Los Angeles River Watershed Monitoring Program
2012 to 2014 Annual Report

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Agencies and Organizations
City of Burbank
City of Los Angeles
Los Angeles County Flood Control District
Los Angeles Regional Water Quality Control Board
Council for Watershed Health
Southern California Coastal Water Research Project
U.S. Environmental Protection Agency (USEPA)
U.S. Forest Service

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List of Acronyms

ATL	Advisory Tissue Levels
BMI	Benthic Macroinvertebrate
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRAM	California Rapid Assessment Method
CRM	Certified Reference Material
CTR	California Toxics Rule
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DQO	Data Quality Objective
FCG	Fish Contaminant Goals
IBI	Index of Biological Integrity
LARWMP	Los Angeles River Watershed Monitoring Program
MLOE	Multiple Lines Of Evidence
MQO	Measurement Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
OEHHA	Office of Environmental Health and Hazard Assessment (CA)
PAH	Polycyclic Aromatic Hydrocarbons
PCA	Principle Component Analysis
PCB	Polychlorinated Biphenyl
POP	Persistent Organic Pollutant. The listed constituents PCBs and DDTs are both persistent organic pollutants under the Stockholm Convention.
POTW	Publicly Owned Treatment Works
RPD	Relative Percent Difference
SGRRMP	San Gabriel River Regional Monitoring Program
SQO	Sediment Quality Objective
TDS	Total Dissolved Solids
TEQ	Toxicity Equivalent
TIE	Toxicity Identification Evaluation
USEPA	United States Environmental Protection Authority
VOC	Volatile Organic Compound

WQO	Water Quality Objective
WRP	Water Reclamation Plant

Executive Summary

This report represents the 2012 to 2014 Los Angeles River Regional Monitoring Program (LARWMP) report and is intended to describe the monitoring activities that took place and to answer five specific questions of interest to a broad range of stakeholders in the watershed:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

Question 1: What is the condition of streams in the watershed?

Ambient watershed condition was assessed using data collected from 2009 through 2014 at a total of 60 random sites. Biotic index scores for benthic macroinvertebrates (CSCI) and riparian zone (CRAM) condition were used as the key measures of stream condition. To evaluate potential key stressors to the biotic condition, samples for water chemistry, toxicity, and physical habitat condition were also collected at each site.

Key findings are listed below:

- Biotic condition was measured using benthic macroinvertebrates (BMIs) and riparian zone condition. Each of the indices showed a clear distinction between reference-like conditions in the upper watershed and non-reference conditions in the lower watershed.
    - BMI community condition was measured using the new California Stream Condition Index (CSCI). BMI communities were healthiest in the upper watershed compared to the lower watershed, where lined and altered channels predominate. CSCI scores at just over 45% of sites in the watershed were below levels associated with reference condition.
    - Riparian zone physical habitat conditions ranged from nearly pristine in the upper watershed to highly degraded in the channelized lower watershed and effluent-dominated channel as measured by the California Rapid Assessment Method (CRAM).

- Nutrients and metals were consistently lower at natural sites compared to urban and effluent sites from 2009 to 2014. Nutrients, especially nitrate, were greatest in the effluent-dominated channel, but these concentrations were below the basin plan objective of 10 mg/L-N. Most metals were greatest in the lower watershed at urban and effluent-dominated sites. Specifically, median cadmium and zinc concentrations were highest at effluent-dominated sites and arsenic and copper were higher at urban sites.
- There were few exceedances of dry-weather Los Angeles Basin Plan standards for any water quality parameters measured during the three-year period. Nitrate and ammonia were well below these thresholds, and there were few exceedances of the hardness-adjusted CTR for any metal, except for copper, which exceeded the chronic standard on three occasions and selenium, which exceeded the chronic standards on one occasion. These elevated concentrations occurred in tributaries to the Los Angeles River.
- Of the 30 samples collected and measured for organophosphorus pesticides and pyrethroids over the three-year period, nearly all were below method detection limits.
- Of the 30 toxicity tests conducted from 2012 to 2014, 53% showed reproductive toxicity: one (3%) from the effluent-dominated channel, 8 (62%) from sites located at natural (mostly upper watershed) sites, and seven (58%) from lower watershed urban sites. There is no clear explanation for elevated reproductive toxicity in the natural, upper parts of the watershed.

Question 2: Are conditions at areas of unique interest getting better or worse?

To address changes in condition at specific locations in the watershed that represent unique areas of special concern to the workgroup, four sampling programs were created:

Trends at Freshwater Target Sites

A total of 24 annual site visits have occurred at four target sites located at major confluences of the Los Angeles River during the six annual surveys from 2009 to 2014.

- Nitrate concentrations were highest at the Arroyo Seco confluence (LALT501) across years, but were below the water quality threshold protective of human life (10 mg/L) specified in the Los Angeles Basin Plan.
- Dissolved arsenic, copper, nickel, and zinc concentrations were routinely greatest in the Burbank Channel, with arsenic and copper trending lower over time.

- Chronic (reproductive) toxicity was sporadic at the confluence of the Arroyo Seco with the Los Angeles River, occurring in 2012 and 2014.
- Biological conditions, as measured by the Southern CA IBI, were below reference conditions at all four sites during the six-year period.
- Habitat quality at these sites, which are cement-lined, was poor.

Los Angeles River Estuary

Sediment samples were collected from 2009 through 2014 at the mouth of the Los Angeles River Estuary and assessed using the State of California's Sediment Quality Objectives framework.

- For the years when integrated scores could be calculated, EST2 ranked from 'unimpacted' (2011) to 'clearly impacted' (2009).
- Annual scouring due to winter runoff from the Los Angeles River leads to replacement of sediments leading to these large changes in biotic habitat conditions.

High-Value Habitat Sites

The CRAM scores for each of nine high-value sites fell below the reference site threshold, except in 2014 when stations LAUT401 located in the Tujunga Sensitive Habitat and LAUT402 located in the Upper Arroyo Seco were above this reference threshold. Each of these sites is located in the areas that were burned by the 2009 Station Fire.

Sentinel Site Bacteria

A total of 349 samples were collected from six sentinel sites located on major confluences to the Los Angeles River and analyzed for *E. coli*. Of these, 79%, 86% and 86% exceeded the single-sample recreational standard for *E. coli* (235 MPN/100 mL) in 2012, 2013 and 2014, respectively.

- The frequency of single-sample exceedances was high (82 to 100%) at all sites across the three years, except for LALT101 on the Los Angeles River at Figueroa St, where exceedances of the single-sample standard ranged from 9% in 2012 to 40% in 2014.
- LALT101 is located downstream of the Los Angeles Glendale Water Reclamation Plant (LAGWRP). The lowest bacteria concentrations, and fewest exceedances, occurred at sites

at or below publicly owned treatment works (POTW) discharges. These findings are consistent with those reported by CREST (2008).

- Sentinel sites exceeded the 30-day geometric mean REC-1 standard during each of the study months, except at LALT101 where the standard was not exceeded in May and July, 2012.

- Bacteria concentrations in the Los Angeles River Estuary routinely exceeded REC-1 standards for both the single-sample and the 30-day geometric mean standards for *E. coli* and Enterococcus.

Question 3: Are receiving waters near discharges meeting water quality objectives?

The cities of Los Angeles and Burbank POTWs monitor receiving waters downstream of their discharges as a requirement of their NPDES permits. Indicator bacteria, aquatic chemistry, and toxicity results for samples collected from 2012 to 2014 were evaluated against WQOs thresholds. The following patterns were observed:

- The single-sample WQO of 235 MPN/100mL for REC-1 beneficial use was attained for the following:
    - DCTWRP - 65% of upstream samples compared to 55% of downstream samples.
    - LAGWRP – 45% of upstream and 52% of downstream samples.
    - BWRP – 5% of upstream samples compared to 25% of downstream samples.
- Concentrations of nitrogenous compounds below the BWRP discharge did not exceed the WQOs described in the Los Angeles Basin Plan.
- Metal concentrations downstream of the three POTW discharge points were below the California Toxics Rule (CTR) chronic and acute standards in every case except for the BWRP, where copper exceeded the acute threshold on two occasions and the chronic threshold once.
- No acute toxicity to fathead minnows was measured above or below the discharge points for the three POTWs over the three-year period.
- Trihalomethanes were typically present below the discharges, but in all cases concentrations were well below the WQOs.

Question 4: Is it safe to swim?

The monitoring design for Question 4 focuses on the safety of swimming sites in the Los Angeles Watershed. Bacteria sampling was conducted at up to nine sites known to be heavily used by the public from May to September, 2012 to 2014. The concentrations of *E. coli* from these samples were compared to REC-1 bathing water standards. Major findings of this sampling effort are as follows:

- A total of 459 *E. coli* samples were collected from the nine sampling locations during the summers of 2012 through 2014. Twenty to 25% of these samples exceeded the REC-1 bathing water standard (235 MPN/100 mL), depending on the year.
- During all three years exceedances of the bathing water standard were mostly sporadic at each site, ranging from two to five days.
- Bull Creek in the Sepulveda Basin, Eaton Canyon Natural Area Park, and Hansen Dam Recreation Area had persistently elevated *E. coli* concentrations during the three-year period. In 2014, Hansen Dam exceeded the REC-1 standard in 100% of the samples collected.
- The only site that had no exceedances during the three sampling years was the Gould Mesa Campground. Millard Campground also had no exceedances in 2012, but this site was not sampled in 2013 and 2014 as it was closed to the public for construction.
- The sampling effort was focused on holidays and weekends to capture high-use recreational activity, but only in 2012, on the Fourth of July, were REC-1 standards exceeded at more sites than on other days of the sampling season.
- Drought conditions persisted over the three-year period, which led to dry conditions at several sites by mid-July 2014, meaning they could no longer be sampled.

Question 5: Are fish safe to eat?

The monitoring design for Question 5 is focused on assessing whether the consumption of recreationally caught fish in the Los Angeles River Watershed is safe. During 2012, 2013, and 2014, 50 individual fish from four species were collected from Legg Lake, Lake Balboa, and Belvedere Lake, respectively. Eleven composite samples were analyzed for total mercury, selenium, total DDT, and total PCB. Tissue concentrations were compared to OEHHA consumption thresholds.

- Of the four contaminants measured in each of the composites of fish tissue, none exceeded the lowest OEHHA ATL thresholds indicating that these fish were safe to eat.
- Of the three lakes where fish were collected, only Lake Balboa had been sampled previously in 2009. For 2009, concentrations in tilapia were similar to concentrations measured in 2013, indicating no increasing or decreasing trend in contaminant concentration.

Introduction

This report is part of a series of monitoring reports produced for the Los Angeles River Watershed Monitoring Program (LARWMP). This report describes the monitoring activities and highlights of the monitoring data results for the years 2012 to 2014. This report expands the findings previously presented in reports generated from 2008 to 2011. Future reports will build on the analyses presented here and include additional analyses as needed. A comprehensive “State of the Los Angeles River Watershed” report was published in 2012 following the first 5 years of monitoring for the program. The next “State of the Watershed” report will be produced in 2018 following the next 5 years of monitoring for the program.

Motivation and Goals for the LARWMP

In 2007, local, state, and federal stakeholders formed the LARWMP to provide managers and the public with a more complete picture of conditions and trends in the Los Angeles River watershed. The objectives of the program are to develop a watershed-scale understanding of the condition (health) of surface waters and to improve the coordination and integration of existing monitoring efforts for both compliance and ambient conditions. The LARWMP incorporates elements of pre-existing water quality and biological monitoring in the watershed that focused on compliance monitoring around publicly owned Water Reclamation Plants (WRPs) and extends this to the entire watershed area. The LARWMP sampling design provides the ability to track trends at fixed (target) sites and to evaluate them in the context of conditions in the watershed by comparing them to data collected from random (probabilistically-selected) sites. This approach provides a more comprehensive picture of conditions in the watershed relevant to the questions that concern managers and the public.

The LARWMP is designed to answer the following five questions that are relevant to both watershed managers and the public:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

Implementation of the LARWMP was phased-in over two years, with a portion of the program commencing in 2008 and full implementation initiated in 2011 (Figure 1 and Table 1). The funding, sampling, analysis, and reporting effort for this program were shared by the Cities of Los Angeles and Burbank and the Los Angeles County Flood Control District (Table 2, Table 3, and

Table 4). A more complete description of the LARWMP regional setting, motivating questions, its technical design, and its implementation approach can be found in the Los Angeles River Watershed Monitoring Program Monitoring Plan (CWH 2009[1]), Annual Reports (CWH 2008, CWH 2009[2], CWH 2010, CWH 2013) and Quality Assurance Project Plans (CWH 2009 to 2014) posted on the project webpage: https://www.watershedhealth.org/resources.

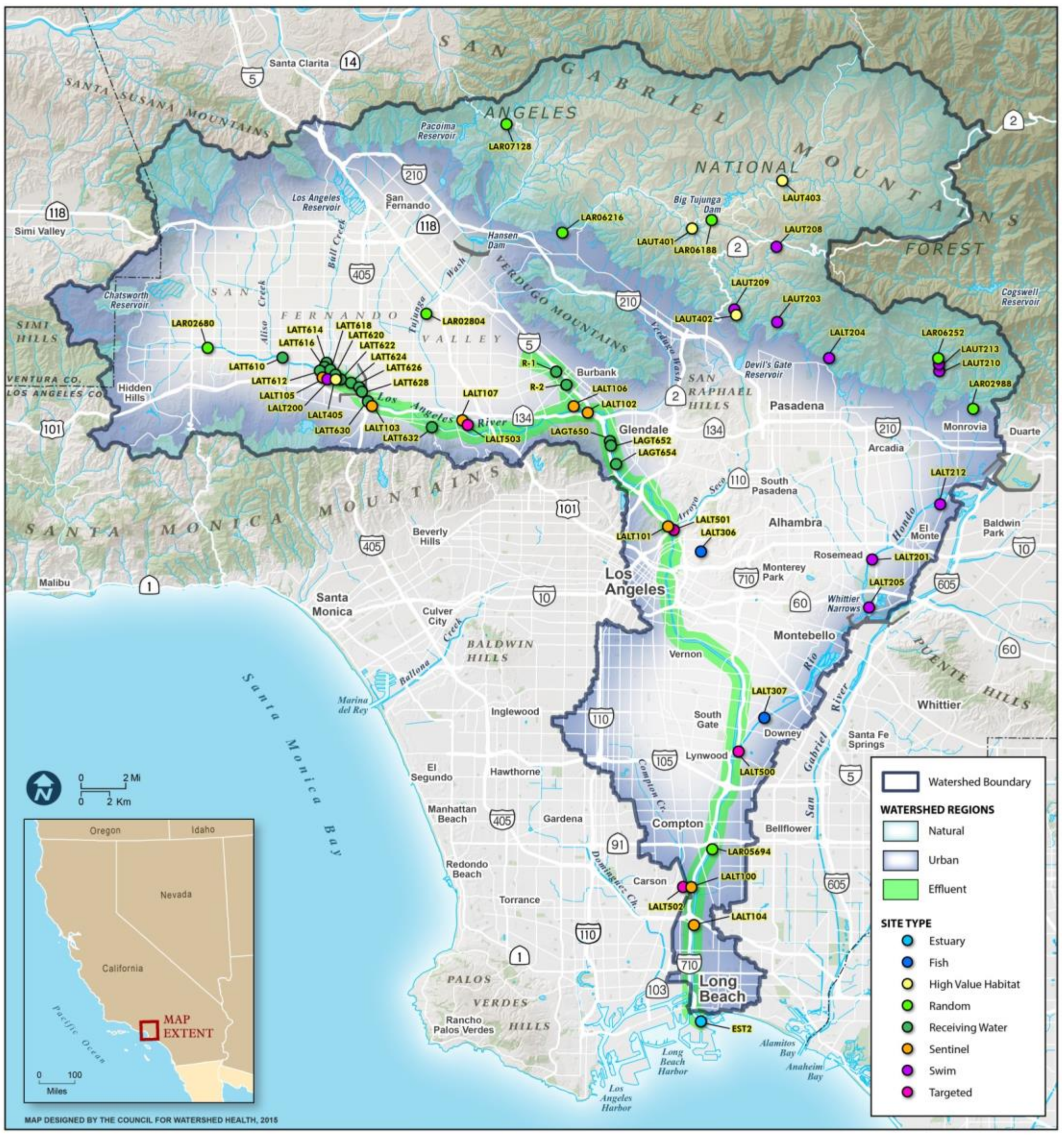


Figure 1. 2012 to 2014 sampling locations for the LARWMP.

Table 1. Monitoring design, indicators, and sampling frequency.

Question	Approach	Sites	Indicators	Frequency
Q1: What is the condition of streams?	Probabilistic design with streams assigned to natural, effluent-dominated, urban runoff dominated sub-regions	10 randomly selected each year	Triad: bioassessment using BMIs and attached algae, physical habitat, CRAM, water chemistry, toxicity	Annually, in spring and summer
Q2: What is the trend of conditions at unique areas?	Fixed target sites located to detect changes over time	9 high-value habitat sites[1]	Riparian habitat condition: CRAM	2-4 sites rotating annually in summer
		4 confluence sites to major tributaries/mainstem	Triad: bioassessment, physical habitat, water chemistry, toxicity	Annually, in spring/summer
		3 post fire sites: monitor recovery from Station Fire	Triad: bioassessment, physical habitat, water chemistry, toxicity	Annually, in spring/summer
		1 non-perennial stream site (3 visits in one year)	Triad: bioassessment, physical habitat, water chemistry, toxicity	Annually, in spring/summer
		1 LA River Estuary site	Sediment Quality Objective parameters: sediment chemistry, toxicity, infauna, chemistry, toxicity	Annually in the summer
		9 sentinel bacteria sites	*E. coli*	Weekly, May to Sept.
Q3: Are receiving waters near discharges meeting objectives?	Use existing NPDES water quality data collected by LA River dischargers from receiving waters upstream and downstream of their discharge points.	Sites located upstream and downstream of discharges: -Los Angeles/Glendale -City of Burbank -DC Tillman Water Reclamation Plant	Constituents with established water quality standards, e.g., CTR for dissolved metals; *E. coli* bacteria; trihalomethane(s)	Varies depending on permit: monthly, quarterly, annually
Q4: Is it safe to swim?	Swim sites selected based on use by the public	12 sites located in ponds, reservoirs, streams, and LA River	*E. coli*	Weekly, May to Sept.
Q5: Is it safe to eat locally caught fish?	Focus on popular fishing sites; commonly caught species; measuring high-risk chemicals	2 sites located in streams, reservoirs, lakes, rivers, and estuary	Measure mercury, selenium, DDT, and PCB in commonly caught fish at each location	Annually in summer

[1] High-value sites are locations of relatively isolated, unique habitat

Table 2. Sampling and laboratory analysis responsibilities for random and target sites for summer surveys from 2012 through 2014

Spring/Summer Sampling	Site ID	Chemistry sampling	Chemistry lab analysis	Chemistry funding	Benthic Macroinvertebrates sampling	Benthic Macroinvertebrates lab analysis	Benthic Macroinvertebrates funding	Toxicity sampling	Toxicity lab analysis	Toxicity funding	CRAM assessment	CRAM funding
Targeted Sampling @ LA River Confluences (2012 to 2014)												
Confluence of Rio Hondo	LALT500	ABC	EMD	Cities	Weston	Weston	LACDPW	ABC	EMD	Cities	ABC	Cities
Confluence of Arroyo Seco	LALT501	ABC	EMD	Cities	Weston	Weston	LACDPW	ABC	EMD	Cities	ABC	Cities
Confluence of Compton Creek	LALT502	ABC	EMD	Cities	Weston	Weston	LACDPW	ABC	EMD	Cities	ABC	Cities
Confluence of Tujunga Creek	LALT503	ABC	EMD	Cities	Weston	Weston	LACDPW	ABC	EMD	Cities	ABC	Cities
2012												
Big Tujunga Creek	LAR04880	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Cabarello Creek	LAR01656	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Pacoima Canyon	LAR02712	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Aliso Canyon Wash	LAR01464	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Big Tujunga Creek	LAR02568	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Santa Anita Wash	LAR04204	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Alhambra Wash	LAR01772	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Los Angeles River	LAR04532	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Santa Susana Creek	LAR01912	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Arroyo Seco	LAR02028	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
2013												
Wilbur Wash	LAR02488	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Limekiln Canyon Wash	LAR02232	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Los Angeles River	LAR03646	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Tujunga Wash **Dup**	LAR02484	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Big Tujunga Creek	LAR05640	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Arroyo Seco	LAR06044	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Rubio Wash	LAR02796	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Gold Creek	LAR05848	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Bell Creek Tributary	LAR02936	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Arroyo Seco	LAR05020	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
2014												
Random Samples												
Natural 1 (Big Tujunga Creek)	LAR06188	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Natural 2 (Santa Anita Wash)	LAR06252	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Urban 1 (Los Angeles River)	LAR02680	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Urban 2 (Sawpit Wash)	LAR02988	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Urban 3 (Tujunga Wash)	LAR02996	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Effluent 1 (Los Angeles River)	LAR05694	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Revisit Sites												
Revisit Site 1 (Big Tujunga Wash)[1.]	LAR00520	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Revisit Site 2 (Gould Mesa)[1.]	LAR00924	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Revisit Site 3 (Big Tujunga Wash)	LAR06216	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Non-Perennial Stream												
NP Site 1 (Pacoima Canyon)	LAR07128	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Post Fire Sites (2012 to 2013)												
Post Fire Site 1 (Big Tujunga Wash)	LAR00520	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Post Fire Site 2 (Gould Messa)[1.]	LAR00924	ABC	EMD	Cities	ABC	ABC	Cities	ABC	EMD	Cities	ABC	Cities
Estuary (2012 to 2014)												
Los Angeles River Estuary	LAREST2	ABC	EMD	Cities	EMD	EMD	Cities	ABC	EMD	Cities	NA	NA

Table 3. Sampling and laboratory analysis responsibilities for bacteria monitoring.

Spring/Summer Sampling	Site ID	Sampled In 2012	2013	2014	Microbiology sampling	lab analysis	funding
Swimming Sites							
Bull Creek Sepulveda Basin	LALT200	X	X	X	EMD/ABC	EMD	Cities
Millard Campground	LALT203	X	X		ABC	EMD	Cities
Eaton Canyon Natural Area Park	LALT204	X	X	X	ABC	EMD	Cities
LA-Glendale R7	LALT207	X	X	X	EMD	EMD	Cities
Peck Rd Park	LALT212	X	X	X	CWH	EMD	Cities
Hansen Dam	LALT214		X	X	ABC	EMD	Cities
Big Tujunga Delta Flat Day Use	LAUT206			X	ABC	EMD	Cities
Oakwilde Campground or Switzer Falls/Campground	LAUT208	X	X	X	ABC	EMD	Cities
Gould Mesa Campground	LAUT209	X		X	CWH	EMD	Cities
Sturtevant Falls	LAUT210	X	X	X	ABC	EMD	Cities
Hermit Falls	LAUT213	X	X	X	CWH	EMD	Cities
Sentinel Sites							
Status &Trend Del Amo	LALT100	X	X	X	LACDPW	EMD	Cities
Status &Trend Figueroa St	LALT101	X	X	X	LACDPW	EMD	Cities
LA River Riverside Dr Cross	LALT102	X	X	X	LACDPW	EMD	Cities
Tillman R7	LALT103	X	X	X	LACDPW	EMD	Cities
LACDPW at Wardlow St	LALT104	X	X	X	LACDPW	EMD	Cities
Tillman Site I	LALT105	X	X	X	LACDPW	EMD	Cities
Status &Trend Burbank	LALT106	X	X	X	LACDPW	EMD	Cities
Status &Trend Tujunga Moorpak	LALT107	X	X	X	LACDPW	EMD	Cities

Table 4. Sampling and laboratory analysis responsibilities for fish tissue bioaccumulation monitoring.

