated as the primary toxicants affecting sea urchin fertilization.

The predicted acute toxicity of the sample is calculated from the measured concentrations of the chemical constituents and their corresponding EC_{50} or LC_{50}. Similar analyses of the characteristics of toxicity in the early years of this program demonstrated good correlations with the chemical data. In this most recent year, measured concentrations of all relevant toxicants failed to routinely explain the occurrence of toxicity. This lack of correlation was only observed in the sea urchin fertilization tests (Figure 54). The concentrations of dissolved zinc during the first-flush monitoring event indicate that we should have encountered toxicity. In contrast, actual toxicity encountered in the Belmont Pump Station samples from the January 21, 2012 storm event indicated the presence of toxicity not predicted by the typical contaminants. Thus, chemical concentrations no longer appear to match observed toxic responses or lack thereof.

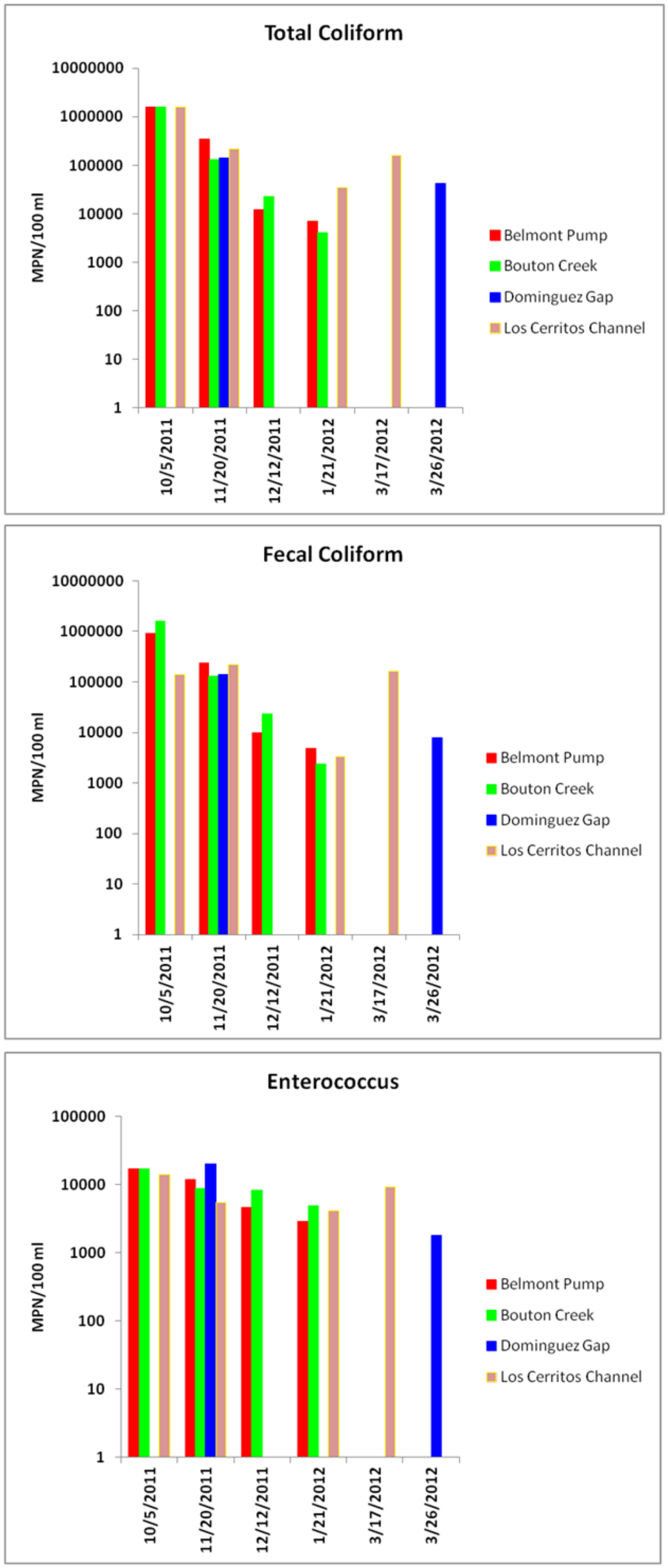
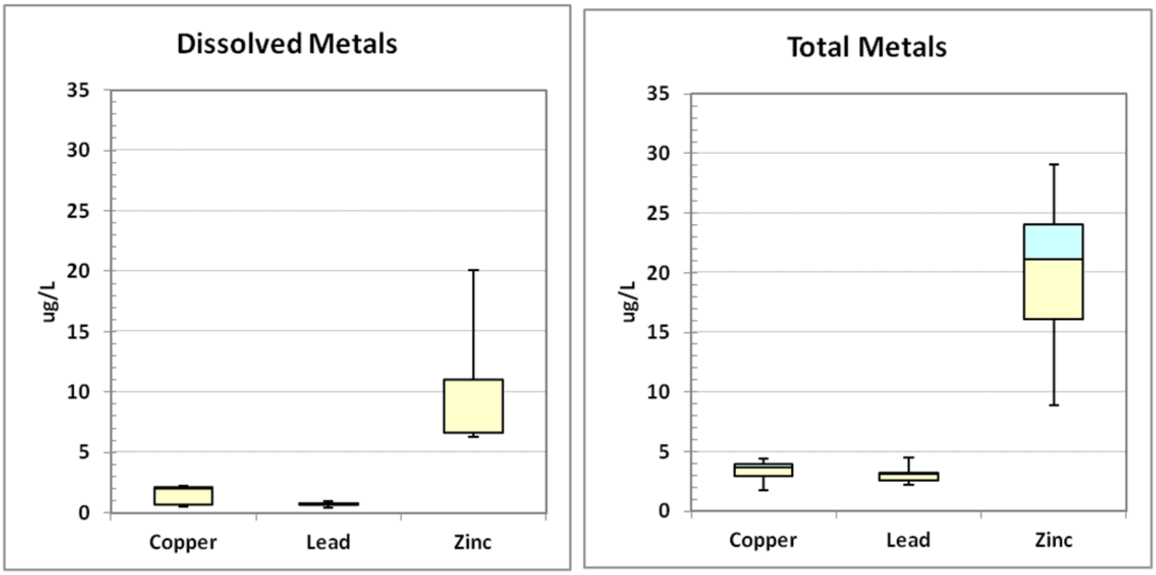


Figure 40. Column Plots of Fecal Indicator Bacteria Concentrations by Date and Location.



Total Metals	*Total Copper*	*Total Lead*	*Total Zinc*
Mean	3.6	3.4	24.7
Standard Deviation	0.8	1.0	4.0
Minimum	2.9	2.5	21.0
Median	3.6	3.2	24
Maximum	4.4	4.5	29
Dissolved Metals	*Dissolved Copper*	*Dissolved Lead*	*Dissolved Zinc*
Mean	1.5	0.67	11.0
Standard Deviation	0.8	0.2	5.5
Minimum	0.5	0.39	6.3
Median	2.0	0.7	11
Maximum	2.2	1.0	20

Figure 41. Total Recoverable and Dissolved Copper, Lead and Zinc in Dry Weather Discharges from the Dominguez Gap Pump Station.