Fish Tissue Bioaccumulaiton Sites	Year	Site ID	Bioaccumulation sampling	lab analysis	funding
Legg Lake	2012	LALT308	ABC/DFG	EMD	Cities
Lake Balboa	2013	LALT301	ABC/DFG	EMD	Cities
Belvedere Lake	2014	LALT310	ABC/DFG	EMD	Cities

Methods

The methods employed for the 2012 to 2014 sampling surveys are briefly described in the following paragraphs, and include references to reports, standard operating procedures (SOPs), and other documents with additional detail. More detailed discussions of the procedures are provided in each report chapter and in the LARWMP Monitoring Plan and Quality Assurance Project Plans (QAPP) available for download from the project webpage: (https://www.watershedhealth.org/resources). The analytical methods for each chemical constituent measured in water (fresh and seawater), sediments, and fish tissues, are listed in Table 5.

Monitoring for Questions 1 and 2 were based on a Multiple Lines of Evidence (MLOE) approach, in which bioassessment (and its associated suite of physical habitat measurements), aquatic toxicity, and chemistry data provide a variety of perspectives on the condition of water and sediment quality at a site. The triad of measurements provides an opportunity to assess whether there are apparent linkages between observed levels of chemicals of concern, toxicity, and/or changes to physical habitat and impacts on the instream community itself. As shown in Table 2, ten random sites and four targeted sites located at major confluences located throughout the watershed were visited each year from 2012 through 2014.

Based on land use and other landscape characteristics, streams were assigned to one of three watershed sub-regions: relatively natural streams in the upper watershed, effluent-dominated streams of the mainstem and middle to lower watershed tributaries, and urban runoff- dominated streams in the developed portions of tributaries in the middle and lower watershed.

In 2014, the Technical Stakeholder Group (TSG) agreed to modify the LARWMP sampling design based on design changes made by the Southern California Stormwater Monitoring Coalitions (SMC) Regional Monitoring Program. This design change was made to help improve our ability to detect changing conditions not only in the Los Angeles watershed, but in the southern California region as a whole, and incorporated site revisits at sites previously sampled by the program. In addition, to better understand the condition of non-perennial stream systems in the watershed, one random site known to be non-perennial was sampled.

Bioassessment provides a measure of the structure of one or more components of a biological community and is a useful indicator of the ecological status of instream communities. The LARWMP employed benthic macroinvertebrates (BMIs), attached algae communities, and riparian wetland habitat condition for this purpose.

- The field protocols and assessment procedures for BMIs followed the protocols described by Ode (2007) and Fetscher *et al.* (2009). BMIs were collected using a D kick-net from eleven equidistant transects along a 150-m reach and were identified to Level 2 (generally genus) as specified by the Southwest Association of Freshwater Invertebrate Taxonomists, Standard Taxonomic Effort List (SAFIT; Richards and Rogers 2006). The California Stream Condition Index (CSCI) was used for the first time to assess the BMI community condition (Rehn et al. 2015).
- Riparian wetland condition was assessed using the California Rapid Assessment Method (CRAM; Collins et al. 2008). Briefly, the CRAM method assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. Each of these attributes is comprised of several metrics and sub-metrics that are evaluated in the field for a prescribed assessment area. Streams in reference condition are expected to have a CRAM score of 79 (Mazor 2015). In addition, because CRAM scores provide insight into a stream's physical condition, it is often used as a surrogate for abiotic stress.

Physical habitat conditions were assessed using a method originally developed by the USEPA and modified by SWAMP for use in California (Fetscher and McLauglin, 2008). This method focuses on the habitat conditions found in the streambed and banks. A method for summarizing these data that would allow for comparison of overall habitat conditions across sites is not yet available. However, some of the data types collected by this method (canopy density, substrate size, etc.) were used to evaluate sites using multivariate statistics. In addition to these measures, the LARWMP used the CRAM to more broadly characterize the overall biology of the riparian system (Collins et al. 2008). The greater the CRAM score, the better the biotic, physical, hydrologic, and buffer zone condition of the habitat.

Aquatic toxicity bioassays provided another measure of potential impact, although the use of test organisms in the laboratory makes bioassays a less direct indicator of site-specific impacts than the bioassessment leg of the Triad. However, aquatic toxicity bioassay tests can furnish a more direct measure of potential impacts from chemical contaminants. The water flea (*Ceriodaphnia dubia*; USEPA-821-R-02-013) survival and reproduction test was used at each freshwater site. The silversides (*Menidia beryllina*; USEPA/600/4-91-003) 7-day survival test was used at the three estuary sites to test for water toxicity. Estuary sediment samples were tested for toxicity using the amphipod (*Eohaustorius estuarius*; USEPA-600/R-94/025) 10-day survival test and bivalve (*Mytilus galloprovincialis*; developed from Anderson, et. al, 1996 and Phillips, et. al, 2003) 48-hour development test.

As a requirement of their NPDES permits, the cities of Los Angeles and Burbank are required to monitor surface waters receiving effluent from their respective Water Reclamation Plants (WRPs). These monitoring sites are therefore located in the effluent-dominated portion of the watershed. Data collected by the cities of Los Angeles and Burbank from locations upstream and downstream of their WRPs were used to assess Question 3, "Are receiving waters near discharges meeting water quality objectives?"

The sampling and analysis methods used to assess Chapters 4, "Is it safe to swim?", and Chapter 5, "Is it safe to eat locally caught fish?", are included in each of those chapters, respectively.

Table 5. Analyte list and method for each program element.

Analyte	Method	Units	Reporting Limit
Conventional Water Chemistry			
Temperature	Probe	^{o}C	-5
pH	Probe	None	NA
Specific Conductivity	Probe	mS/cm	2.5
Dissolved Oxygen	Probe	mg/L	N/A
Salinity	Probe	ppt	N/A
Water Chemistry: freshwater			
Alkalinity as CaCO3	SM 2320 B	mg/L	10
Hardness as CaCO3	SM 2340 B	mg/L	1.32
Suspended Solids	SM 2540 D	mg/L	3
Nutrients			
Ammonia as N	EPA 350.1	mg/L	0.1
Nitrate as N	EPA 300.0	mg/L	0.1
Nitrite as N	EPA 300.0	mg/L	0.1
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Total Nitrogen	Calculated	NA	NA
Total Organic Carbon	SM 5310 C	mg/L	0.1
Dissolved Organic Carbon	SM 5310 C	mg/L	0.1
OrthoPhosphate as P	SM 4500-P E	mg/L	0.1
Phosphorus as P	SM 4500-P E	mg/L	0.1
Major Ions			
Chloride	EPA 300.0	mg/L	1.0
Sulfate	EPA 300.0	mg/L	1.0
Silica	SM 4500-Si D	mg/L	0.1
Metals			
Arsenic	SM 3114B	ug/L	1
Cadmium	EPA 200.8	ug/L	0.2
Chromium	EPA 200.8	ug/L	0.5
Copper	EPA 200.8	ug/L	0.5
Iron	EPA 200.8	ug/L	50
Lead	EPA 200.8	ug/L	1
Mercury	SM 3112 B	ug/L	0.2
Nickel	EPA 200.8	ug/L	1
Lead	EPA 200.8	ug/L	1
Selenium	SM 3114 B	ug/L	1
Zinc	EPA 200.8	ug/L	1
Organics			
Organophosphorus Pesticides (2012-13)	EPA 625	ng/L	2-16
Pyrethroid Pesticides	EPA 625 NCI	ng/L	0.005-0.01
Water Toxicity: Freshwater			
Chronic *Ceriodaphnia dubia*: primary test organism	EPA 821/R-02-013	% Survival, %reproduction	N/A

Chronic *Hyallela azteca*: secondary test organism if conductivity is > 2,500 µS/cm	EPA 821/R-02-013m	% Survival	N/A
Taxonomy: Freshwater			
Benthic Macroinvertebrate	SWAMP (2007), SAFIT STE	Count	NA
Qualitative Algae	SWAMP, In Development	Count	NA
Quantitative Diatom	SWAMP, In Development	NA	NA
Quantitative Algae	SWAMP, In Development	NA	NA
Habitat Assessments: Freshwater			
Freshwater Bioassessments	SWAMP (2007)	NA	NA
Freshwater Algae (collected in conjunction with bioassessments)	SWAMP (2010)	NA	NA
California Rapid Assessment Method (CRAM)	Collins et al., 2008	NA	NA
Water Chemistry: Estuary Seawater			
Alkalinity as CaCO3	SM 2320 B	mg/L	10
Hardness as CaCO3	SM 2340 B	mg/L	1.32
Suspended Solids	SM 2540 D	mg/L	3
Dissolved Solids	SM 2540 C	mg/L	37
Nutrients			
Ammonia	SM 4500-NH3 B&C; EPA 350.1	mg/L	0.1
Nitrate	EPA 300.0 or EPA 353.2	mg/L	0.1
Nitrite	EPA 300.0 or EPA 353.2	mg/L	0.1
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Dissolved Organic Carbon	SM 5310 C	mg/L	0.1
Total Organic Carbon	SM 5310 B	mg/L	0.1
OrthoPhosphate as P	SM 4500-P E	mg/L	0.1
Phosphorus as P	SM 4500-P E	mg/L	0.1
Metals			
Arsenic	SM 3114 B	mg/L	1
Cadmium	EPA 200.8 or 200.7	mg/L	0.2
Chromium	EPA 200.8 or 200.7	mg/L	0.5
Copper	EPA 200.8 or 200.7	mg/L	0.5
Iron	EPA 200.8 or 200.7	mg/L	50
Lead	EPA 200.8 or 200.7	mg/L	0.5
Mercury	SM 3112 B	mg/L	0.2
Nickel	EPA 200.8 or 200.7	mg/L	1
Selenium	SM 3114 B	mg/L	1
Zinc	EPA 200.8 or 200.7	mg/L	1
Organics			
Organophosphorus Pesticides (2012-13)	EPA 625	ug/L	0.002-0.016
Pyrethroid Pesticides	EPA 625-NCL	ug/L	0.002-0.005
Sediment Chemistry: Estuary			
Sediment Particle Size (% fines)	SM 2560 D	um	<2000->0.2
Metals			
Arsenic	EPA 6010 B	mg/Kg dw	1
Cadmium	EPA 6010 B	mg/Kg dw	1

Chromium	EPA 6010 B	mg/Kg dw	1
Copper	EPA 6010 B	mg/Kg dw	1
Iron	EPA 6010 B	mg/Kg dw	100
Lead	EPA 6010 B	mg/Kg dw	0.5
Mercury	EPA 7471 A	mg/Kg dw	0.01
Nickel	EPA 6010 B	mg/Kg dw	2
Selenium	EPA 6010 B	mg/Kg dw	1
Zinc	EPA 6010 B	mg/Kg dw	2
Nutrients			
Total Kjeldahl Nitrogen (TKN)	EPA 351.2; SM4500-N ORG B	mg/Kg dw	0.5
Total Organic Carbon	SM 5310 B	mg/Kg dw	0.05
Phosphorus as P	SM 4500-P E	mg/Kg dw	0.05
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	µg/Kg dw	1.7-83.3
Polychlorinated Biphenyl (PCBs)	EPA 8082	µg/Kg dw	0.5
Polynuclear Aromatic Hydrocarbons (PAHs)	EPA 8270C	µg/Kg dw	1.7
Sediment Toxicity: Estuary			
Chronic *Eohaustorius* sp. (sediment) 10 day survival	EPA 600/R-94/025	% survival	N/A
Chronic *Mytilus* Sediment Water Interface	EPA 600/R-95-136m	% development	N/A
Taxonomy: Sediment			
Infauna	SCCWRP (2008)*, SCAMIT STE	N/A	N/A
Habitat Assessments: Estuary			
California Rapid Assessment Method (CRAM)	Collins et al., 2008	NA	NA
Tissue Chemistry: Fish			
Percent Lipids	Bligh, E.G. and Dyer ,W.J. 1959.	%	NA
Metals			
Mercury	EPA 7471A	mg/kg ww	0.02
Selenium	EPA 6010B	mg/kg ww	0.25
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	µg/kg ww	1.7-83
Polychlorinated Biphenyl (PCBs)	EPA 8082	µg/kg ww	2
Indicator Bacteria			
Total Coliform and *E. coli*	SM 9223 B	MPN/100mL	10
Enterococcus	SM 9230 D (21st ed. on line)	MPN/100mL	10

Question 1. What is the condition of streams in the Los Angeles River Watershed?

To determine the condition of streams in the Los Angeles River watershed, data were collected at 60 random sites during seven annual surveys from 2009 through 2014 (10 sites in each year; Figure 2 and Table 6). Spatially, these sites were selected to represent conditions for the entire watershed and are equally representative of the three major sub-regions: natural streams in the upper reaches of both the mainstem and tributaries; effluent-dominated reaches in the mainstem and the lower portions of the estuary, and urban runoff-dominated reaches of tributaries flowing through developed portions of the watershed. The following sections present information on the aquatic chemical, toxicological, biological (stream invertebrates), and physical habitat characteristics of the stream segments, along with preliminary conclusions about the potential relationships among these three indicators of stream condition.

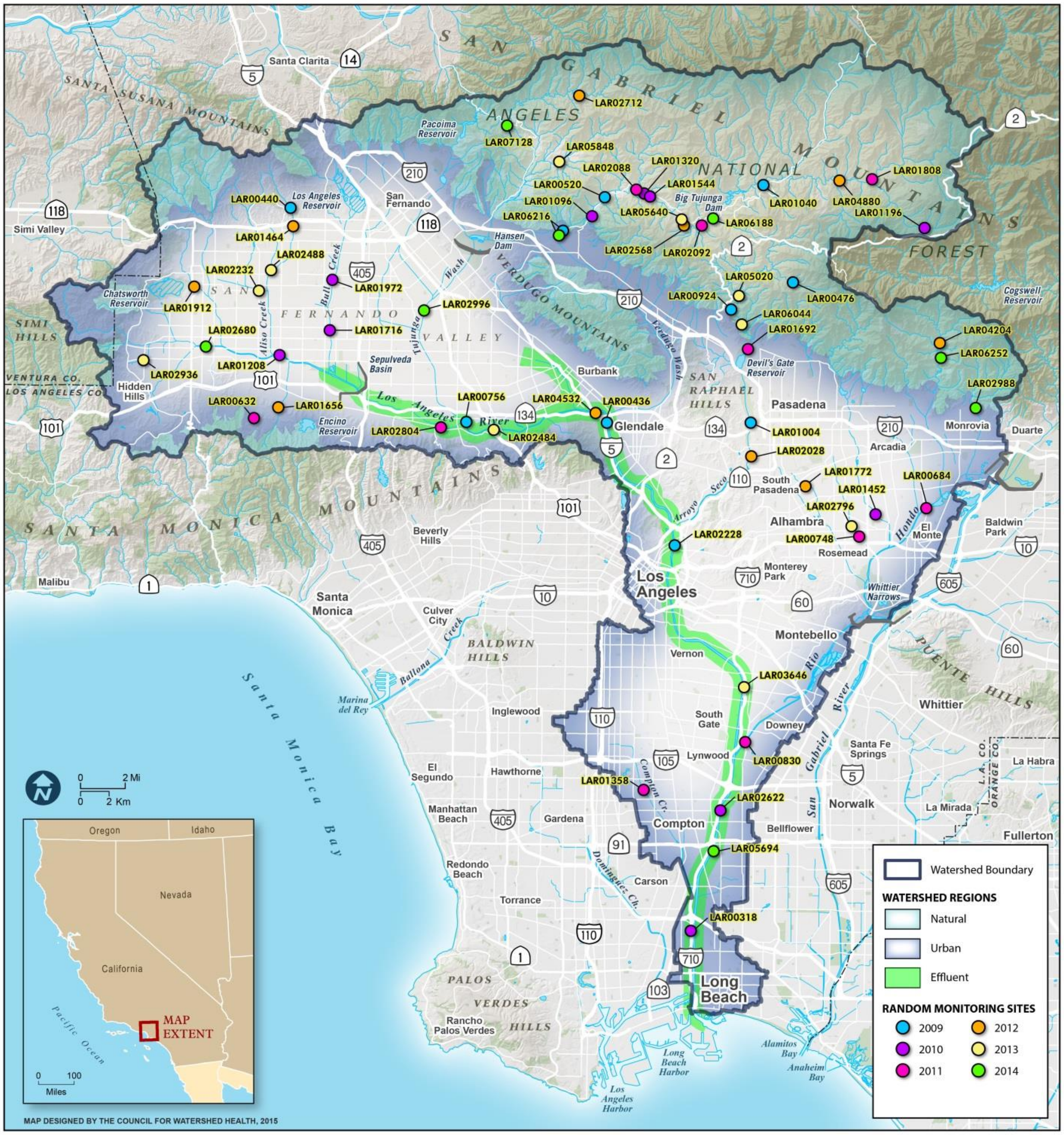


Figure 2. Map of all random sites sampled from 2009 to 2014.

Table 6. Summary statistics (2009 to 2014) for sites within the three watershed subregions.

Analyte	Natural				Effluent				Urban			
	n =	mean ± SD	Min	Max	n =	mean ± SD	Min	Max	n =	mean ± SD	Min	Max
Biotic Condition												
CSCI	24	0.95 ± 0.16	0.65	1.35	7	0.55 ± 0.14	0.35	0.72	25	0.50 ± 0.17	0.21	0.8
Riparian Zone Condition												
Overall Score (CRAM)	24	77.79 ± 10.15	63	99	7	36.86 ± 5.93	27	47	25	35.28 ± 3.74	27	40
Biotic Structure (CRAM)	24	70.02 ± 18.02	39	97	7	26.97 ± 6.36	22	36	25	26.11 ± 5.33	22	42
Buffer and Landscape Context (CRAM)	24	91.18 ± 6.62	75	100	7	59.11 ± 15.39	25	68	25	52.75 ± 15.54	25	68
Hydrology (CRAM)	24	81.59 ± 13.01	58	100	7	34.51 ± 11.21	25	58	25	35.65 ± 9.17	25	58
Physical Structure (CRAM)	24	67.71 ± 18.03	38	100	7	25 ± 0	25	25	25	25 ± 0	25	25
Physical Habitat												
% sand and fines	24	21.69 ± 8.86	9	42	7	7.62 ± 6.22	0	16	25	11.35 ± 20.13	0	79
% cobble & gravel	24	57.98 ± 12.97	37	80	7	3.13 ± 5.21	0	14	25	1.22 ± 3.66	0	16
% concrete/asphalt	24	0.04 ± 0.19	0	1	7	89.12 ± 7.17	80	100	25	86.86 ± 24.58	0	100
% Cover (Densiometer)	24	48.01 ± 34.4	0	100	7	2.94 ± 7.78	0	21	25	16.4 ± 23.76	0	95
% CPOM	24	13.99 ± 12.39	2	53	7	4.22 ± 5.09	0	12	25	10.74 ± 15.17	0	62
% Fast Water	24	59.48 ± 32.12	3	95	7	73.29 ± 29.47	33	100	25	33.36 ± 39.63	0	100
% Macroalgae	24	21.29 ± 19.19	0	70	7	66.47 ± 17.13	37	93	25	47.75 ± 27.1	0	88
% Macrophytes	24	2.62 ± 5.43	0	24	7	1.8 ± 2.4	0	7	25	1.46 ± 4.07	0	18
MicroalgaeThickness (mm)	24	2.98 ± 8.94	0	40	7	0.14 ± 0.11	0	0	25	0.1 ± 0.11	0	0
% Slow Water	24	39.95 ± 31.84	6	98	7	26.64 ± 29.52	0	67	25	66.64 ± 39.63	0	100
Mean Slope (%)	24	2.37 ± 1.52	1	8	7	0.53 ± 0.48	0	1	25	1.26 ± 1.18	0	5
Discharge (m3/sec)	23	0.76 ± 2.42	0	11	7	3.12 ± 1.12	2	4	23	0.39 ± 1.24	0	6
Eroded	24	8.69 ± 16.31	0	50	7	0 ± 0	0	0	25	0 ± 0	0	0
Stable	24	36.01 ± 38.83	0	100	7	100 ± 0	100	100	25	100 ± 0	100	100
Vulnerable	24	55.3 ± 34.56	0	100	7	0 ± 0	0	0	25	0 ± 0	0	0
Wetted Width (m)	24	4.61 ± 2.24	1	10	7	64.59 ± 35.56	19	99	25	6.18 ± 6.48	1	29
Visual Physical Habitat												
Channel Alteration	24	16.88 ± 3.1	10	20	7	0.86 ± 0.38	0	1	25	0.84 ± 0.47	0	2
Epifaunal Substrate	24	12.88 ± 3.95	4	18	7	1.14 ± 0.69	0	2	25	1.2 ± 0.65	0	3
Sediment Deposition	24	12.17 ± 4.11	4	20	7	16.71 ± 1.38	15	19	25	17.56 ± 3.65	4	20
In-situ Water Quality												
Oxygen, Dissolved (mg/L)	24	8.23 ± 0.96	6.66	10.48	7	11.5 ± 3.23	7.45	17.45	25	10.36 ± 2.65	7.3	16.8
pH	24	7.98 ± 0.39	7.1	8.51	7	8.66 ± 0.46	8	9.15	25	8.69 ± 0.83	7.4	10.8
Salinity (ppt)	24	0.22 ± 0.06	0.13	0.37	6	0.55 ± 0.05	0.47	0.6	25	0.68 ± 0.45	0.1	1.9
Specific Conductivity (us/cm)	24	436.31 ± 127.69	245	751	7	1084 ± 68.26	962	1154	25	1276.38 ± 819.05	7.8	3681
Temperature (deg C)	24	17.4 ± 3.78	10.97	25.03	7	23.82 ± 5.71	18.4	32.8	25	24.43 ± 6.21	13.8	35.3
General Chemistry												
Alkalinity (mg/L)	24	197.79 ± 37.71	119	270	7	154.57 ± 31.66	100	206	25	354.08 ± 871.05	77	4520
Hardness as CaCO3	22	200.73 ± 60.8	96	370	7	266.57 ± 37.58	196	310	23	486.91 ± 558.86	94	2540
TSS	18	3.53 ± 4.22	0	17	5	43.6 ± 30.36	12	94	18	128.39 ± 333.06	5	1330
Nutrients												
Ammonia as N	24	0.03 ± 0.02	0.03	0.08	7	0.06 ± 0.05	0.03	0.16	25	0.47 ± 1.98	0.03	9.95
Nitrate as N	24	0.08 ± 0.14	0.01	0.53	7	3.36 ± 1.35	0.98	5.2	25	1.1 ± 1.39	0.01	4.26
Nitrate/Nitrite as N	24	0.08 ± 0.14	0.01	0.53	7	3.43 ± 1.24	1.39	5.2	25	1.11 ± 1.41	0.01	4.33
Nitrite as N	24	0.01 ± 0	0.01	0.01	7	0.09 ± 0.15	0.01	0.41	25	0.02 ± 0.03	0.01	0.14
OrthoPhosphate as P	24	0.05 ± 0.03	0.03	0.12	7	0.16 ± 0.08	0.03	0.28	25	0.17 ± 0.19	0.03	0.77
Phosphorus as P	24	0.07 ± 0.06	0.01	0.22	7	0.33 ± 0.04	0.25	0.37	25	0.5 ± 0.5	0.01	2.19
TKN (mg/L)	24	0.34 ± 0.37	0	1.73	7	2.31 ± 0.28	1.91	2.8	25	3.22 ± 3.87	0.14	18.37
TN (mg/L)	24	0.68 ± 1.33	0	6.46	7	5.92 ± 1.36	3.87	8	25	5.87 ± 8.01	0.23	38.84
TOC	24	7.43 ± 20.3	0.18	102.22	7	7.76 ± 0.85	6.79	9.15	25	13.31 ± 10.95	2.5	42
Dissolved Metals												
Arsenic	22	1.18 ± 1.14	0.03	4.44	7	1.67 ± 0.95	0.31	3.08	23	2.35 ± 1.42	0.11	6.52
Cadmium	24	0.01 ± 0	0.01	0.02	7	0.19 ± 0.12	0.01	0.35	25	0.08 ± 0.09	0.01	0.32
Chromium	24	1.59 ± 1.59	0.07	7.26	7	1.58 ± 0.64	0.48	2.46	23	2.08 ± 1.72	0.48	7.5
Copper	24	1.21 ± 0.65	0.04	2.91	7	5.94 ± 2.98	1.47	8.99	25	10.38 ± 7.9	0.58	30.6
Iron	24	57.71 ± 72.18	2.6	337	7	42.96 ± 51.96	12.2	156	25	68.36 ± 66.17	2.5	253
Lead	24	0.09 ± 0.05	0.01	0.21	7	0.26 ± 0.14	0.06	0.46	25	0.31 ± 0.31	0.02	1.29
Mercury	24	0 ± 0.01	0	0.04	7	0 ± 0	0	0	25	0.01 ± 0.01	0	0.05
Nickel	24	1.44 ± 0.81	0.54	3.87	7	5.39 ± 2.12	1.69	7.81	25	8.93 ± 17.42	0.65	78
Selenium	24	0.13 ± 0.06	0.06	0.25	7	1.18 ± 0.48	0.22	1.58	25	1.84 ± 2.67	0.1	11.5
Zinc	24	3.29 ± 2.43	0.73	13.2	7	25.71 ± 10.52	8.39	42.2	25	9.42 ± 7.05	1.47	24.2

Biotic Condition

Appendix B, Table B-1, includes CSCI and CRAM results for each random station sampled from 2009 to 2014.

The California Stream Condition Index (CSCI) is a new statewide biological scoring tool that translates complex data about benthic macroinvertebrates (BMIs) found living in a stream into an overall measure of stream health (Mazor *et al.* 2015). In practice, CSCI scores observed from nearly 2000 study reaches sampled across California range from about 0.1 to 1.4. Mazor (*et al.* 2015) and Rhen (2015) suggested that for the purposes of making statewide assessments, three thresholds be established based on the 30^{th}, 10^{th}, and 1st percentiles of CSCI scores at reference sites (Figure 3). These three thresholds divide the CSCI scoring range into 4 categories of biological condition as follows: ≥0.92 = likely intact condition; 0.91 to 0.80 = possibly altered condition; 0.79 to 0.63 = likely altered condition; ≤0.62 = very likely altered condition. While these ranges do not represent regulatory thresholds, they provide a useful method for interpreting CSCI results.

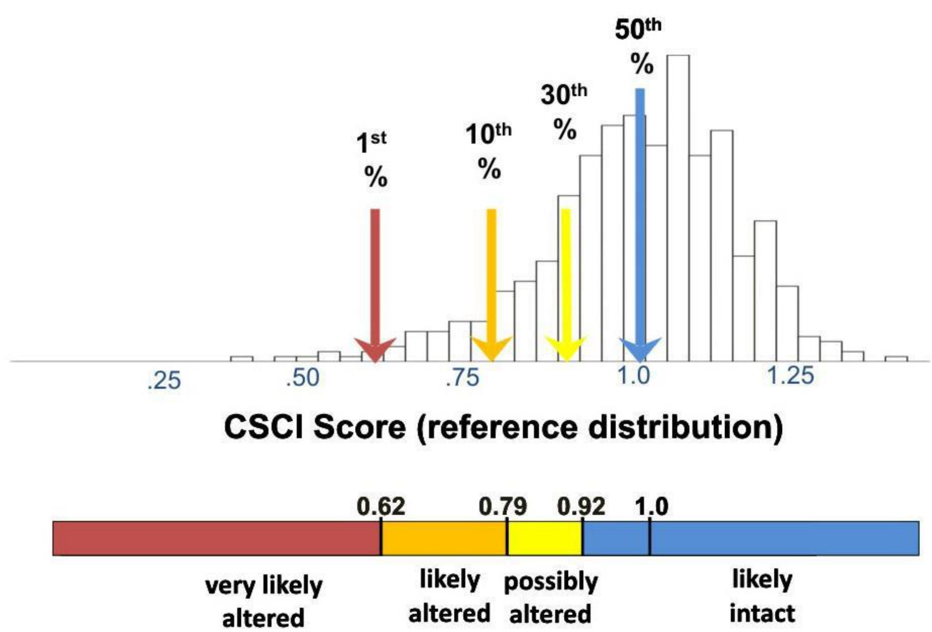


Figure 3. Distribution of CSCI scores at CA reference sites with thresholds and condition categories (Rhen et al., 2015).

There was a clear distinction between biotic condition in the upper and lower watersheds (Figure 4). Nearly all the sites sampled in the upper watershed had CSCI scores that were from ‘possibly altered’ to ‘likely intact’ and were indicative of communities in reference condition (CSCI ≥ 0.79). In contrast, CSCI scores were below reference condition at sites located in the lower watershed and effluent-dominated channel.

The cumulative frequency distribution for the index scores for biotic condition provides insight into the percentage of streams that are in reference and non-reference condition (Figure 5). Benthic macroinvertebrate communities were altered compared to a reference at approximately 55% of sites.

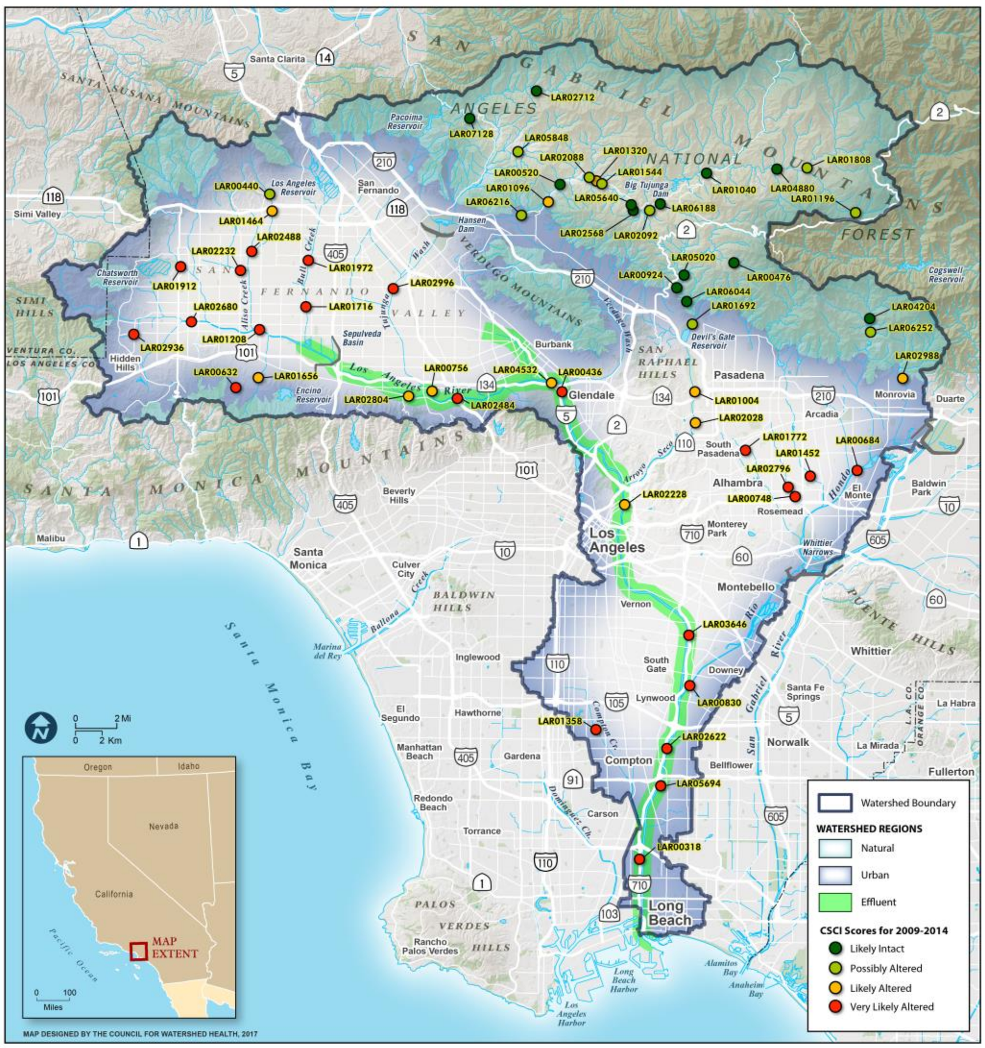


Figure 4. CSCI scores based on probabilistic sites sampled from 2009 to 2014. Likely intact condition = CSCI ≥0.92; possibly altered condition = CSCI 0.91 to 0.80; likely altered condition = CSCI 0.79 to 0.63; very likely altered condition = CSCI ≤0.62.

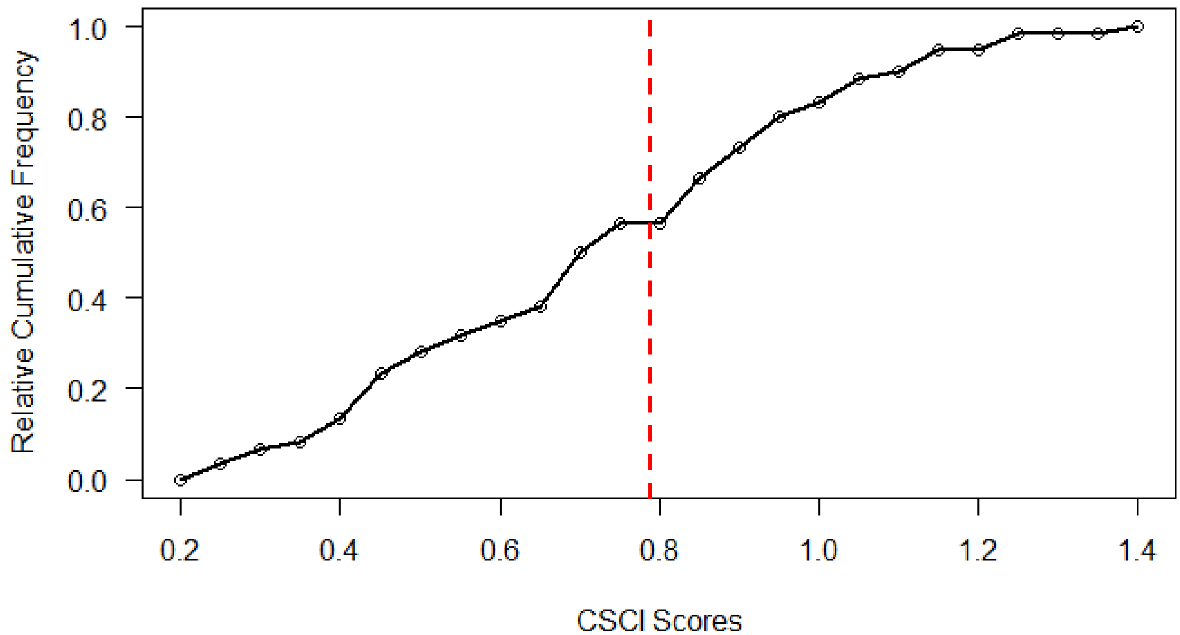


Figure 5. Cumulative frequency distribution of CSCI scores at random sites in 2009 and 2014.

Riparian Zone Condition

Riparian wetland condition was assessed using the California Rapid Assessment Method (CRAM; Collins et al. 2008, CWMW 2012 and CWMW 2013). Briefly, the CRAM method assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. Each of these attributes consists of several metrics and sub-metrics that are evaluated in the field for a prescribed assessment area. Streams in reference condition are expected to have a CRAM score of ≥79 (Mazor 2015). In addition, because CRAM scores provide insight into a stream's physical condition, it is often used as a surrogate for abiotic stress.

Streams in the watershed exhibit a broad range of physical habitat conditions in terms of overall integrity of the riparian and stream habitat (Figure 6). The overall CRAM scores at all sites ranged from 27% (with the minimum score possible of 27%) to 99% (out of a maximum possible score of 100%). The upper watershed, which is comprised of mostly natural streams, had the highest CRAM scores while the mainstem of Los Angeles River, which is a cement-lined channel, had the lowest CRAM scores (= 27).

Each CRAM score is composed of four individual attribute scores that define the condition of the riparian buffer zone, hydrology, and physical and biotic structure (Figure 6). Natural sites were characterized by wide, undisturbed buffer zones, good hydrologic connectivity, and a multilayer, interspersed vegetative canopy composed of native species. In contrast, the urban and effluent-dominant sites had no buffer zones, highly modified cement-lined channels, and lacked vegetative cover of any kind. Intermediate to these extremes were the urban sites that included areas that ranged from cement-lined channels to nearly undisturbed reaches.

The CRAM results underscore the contrast between the highly urbanized lower watershed and the relatively natural conditions found in the upper watershed. Development in the lower watershed has virtually eliminated natural streambed habitat and surrounding buffer zones. In most cases, the natural riparian vegetation has either been eliminated or replaced by invasive or exotic species.

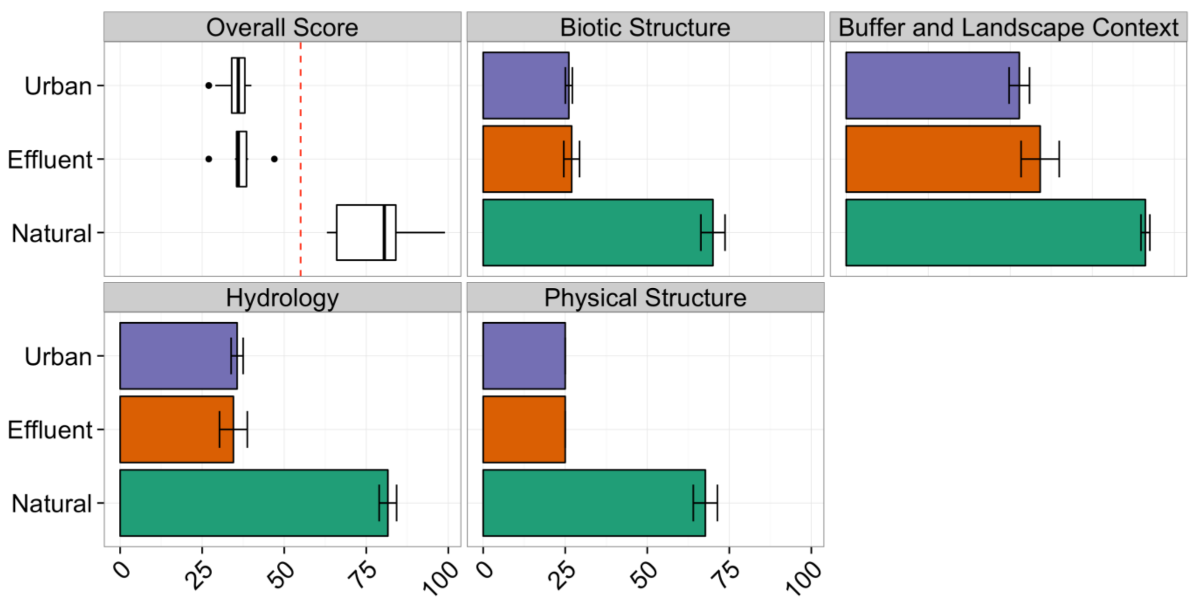
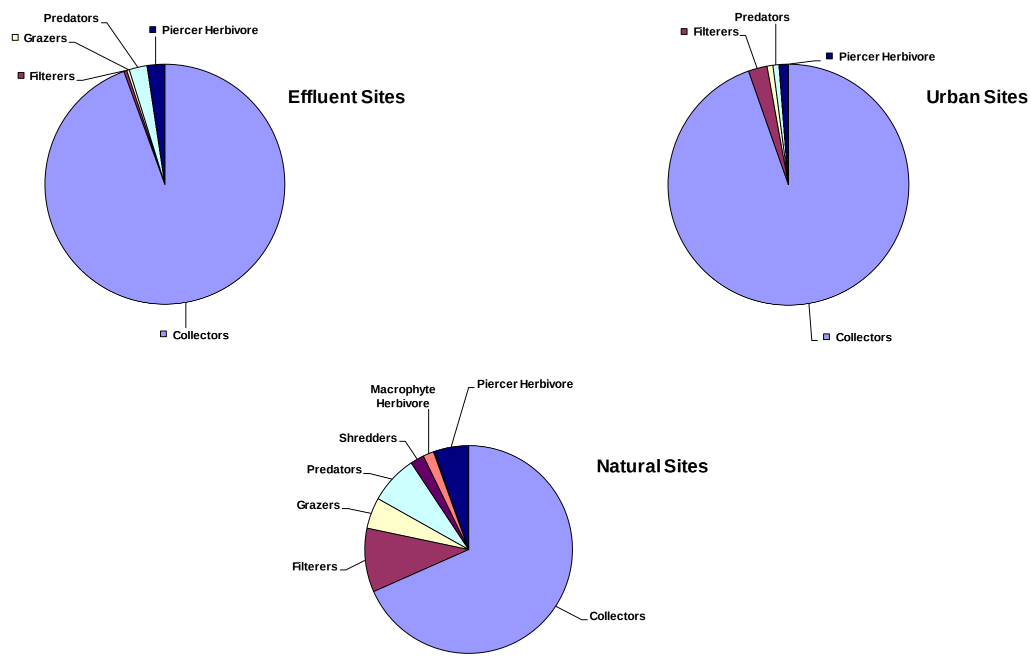


Figure 6. Median overall, represented by the dotted line, and individual attribute CRAM scores by watershed subregion for all random sites from 2009 to 2014.

Figure 7 shows the proportion of BMI feeding groups represented in each of the three watershed sub-regions for all random sites combined from 2009 to 2014. The effluent-dominated and urban portions of the watershed were dominated by collectors and each had five feeding groups represented. These parts of the watershed had mostly concrete-lined and/or highly channelized reaches with little or no canopy cover and substrate complexity. The upper watershed communities contained a large proportion of collectors, but also a more balanced assemblage represented by six feeding groups. Also, filterers were prevalent in this sub-region, generally indicating better water quality conditions (Vannote et al. 1980).

Figure 7. Relative proportion of macroinvertebrate functional feeding groups in each watershed sub-region for 2009 and 2014 random sites combined.



Aquatic Chemistry

The spatial variability of nutrients in the watershed is shown in Figure 8. Effluent-dominated and urban sites had greater median concentrations of nutrients compared to natural sites. Nitrate concentrations were elevated in the effluent-dominated stream segments, but these concentrations were below the basin plan objective of 10 mg/L-N for nitrate.

The median concentrations of dissolved metals were generally highest at sites dominated by urban runoff and POTW effluents (Figure 9 and Figure 10). Specifically, median cadmium and zinc concentrations were highest at effluent-dominated sites and arsenic and copper were higher at urban sites. The effluent-dominated reaches of the Los Angeles River are adjacent to major freeways including the I-5, CA-134 and I-710 (Figure 2). Emissions from transport (mechanical wear and tear of brake pads and tires of cars, overhead lines of rail vehicles etc.) are known nonpoint sources of metals.

Figure 11 shows the hardness-adjusted dissolved metal concentrations compared to the acute and chronic thresholds described by the California Toxics Rule (CTR). Copper concentrations exceeded the chronic thresholds on three occasions: at urban sites in Tujunga Wash upstream of the Los Angeles River confluence, and at Wilbur Wash and Limekiln Canyon Wash, both upstream of the confluence of Aliso Canyon Wash with the Los Angeles River. The chronic threshold for selenium was also exceeded on one occasion on the mainstem of the Los Angeles River below the confluence with Aliso Creek.

Over the three-year period from 2012 to 2014, 30 samples were collected from the random sites and analyzed for organophosphorus and pyrethroid pesticides (Table 7). Of the organophosphorus pesticides measured, only Diazinon was detected in a single sample from Limekiln Canyon Wash in 2013. Pyrethroid congeners were detected from six urban site samples, one in 2012 and the rest in 2013. The most commonly detected pyrethroids included bifenthrin, cyhalothrin, permethrin, cypermethrin, and deltamethrin.

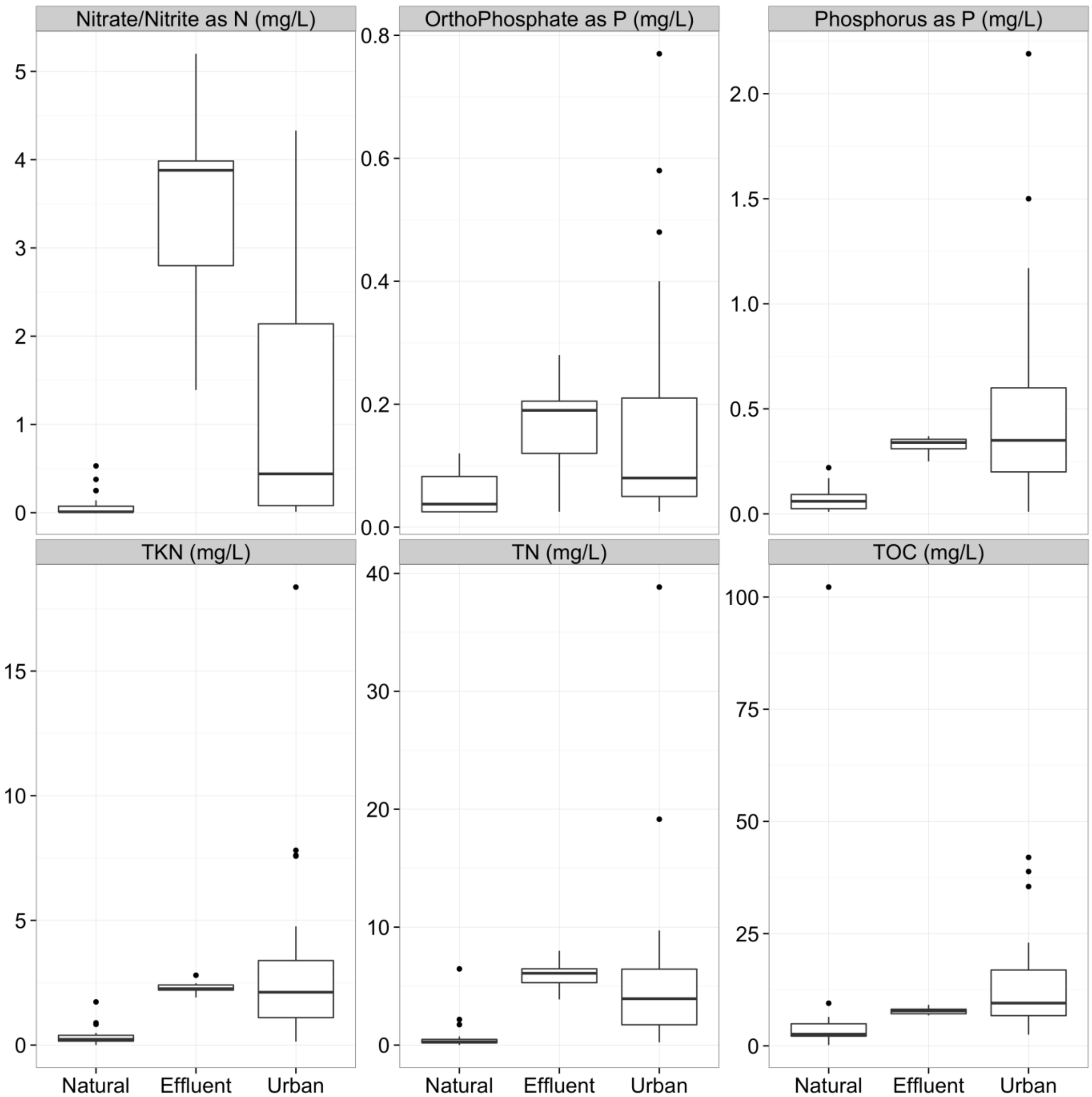


Figure 8. Box-and-whisker plots showing the median and range of representative nutrients measured in each of the three Los Angeles River watershed regions from 2009 to 2014.