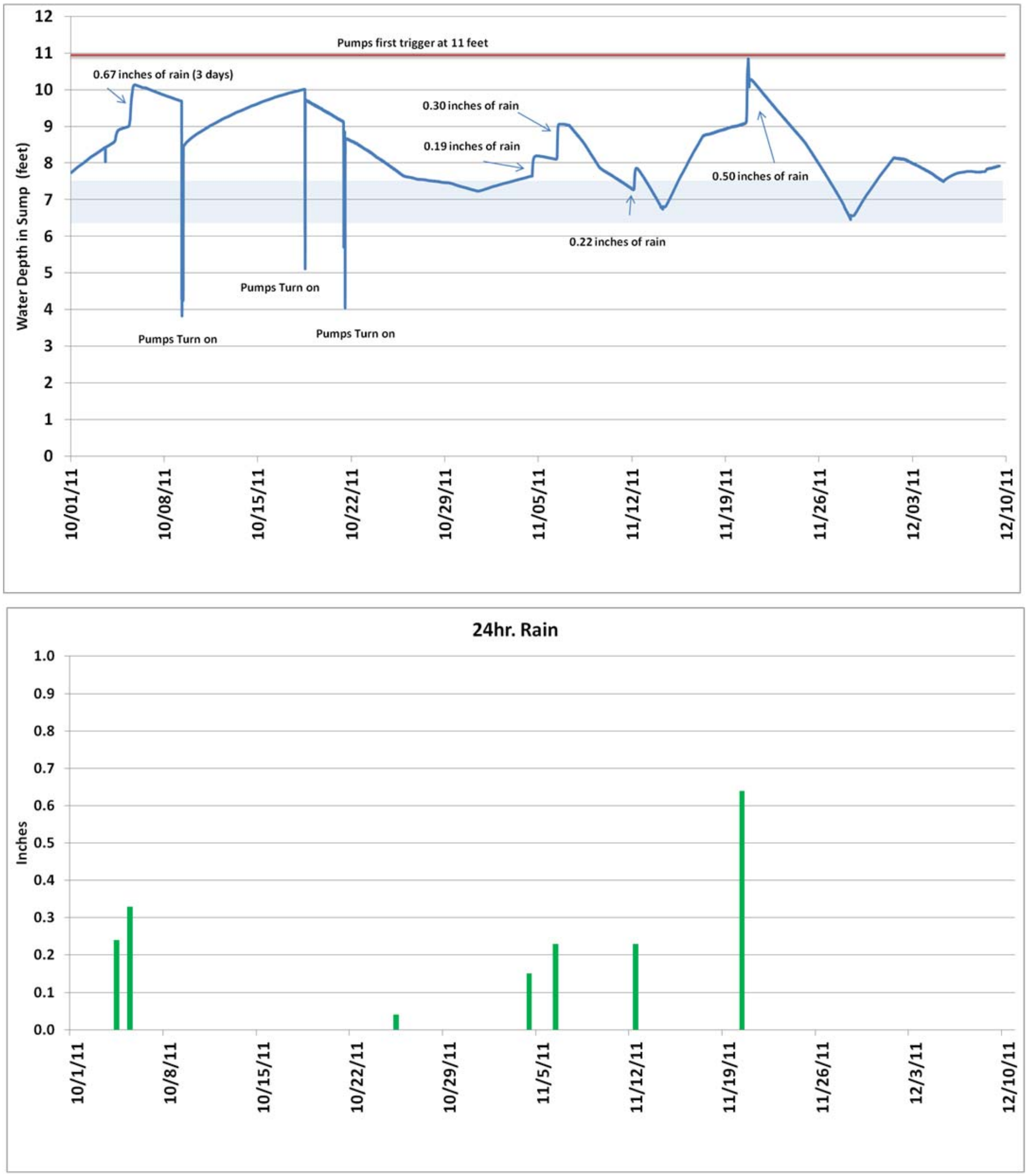


Figure 42. **Sump water level and daily rainfall at the Dominguez Gap Pump Station, 10/1/11 through 12/10/11.**

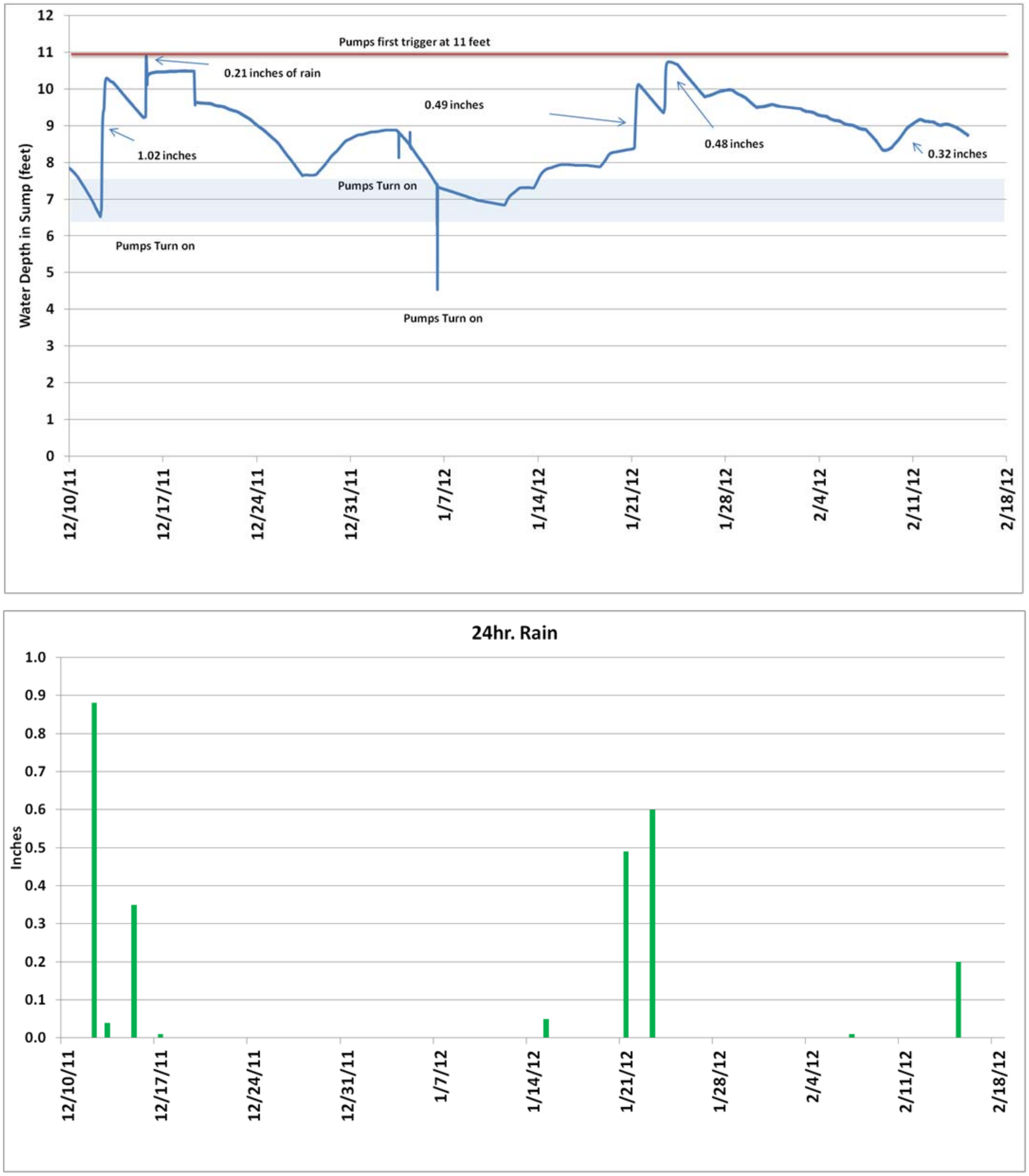
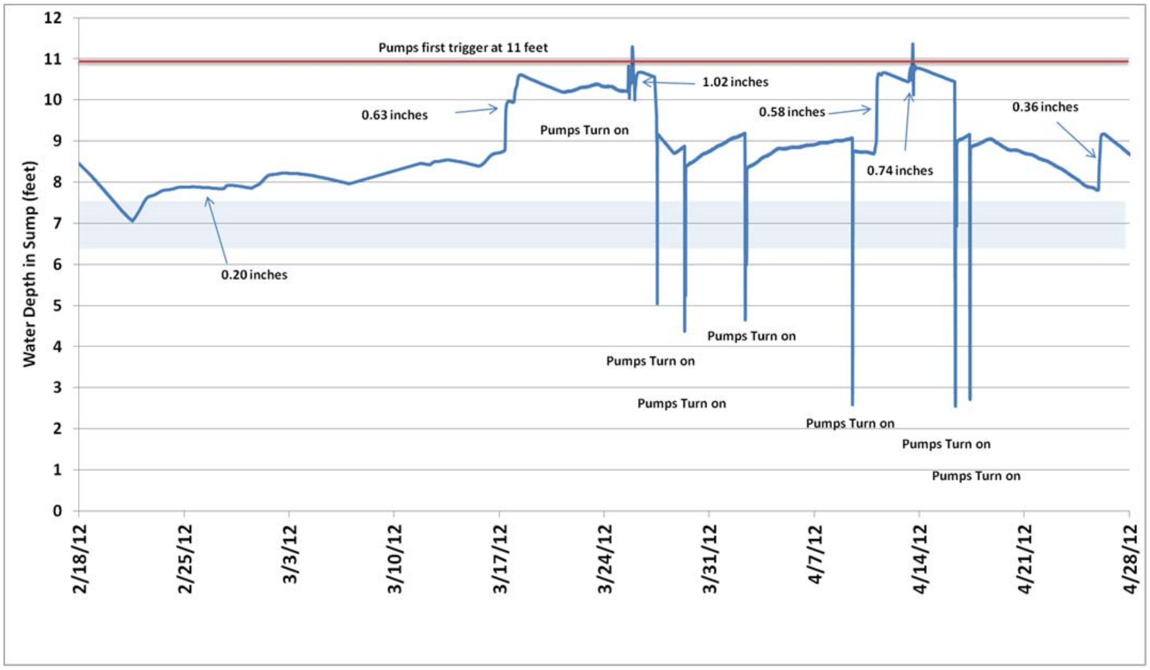


Figure 43. **Sump water level and daily rainfall at the Dominguez Gap Pump Station, 12/10/11 through 2/18/12.**



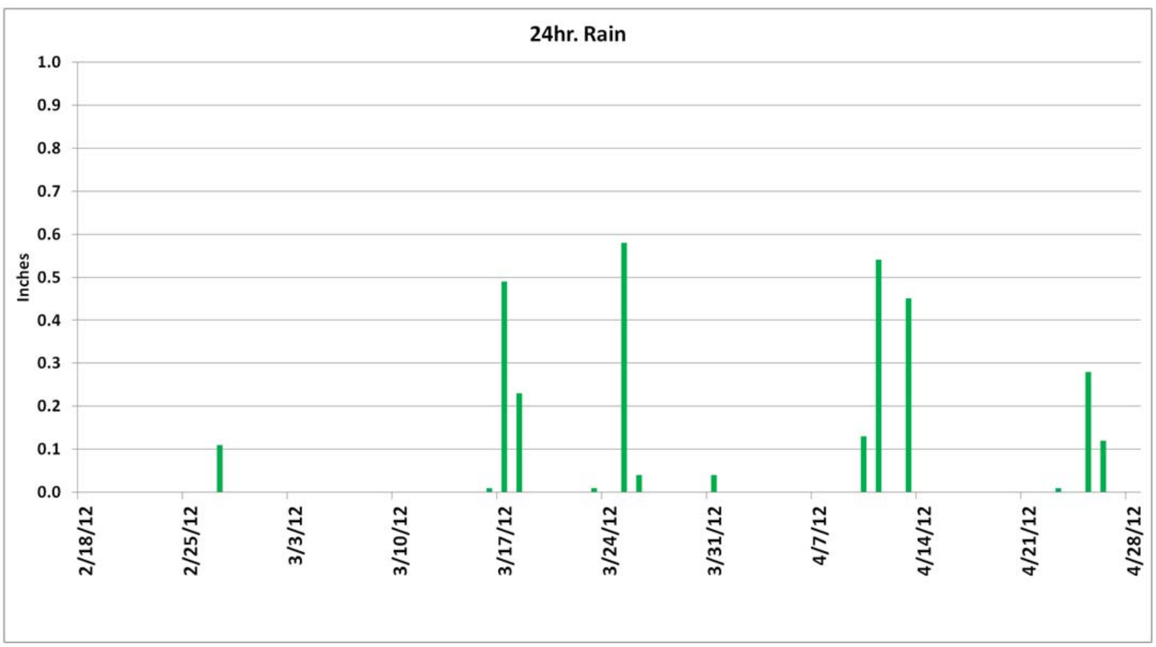
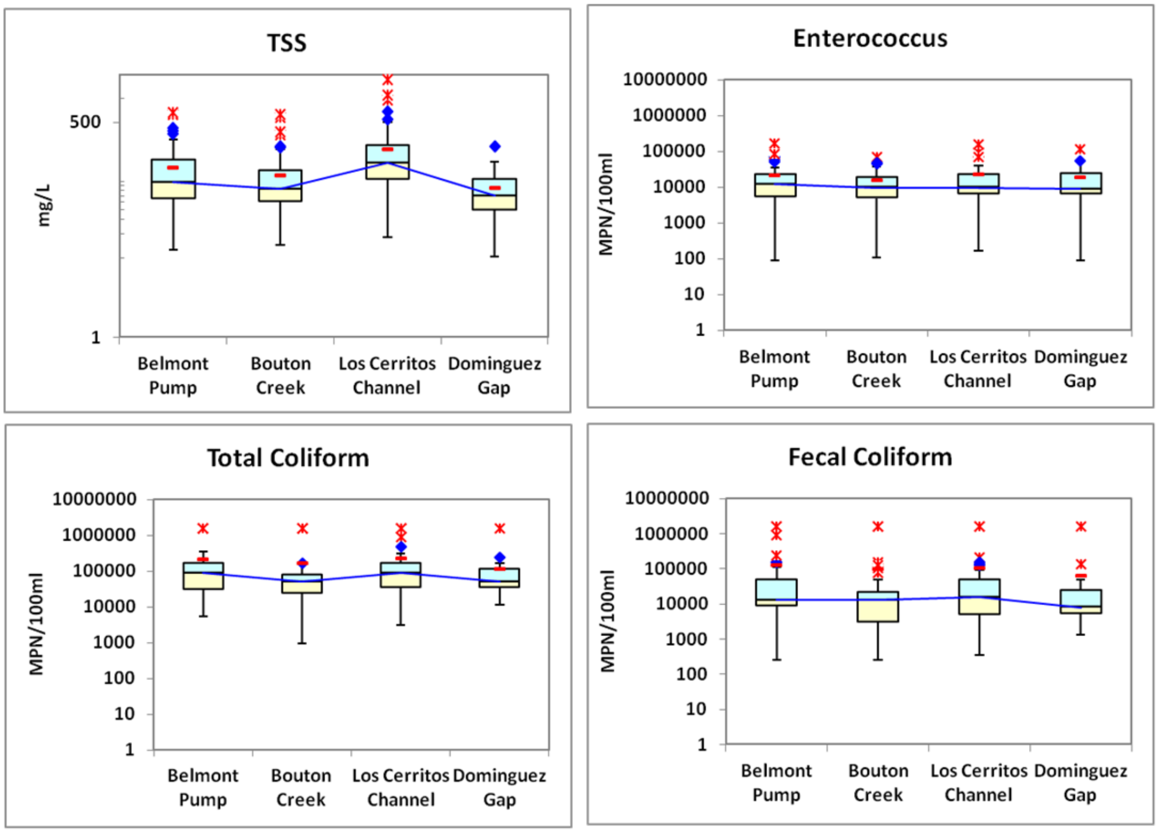
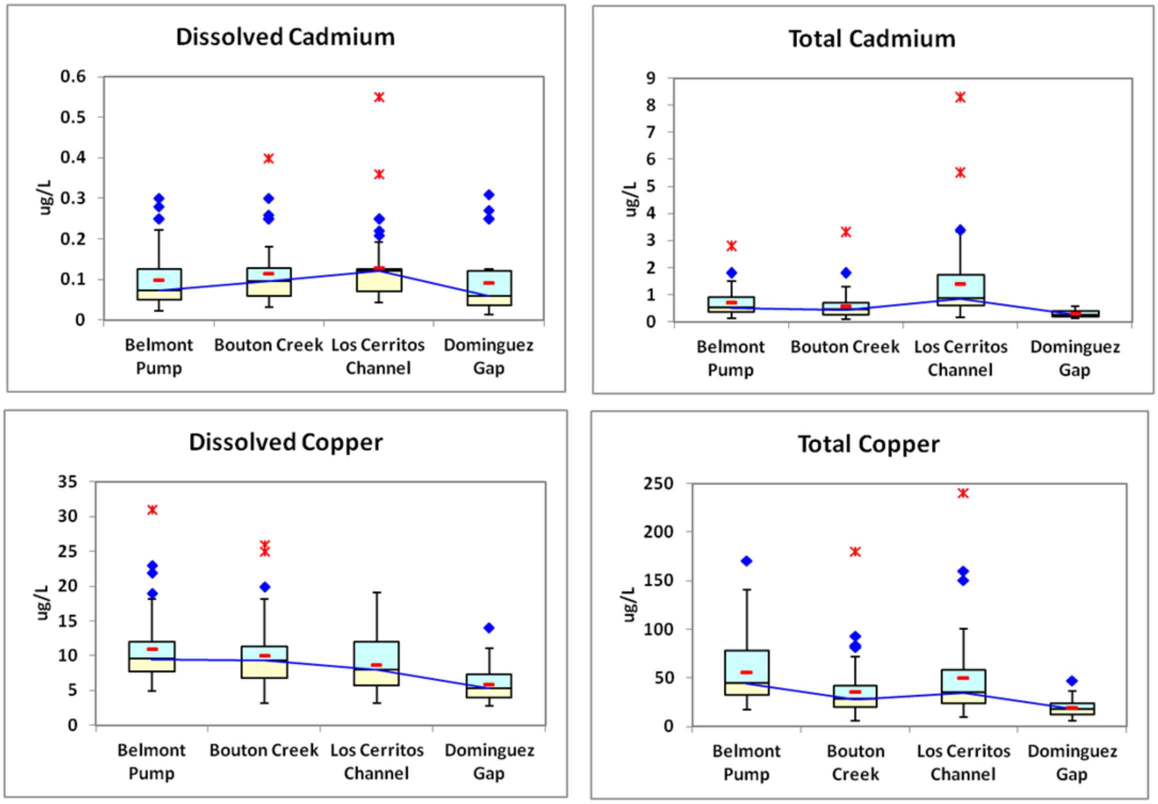


Figure 44. Sump water level and daily rainfall at the Dominguez Gap Pump Station, 2/18/12 through 4/28/12.