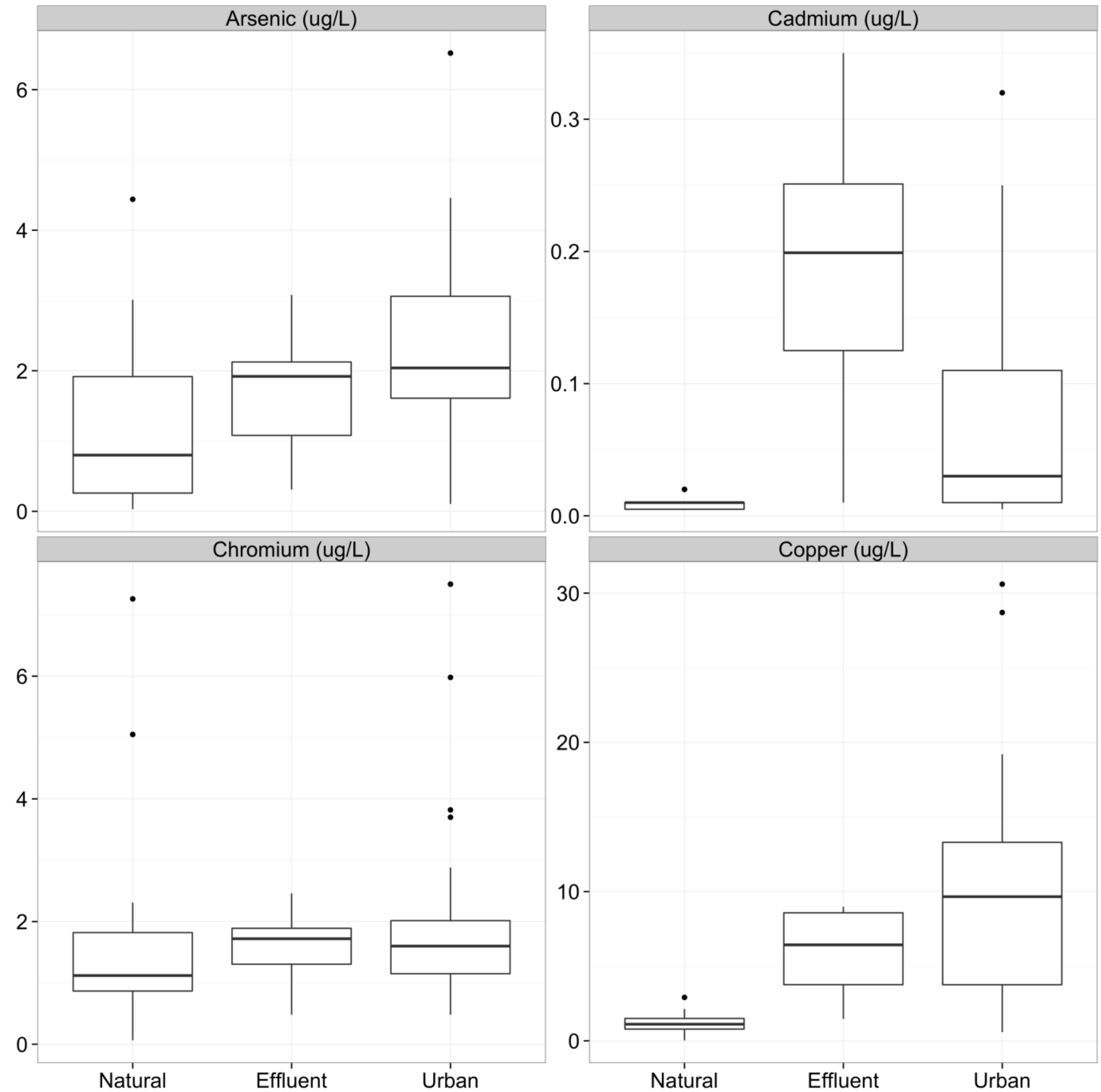


Figure 9. Box-and-whisker plots showing the median and range of representative dissolved metals measured in each of the three Los Angeles River watershed regions from 2009 to 2014.

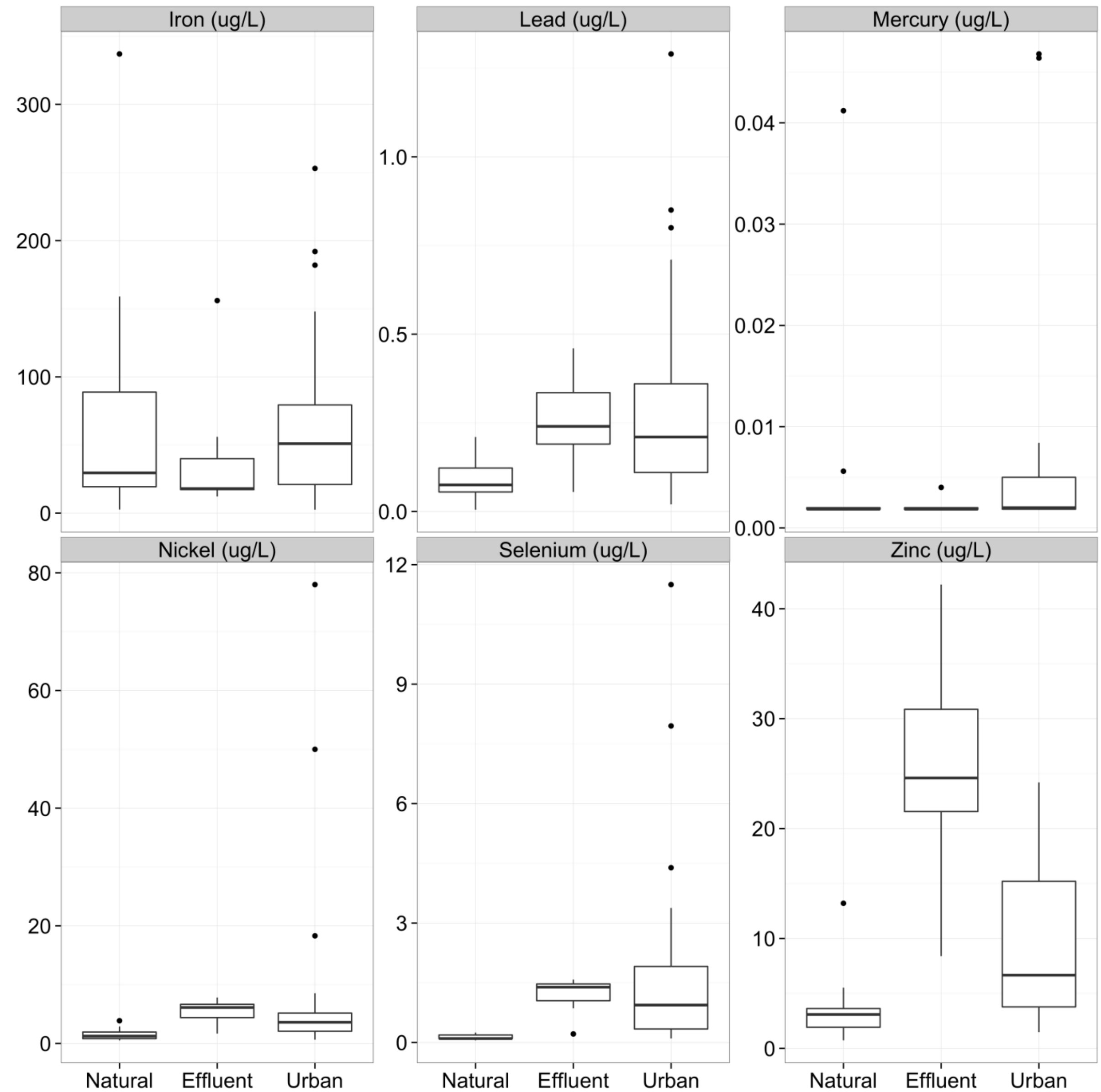


Figure 10. Box-and-whisker plots showing the median and range of representative dissolved metals measured in each of the three Los Angeles River watershed regions from 2009 to 2014.

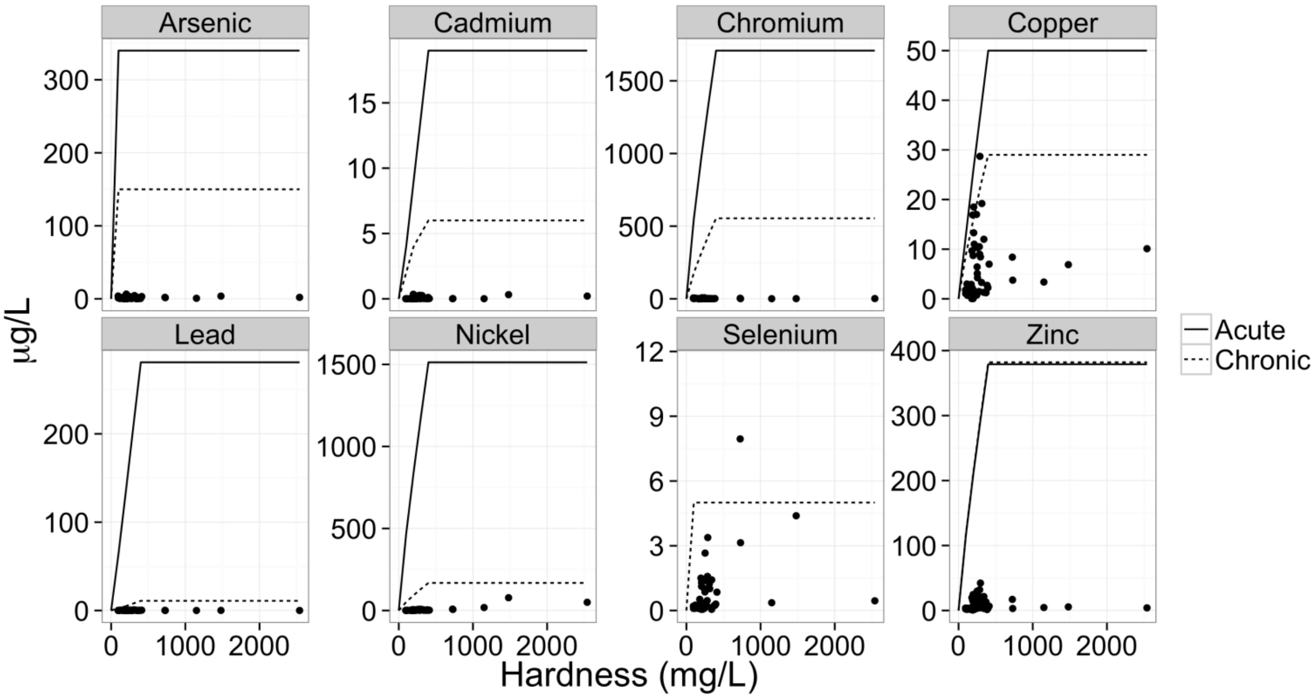


Figure 11. Dissolved metal concentrations at random sites compared to CTR chronic and acute thresholds from 2009 to 2014.

Table 7. Pyrethroid and organophosphorus pesticides measured above method detection limits (MDLs) from urban sites in the Los Angeles River watershed from 2012 to 2014.

StationCode	Station Description	Year	Group	Analyte	Result (ng/L)	MDL (ng/L)	RL (ng/L)
SMC01656	Cabarello Creek	2012	Pyrethroid	Bifenthrin	18.7	5	25
SMC02232	Limekiln Canyon Wash	2013	Pyrethroid	Bifenthrin	23.1	0.5	2
SMC02232	Limekiln Canyon Wash	2013	Organophosphorus Pesticide	Diazinon	64.7	2	4
SMC02484	Central Branch Tujunga Wash	2013	Pyrethroid	Bifenthrin	77.7	0.5	2
SMC02484	Central Branch Tujunga Wash	2013	Pyrethroid	Bifenthrin	59.6	0.5	2
SMC02488	Wilbur Wash	2013	Pyrethroid	Bifenthrin	34.6	0.5	2
SMC02488	Wilbur Wash	2013	Pyrethroid	Cyhalothrin	5.2	0.5	2
SMC02488	Wilbur Wash	2013	Pyrethroid	Permethrin, total	106.9	5	25
SMC02488	Wilbur Wash	2013	Pyrethroid	Permethrin-2	106.9	5	25
SMC02796	Rubio Wash	2013	Pyrethroid	Bifenthrin	20.4	0.5	2
SMC02796	Rubio Wash	2013	Pyrethroid	Cypermethrin, total	21.3	0.5	2
SMC02936	Bell Creek Tributary	2013	Pyrethroid	Bifenthrin	46	0.5	2
SMC02936	Bell Creek Tributary	2013	Pyrethroid	Cyhalothrin	8.2	0.5	2
SMC02936	Bell Creek Tributary	2013	Pyrethroid	Deltamethrin	14.3	0.5	2

Toxicity

Toxicity was evaluated with the 7-day *Ceriodaphnia dubia* survival (acute) and reproduction (chronic) test from a total of 30 samples collected during the 2012 through 2014 surveys (Table 8). Survival toxicity was only measured in one sample collected in 2014 from an urban site located in Sawpit Wash. In contrast, reproductive toxicity was measured in a total of 16 samples (53%) over the three years. The number of toxic samples decreased from eight occurrences in 2012, to five in 2013, and finally to three in 2014. Of the samples exhibiting reproductive toxicity, one (3%) was from the effluent-dominated channel, 8 (62%) from sites located at natural (mostly upper watershed) sites, and seven (58%) from lower watershed urban sites.

Reproductive toxicity at lower watershed effluent-dominated and urban sites makes intuitive sense owing to the numerous point and nonpoint source discharges located there. More surprising was the level of reproductive toxicity at the more natural, upper watershed sites where human influences are generally less concentrated. This pattern was also detected by the SMC Regional Monitoring Program in samples collected from upper watershed locations throughout the southern California region in 2009 and 2010 (Mazor 2015). For the most part, natural site reproductive toxicity disappeared in the region over the next few years. Several explanations have included a toxicity testing artifact resulting from differences in the composition of laboratory dilution water compared to ambient river water; the influence of the geomorphology of these upper watershed locations, or the potential effect of naturally occurring toxins (microcystins) released by cyanobacteria under certain environmental conditions (Fetscher et al. 2015).

Table 8. Water flea (*Ceriodaphnia dubia*) acute and chronic significant response endpoints for tests conducted in 2012 through 2014. Toxic endpoints included only control adjusted responses that were statistically significant and were greater than the 80% evaluation threshold level specified by SWAMP. Toxic endpoints = red; not toxic = green; inconclusive = yellow.

Station	Station Descrioption	Organism	Ceriodaphnia Toxicity	
			Survival	Reproduction
2012				
LAR04532	Effluent (Los Angeles River)	*Ceriodaphnia*	NSG	SL
LAR02568	Natural (Big Tujunga Creek)	*Ceriodaphnia*	NSG	NSG
LAR02712	Natural (Pacoima Canyon)	*Ceriodaphnia*	NSG	SL
LAR04204	Natural (Santa Anita Wash)	*Ceriodaphnia*	NSG	SL
LAR04880	Natural (Big Tujunga Creek)	*Ceriodaphnia*	NSG	SL
LAR01464	Urban (Aliso Canyon Wash)	*Ceriodaphnia*	NSL	SL
LAR02028	Urban (Arroyo Seco)	*Ceriodaphnia*	NSG	SL
LAR01656	Urban (Cabarello Creek)	*Ceriodaphnia*	NSG	SL
LAR01772	Urban (Alhambra Wash)	*Ceriodaphnia*	NSG	SL
LAR01912	Urban (Santa Susana Creek)	*Ceriodaphnia*	NSG	NSG
2013				
LAR03646	Effluent (Los Angeles River)	*Ceriodaphnia*	NSG	NSG
LAR05020	Natural (Arroyo Seco)	*Ceriodaphnia*	NSG	NSL
LAR05640	Natural (Big Tujunga Creek)	*Ceriodaphnia*	NSL	SL
LAR05848	Natural (Gold Creek)	*Ceriodaphnia*	NSL	SL
LAR06044	Natural (Arroyo Seco)	*Ceriodaphnia*	NSG	SL
LAR02232	Urban (Limekiln Canyon Wash)	*Ceriodaphnia*	NSG	NSG
LAR02484	Urban (Central Branch Tujunga Wash)	*Ceriodaphnia*	NSG	NSG
LAR02488	Urban (Wilbur Wash)	*Ceriodaphnia*	NSG	SL
LAR02796	Urban (Rubio Wash)	*Ceriodaphnia*	NSG	NSG
LAR02936	Urban (Bell Creek Tributary)	*Ceriodaphnia*	NSG	SL
2014				
LAR05694	Effluent (Los Angeles River)	*Ceriodaphnia*	NSG	NSG
LAR05020	Natural (Arroyo Seco)	*Ceriodaphnia*	NSG	NSG
LAR06216	Natural (Big Tujunga Creek)	*Ceriodaphnia*	NSG	SL
LAR07128	Natural (Pacoima Canyon)	*Ceriodaphnia*	NSG	NSL
LAR06188	Natural (Big Tujunga Creek)	*Ceriodaphnia*	NSG	SL
LAR06252	Natural (Santa Anita Wash)	*Ceriodaphnia*	NSG	NSG
LAR00924	Natural (Arroyo Seco)	*Ceriodaphnia*	NSG	NSG
LAR02680	Urban (Los Angeles River)	*Ceriodaphnia*	NSG	NSG
LAR02996	Urban (Big Tujunga Wash)	*Ceriodaphnia*	NSG	NSG
LAR02988	Urban (Sawpit Wash)	*Ceriodaphnia*	SL	SL
		(n=)		
	Total Number Toxic		**1**	**16**
	Effluent	**3**	**0**	**1**
	Natural	**13**	**0**	**8**
	Urban	**12**	**1**	**7**

NSG = treatment and control not significantly different and response greater than evaluation threshold
NSL = treatment and control not significantly different and response less than evaluation threshold
SL = treatment and control significantly different and response less than evaluation threshold

Chapter Summary: Question 1

This portion of the program is designed to assess the dry-weather ambient condition of streams in the watershed based on a probabilistic sampling design. Sixty random sites have been visited since 2009 and measured for biotic and riparian zone condition, water chemistry, toxicity, and physical habitat condition.

Key findings include:

- Biotic condition was measured using benthic macroinvertebrates (BMIs) and riparian zone condition. Each of the indices showed a clear delineation between reference-like conditions in the upper watershed and non-reference conditions in the lower watershed.
    - BMI community condition was measured using the new California Stream Condition Index (CSCI). BMI communities were healthiest in the upper watershed compared to the lower watershed, where lined and altered channels predominate. CSCI scores at just over 45% of sites in the watershed were below levels associated with reference condition.
    - Riparian zone physical habitat conditions ranged from nearly pristine in the upper watershed to highly degraded in the channelized lower watershed and effluent-dominated channel as measured by the California Rapid Assessment Method (CRAM). Similarly, physical habitat conditions as measured using SWAMP protocols followed this same pattern.
- Nutrients and metals were consistently lower at natural sites compared to urban and effluent sites from 2009 to 2014. Nutrients, especially nitrate, were greatest in the effluent-dominated channel, but these concentrations were below the basin plan objective of 10 mg/L-N. Most metals were greatest in the lower watershed at urban and effluent-dominated sites. Specifically, median cadmium and zinc concentrations were highest at effluent-dominated sites and arsenic and copper were higher at urban sites.
- There were few exceedances of dry-weather Basin Plan standards for any water quality parameters measured during the period. Nitrate and ammonia were well below the thresholds and there were few exceedances of the hardness adjusted CTR for any dissolved metal, except for copper, which exceeded the chronic standard on

three occasions, and selenium, which exceeded the chronic standards on one occasion. These elevated concentrations occurred in tributaries to the upper Los Angeles River.

- Of the 30 samples collected and measured for organophosphorus pesticides and pyrethroids over the three-year period, nearly all were below method detection limits.
- Of the 30 toxicity tests conducted from 2012 to 2014, 53% showed reproductive toxicity; one (3%) from the effluent-dominated channel, 8 (62%) from sites located at natural (mostly upper watershed) sites, and seven (58%) from lower watershed urban sites. There is no clear explanation for elevated reproductive toxicity in the natural, upper watershed parts of the watershed.

Question 2. Are conditions at areas of unique interest getting better or worse?

Question 2 addresses specific locations in the watershed that represent unique areas of special concern to the workgroup. For this purpose, four separate programs were created:

- Four target sites were established upstream of confluence points in the lower watershed, where bioassessment samples are collected to provide information regarding water quality trends over time (Figure 12). These sites differ from the random sampling component of the program in that their locations are fixed and are sampled each year. Over time these data are being used to assess trends and if changes in these trends can be attributed to natural, anthropogenic, or watershed management changes.

- One site in the Los Angeles River Estuary is located at the head of the Estuary near the Los Angeles River mainstem. This program was designed so that data assessment tools specific to sediment quality objectives (SQOs), developed by SWAMP, could be used to assess the condition of the Estuary (Bay et al. 2014).

- The Workgroup chose nine high-value locations with unique habitats to assess trends in riparian zone condition. The emphasis of these assessments is on habitat conditions rather than water quality, and they provide valuable baseline data for potential habitat restoration or protection efforts.

- Nine sentinel sites were established at major tributaries in the lower watershed and at one site in the estuary near the ocean to assess the concentrations of indicator bacteria emanating from different areas in the lower watershed. Since these sites were established in areas designated as 'non-swimmable', they are not part of the swimming safety program discussed later in this report.

Trends at Freshwater Target Sites

A total of 24 samples have been collected from the four target sampling locations during the six annual surveys from 2009 to 2014 (Figure 12 and Table 9). Samples were collected and analyzed for aquatic chemistry, toxicity, and biological and physical habitat conditions at each site. The goal of repeated annual sampling at these locations is to monitor changes in water quality conditions at four sub-regions of the watershed over time.