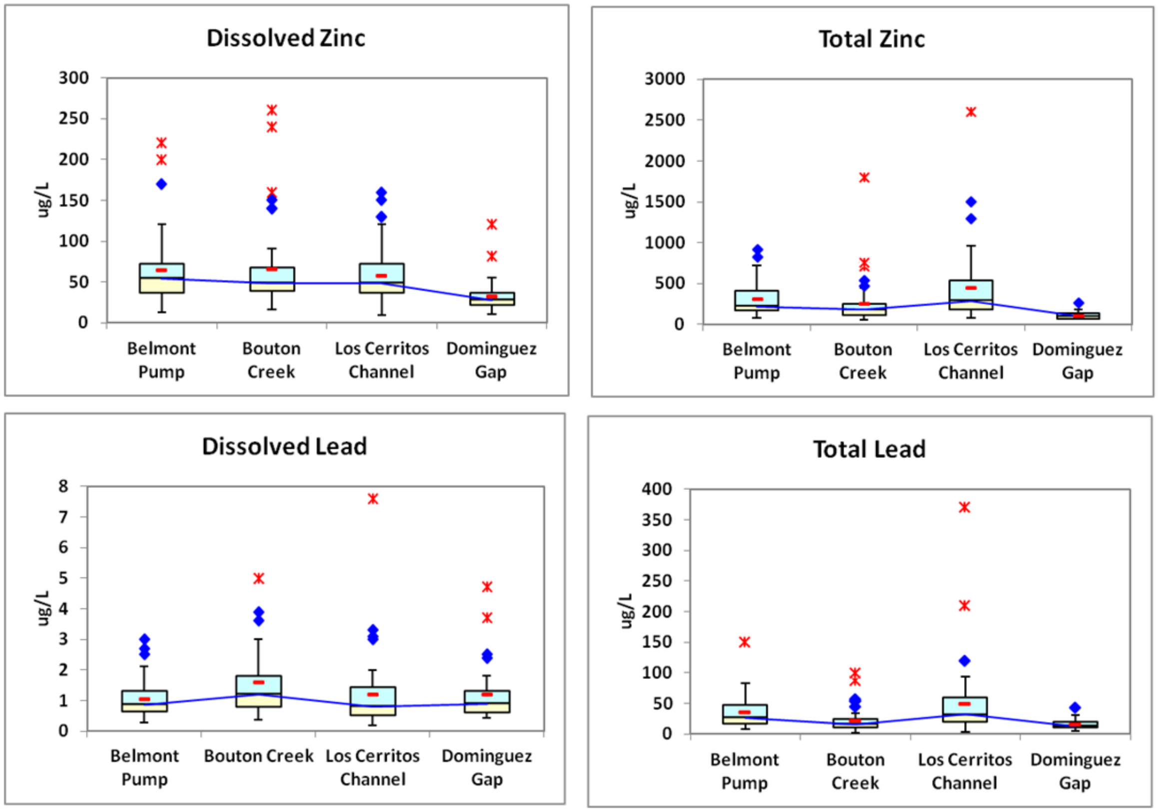
* Indicates points greater than 3x the interquartile range
◊ indicates points greater than 1.5x the interquarile range
_ Indicates the average value
Blue line connects the median values

Figure 45. Box Plots of TSS and Fecal Indicator Bacteria from All Wet Weather Events at each Mass Emission Site.



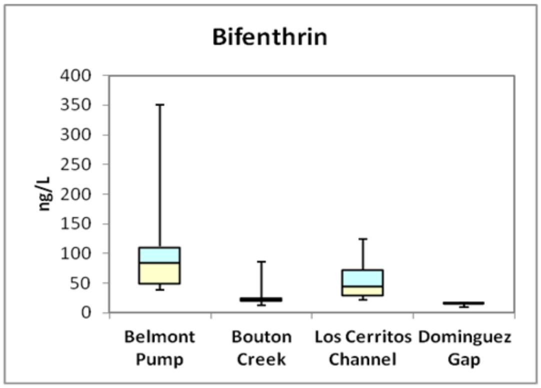
* Indicates points greater than 3x the interquartile range
◊ indicates points greater than 1.5x the interquarile range
_ Indicates the average value
Blue line connects the median values

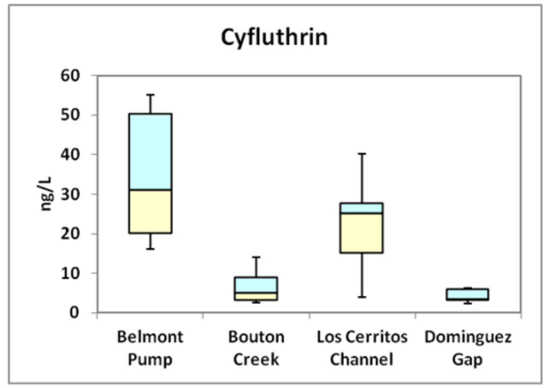
Figure 46. Box Plots of Dissolved and Total Cadmium and Copper from All Wet Weather Events at each Mass Emission Site.

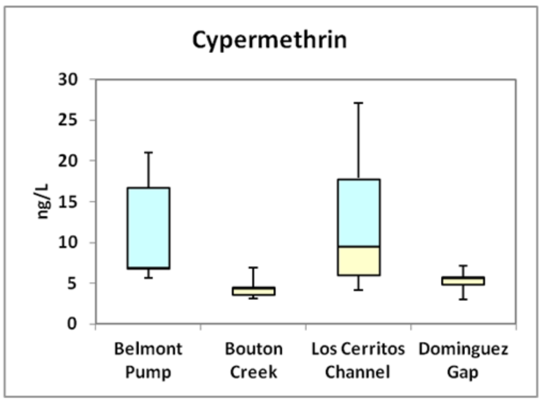


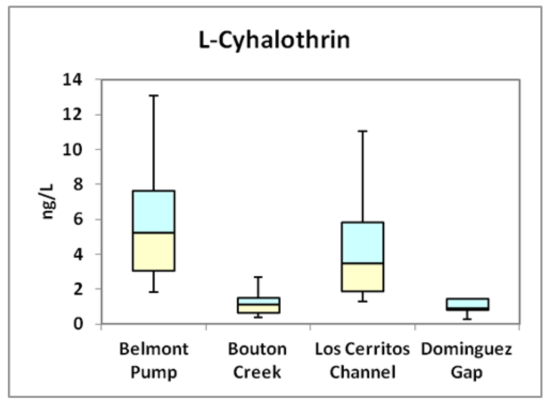
* Indicates points greater than 3x the interquartile range
◊ indicates points greater than 1.5x the interquarile range
_ Indicates the average value
Blue line connects the median values

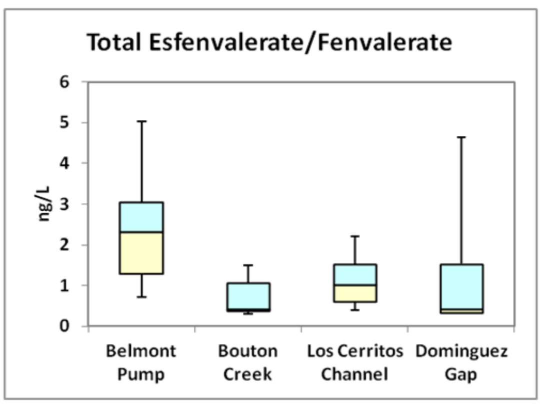
Figure 47. Box Plots of Dissolved and Total Zinc and Lead from All Events at each Mass Emission Site.

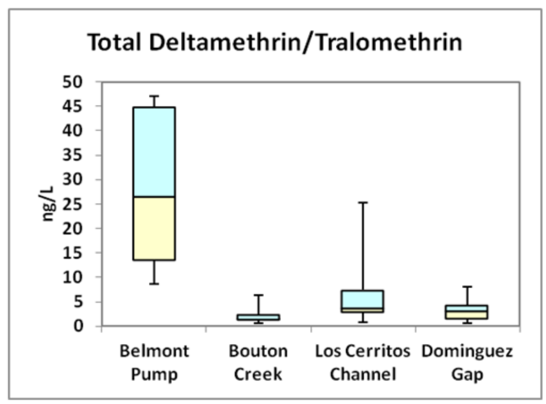












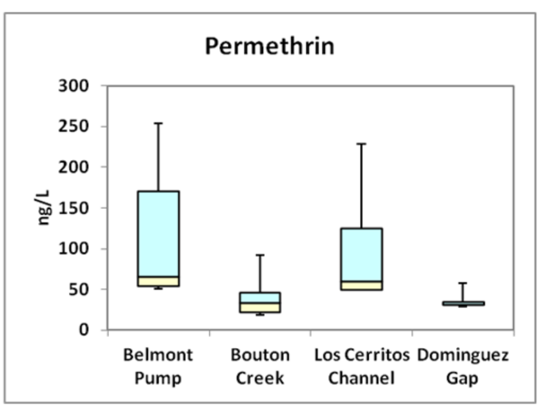


Figure 48. Box plots showing overall concentrations of pyrethroid pesticides at each monitoring site.

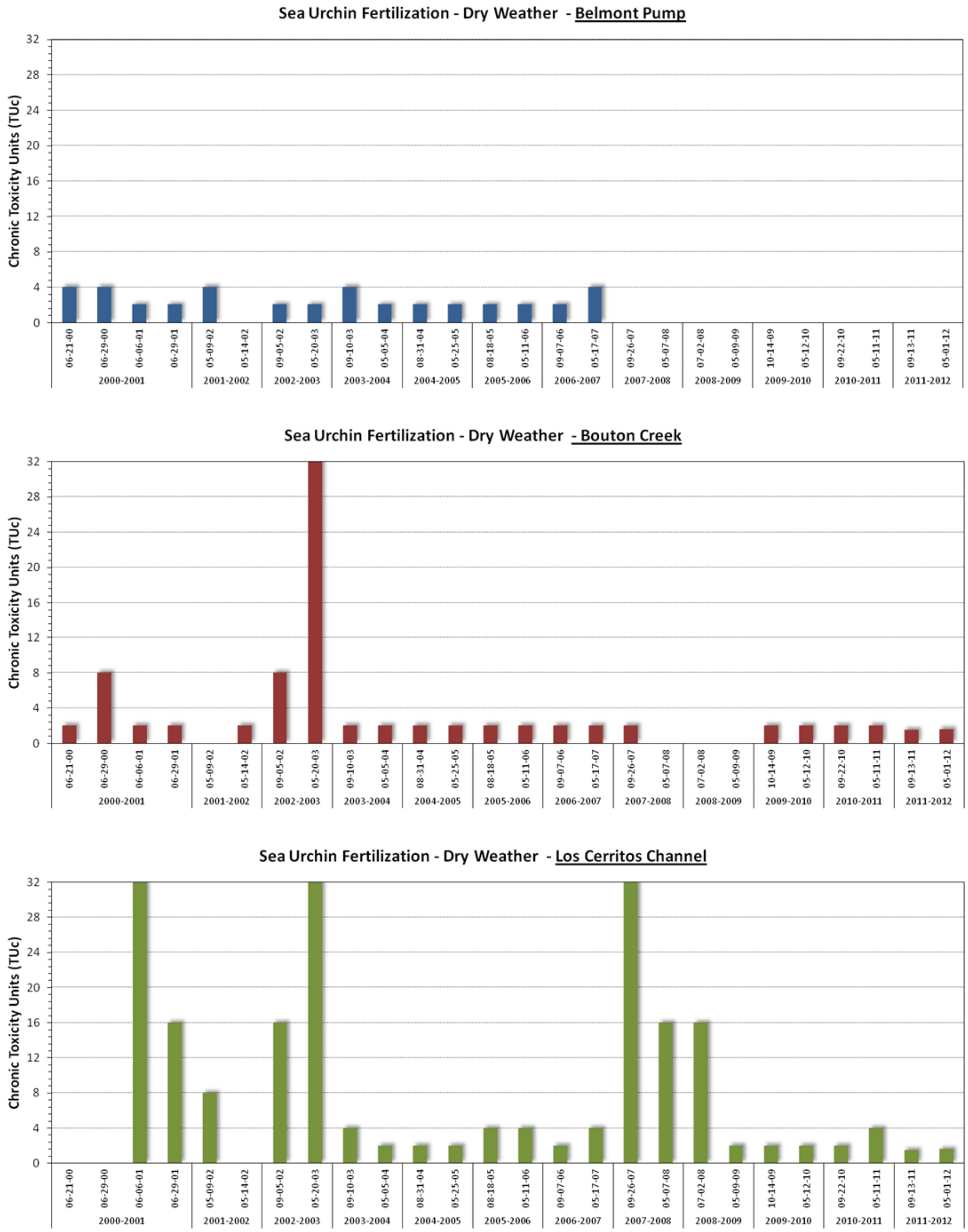


Figure 49. Chronic Toxicity of Dry Weather Discharge to Sea Urchin Fertilization 2000 to 2012.

Figure 50. Chronic Toxicity of Stormwater Discharge to Sea Urchin Fertilization 2000 to 2012.

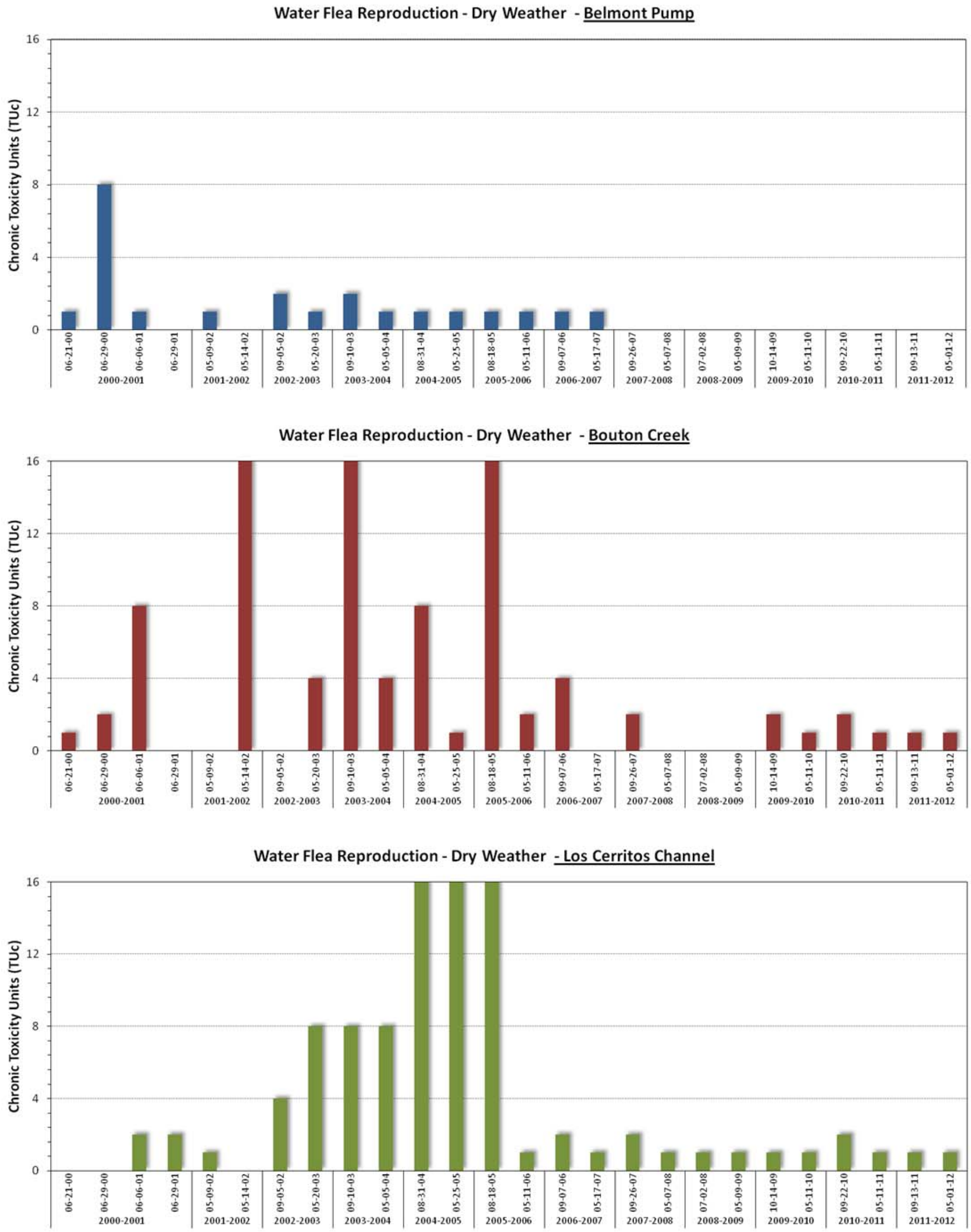


Figure 51. Chronic Toxicity of Dry Weather Discharge to Water Flea Reproduction 2000 to 2012.