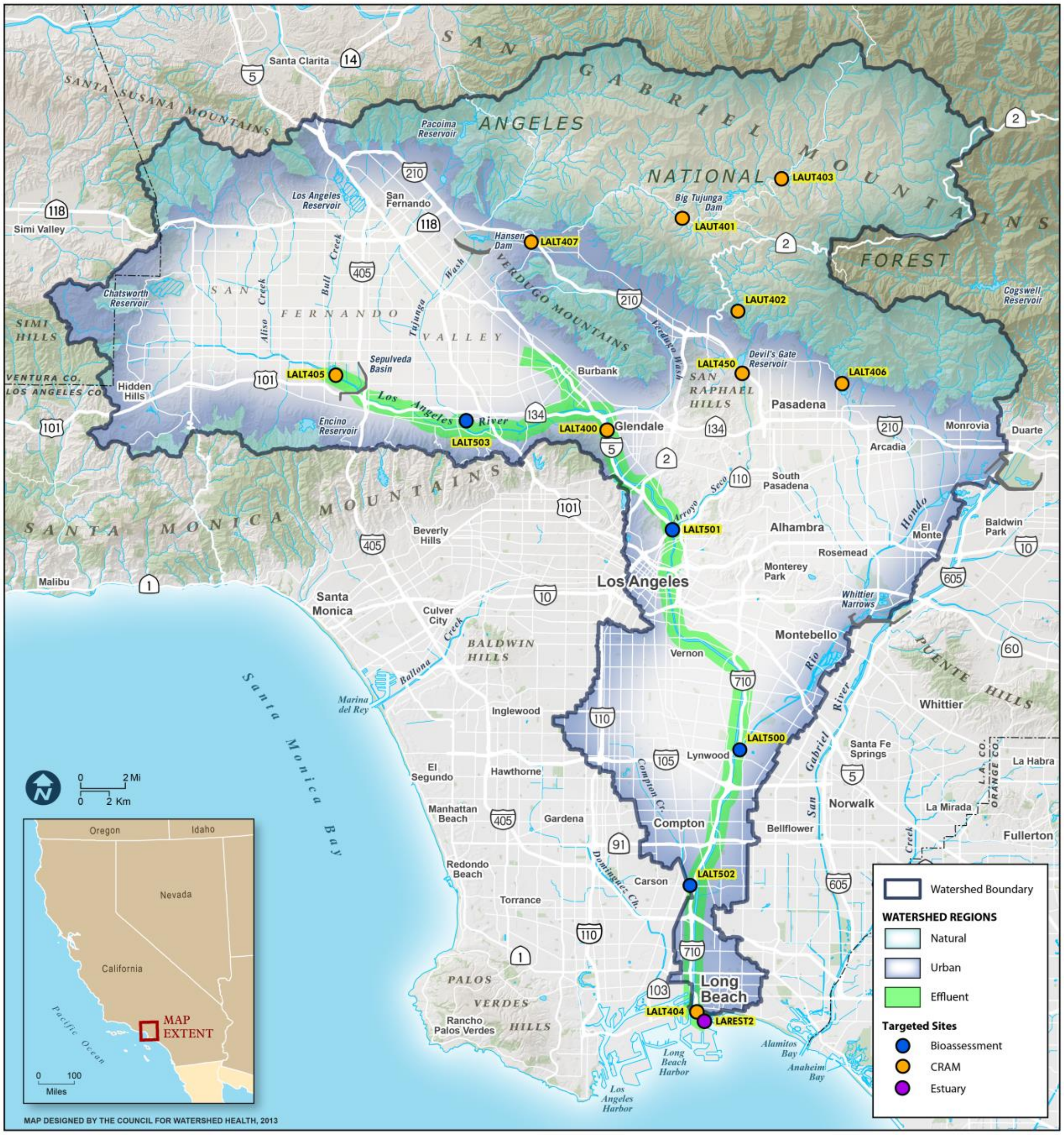


Figure 12. Location of confluence, estuary, and high-value habitat sites.

Table 9. Location of targeted confluence sites sampled from 2009 through 2014 for the LARWMP

Targeted Confluence Locations	Channel Type	Site ID	Latitude	Longitude
Confluence of Rio Hondo and mainstem of LA River	Lined	LALT500	33.93642	-118.17147
Confluence of Arroyo Seco and mainstem of LA River	Lined	LALT501	34.08059	-118.22475
Confluence of Compton Creek and mainstem of LA River	Unlined	LALT502	34.84529	-118.20784
Confluence of Tujunga Creek and mainstem of LA River (W. Burbank Channel)	Lined	LALT503	34.14833	-118.38916

Aquatic chemistry

Aquatic chemistry results were highly variable for most constituents during the six-year period, but some interesting trends were detected. Nitrate concentrations were greatest at the Arroyo Seco confluence (LALT501) across years, but were below the water quality threshold protective of human life (10 mg/L) specified in the Los Angeles Basin Plan (LARWQCB 2014) (Figure 13). Orthophosphate was consistently elevated at Compton Creek (LALT502) compared to the other sites, except in 2010 at the Burbank Channel (LALT503) where orthophosphate levels were also elevated. Total phosphorus concentrations were variable across years with no clear trend at any site.

Arsenic, copper, nickel, and zinc concentrations were routinely greater at the Western Burbank Channel (LALT503) during the six-year period (Figure 14 and Figure 15). Arsenic and copper concentrations in the Burbank Channel trended lower over the six years. Lead also trended lower at each site, except at the Arroyo Seco confluence (LALT501), which remained low during the six years.

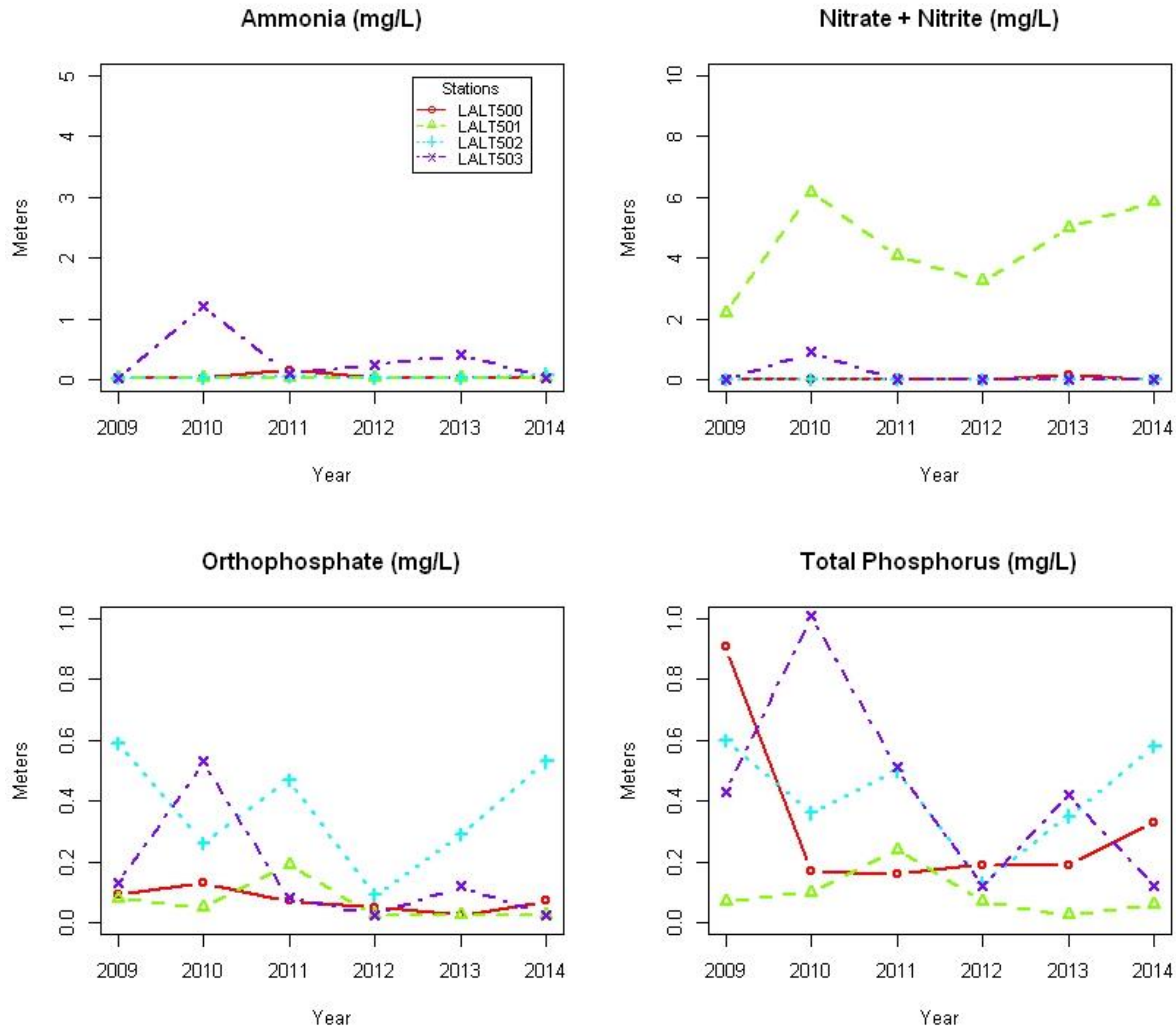


Figure 13. Nutrient concentrations at confluence sites sampled annually from 2009 to 2014.

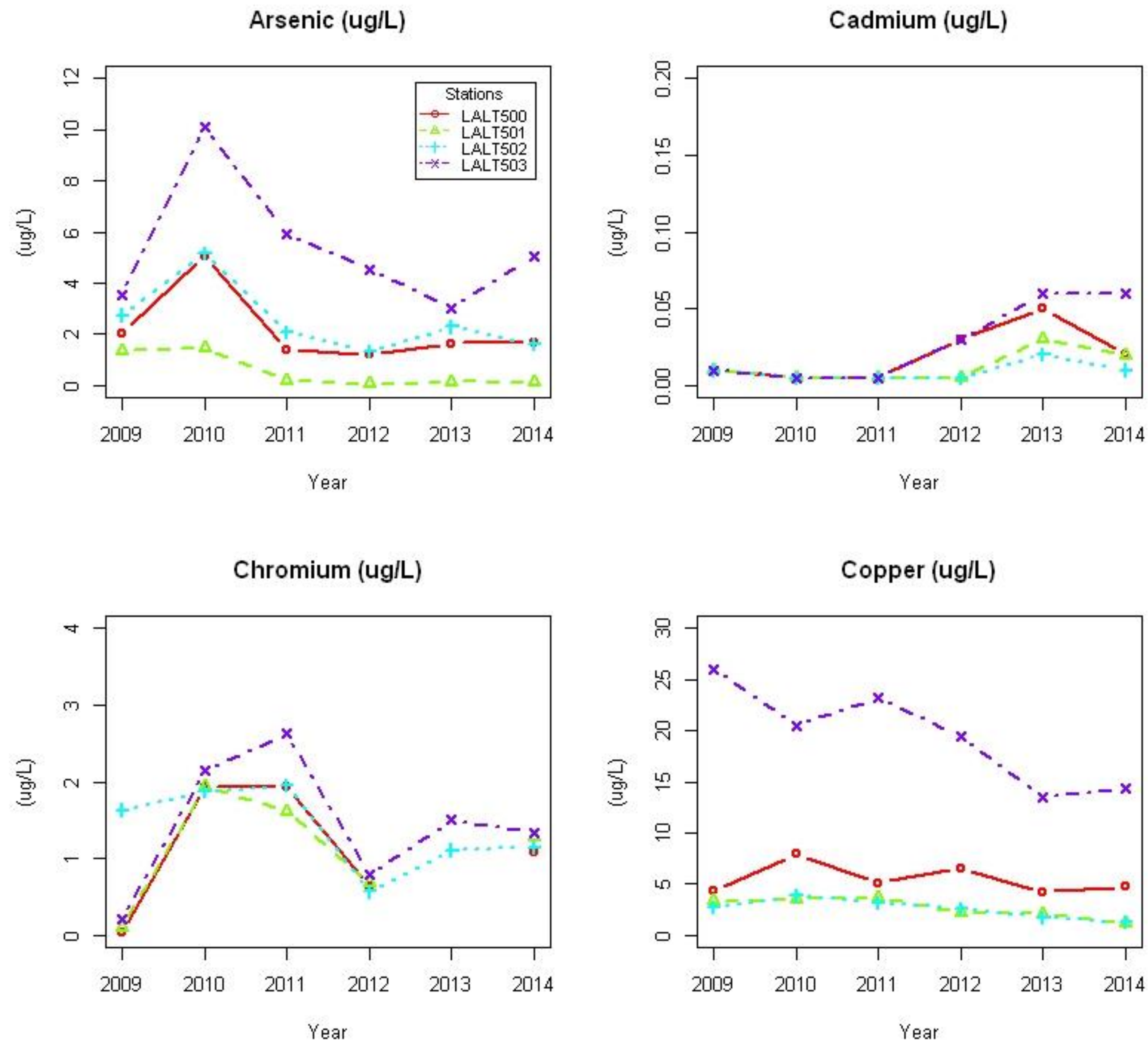


Figure 14. Dissolved metal concentrations (arsenic, cadmium, chromium, and copper) at confluence sites sampled annually from 2009 to 2014.

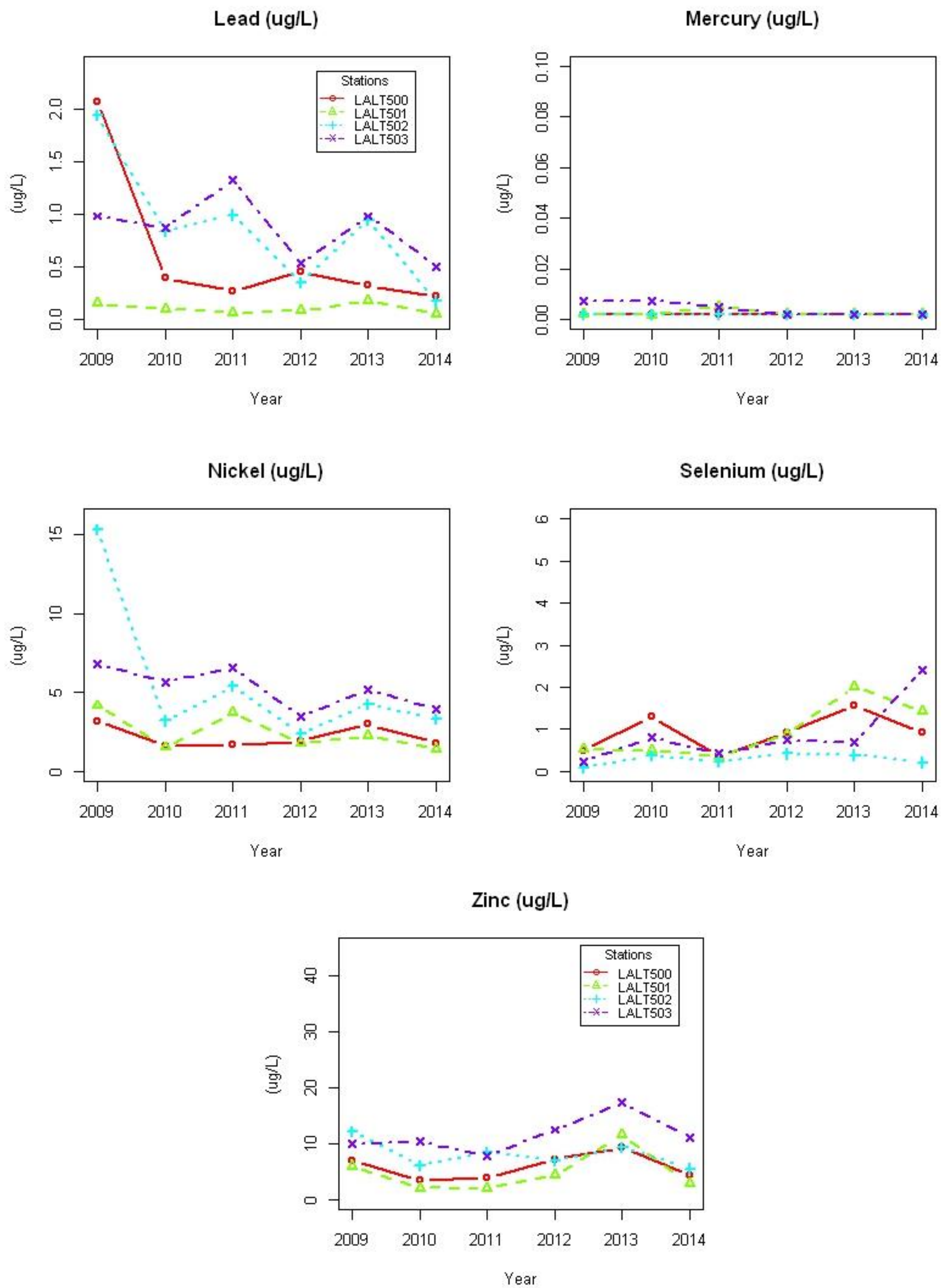


Figure 15. Dissolved metal concentrations at confluence sites sampled annually from 2009 to 2014.

Toxicity

Water toxicity was evaluated at the four target sites using the *Ceriodaphnia* acute and chronic toxicity test (Table 10). No survival (acute) toxicity was measured at any site during the 2012, 2013, or 2014 surveys. In 2014 the survival response at Tujunga Creek (LALT503) (78%), was less than the SWAMP evaluation threshold (80%), but this response was not statistically significant. Reproductive (chronic) toxicity was measured at station LALT501 at the confluence of the Arroyo Seco with the Los Angeles River in both 2012 and 2014. Additionally, in 2013 the chronic response at this site was below the SWAMP evaluation threshold, but this difference was not statistically significant. Water samples collected at this site in 2009 and 2011 (CWH 2013) also had reproductive toxicity, indicating a persistent toxicity problem at this site.

Table 10. Summary of *Ceriodaphnia dubia* acute and chronic toxicity responses at target sites from 2012 to 2014.

Station	Station Description	Ceriodaphnia Toxicity			
		Survival		Reproduction	
2012		% Control	Sig. Effect	% Control	Sig. Effect
LALT500	Confluence of Rio Hondo and mainstem of LA River	125	NSG	132	NSG
LALT501	Confluence of Arroyo Seco and mainstem of LA River	88	NSG	46	SL
LALT502	Confluence of Compton Creek and mainstem of LA River	100	NSG	112	NSG
LALT503	Confluence of Tujunga Creek and mainstem of LA River	113	NSG	139	NSG
2013					
LALT500	Confluence of Rio Hondo and mainstem of LA River	111	NSG	187	NSG
LALT501	Confluence of Arroyo Seco and mainstem of LA River	100	NSG	66	NSL
LALT502	Confluence of Compton Creek and mainstem of LA River	111	NSG	237	NSG
LALT503	Confluence of Tujunga Creek and mainstem of LA River	100	NSG	157	NSG
2014					
LALT500	Confluence of Rio Hondo and mainstem of LA River	111	NSG	174	NSG
LALT501	Confluence of Arroyo Seco and mainstem of LA River	89	NSG	50	SL
LALT502	Confluence of Compton Creek and mainstem of LA River	111	NSG	124	NSG
LALT503	Confluence of Tujunga Creek and mainstem of LA River	78	NSL	112	NSG
	Total Number Toxic	0		2	

SG = treatment and control not significantly different and response greater than evaluation threshold
NSL = treatment and control not significantly different and response less than evaluation threshold
SL = treatment and control significantly different and response less than evaluation threshold

Biological and Riparian Habitat (CRAM) Condition

Figure 16 presents the Southern California IBI (So CA IBI, Ode and Rhen 2005) and CRAM scores (overall and attribute) for the targeted sites sampled from 2009 to 2014. The biological condition at each of the four sites scored in the 'very poor' range for all six years compared to 'reference site' conditions in Southern California. CRAM scores were well below the 10th percentile of sites in reference condition in California (79). This is not surprising given that these sites are in highly modified channels in the urbanized portion of the watershed. In addition to good water quality conditions, healthy benthic macroinvertebrate communities require complex instream and riparian cover and a wide and undisturbed riparian and buffer zone.

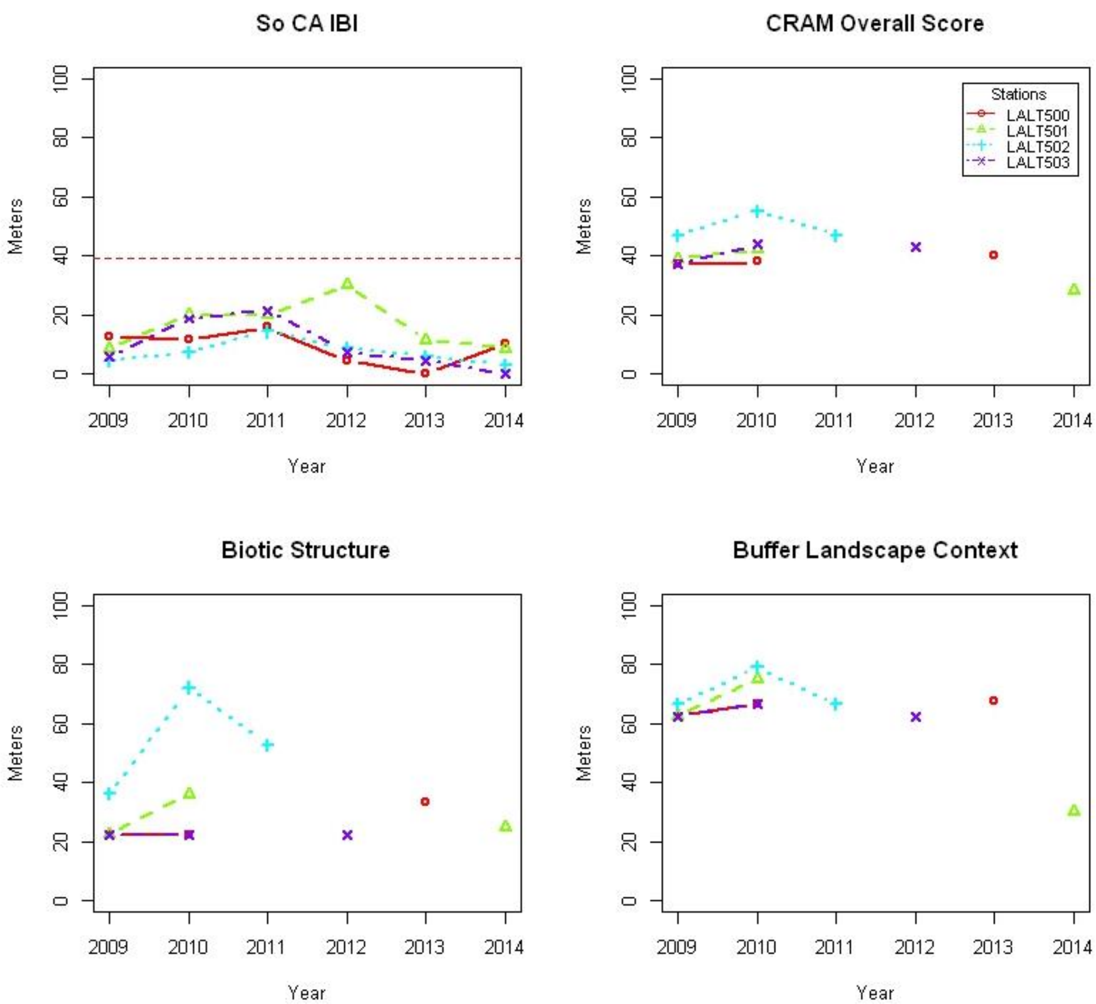


Figure 16. Southern CA IBI and CRAM scores (overall and attribute) at confluence sites sampled annually from 2009 to 2014. The red horizontal line on the IBI graph indicates the threshold (39) below which the biotic condition is in non-reference condition.

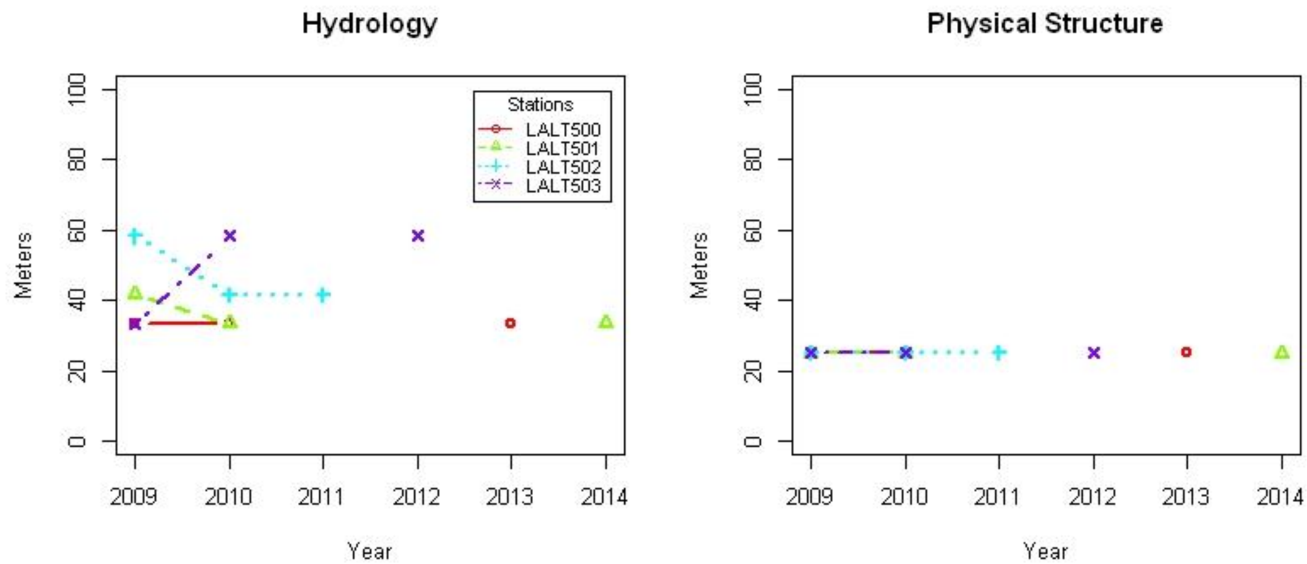


Figure 16. continued.