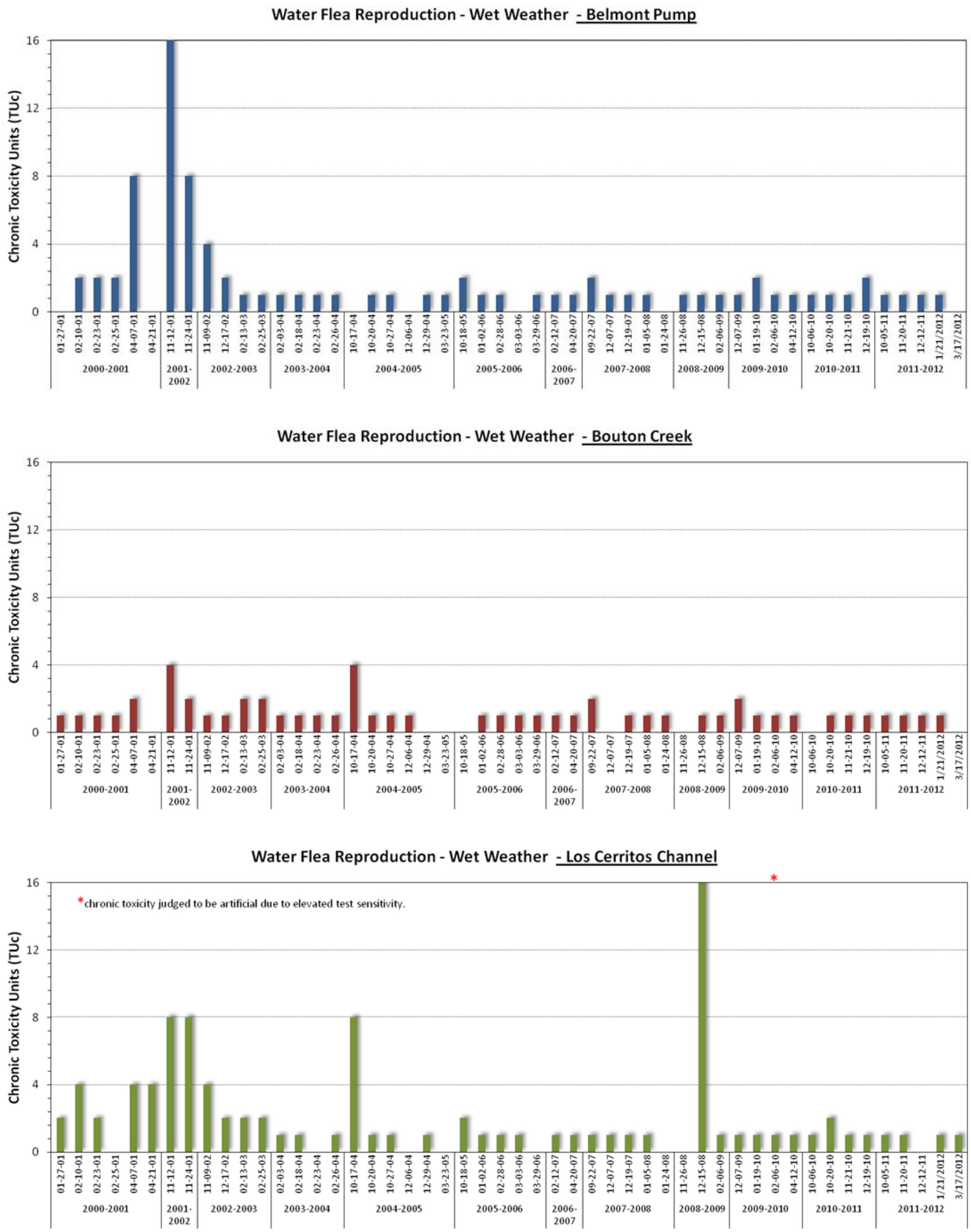


Figure 52. Chronic Toxicity of Stormwater Discharges to Water Flea Reproduction 2000 to 2012.

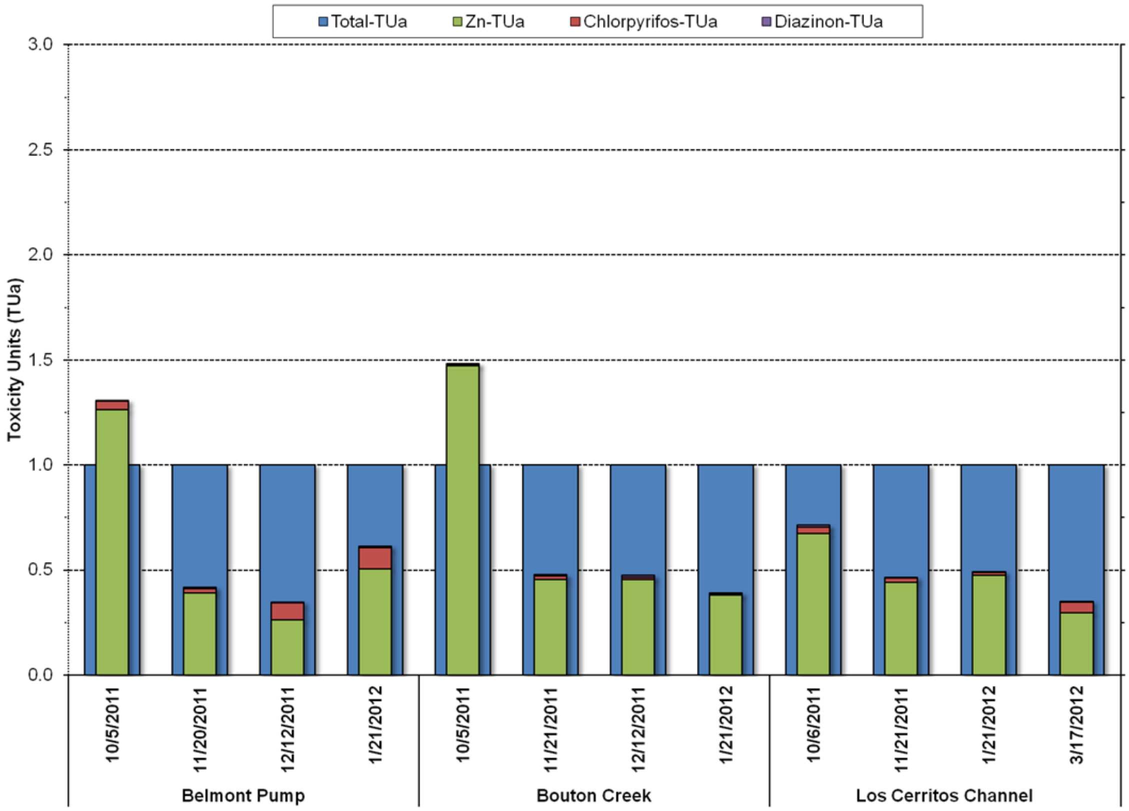


Figure 53. **Measured Acute Toxicity to *Ceriodaphnia dubia* versus Predicted Toxicity due to Zinc, Chlorpyrifos and Diazinon, 2011/2012.**

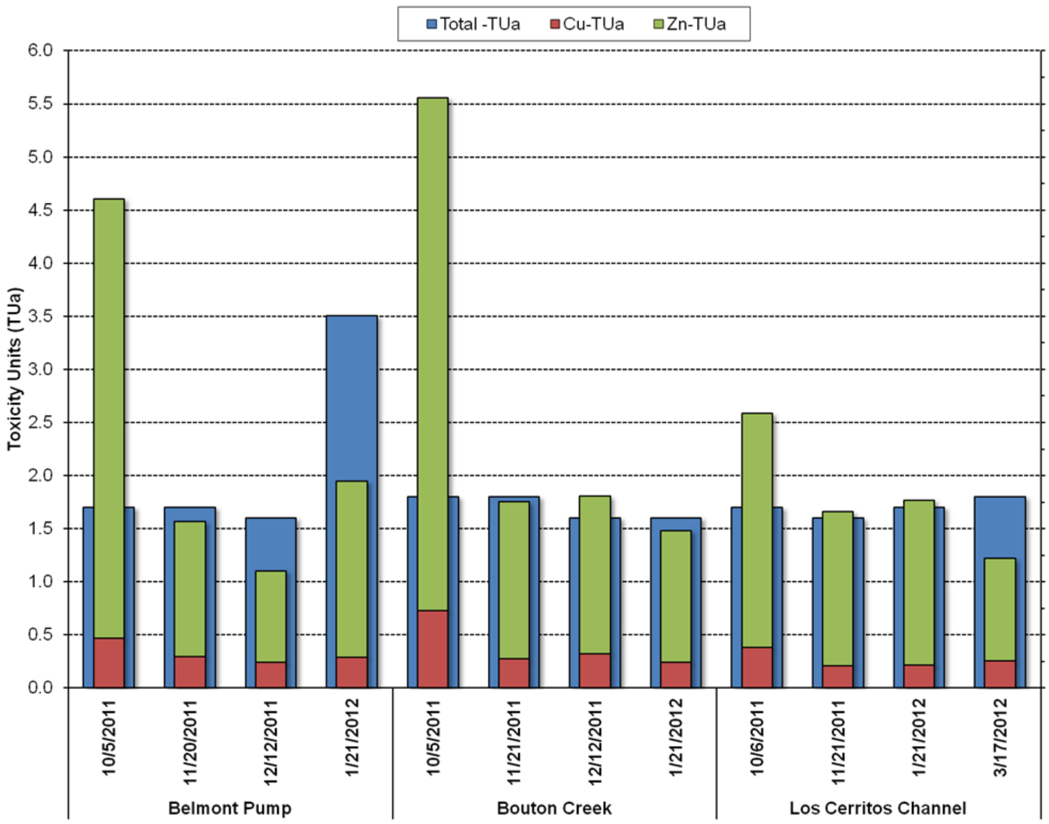


Figure 54. **Measured Acute Toxicity to *Strongylocentrotus purpuratus* versus Predicted Toxicity due to Zinc and Copper, 2011/2012.**

Table 34. Summary of Beneficial Uses for Receiving Water Bodies Associated with each Monitoring Location[1].

DISCHARGE LOCATION	HYDRO. UNIT	COMM	EST	GWR	IND	MAR	MUN	NAV	RARE	REC1	REC2	SHELL	WARM	WET	WILD
Bouton Creek	405.15						P			P	I		I		E
Los Cerritos Channel	405.15						P			P	I		I		E
Dominguez Gap Pump Sta.	405. 15			E	P		P			E	E		E		P
Belmont Pump Sta./Alamitos Bay	405.12	E	E		E	E		E	E	E	E	E		E	E

1. Source: California Regional Water Quality Control Board, Los Angeles Region. 1994. Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties. P=Potential, E=Existing, and I=Intermittent

Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Estuarine Habitat (EST): Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Ground Water Recharge (GWR): Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Industrial Service Supply (IND): Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Marine Habitat (MAR): Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation, such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water.