Los Angeles River Estuary

Sediment samples were collected from 2009 through 2014 at the mouth of the Los Angeles River Estuary near Queensway Bridge (LAREST2; Figure 12). The design of the LARWMP estuary monitoring program is based on a multiple lines of evidence (MLOE) approach developed by SCCWRP for the State of California's Sediment Quality Objectives (SQO) program (Bay *et al.*, 2014). This approach incorporates sediment chemistry, toxicity, and biological community assessments to evaluate the condition of sites located in marine embayments in southern California. The results of each of these analyses represent a line of evidence (LOE) that is converted to a condition category score. The three condition category scores are then combined to provide a single-station assessment category.

Sediment chemistry testing included the suite of metals and organic constituents specified in the SQO program (Bay *et al.*, 2014). Toxicity testing included the 10-day amphipod (*Eohaustorius estuarius;* U.S. EPA600/R-94-025) survival test and the 48-hour mussel (*Mytilus galloprovincialis*; Anderson et al. 1996) development test. Infauna samples were collected and analyzed in adherence to protocols of the Southern California Bight Regional Monitoring Program (SCCWRP 2008).

Sediment Quality Objectives

The integrated SQO's category scores for the Los Angeles River Estuary site are provided in Table 11 (Bay *et al.* 2014). In 2010, 2013 and 2014, integrated scores could not be calculated due to missing data for either chemistry or toxicity. For the years when integrated scores could be calculated, EST2 ranked from 'unimpacted' to 'clearly impacted'.

The integrated SQO chemistry scores ranged from 'highly disturbed' in 2009, to 'moderately disturbed' in 2010, 2011 and 2012, indicating some reduction in sediment contaminant concentrations. The integrated toxicity scores ranged from 'non-toxic' in 2011 to 'moderately disturbed' in all other years, except 2013 when they were 'minimally disturbed'. The integrated infauna scores ranged from 'minimally disturbed' in 2010 and 2011, to 'high disturbance' in 2012.

These results indicate that the distributions of contaminants are highly variable on a temporal scale. Annual scouring due to winter runoff from the Los Angeles River leads to replacement of sediments leading to these large changes in biotic habitat conditions.

Table 11. Integration of chemistry, toxicity, and infauna category scores for estuarine sediment quality objectives through 2014. Category scores range from: (1) reference; (2) minimal disturbance; (3) moderate disturbance; (4) high disturbance.

Metric	2009	2010	2011	2012	2013	2014
Chemisty						
CA LRM	4	3	4	4	Not Analyzed	Not Analyzed
CSI	3	2	2	2	Not Analyzed	Not Analyzed
Integrated Chemistry Score	4	3	3	3	Not Analyzed	Not Analyzed
Toxicity						
Eohaustorius estuarius	3	Not Analyzed	1	4	2	4
Mytilus galloprovincialis	3	3	1	1	1	2
Integrated Toxicity Score	3	3	1	3	2	3
Infauna						
BRI	2	1	2	4	1	3
IBI	3	2	1	4	3	3
RBI	4	1	2	4	3	3
RIVPACS	2	2	1	4	4	2
Integrated Infauna Score	3	2	2	4	3	3
Site Assesment	Clearly Impacted	NA	Unimpacted	Likely Impacted	NA	NA

High-Value Habitat Sites

The condition of the riparian zone was assessed at nine sites deemed by members of the Workgroup to be minimally impacted, high-value, or high-risk sites in the watershed (Table 12). The goal of measuring the condition of these sites over time is to ensure that conditions are not degrading. The riparian zone was assessed using the California Rapid Assessment Method (CRAM), which is comprised of sets of habitat metrics, including physical, biotic, hydrological, and buffer attributes. CRAM assessments at these sites commenced in 2009. After two to four years of annual visits, the Workgroup determined that subsequent visits would occur every two to three years since conditions at these locations were not changing rapidly.

Figure 17 shows the individual CRAM scores from 2009 to 2014 for the high-value sites. The CRAM scores at each of the lower watershed sites (prefix LALT) fell below the 10^{th} percentile of the reference distribution of sites throughout California, indicating they were 'likely altered'. The best riparian zone conditions were found at sites located in the upper watershed (prefix LAUT) with the CRAM scores at Alder Creek (LAUT403) just at or above the threshold during each site visit. Station LAUT401 and LAUT402, located in the Tujunga Sensitive Habitat and the Upper Arroyo Seco, respectively, burned during the 2009 Station Fire and fell below the 10^{th} percentile threshold in 2009, but then improved over the next set of site visits to well above the 10^{th} percentile of the reference distribution.

Table 12. Location of high value habitat sites.

Site Name	Channel Type	Site ID	Latitude	Longitude
Arroyo Seco USGS Gage	Unlined	LALT450	34.18157	-118.17297
Glendale Narrows	Unlined	LALT400	34.139368	-118.2752
Golden Shores Wetlands	Unlined	LALT404	33.76442	-118.2039
Sepulveda Basin	Unlined	LALT405	34.17666	-118.49335
Eaton Wash	Unlined	LALT406	34.17463	-118.0953
Haines Creek Pools and Stream	Unlined	LALT407	34.2679	-118.3434
Tujunga Sensitive Habitat	Unlined	LAUT401	34.28220	-118.22160
Upper Arroyo Seco	Unlined	LAUT402	34.22121	-118.17715
Alder Creek	Unlined	LAUT403	34.30973	-118.14190

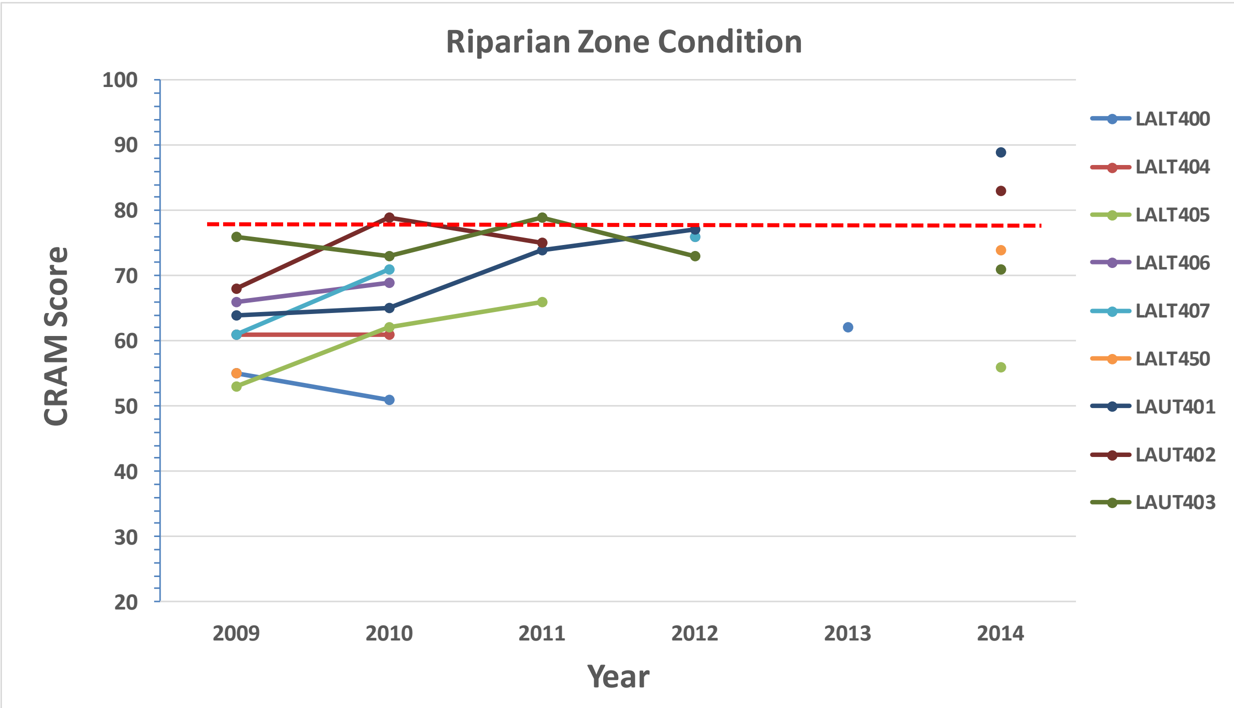


Figure 17. Riparian zone condition (CRAM scores; 2009-2014) at high-value sites. The red horizontal line represents the 10th percentile of the reference distribution of sites in California. Scores below this line represent 'likely altered' habitat.

Sentinel Site Bacteria

The sentinel site program included the weekly collection of samples at six confluence points to the Los Angeles River from May to September in the lower watershed with the intent of quantifying the concentrations of *E. coli* emanating from different areas of the lower watershed (Figure 18 and Table 13). These sentinel sites are not REC-1 recreational swim sites and public access is not allowed.

A second component of the program includes twice weekly sampling for *E. coli,* and *Enterococcus* bacteria at Queensway Drive Bridge located at the lower end of the Estuary before its confluence with the Pacific Ocean. The purpose of including this site is to assess the overall contribution of bacteria from the watershed to the estuary. Eventually, bacteria concentrations in the estuary may be linked to conditions on near shore beaches. It is important to understand that this site is not within a recreational swimming area.

Analyses for all indicator bacteria were conducted using Colilert™ (SM9223) for *E. coli,* and Enterolert™ for *Enterococcus* bacteria. Each of the bacteria data sets were compared against State of California REC-1 swimming standards (LARWQCB 2014) (Table 14). The sentinel sites are not REC-1 bathing waters and public access has only recently been authorized at two specific locations on the Los Angeles River. Bacteria concentrations measured at these sites are compared against REC-1 standards to provide context.

Figure 18. Map of all sentinel bacteria sites sampled from 2012 to 2014.

Table 13. Sentinel and estuary site station codes.

Program Element	Sampling Sites	Site Codes
Sentinel	Status & Trend Del Amo	LALT100
	Status & Trend Figueroa St	LALT101
	LA River Riverside Dr Cross	LALT102
	LACDPW at Wardlow St	LALT104
	Status & Trend Burbank	LALT106
	Status & Trend Tujunga Moorpark	LALT107
Estuary	Estuary Site 1	LAREST2

Table 14. REC1 swimming standards (LARWQCB 2014).

Indicator	Single-Sample Standard	30-Day Geometric Mean
E. coli	235	126
Enterococcus bacteria	104	35

Between May and September from 2012 to 2014, a total of 349 samples were collected from six sentinel sites located on major confluences to the Los Angeles River and analyzed for *E. coli* (Table 15). Of these, 79%, 86%, and 86% exceeded the single-sample recreational standard for *E. coli* (235 MPN/100 mL) in 2012, 2013, and 2014, respectively. The frequency of single-sample exceedances was high (82 to 100%) at all sites across the three years, except for LALT101 at Figueroa St, where exceedances of the single-sample standard ranged from 9% in 2012 to 40% in 2014. LALT101 is located downstream of the Los Angeles/Glendale Water Reclamation Plant (LAGWRP). Each of the other sites is located just upstream of major confluences to the Los Angeles River and convey mostly urban runoff. Monitoring by the City of Los Angeles in the mainstem of the Los Angeles River since 2001 as part of the Status and Trends Program demonstrated that dry-season bacteria concentrations below major POTWs were lower due to dilution of urban runoff by the high quality, disinfected tertiary-treated recycled water emanating from these POTWs (CREST 2006).

Exceedances of the 30-day geometric mean standard (126 MPN/100 mL) occurred every month during the three-year sampling period at every monitoring station, except in May and July 2012 at station LALT101 at Figueroa Street, where the lowest mean values occurred (Table 15). These results indicate that the lower tributaries and main Los Angeles River Channel had persistently elevated *E. coli* concentrations during the entire dry-weather period from 2012 to 2014.

Table 15. 30-day geometric mean *E. coli* concentrations (MPN/100 mL) at sentinel sites in the Los Angeles River Watershed from 2012 through 2014. Single sample exceedance >235 (MPN/100 mL) *E. coli*; 30-day geometric exceedance >126 (MPN/100 mL) *E. coli*.

		30-Day Geometric Mean											Single Sample Exceedances	
Year	Site	May	n=	June	n=	July	n=	August	n=	September	n=	Σ n=	#	%
2012	LALT100	723	5	773	4	2388	4	2953	5	2450	4	22	21	95
	LALT101	102	5	129	4	99	4	133	5	189	4	22	2	9
	LALT102	436	5	737	4	812	4	503	5	353	4	22	22	100
	LALT104	318	5	257	4	1028	4	1932	5	1536	4	22	18	82
	LALT106	431	5	692	4	1011	4	1002	5	4853	4	22	20	91
	LALT107	1287	5	2914	4	4946	4	6186	5	2564	4	22	21	95
											Total	**132**	**104**	**79**
2013	LALT100	1983	5	1882	4	989	3	4600	1	3108	2	15	14	93
	LALT101	310	5	193	4	149	4	289	2	194	2	17	6	35
	LALT102	812	5	361	4	480	4	863	2	745	2	17	17	100
	LALT104	2053	5	966	3	459	3	7700	1	1990	2	14	13	93
	LALT106	1037	5	737	4	3159	4	4499	2	8099	2	17	16	94
	LALT107	1134	5	2871	4	7552	4	9121	2	3041	2	17	17	100
											Total	**97**	**83**	**86**
2014	LALT100	3293	4	706	3	827	5	908	4	1308	4	20	20	100
	LALT101	472	4	195	3	197	5	254	4	547	4	20	8	40
	LALT102	1630	4	878	3	675	5	368	4	981	4	20	18	90
	LALT104	1718	4	517	3	883	5	785	4	933	4	20	18	90
	LALT106	1022	4	1352	3	2625	5	1177	4	995	4	20	19	95
	LALT107	7601	4	4909	3	7255	5	6268	4	2835	4	20	20	100
											Total	**120**	**103**	**86**

Los Angeles River Estuary Bacteria

Three hundred eighty-six samples were collected for *E. coli*, *Enterococcus*, and total coliforms analyses from the Los Angeles River Estuary during the period from May through September, 2012 to 2014 (Table 16). *E. coli* exceeded the single-sample standard in 20%, 7%, and 38% of samples in 2012, 2013, and 2014, respectively. The 30-day average standard for *E. coli* was exceeded for one of the five months in 2012 and 2013, and four of the five months in 2014. *Enterococcus* bacteria increasingly exceeded the single-sample standard over the three-year period, with 5%, 10%, and 17% exceedances in 2012, 2013, and 2014, respectively. The 30-day average standard for *Enterococcus* was exceeded for two of the five months in 2012, all five months in 2013, and four of five months in 2014.

It is acknowledged that the control of bacteria in urbanized watersheds poses an immense challenge, and that bacteria discharges can be highly erratic due to a myriad of potential human and nonhuman sources (CREST 2008). Several of the tributaries described above were previously identified on California's 2006 Clean Water Act Section 303(d) list as impaired for water contact and noncontact recreational beneficial uses (REC-1 and REC-2, respectively) by fecal coliform bacteria. In response, a Bacteria Total Maximum Daily Load (TMDL) was developed by the Los Angeles Region Regional Water Quality Control Board (RWQCB) in cooperation with the Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST) stakeholder group. A comprehensive Bacteria Source Identification (BSI) study was undertaken and identified that approximately 85% of storm drain samples exceeded the 235 MPN/100 mL objectives (CREST 2008). It was recognized, however, that although hundreds of storm drain outfalls discharge varying levels of bacteria to the LA River during dry weather, other in-channel sources—including birds, homeless persons, and perhaps environmental re-growth—also are significant sources of bacteria.

Table 16. 30-day geometric mean bacteria concentrations (MPN/100 mL) at the Los Angeles River estuary site in the Los Angeles River Watershed from 2012 to 2014.

Year	Indicator	30-Day Geometric Mean							Single Sample Exceedanc	
		May (n=9)	June (n=9)	July (n=8)		August (n=9)	September (n=9)	Σ n=	#	%
2012	*E. coli*	30	81	112		76	437	44	9	20
	Enterococcus	26	31	35		28	107	44	2	5
2013		May (n=9)	June (n=8)	July	n	August (n=9)	September (n=8)	Σ n=	#	%
	E. coli	146	54	44	9	88	113	43	3	7
	Enterococcus	114	42	35	8	52	55	42	4	10
2014		May (n=9)	June (n=7)	July (n=9)		August (n=9)	September (n=8)	Σ n=	#	%
	E. coli	197	193	109		214	452	42	16	38
	Enterococcus	47	36	31		46	69	42	7	17

Chapter Summary

Trends at Freshwater Target Sites

- A total of 24 samples have been collected from the four target sampling locations during the six annual surveys from 2009 to 2014.
- Nitrate concentrations were highest at the Arroyo Seco confluence (LALT501) across years, but was below the water quality threshold protective of aquatic life (10 mg/L) specified in the Los Angeles Basin Plan.
- Dissolved arsenic, copper, nickel, and zinc concentrations were routinely greatest in the Burbank Channel, with arsenic and copper trending lower over time.
- Chronic (reproductive) toxicity was measured in 2012 and 2014 at the confluence of the Arroyo Seco with the Los Angeles River.
- Biological conditions, as measured by the Southern CA IBI, were below reference conditions at all four sites during the six-year period.
- Habitat quality at these sites, which are cement-lined, was poor.

Los Angeles River Estuary

- Sediment samples were collected in 2009 through 2014 at the mouth of the Los Angeles River Estuary and assessed using the State of California's Sediment Quality Objectives framework.

- For the years when integrated scores could be calculated, EST2 ranked from 'unimpacted' (2011) to 'clearly impacted' (2009).
- Annual scouring due to winter runoff from the Los Angeles River leads to replacement of sediments leading to these large changes in biotic habitat conditions.

High-Value Habitat Sites

- The CRAM scores for each of the nine high-value sites fell below the reference site threshold, except in 2014 when stations LAUT401 located in the Tujunga Sensitive Habitat and LAUT402 located in the Upper Arroyo Seco were above this reference threshold. Each of these sites are in the areas that were burned by the 2009 Station Fire.

Sentinel Site Bacteria

- A total of 349 samples were collected from six sentinel sites located on major confluences to the Los Angeles River and analyzed for *E. coli*. Of these, 79%, 86%, and 86% exceeded the single-sample recreational standard for *E. coli* (235 MPN/100 mL) in 2012, 2013, and 2014, respectively.

- The frequency of single-sample exceedances was high (82 to 100%) at all sites across the three years, except for LALT101 on the Los Angeles River at Figueroa St, where exceedances of the single-sample standard ranged from 9% in 2012 to 40% in 2014.

- LALT101 is located downstream of the Los Angeles/Glendale Water Reclamation Plant (LAGWRP). The lowest bacteria concentrations, and fewest exceedances, occurred at sites at or below POTW discharges. These findings are consistent with those reported by CREST (2008).

- Sentinel sites exceeded the 30-day geometric mean REC-1 standard during each of the study months, except at LALT101 where the standard was not exceeded in May and July, 2012.

- Bacteria concentrations in the Los Angeles River Estuary routinely exceeded REC-1 standards for both the single-sample and the 30-day geometric mean standards for *E. coli* and Enterococcus.

Question 3. Are permitted discharges meeting WQOs in receiving waters?

Question 3 addresses the potential impacts from permitted point-source discharges into the Los Angeles River and its tributaries on meeting the Water Quality Objectives (WQOs) set forth in the Los Angeles Basin Plan (LARWQCB 2014). The three major Publicly Owned Treatment Works (POTWs) discharge into the Los Angeles River: The City of Los Angeles' Tillman Water Reclamation Plant (DCTWRP) and the Los Angeles/Glendale Water Reclamation Plant (LAGWRP), and the City of Burbank's Water Reclamation Plant (BWRP). Site codes for the receiving water stations and their locations are shown in Table 17 and Figure 19, respectively. These receiving water stations are monitored by the permittees as a requirement of their NPDES permits and were chosen to best represent locations upstream and downstream of the discharge locations. This chapter summarizes NPDES monitoring data for the period from January through December 2012 to 2014.

Table 17. Station designations for NPDES monitoring sites.

POTW	Upstream Site	Downstream Site
City of Los Angeles- Tillman	LATT612	LATT630
City of Los Angeles-Glendale	LAGT650	LAGT654
City of Burbank- Burbank	R-1	R-2

Figure 19. Locations of NPDES receiving water sites monitored by the City of Los Angeles and the City of Burbank

City of Los Angeles - DCTWRP

The cumulative frequency distributions for *E. coli* above and below the City of Los Angeles' DCTWRP discharge location are shown in Figure 20. The single-sample WQO of 235 MPN/100mL for REC-1 beneficial use was attained for approximately 65% of upstream samples compared to 55% of downstream samples from 2012 to 2014.

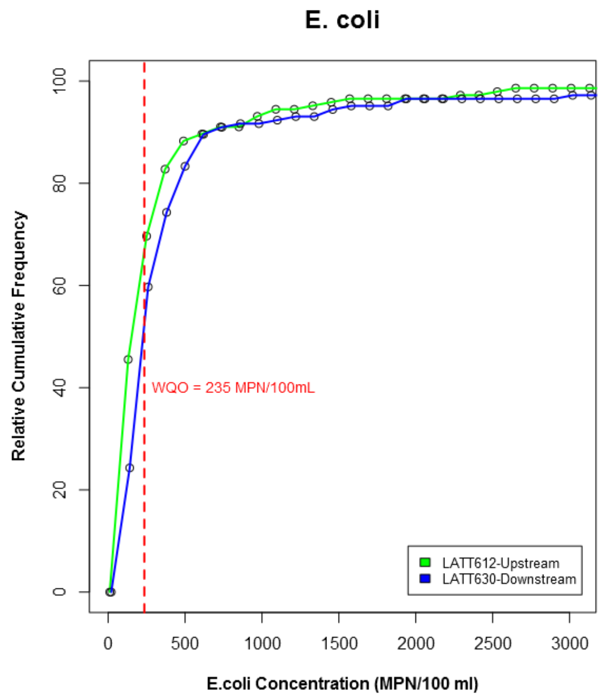


Figure 20. Cumulative frequency distributions of *E. coli* concentrations above and below the DCTWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Acute toxicity to fathead minnows was not detected upstream or downstream of the DCTWRP outfall from 2012 to 2014 (Table 18). Of the 12 quarterly samples collected, survival below the discharge (LATT630) ranged from 97.5% to 100%.

Table 18. Acute toxicity (survival) to fathead minnows above and below the DCTWRP discharge.

	ACUTE TOXICITY			
	SINGLE TEST		NON-COMP.	3 TEST AVG
	LATT612	LATT630	LATT630	LATT630
	Survival		#	Survival
02/07/2012	100.0	100.0	0	100.0
06/26/2012	97.5	100.0	0	100.0
08/14/2012	100.0	97.5	0	100.0
10/23/2012	100.0	100.0	0	100.0
02/19/2013	100.0	96.7	0	97.5
05/14/2013	100.0	100.0	0	100.0
08/20/2013	97.5	97.5	0	96.7
11/05/2013	97.5	100.0	0	100.0
02/25/2014	100.0	97.5	0	97.5
05/05/2014	100.0	97.5	0	100.0
08/19/2014	100.0	97.5	0	97.5
10/01/2014	97.5	97.5	0	97.5

Common disinfection byproducts were routinely detected below the discharge location, but at concentrations that were well below the EPA water quality objective of 80 ug/L for total trihalomethanes (Table 19; U.S. EPA 2002).

Table 19. Trihalomethane concentrations below the DCTWRP discharge (LATT630).

		2012		2013		2014	
Trihalomethanes (ug/L)	**Site**	**02/07/2012**	**08/08/2012**	**02/05/2013**	**08/06/2013**	**02/04/2014**	**08/04/2014**
Bromodichloromethane (ug/L)	LATT630	1.29	0.73	0.79	0.80	0.88	1.26
Bromoform (ug/L)	LATT630	ND	ND	ND	ND	ND	ND
Chloroform (ug/L)	LATT630	3.79	2.25	3.24	ND	2.48	2.34
Dibromochloromethane (ug/L)	LATT630	0.47	0.28	ND	0.37	0.50	0.51
Trihalomethanes (Total) (ug/L)	**LATT630**	**5.55**	**3.26**	**4.03**	**1.17**	**3.86**	**4.11**

Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. “ND” indicates the analyte was not detected.

Figure 21 shows the concentration of select metals upstream and downstream of the DCTWRP discharge location. The metals shown are compared to the California Toxics Rule (CTR) chronic and acute standards, which are typically expressed as dissolved metals concentrations, and applied to hardness-adjusted dissolved metals. It is important to note that total recoverable metals, rather than dissolved metals, were measured by the City of Los Angeles as a requirement of their NPDES permit. Therefore, total recoverable concentrations from DCTWRP and LAGWRP were converted to dissolved concentrations using a Metals Translator Guidance document written by the EPA (USEPA 1996). Metal concentrations at the upstream site were similar to those at the downstream site. Except for selenium, all concentrations were below the hardness-adjusted standards at both the upstream and downstream locations. Selenium concentrations upstream of the discharge exceeded the CTR chronic threshold on all occasions.

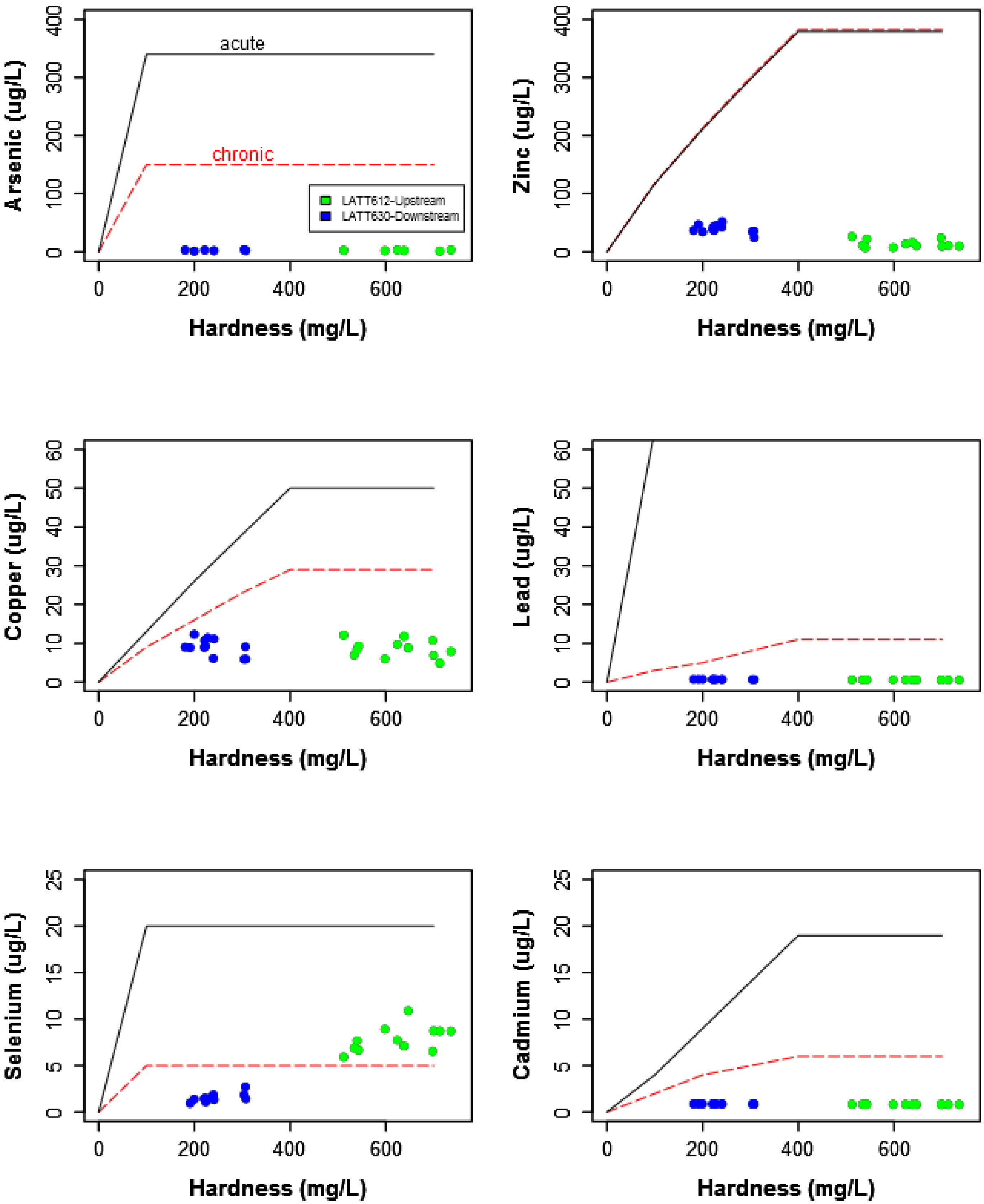


Figure 21. Total recoverable metals concentrations above and below the DCTWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Includes estimated values for low concentrations that exceeded the method detection limit, but did not meet the laboratory's reporting limit.

City of Los Angeles – LAGWRP

Figure 22 shows the cumulative frequency distributions for *E. coli* at sites above and below the discharge point for the LAGWRP. Approximately 45% of *E. coli* concentrations met the WQO at the upstream site vs. 52% at the downstream site from 2012 through 2014.

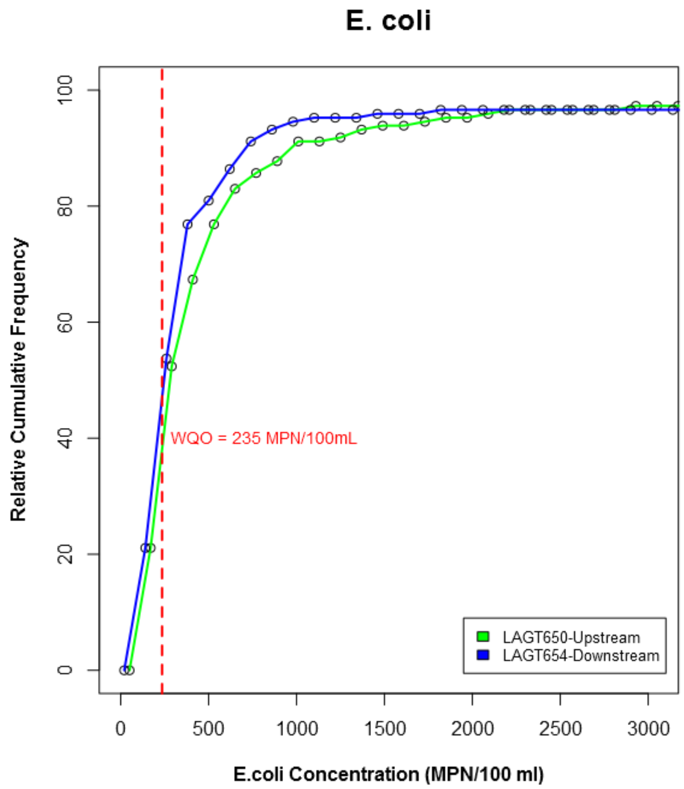


Figure 22. Cumulative frequency distribution of *E. coli* above and below the LAGWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

Total recoverable metals were measured quarterly at both the upstream and downstream locations. The converted dissolved metal concentrations were below both the acute and chronic CTR thresholds for each metal (Figure 23). In general, metals concentrations were similar between upstream and downstream sites.

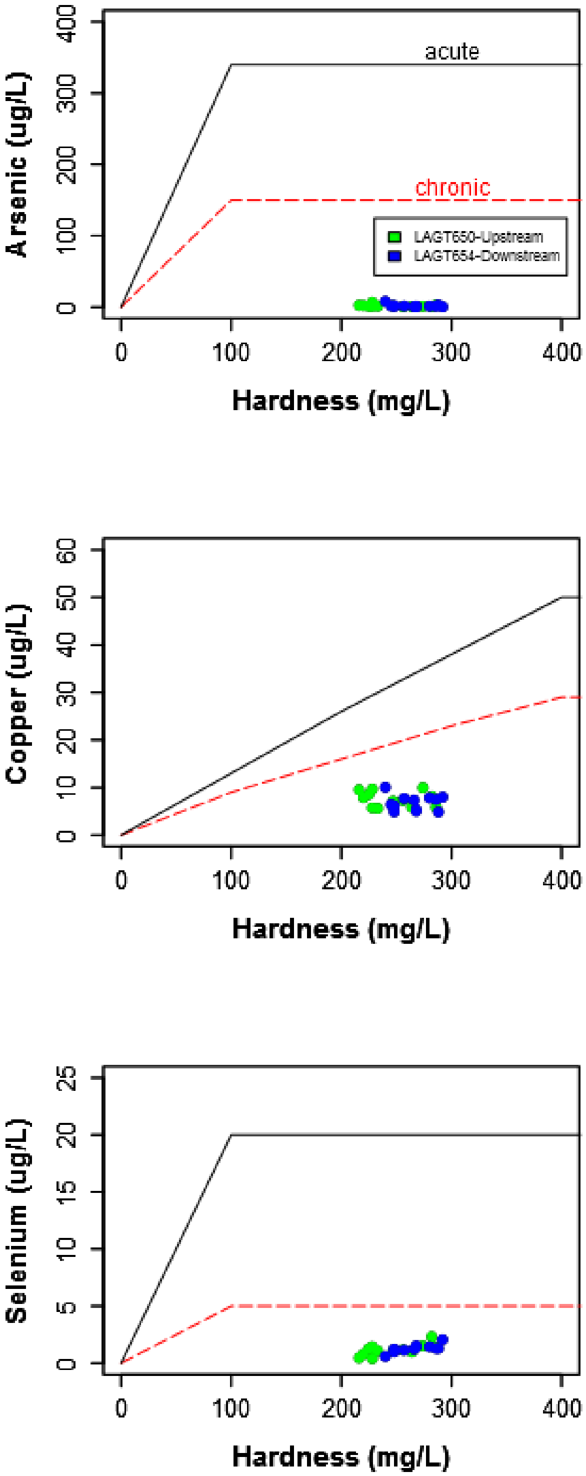


Figure 23. Total recoverable metals concentrations above and below the LAGWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Estimated values for low concentrations that exceeded the method detection limit, but did not meet the laboratory's reporting limit are included.

Acute toxicity was not measured upstream or downstream of the LAGWRP outfall from 2012 to 2014 (Table 20). Of the 12 quarterly samples collected, survival in samples collected below the discharge (LAGT654) ranged from 92.5% to 100%.

Table 20. Acute toxicity (survival) to fathead minnows above and below the LAGWRP discharge.

	ACUTE TOXICITY			
	SINGLE TEST		NON-COMP.	3 TEST AVG
	LAGT650	LAGT654	LAGT654	LAGT654
	Survival		#	Survival
02/15/2012	100.0	100.0	0	99.2
04/17/2012	97.5	100.0	0	100.0
08/21/2012	100.0	100.0	0	100.0
11/13/2012	100.0	100.0	0	100.0
02/05/2013	100.0	97.5	0	99.2
06/18/2013	100.0	100.0	0	99.2
07/09/2013	100.0	100.0	0	99.2
11/05/2013	100.0	100.0	0	100.0
02/25/2014	100.0	97.5	0	99.2
05/05/2014	100.0	92.5	0	96.7
08/06/2014	95.0	97.5	0	95.8
10/15/2014	97.5	100.0	0	96.7

Total Trihalomethanes were detected below the discharge location, but the concentrations downstream of the discharge were still well below the EPA water quality objective of 80 ug/L (Table 21; U.S. EPA 2002).

Table 21. Summary of trihalomethane compounds below (LAGT654) the LAGWRP discharge from 2012 to 2014. Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. "ND" indicates the analyte was not detected.

		2012			2013		2014	
Trihalomethanes (ug/L)	**Site**	**02/07/2012**	**05/01/2012**	**08/07/2012**	**02/05/2013**	**08/13/2013**	**02/04/2014**	**08/04/2014**
Bromodichloromethane (ug/L)	LAGT654	0.67	0.71	0.31	0.63	0.45	0.54	0.21
Bromoform (ug/L)	LAGT654	ND	ND	ND	ND	ND	ND	ND
Chloroform (ug/L)	LAGT654	1.68	1.46	0.75	1.64	1.43	1.56	0.67
Dibromochloromethane (ug/L)	LAGT654	ND	0.18	ND	ND	ND	ND	ND
Trihalomethanes (Total) (ug/L)	**LAGT654**	**2.35**	**2.35**	**1.06**	**2.27**	**1.88**	**2.10**	**0.88**

Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. "ND" indicates the analyte was not detected.

City of Burbank - BWRP

The cumulative frequency distributions for *E. coli* upstream and downstream of the City of Burbank's BWRP discharge location is shown in Figure 24. The number of single-sample exceedances was greater upstream of the discharge compared to below from 2012 to 2014. The single-sample WQO of 235 MPN/100mL for REC-1 beneficial use was attained for only 5% of upstream samples compared to approximately 25% of downstream samples. This indicates a dilution effect of the BWRP effluent on the concentration of *E. coli* concentrations in the receiving water below the discharge.

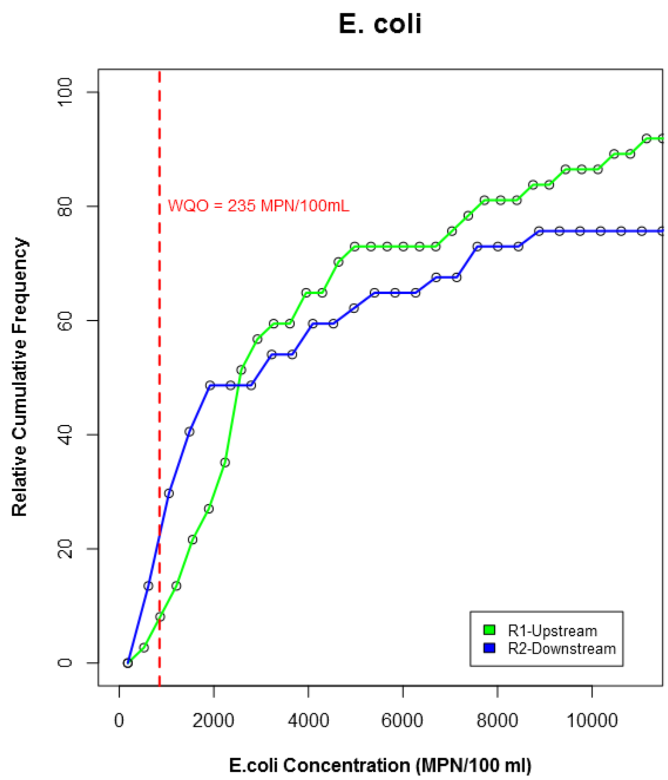


Figure 24. Cumulative frequency distributions for *E. coli* above and below the BWRP discharge. The single-sample WQO is denoted by the vertical dashed red line.

The concentration of nitrogenous compounds, and specifically nitrate, below the BWRP discharge did not exceed WQOs (Table 22).

Table 22. Range of concentrations of nitrogenous compounds downstream of the BWRP discharge point (R2) from 2012 to 2014.

2012	NO3-N (mg/L)	NO2-N (mg/L)	NH3-N (mg/L)	Total-N (mg/L)
MIN	1.2	0.03	0.14	0.29
MAX	7.41	0.74	1	3.18
2013				
MIN	1.5	0.025	0.14	0.08
MAX	6.2	0.22	1.2	3.83
2014				
MIN	1.7	0.045	0.049	0.1
MAX	8.3	0.52	3.7	2.96

Figure 25 shows the hardness-adjusted dissolved metal concentrations compared to their CTR chronic and acute standards. Metal concentrations were generally below the CTR thresholds at both the upstream and downstream sites, except for copper. Two acute threshold exceedances occurred for copper: one each at the upstream and downstream sites, while one exceedance of the chronic threshold occurred at the upstream site. Also, selenium exceeded the chronic threshold on one occasion at the upstream site.

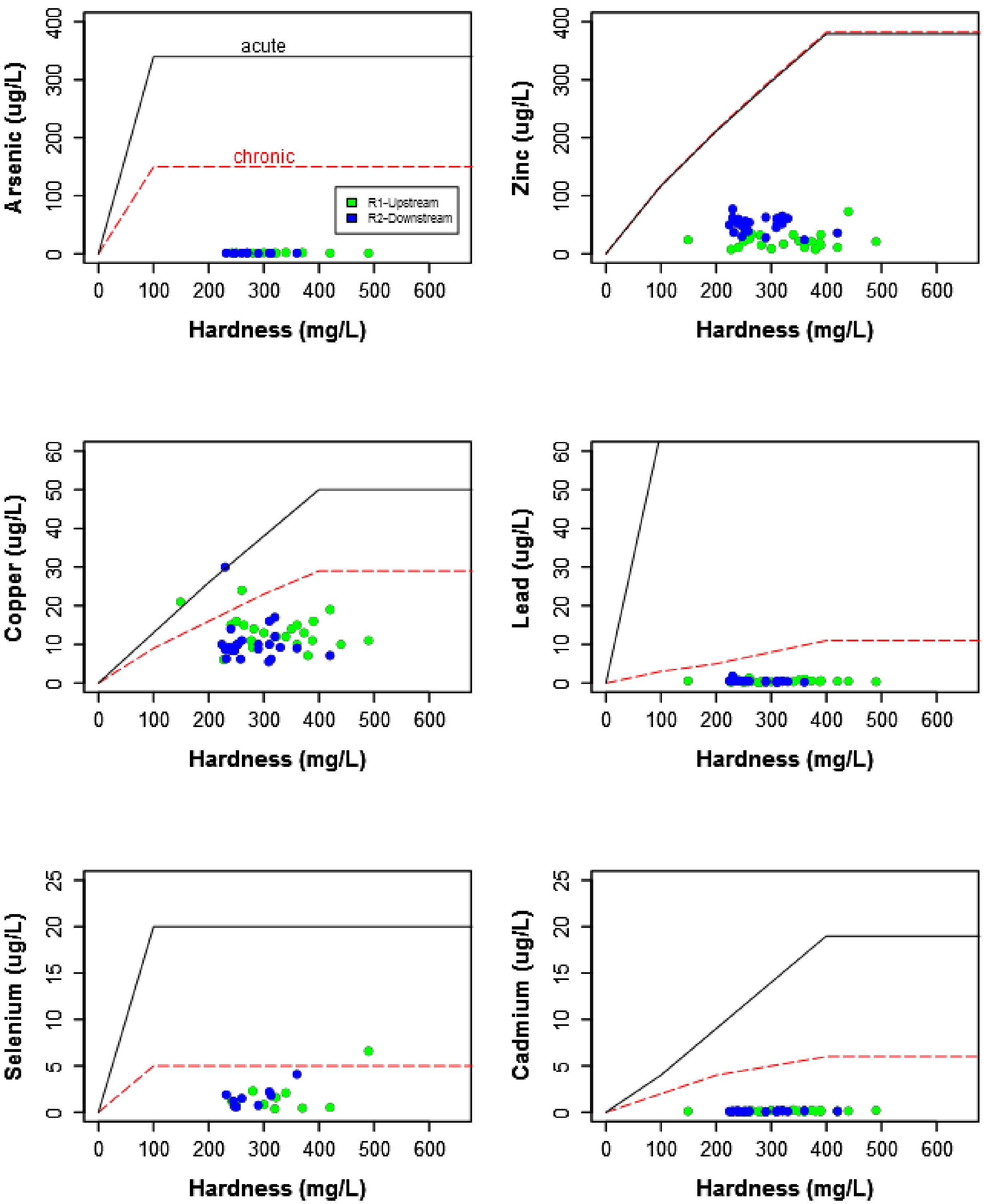


Figure 25. Total recoverable metals concentrations above and below the BWRP discharge compared to hardness-adjusted, total recoverable CTR thresholds for acute and chronic effects. Estimated values for low concentrations that exceeded the method detection limit but did not meet the laboratory's reporting limit are included.

Acute toxicity was not measured upstream or downstream of the BWRP outfall from 2012 to 2014 (Table 23). On February 15th, 2014, the site upstream of the discharge (R1) was just at the regulatory threshold (70% survival), but downstream of the discharge the survival rate was 98%, indicating a dilution effect from the BWRP effluent.

Table 23. Acute toxicity (survival) to fathead minnows above (R1) and below (R2) the BWRP discharge.

Date	Survival %	
	R-1	R-2
2/1/12	100	100
5/9/12	100	100
8/13/12	100	100
11/1/12	100	100
2/6/13	100	100
5/2/13	93	98
8/7/13	98	100
11/6/13	88	85
2/5/14	70	98
5/1/14	100	100
8/6/14	100	100
11/12/14	100	100

Total Trihalomethanes were detected below the discharge location (R2), but the concentrations downstream of the discharge were well below the EPA water quality objective of 80 ug/L (Table 24; USEPA 2002).

Table 24. Summary of trihalomethane concentrations above (R1) and below (R2) the BWRP discharge. Total trihalomethanes was precalculated and reported by the City of Burbank. "ND" indicates the analyte was not detected.

		2012 (n=12)			2013 (n=9)			2014 (n=12)		
	Site	Min	Average	Max	Min	Average	Max	Min	Average	Max
Trihalomethanes (Total) (ug/L)	R1	ND	ND	ND	ND	ND	ND	ND	ND	ND
	R2	1.2	3.43	5.3	1.08	3.54	5.6	1.3	4.00	8.2

Total trihalomethanes were calculated as the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane. "ND" indicates the analyte was not detected.

Chapter Summary

The cities of Los Angeles and Burbank POTWs monitor receiving waters downstream of their discharges as a requirement of their NPDES permits. Indicator bacteria, aquatic chemistry, and toxicity results for samples collected from 2012 to 2014 were evaluated against WQO thresholds. The following patterns were observed:

- The single-sample WQO of 235 MPN/100mL for REC-1 beneficial use was attained for approximately:
    - DCTWRP - 65% of upstream samples compared to 55% of downstream samples.
    - LAGWRP – 45% of both upstream and downstream samples.
    - BWRP – 5% of upstream samples compared to 25% of downstream samples.
- Concentrations of nitrogenous compounds below the BWRP discharge did not exceed the WQOs described in the Los Angeles Basin Plan.
- Metal concentrations downstream of the three POTW discharge points were below the California Toxics Rule (CTR) chronic and acute standards in every case, except for the BWRP where copper exceeded the acute threshold on two occasions and the chronic threshold once.
- No acute toxicity to fathead minnows was measured above or below the discharge points for the three POTWs over the three-year period.
- Trihalomethanes were typically present below the discharges, but in all cases, concentrations were well below the WQOs.