Navigation (NAV): Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Rare, Threatened, or Endangered Species (RARE): Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Water Contact Recreation (REC-1): Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sun bathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Warm Freshwater Habitat (WARM): Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Wetland Habitat (WET): Uses if water that support wetland ecosystems including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., Mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Table 35. Available Freshwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

	Long Beach	LA Basin Plan	California Toxics Rule		California Fish and Game		National Non Priority Pollutant	
Analyte Group	**2001-2011 ML**	**Acute Max. Level**	**Chronic CCC [2]**	**Acute CMC [2]**	**Chronic CCC**	**Acute CMC**	**Chronic CCC**	**Acute CMC**
Bacteria (MPN/100 ml)								
Enterococcus	10	104						
Fecal Coliform	20	400						
Total Coliform	20	10000						
Ratio of Fecal to Total Coliform		FC/TC≥0.1 & TC>1000						
Conventionals (mg/L unless noted)								
pH (pH Units)	0.1	[6.5 - 8.5]						
MBAS	0.025	0.5						
Nitrate (as N)	0.1	10						
Nitrite (as N)	0.1	1						
Total Ammonia (as N)	0.1	-[1]						
Dissolved Metals (**µg/L**)								
Arsenic	0.5		150	340				
Cadmium	0.2		1.3	2.0				
Copper	0.5		5.0	7.0				
Lead	0.2		1.2	30				
Nickel	0.5		29	260				
Silver	0.2			1.0				
Zinc	1		66	65				
Total Metals (**µg/L**)								
Aluminum	25	1000					87	750
Iron	25						1000	
Nickel	0.5	100						
Selenium	1	50	5	20				

1. The one-hour average ammonia-N criterion applicable to storm events is pH dependent. The 30-day ammonia-N criterion applicable to dry weather is both temperature and pH dependent.
2. CTR freshwater dissolved metals are hardness dependant. The values listed here are computed for a hardness of 50 mg/L.
   CTR freshwater dissolved cadmium and lead coefficients for conversion of total recoverable to dissolved criteria are also hardness dependent.

Table 35. Freshwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites (continued)

Analyte Group	Long Beach 2001-2012 ML	LA Basin Plan Acute Max. Level	California Toxics Rule Chronic CCC *	California Toxics Rule Acute CMC *	California Fish and Game Chronic CCC	California Fish and Game Acute CMC	UC Davis Chronic CCC	UC Davis Acute CMC
Aroclors (µg/L)								
Aroclor 1016	0.02	0.5						
Aroclor 1221	0.02	0.5						
Aroclor 1232	0.02	0.5						
Aroclor 1242	0.02	0.5						
Aroclor 1248	0.02	0.5						
Aroclor 1254	0.02	0.5						
Aroclor 1260	0.02	0.5						
Chlorinated Pesticides (µg/L)								
4,4'-DDT	0.005		0.001	1.1				
Aldrin	0.005			3				
Dieldrin	0.005		0.056	0.24				
Endrin	0.005	2	0.036	0.086				
gamma-BHC (Lindane)	0.005			0.95				
Endosulfan I	0.005		0.056	0.22				
Endosulfan II	0.005		0.056	0.22				
Heptachlor	0.005	0.01	0.0038					
Heptachlor epoxide	0.005	0.01	0.0038					
Total Chlordane	0.005	0.1	0.0043	2.4				
Methoxychlor	0.005	40						
Mirex	0.005							
Toxaphene	0.05	2	0.0002					
Organophosphates (µg/L)								
Chlorpyrifos	0.002				0.014	0.02		
Diazinon	0.004				0.05	0.08		
Malathion	0.006				0.1	0.43	0.028	0.17
Pyrethroids (ng/L)								
Bifenthrin	1.5	3					0.6	4
Cyfluthrin	1.5	2					0.05	0.3
Cypermethrin	1.5						0.2	1
L-Cyhalothrin	1.5						0.5	1
Permethrin	15						2	10
Total Deltamethrin/Tralomethrin	3							
Total Esfenvalerate/Fenvalerate	1.5							

Table 36. Saltwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites.

	Long Beach	California Ocean Plan			California Toxics Rule		California Fish and Game		UC Davis	
Analyte Group	**2001-2011 ML**	**Instantaneous Single Sample**	**Daily Maximum**	**30-day Average**	**Chronic CCC**	**Acute CMC**	**Chronic CCC**	**Acute CMC**	**Chronic CCC**	**Acute CMC**
Bacteria (MPN/100 ml)										
Enterococcus	10	104								
Fecal Coliform	20	400								
Total Coliform	20	10000								
Ratio of Fecal to Total Coliform		FC/TC≥0.1 & TC>1000								
Conventionals (mg/L unless noted)										
pH (pH Units)	0.1		[6.0 - 9.0]							
Total Ammonia (as N)	0.1		2.4							
Dissolved Metals (µg/L)										
Arsenic	0.5				36	69				
Cadmium	0.2				9.3	42				
Copper	0.5				3.1	4.8				
Lead	0.2				8.1	210				
Nickel	0.5				8.2	74				
Selenium	1				71	290				
Silver	0.2				-	1.9				
Zinc	1				81	90				
Total Metals (µg/L)										
Arsenic	0.5	80	32							
Cadmium	0.2	10	4							
Copper	0.5	30	12							
Lead	0.2	20	8							
Nickel	0.5	50	20							
Selenium	1	150	60							
Silver	0.2	7	2.8							
Zinc	1	200	80							
Aroclors (µg/L)										
Total Aroclors				0.000019						

Table 36. Saltwater Benchmarks and Guidelines Used to Evaluate Quality of Wet and Dry Season Discharges from the Mass Emission Sites (continued.)

	Long Beach	California Ocean Plan			California Toxics Rule		California Fish and Game		UC Davis	
	2001-2011	Instantaneous	Daily	30-day	Chronic	Acute	Chronic	Acute	Chronic	Acute
Analyte Group	**ML**	**Single Sample**	**Maximum**	**Average**	**CCC**	**CMC**	**CCC**	**CMC**	**CCC**	**CMC**
Chlorinated Pesticides (µg/L)										
4,4'-DDT	0.005				0.001	0.13				
Aldrin	0.005			0.000022		1.3				
Dieldrin	0.005			0.00004		0.71				
Endrin	0.005		0.004			0.037				
gamma-BHC (Lindane)	0.005					0.16				
Endosulfan I	0.005		0.018			0.034				
Endosulfan II	0.005		0.018			0.034				
Heptachlor	0.005			0.00005		0.053				
Heptachlor epoxide	0.005			0.00002		0.053				
Total Chlordane	0.005				0.004	0.09				
Methoxychlor	0.005									
Mirex	0.005									
Toxaphene	0.05			0.00021		0.21				
Organophosphates **(µg/L)**										
Chlorpyrifos	0.002						0.009	0.02		
Malathion	0.006						0.1	0.34	0.028	0.17
Pyrethroids (ng/L)										
Bifenthrin	1.5								0.6	4
Cyfluthrin	1.5								0.05	0.3
Cypermethrin	1.5								0.2	1
L-Cyhalothrin	1.5								0.5	1
Permethrin	15								2	10
Total Deltamethrin/Tralomethrin	3									
Total Esfenvalerate/Fenvalerate	1.5									

Notes to Table 34 and 35:

General

- Minimum Level (ML) is the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.
- Criteria continuous concentration (CCC) equals the highest concentration of pollutant to which aquatic life can be exposed for an extended period of time without deleterious effects.
- Criteria maximum concentration (CMC) equals the highest concentration of pollutant to which aquatic life can be exposed for a short period of time with deleterious effects.

California Toxics Rule

- CTR freshwater dissolved metals are hardness dependant. The values listed here are computed for a hardness of 50 mg/L.
- CTR freshwater dissolved cadmium and lead conversion coefficients for total to dissolved are also hardness dependent.
- CTR freshwater and saltwater dissolved metal criteria are "CCC" except for silver which are "CMC".
- CTR freshwater and saltwater organics are "CCC" except for aldrin and gamma-BHC which are "CMC".

Ocean Plan and LA Basin Plan

- Bacteria are instantaneous or single sample criteria.
- LA Basin Plan contains Title 22 Drinking Water standards
- Ammonia listed is Acute 1-hour average objective for waters not designated COLD and/or MIGR and is pH dependent. The value listed is for a pH of 7.5. Chronic criteria are applied to Dry Weather results and are pH and temperature dependent

California Fish and Game

- All values are "CMC" criteria. CMCs are considered acute criteria.

Table 37. TMDL Load Limitations and Measured Loads at the Los Cerritos Monitoring Site during Storm Events.

	TMDL Load Limits (ug/L)								
	Total Copper	Total Lead	Total Zinc						
	9.8	55.8	95.6						
	TMDL Load Limits (kilograms/day)			Total Measured Loads (kilograms/day)			Exceedance Factors (TMDL Load Limit/Measured Load)		
Total Flow (cf)	Total Copper	Total Lead	Total Zinc	Total Copper	Total Lead	Total Zinc	Total Copper	Total Lead	Total Zinc
2.07E+08	2.0	11.6	19.8	16.2	7.7	116	8.0	0.7	5.9
2.99E+08	2.9	16.7	28.6	11.6	7.8	86	4.0	0.5	3.0
2.36E+08	2.3	13.2	22.6	4.5	2.2	31	1.9	0.2	1.4
1.8E+08	1.8	10.1	17.2	10.4	7.7	70	5.9	0.8	4.1

Table 38. Comparison of Measured Concentration of Pyrethoid Pesticides with Toxicity.

	EMC Data from All Sites					Toxicity Reference Values for Sensitive Species			
Pyrethroid	**Mean**	**Stand. Dev.**	**Min**	**Med.**	**Max**	*Ceriodaphnia dubia (48-hr LC_{50}s in ug/L)*	*Daphia magma (48-hr LC_{50}s in ug/L)*	*Hyallela azteca (48-hr LC_{50}s in ug/L)*	*Americamysis bahia (96-hr LC_{50}s in ug/L)*
Allethrin	1.4	0.24	0.4	1.5	1.5				
L-Cyhalothrin	3.2	3.4	0.3	1.5	13		360	2.3	
Permethrin	72.1	66.0	18	49	253	550	75	21.1[1]	20
Cyfluthrin	16.9	16.2	2.4	10.6	55	140	170		2.4
Bifenthrin	55.0	71.2	9.9	25	348	70	320	9.1[1]	4
Cypermethrin	8.3	6.6	3	5.6	27		130	5	5
Total Deltamethrin/ Tralomethrin	10.2	14.3	0.7	3.5	47		370		1.7
Total Esfenvalerate/ Fenvalerate	1.4	1.3	0.3	0.95	5	310[1]	240	50	38
Tetramethrin	1.5	0	1.5	1.5	1.5				
Fenpropathrin	1.5	0	1.5	1.5	1.5				
Fluvalinate	1.6	0.7	0.4	1.5	4.2				

LC_{50} data summarized from Werner and Oram 2008

1. Value corresponds to the 96-hr LC_{50} rather than the 48-hr LC_{50}. All test data for mysids are also based upon the 96-hr LC_{50}.

Table 39. Comparison of Daphnid Toxicity Characteristics of Stormwater from Long Beach and Various Southern California Watersheds.

Location	Date	Number of Samples	%Toxic	TU_c
Long Beach	2011-2012	12	0	1
	2010-2011	11	18	1-2
	2009-2010	12	8	1-2
	2008-2009	7	57	1->16
	2007-2008	12	33	1-2
	2006-2007	6	0	1
	2005-2006	2	17	1-2
	2004-2005	12	25	1-8
	2003-2004	11	9	1-2
	2002-2003	13	31	1-4
	2000-2002	22	77	1->16
Los Angeles River	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	50	1-1.1
San Gabriel River	2010-2011	1	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	0	1
Ballona Creek	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	0	<1
	2007-2008	2	0	1
Chollas Creek	2007-2008	2	0	1
	2006-2007	3	0	1
	2005-2006	3	33	1-2
	2004-2005	3	33	1-4
	2003-2004	3	0	1
	2002-2003	2	50	1-2
	2001-2002	3	100	4-8
	2000-2001	40	35[1]	Not reported
	1999-2000	5	100	8-32
	1999	3	0	1
	1999	3	67	1-2
	1994-1998	11	100	2-8

1. Percent toxic based only on daphnid survival LC_{50}.

Table 40. Comparison of Sea Urchin Fertilization Toxicity Characteristics of Stormwater from Long Beach and Various Southern California Watersheds.

Location	Date	Number of Samples	%Toxic	TU_c
Long Beach	2011-2012	12	75	8->16
	2010-2011	11	0	<2
	2009-2010	12	0	<2
	2008-2009	7	29	2-8
	2007-2008	12	42	2-32
	2006-2007	6	100	4->32
	2005-2006	12	83	2->32
	2004-2005	12	58	2-16
	2003-2004	11	45	<2-32
	2002-2003	13	46	≤2-32
	2000-2002	22	86	≤2-32
Los Angeles River	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2-3
	1997-1999	4	100	4-8
San Gabriel River	2010-2011	1	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2-3
	1997-1999	4	50	≤2-4
Ballona Creek	2010-2011	2	0	<1
	2009-2010	2	0	<1
	2008-2009	2	50	2-3
	1996-1997	13	85	≤4-32
Chollas Creek	1999-2000	5	100	8-32

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CONCLUSIONS

The City of Long Beach's water quality monitoring program for stormwater and dry weather discharges through the City's municipal separate storm sewer system (MS4) began in the 1999/2000 wet weather season under terms of Order No. 99-060 National Pollutant Discharge Elimination Systems Municipal Permit No. CAS004003 (CI 8052). Since that time, 160 wet weather monitoring events have been conducted at the four Long Beach mass emission stations for the full set of analytes, along with 91 dry weather inspections/monitoring events. In addition 82 wet weather events have been monitored to develop Event Mean Concentrations (EMCs) for total suspended solids only.

The Long Beach stormwater monitoring program has emphasized an approach of paired chemical analysis and toxicity testing of discharges of municipal stormwater. The purpose of this approach was to first identify the constituents in the City of Long Beaches stormwater discharges that exhibited potential water quality impacts. This requires that the chemical analyses and toxicity tests be conducted on the same composite water samples. This approach has successfully led to identification of impacts of organophosphate pesticides as problems early in the program. Removal of diazinon and chlorpyrifos has led to a significant reduction in toxicity of stormwater discharges using current test species, particularly, the water flea (*Ceriodaphnia*). Bioassay tests using sea urchin (*Strongylocentrotus*) gametes has also shown signs of decreasing which may be partially associated with the gradual reduction in several trace metal contaminants. This year's apparent increase in toxicity based upon the sea urchin fertilization test was not explained by levels of dissolved metals in the stormwater discharges. Furthermore, the tendency of the toxicity to decay over a brief amount of time is inconsistent with previous results.

A couple of factors may play a role in the increased toxic response measured by the sea urchin test. This is the first year that we have used a new bioassay laboratory (Nautilus). The laboratory is capable of running slightly higher concentrations of stormwater using more concentrated brines but this alone was not sufficient to explain the differences. There is the possibility that some of the new organic compounds are capable of causing this initial toxicity especially since the site subject to the highest measured toxicity also tended to have the highest concentrations of pyrethroid pesticides. It is also possible that some of the toxicity may be associated with unmeasured analytes such as fipronil. Decreases in toxicity would be likely for pyrethroids since they tend to plate out onto glassware and particles becoming unavailable to animals or gametes in the test solutions. Understanding the true cause for the increased toxicity measured with the sea urchin fertilization test will require further work. If increasing use of alternative pesticides is the cause of the temporary toxicity, this should also be observed in other stormwater programs. Current data were not available from other programs at this time. Generally, the sea urchin fertilization test is considered to be more sensitive to metals than organics and the water flea test is considered more sensitive to organics. A toxic response to the sea urchin fertilization test without evidence of a toxic response to water fleas would be highly unusual making this a perplexing problem.

Most long-term trends tend to be obscured by factors that are not evident when exclusively looking at changes in concentrations. Unlike the abrupt decline in diazinon and chlorpyrifos that was occurred soon after removing these pesticides from the market, changes have been relatively gradual. In some cases, it has taken a full decade to observe clear visual trends based upon the long-term graphics.

No trends are evident in the concentrations of total and dissolved copper measured at each site during either wet or dry weather but other metals are starting to show evidence of decreasing trends over the past 12 years. Concentrations of both total and dissolved lead have decreasing slowly at all sites since the start of the stormwater program in 2000. Although changes are not as distinct, total and dissolved zinc show some signs of decreasing particularly in the Los Cerritos Channel.

Increased use of malathion, another organophosphate pesticide, was evident after both diazinon and chlorpyrifos were removed from the retail market but now is showing signs of decreased use. This pesticide is most commonly encountered at high concentrations in the Belmont Pump Station subwatershed and, to a lesser degree, in the Los Cerritos Channel subwatershed. This pesticide was rarely encountered at the other mass emission sites.

Decreasing dry weather flow rates in the Los Cerritos Channel are now showing signs of decreasing concentrations of fecal indicator bacteria. Total coliforms, fecal coliforms, and entercoccus are trending lower are more frequently meeting water quality objectives during dry weather monitoring. This is likely attributed to prolonged exposure to UV light during transit in the open portion of the channel.

Two of the mass emission sites, the Los Cerritos Channel and Dominguez Gap Pump Stations, are subject to TMDL. Both wet and dry weather limitations are established for the Los Cerritos Channel. The Dominguez Gap Pump Station discharges into the lower segment of Los Angeles River thus wet season and dry season discharges were compared against TMDL objectives established at the Wardlow monitoring site.

TMDL limits established for the Los Cerritos Channel were achieved during the dry season but significant improvements will be required to meet all wet weather limits. Dry weather flows in the Los Cerritos Channel have dramatically declined over the past few years. The lower flows enabled the dry weather waste load allocations to be easily met for copper. Wet weather flows are subject to targets for copper, lead and zinc. Lead remained well below TMDL limits but both copper and zinc exceeded TMDL limits during each of the four storm events. Copper loads were exceeded by a factor of 1.9 to 8 times the limit while zinc loads were by a factor of 1.4 to 5.9 times the limit.

The Los Angeles River is subject to both a metals TMDL and bacteria TMDL. All dry weather discharges from the Dominguez Gap Station meet the CTR freshwater chronic criteria for metals and Basin Plan criteria established for fecal indicator bacteria necessary to meet Rec1 beneficial use objectives. Stormwater discharges exceeded Basin Plan objectives for all fecal indicator bacteria but all dissolved metals were below CTR freshwater acute criteria. However, the TMDL objectives at the Wardlow monitoring site were established as total recoverable values. Total copper measured in stormwater discharges from the Dominguez Pump Station were 19 and 20 ug/L which exceed the TMDL limit of 17 ug/L at Wardlow. Total lead and zinc concentrations in effluent from this Pump Station were well within TMDL waste load allocations.

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