Question 4: Is it safe to swim?

The fourth element of the monitoring program assesses the beneficial use of the Los Angeles River—Water Contact Recreation (REC-1). It reflects concerns about the risk posed by pathogen contamination to recreational swimmers in streams of the Los Angeles River watershed. Prior to the initiation of the LARWMP, the concentrations of potentially harmful bacteria in the freshwater streams of the upper watershed were not known even though thousands of people swim in these waters during the summer months. Thus, the LARWMP bacteria monitoring program was established with weekly sampling for *E. coli* during the summer (May to September) at high-use recreational swimming areas (Figure 26 and Table 25). To elucidate the relationships between heavy recreational use and *E. coli* concentrations, sampling was conducted on or near weekends and holidays to capture times when the greatest numbers of people were swimming.

To assess swim safety, samples were collected at eight sites in 2012 and 2013, and nine sites in 2014, with the addition of Big Tujunga Delta Flat Day Use (Figure 26 and Table 25). Sites sampled for swimming safety were selected based on the collective knowledge of the workgroup of the most frequently used swimming locations in the watershed. Depending on the site, sources of indicator bacteria and pathogen contamination could include humans, dogs, wildlife, urban runoff, and refuse from campgrounds.

The State of California REC-1 bathing water standards (LARWQCB 2014) require that at least five samples be collected per month per site before the 30-day geometric mean standard can be applied. The 30-day geometric mean provides an indication of how persistent elevated bacterial concentrations are at a site. The standard overestimates persistent contamination when fewer than five samples are taken per month. Thus, the geometric means presented herein may represent conservative estimates of this standard. During the three summer surveys from 2012 to 2014, there is a goal to collect no fewer than five samples per month at each of the swimming sites. Also, in a similar program conducted in the San Gabriel River Watershed it was found that indicator bacteria levels were potentially greater on weekends and holidays when recreational use was greatest (SGRRMP 2009). As a result, bacteria sampling for the LARWMP was focused on weekends and holidays.

Analyses for all indicator bacteria were conducted using Colilert™ (SM9223) for *E. coli*. The bacteria data sets were compared against State of California REC-1 swimming standards (LARWQCB 2014) (Table 26). Exceedances of REC-1 standards at public swim sites indicate that there is a potential swimming safety issue.

Figure 26. Recreational swimming site locations in 2012, 2013 and 2014.

Table 25. Sampling locations and site codes for indicator bacteria.

Program Element	Sampling Sites	Site Code	Year(s) Sampled
Swim Sites	Bull Creek Sepulveda Basin	LALT200	2012, 2013, 2014
	Eaton Canyon Natural Area Park	LALT204	2012, 2013, 2014
	Peck Road Water Conservation Park	LALT212	2012, 2013, 2014
	Hansen Dam	LALT214	2013, 2014
	Millard Campground	LAUT203	2012
	Big Tujunga Delta Flat Day Use	LAUT206	2014
	Switzer Falls	LAUT208	2012, 2013, 2014
	Gould Mesa Campground	LAUT209	2012, 2013, 2014
	Sturtevant Falls	LAUT210	2012, 2013, 2014
	Hermit Falls	LAUT213	2012, 2013, 2014

Table 26. Indicator bacteria REC-1 standards for freshwaters.

Indicator	Single-Sample Standard	30-Day Geometric Mean
E. coli	235 MPN/100 mL	126 MPN/100 mL

Swim Sites

During the summers of 2012, 2013, and 2014, a total of 459 water samples were successfully collected from the nine swimming sites and analyzed for *E. coli* (Table 27, Table 28 and Table 29). The overall percentage of samples that exceeded the REC-1 standard for *E. coli* (235 MPN/100 mL) each year was similar among the three years, ranging from 20% in 2012 to 25% in 2013.

2012

In 2012, the greatest frequency of REC-1 exceedances occurred at Bull Creek in the Sepulveda Basin and at Eaton Canyon (35% each), followed by Hermit Falls and Peck Road Park (25%) (Table 27). Four of the eight sites exceeded the REC-1 standard on the Fourth of July, when recreational use was especially heavy, supporting the premise that heavy recreational use would lead to exceedances of the REC-1 standard. However, this premise was not supported for the Memorial Day or Labor Day holidays when only one site on each holiday exceeded the standard. There was no clear exceedance pattern for the weekday and weekends, with the number of exceedances ranging from zero to three across all sites. The 30-day geometric mean standard was exceeded twice at Bull Creek and Switzer Falls (Table 30).

<u>2013</u>

In 2013, the greatest frequency of REC-1 exceedances occurred at Hansen Dam (74%), Eaton Canyon (55%), and Bull Creek (21%) (Table 28). Hansen Dam was added by the Workgroup in 2013 when it was learned that heavy recreational use was occurring there. There was no clear exceedance pattern for the holidays, weekday, or weekends in 2013. The 30-day geometric average was exceeded during each of the three months at Eaton Canyon and Hansen Dam, and in August at Bull Creek and Switzer Falls (Table 30). On several occasions samples were not collected in 2013 at Gould Mesa Campground, Hansen Dam, Peck Rd. Lake, etc. owing to road closures, construction, and special events, and not due to a lack of effort on the part of the sampling crews.

<u>2014</u>

In 2014, sampling was curtailed at several sites from mid-July through the end of the sampling season due to extreme drought conditions and a lack of water for recreation at these sites (Table 29). One hundred percent of the samples collected at Hansen Dam exceeded the single-sample standard, while Bull Creek and Sturtevant Falls had four single-sample exceedances each, representing 20% and 33% of the samples collected at those two sites, respectively. The 30-day geometric average standard was exceeded during all three months at Hansen Dam, in July at Switzer Falls, and in August at Bull Creek (Table 30).

Table 27. ***E. coli*** **concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from May through September 2012. <10 MPN/100 mL = non-detect. Blank cells indicate that the site was not sampled on that date. Red-shaded cells indicate exceedance of single-sample REC-1 standard.**

	5/28/12	5/29/2012	6/5/2012	6/9/2012	6/10/2012	6/24/2012	6/29/2012	7/4/2012	7/5/2012	7/13/2012	7/21/2012	7/29/2012	8/6/2012	8/12/2012	8/18/2012	8/22/2012	8/31/2012	9/2/2012	9/3/2012	9/4/2012	# Exceedance REC 1 Std.	n	% Exceedance REC 1 Std.
Bull Creek Sepulveda Basin	199	109	132	455	52	108	122	794	<10	857	305	275	<10	<10	292	452	63	197	31	63	7	20	35
Eaton Canyon Natural Area Park	1350	<10	75	121	31	<10	<10	279	<10	153	98	677	1450	292	52	<10	<10	86	2010	2360	7	20	35
Gould Mesa Campground	<10	<10	<10	<10	20	41	52	20	75	41	63	<10	41	20	73	20	<10	20	<10	<10	0	20	0
Hermit Falls	<10	<10	41	298	183	<10	884	295	789	85	122	62	75	98	20	52	63	393	41	63	5	20	25
Millard Campground	<10	75	20	31	20	75	<10	31	<10	<10	<10	<10	52	41	<10	41	<10	<10	<10	<10	0	20	0
Peck Road Park	86	50	122	1310	145	135	1470	161	85	1350	<10	41	20	341	30	75	554	41	108	41	5	20	25
Sturtevant Falls	146	75	20	20	20	309	20	292	305	216	86	110	246	146	74	<10	63	41	158	41	4	20	20
Switzer Falls	<10	<10	41	189	31	738	323	63	108	130	132	173	173	175	145	31	243	63	41	588	4	20	20
# Exceedance REC 1 Std.	1	0	0	3	0	2	3	4	2	2	1	2	2	2	1	1	2	1	1	2	32		
n	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		160	
% Exceedance REC 1 Std.	13	0	0	38	0	25	38	50	25	25	13	25	25	25	13	13	25	13	13	25			20

Holiday

Weekday

Weekend

Table 28. ***E. coli*** **concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from May through September 2013. Values <10 MPN/100 mL = non-detect. Blank cells indicate that the site was not sampled on that date. Red-shaded cells indicate exceedance of single-sample REC-1 standard.**

	5/27/13	5/28/2013	6/5/2013	6/8/2013	6/9/2013	6/23 & 26 /2013	6/28/2013	7/4/2013	7/5/2013	7/12/2013	7/20/2013	7/28/2013	8/5/2013	8/11/2013	8/17/2013	8/21/2013	8/30/2013	9/1/2013	9/2/2013	9/3/2013	# Exceedance REC 1 Std.	n	% Exceedance REC 1 Std.
Bull Creek Sepulveda Basin	185	189	86	63	86	63		75	489	1940	<10	85	187	52	228	259	292	51	63	228	**4**	**19**	**21**
Eaton Canyon Natural Area Park	201	<10	5170	1660	703	749	63	336	1230	933	84	19900	145	97	776	613	295	109	231	135	**11**	**20**	**55**
Gould Mesa Campground				63	10	20	31	10	52	86	10	20	41	20				160	96	86	**0**	**14**	**0**
Hansen Dam	183	173	189	231	203	285	904	776	520	1620	435	1660	435	473	602	487	959		1420	1010	**14**	**19**	**74**
Hermit Falls	<10	<10	10	20	10	<10	<10	146	10	31	41	31	<10	<10	135	31	121	243	122	554	**2**	**19**	**11**
Peck Road Park	243	10		<10	97	31	63	10	10	<10	<10	<10	10	175	10	<10		173	<10	31	**1**	**18**	**6**
Sturtevant Falls	<10	<10	10	529	313	52	75	10	158	20	10	<10	<10	<10	51		10	41	121	20	**2**	**18**	**11**
Switzer Falls	31	195	10	20	62	20	30	<10	20	41	96	75	75	135	265	135		97	223	243	**2**	**19**	**11**
# Exceedance REC 1 Std.	**1**	**0**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**	**1**	**2**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**3**	**36**		
n	**7**	**7**	**6**	**8**	**8**	**8**	**7**	**8**	**8**	**8**	**8**	**8**	**8**	**8**	**7**	**6**	**5**	**7**	**8**	**8**		**146**	
% Exceedance REC 1 Std.	**14**	**0**	**17**	**25**	**25**	**25**	**14**	**25**	**38**	**38**	**13**	**25**	**13**	**13**	**43**	**50**	**60**	**14**	**13**	**38**			**25**

Holiday
Weekday
Weekend

Table 29. ***E. coli*** **concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from May through September 2014. Values <10 MPN/100 mL = non-detect. Blank cells indicate that the site was not sampled on that date. Red-shaded cells indicate exceedance of single-sample REC-1 standard.**

	5/26/14	5/27/14	6/4/14	6/8/14	6/14/14	6/21/14	6/27/14	7/4/14	7/5/14	7/11/14	7/19/14	7/27/14	8/4/14	8/10/14	8/16/14	8/20/14	8/29/14	8/31/14	9/1/14	9/2/14	# Exceedance REC 1 Std.	n	% Exceedance REC 1 Std.
Bull Creek Sepulveda Basin	183	85	97	109	158	30	175	41	**428**	20	52	63	**>24200**	**426**	75	**1270**	20	20	62	161	**4**	**20**	**20**
Eaton Canyon Natural Area Park	107	52	<10	206	**5790**	41	109	10	<10	<10	<10										**1**	**11**	**9**
Big Tujunga Delta Flat Day Use		75	10	52	10	86	109	20	197	73		41	75	20	<10						**0**	**13**	**0**
Switzer Falls	20	<10	<10	20	20	75	158	**266**	**359**	199	75	135	121	10	<10	63	10	75	122	96	**2**	**20**	**10**
Gould Mesa Campground	20	63	75	20	20	10	20	97	52	75	96	31	31	31	41	218	52				**0**	**17**	**0**
Sturtevant Falls	20	20	<10	31	10	10	**717**	**404**	**450**	86	<10	**309**									**4**	**12**	**33**
Peck Road Park	110	52	63	<10	20	31	10	41	20	<10	20	10	**1450**	<10	20	10	10	<10	10	20	**1**	**20**	**5**
Hermit Falls	52	<10	10	31	10	**345**	109	86	75	<10	20	10	10	<10	**285**	31	10	52	63	107	**2**	**20**	**10**
Hansen Dam	**1330**	**496**	**369**	**473**	**880**	**697**	**5170**	**1520**	**842**	**3650**	**256**	**932**	**504**	**1720**	**10500**	**554**	**759**	**959**	**3450**	**1250**	**20**	**20**	**100**
# Exceedance REC 1 Std.	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**5**	**2**	**2**	**3**	**4**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**34**		
n	**9**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**9**	**9**	**8**	**8**	**8**	**7**	**7**	**6**	**6**	**6**		**153**	
% Exceedance REC 1 Std.	**22**	**20**	**20**	**20**	**30**	**30**	**30**	**40**	**50**	**20**	**22**	**33**	**50**	**38**	**38**	**43**	**29**	**33**	**33**	**33**			**22**

Holiday
Weekday
Weekend

Table 30. 30-day geometric mean *E. coli* concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from 2012 to 2014. REC-1 exceedance occurs at values >126 (MPN/100 mL) *E. coli*. NS = site was not sampled during that month.

	2012				2013				2014			
Location	June (n=5)	July (n=5)	August (n=5)	>126 MPN/100 mL	June (n=6)	July (n=5)	August (n=5)	>126 MPN/100 mL	June (n=5)	July (n=5)	August (n=6)	>126 MPN/100 mL
Bull Creek Sepulveda Basin	133	195	46	2	74	125	176	1	97	65	271	1
Big Tujunga Delta Flat Day Use	NS	NS	NS	-	NS	NS	NS	-	34	59	20	0
Eaton Canyon Natural Area Park	23	107	56	0	778	916	288	3	122	6	NS	0
Gould Mesa Campground	16	29	23	0	25	25	29	0	23	65	54	0
Hansen Dam	NS	NS	NS	-	296	861	566	3	888	1022	1242	3
Hermit Falls	100	172	55	1	9	36	26	0	41	23	25	0
Millard Campground	22	7	19	0	NS	NS	NS	-	NS	NS	NS	-
Peck Road Park	341	82	97	1	31	7	17	0	18	15	20	0
Sturtevant Falls	35	179	61	1	92	17	11	0	26	119	NS	0
Switzer Falls	142	115	127	2	24	31	138	1	30	181	26	1

Chapter Summary

To assess the safety of recreational swimming sites in the Los Angeles River Watershed, bacteria sampling was conducted at up to nine sites known to be heavily used by the public from May to September, 2012 to 2014. The concentrations of *E. coli* from these samples were compared to REC-1 bathing water standards. Major findings of this sampling effort are as follows:

- A total of 459 *E. coli* samples were collected from the nine sampling locations during the summers of 2012 through 2014. From 20% to 25% of these samples exceeded the REC-1 bathing water standard (235 MPN/100 mL), depending on the year.

- During all three years, exceedances of the bathing water standard were mostly sporadic at each site, ranging from two to five days during which the REC-1 standard was exceeded.

- Bull Creek in the Sepulveda Basin, Eaton Canyon Natural Area Park, and Hansen Dam Recreation Area had persistently elevated *E. coli* concentrations during the three-year period. In 2014, Hansen Dam exceeded the REC-1 standard in 100% of the samples collected.

- The only site that had no exceedances during the three sampling years was the Gould Mesa Campground. Millard Campground also had no exceedances in 2012, but this site was not sampled in 2013 and 2014 as it was closed to the public for construction.

- The sampling effort was focused on holidays and weekends to capture high-use recreational activity, but only in 2012, on the Fourth of July, were REC-1 standards exceeded at more sites than on other days of the sampling season.

- Drought conditions persisted over the three-year period, which led to dry conditions at several sites by mid-July 2014. Swim site locations changed from year to year when dry conditions developed at a site, meaning it could no longer be sampled.

Question 5: Are locally caught fish safe to eat?

Question 5 addresses the human health risk associated with consuming contaminated fish caught at popular fishing locations in the watershed. The goal of this monitoring is to improve our understanding of health risks by identifying fish species (and their water bodies) that are of greatest concern for human consumption. This information will provide watershed managers with the information necessary to educate the public regarding the safety of consuming the fish they catch.

It is important to note that this program component does not include rainbow trout, a popular stocked and locally caught fish. Once rainbow trout are released to a waterbody, they are caught very quickly, and therefore have a very short residence time, reducing their potential to accumulate contaminants from that waterbody. There is still the potential for stocked fish to accumulate contaminants from the waterbody where they were raised, but that is not the focus of this study.

The LARWMP analyzed tissues from a total of 50 fish that were successfully collected from Legg Lake, Lake Balboa, and Belvedere Lake from 2012, 2013, and 2014, respectively (Figure 27). These lakes were selected by the Workgroup based on their recreational use by anglers. Fish were collected at each lake with the use of a boat and electroshocking equipment in accordance to OEHHA sport fish sampling and analysis protocols, which allowed specific species and size classes to be targeted (OEHHA 2005).

OEHHA specifies that the muscle fillets from at least five individual fish of the same species and size class be combined to form a composite sample from each sampling location. Four contaminants (mercury, selenium, total DDTs, and total PCBs) were selected for analysis based on their contribution to human health risk in California's coastal and estuarine fishes. It is widely assumed that nearly all (>95%) of the mercury present in fish is methyl mercury (Wiener et al. 2007). Consequently, monitoring programs usually analyze total mercury as a proxy for methyl mercury, as was done in this study. The U.S. EPA (2000) recommends using the conservative assumption that all mercury is present as methyl mercury, since it is most protective of human health.

Concentrations of contaminants in each fish species were compared to State Fish Contaminant Goals (FCGs) and Advisory Tissue Levels (ATLs) for human consumption developed by the State of California's Office of Environmental Health Hazard Assessment (OEHHA 2008) (Table 31 and Table 32). The OEHHA Fish Contaminant Goals (FCGs) are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, and over a lifetime. This guidance assumes a lifetime risk level of 1 in one million for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant.

The OEHHA Advisory Tissue Levels (ATLs), while still conferring no significant health risk to individuals consuming sport fish in the quantities shown over a lifetime, were developed with the recognition that there are unique health benefits associated with fish consumption and that the advisory process should be expanded beyond a simple risk paradigm to best promote the overall health of the fish consumer. ATLs protect consumers from being exposed to more than the average daily reference dose for noncarcinogens or to a lifetime cancer risk level of 1 in 10,000 for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant. For specific details regarding the assumptions used to develop the FCGs and ATLs, go to: http://oehha.ca.gov/fish/gtlsv/crnr062708.html (OEHHA, 2008).

Figure 27. Fish tissue sampling locations for the 2012, 2013, and 2014 bioaccumulation surveys.

Table 31. Fish contaminant goals (FCGs) for selected fish contaminants based on cancer and noncancer risk * using an 8-ounce/week (prior to cooking) consumption rate (32 g/day). **

	FCGs (ppb, wet weight)
Contaminant Cancer Slope Factor (mg/kg/day)-1	
DDTs (0.34)	**21**
PCBs (2)	**3.6**
Contaminant Reference Dose (mg/kg-day)	
DDTs (5x10-4)	1600
Methylmercury (1x10-4)[S]	**220**
PCBs (2x10-5)	63
Selenium (5x10-3)	**7400**

*The most health protective Fish Contaminant Goal for each chemical (cancer slope factor-
**g/day represents the average amount of fish consumed daily, distributed over a 7-day
[S]Fish Contaminant Goal for sensitive populations (i.e., women aged 18 to 45 years and children aged 1 to 17 years.)

Table 32. OEHHA (2008) advisory tissue levels (ATLs) for selected fish contaminants based on cancer or noncancer risk using an 8-ounce serving size (prior to cooking; ppb, wet weight)

Contaminant	Three 8-ounce Servings* a Week	Two 8-ounce Servings* a Week	One 8-ounce Servings* a Week	No Consumption
DDT[snc]**	≤520	>520-1,000	>1,000-2,100	>2,100
Methylmercury (Women aged 18-45 years and children aged 1-17 years)[nc]	≤70	>70-150	>150-440	>440
Methylmercury (Women over 45 years and men)[nc]	≤220	>220-440	>440-1,310	>1,310
PCBs[nc]	≤21	>21-42	>42-120	>120
Seleniumn[c]	≤2500	>2500-4,900	>4,900-15,000	>15,000

[c]ATLs are based on cancer risk
[nc]ATLs are based on non-cancer risk
*Serving sizes are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts (for
**ATLS for DDTs are based on non-cancer risk for two and three servings per week and cancer risk for one serving per week.

Results

A total of 50 fish were successfully collected from Legg Lake (2012), Lake Balboa (2013), and Belvedere Lake (2014) (Table 33). Two species were collected at Legg Lake—bluegill (*Lepomis macrochirus*) and redear sunfish (*Lepomis microlophus*)—for a total of 23 individuals that were combined, by species, into four separate composites. Three species were collected at Lake Balboa—Tilapia (*Oreochromis sp*.), white catfish (*Ameiurus catus*) and common carp (*Cyprinus carpio*)—for a total of 16 individuals that were combined into four composites. Eleven common carp were collected at Belvedere Lake and combined into a total of three composites.

The largest fish captured in the three lakes were common carp (5,550 g) and white catfish (5,200 g) from Lake Balboa, while the smallest fish included bluegill (45.0 g) and redear sunfish (44.4 g) from Legg Lake.

The feeding strategies for each of five species are as follows:

- Blue gill feed on aquatic insects and their larvae; up to 50% of their diet can consist of midge larvae (Page, 1991).
- Common carp adults feed on bottom-dwelling invertebrates and aquatic plants that provide habitat for invertebrates (McGinnis, 1984).
- White catfish, like other catfish in the family Ictaluridae, drag their barbels along the substrate to locate and taste prey. This allows them to feed at night and under turbid conditions (McGinnis, 1984).
- Redear sunfish are molluscivorous (snail eating) species that live in vegetated littoral zones of small to large lakes, marshes, and reservoirs (French and Morgan 1995).

Of the four contaminants measured in each of the composites of fish tissue, none exceeded the lowest OEHHA ATL thresholds (Table 34). In 2014, mercury was not analyzed in fish tissue composites collected from Belvedere Lake due to a laboratory oversight (Appendix A). The concentrations of each contaminant were well below the lowest ATL threshold, except for total DDTs measured in common carp collected from Lake Balboa, which was just below the three servings a week threshold. Of the three lakes where fish were collected, only Lake

Balboa had been sampled previously in 2009. Tilapia concentrations in 2009 were similar to concentrations measured in 2013.

Table 33. Number, average standard weight, and length of the individual and composite fish samples collected from 2012 to 2014.

Waterbody	Comp. #	Sample Type	n	Species Name	CommonName	Avg. Weight (g)	Standard Length Avg. (mm)	Standard Length Min (mm)	Standard Length Max (mm)	Total Length Avg. (mm)	Total Length Min (mm)	Total Length Max (mm)
2012												
Legg Lake (LALT308)	1	Composite	4	*Lepomis macrochirus*	bluegill	45.0	110.8	106	118	135.3	130	145
	1	Individual	1	*Lepomis microlophus*	redear sunfish	190.0	184.0	184	184	223.0	223	223
	2	Composite	8	*Lepomis microlophus*	redear sunfish	44.4	111.6	106	121	136.5	132	147
	3	Composite	10	*Lepomis microlophus*	redear sunfish	77.0	132.0	122	148	159.4	146	179
2013												
Lake Balboa (LALT301)	1	Composite	6	*Oreochromis* sp	Tilapia	73.0	129.0	120	143	157.8	150	172
	2	Composite	4	*Oreochromis* sp	Tilapia	117.1	158.9	150	180	192.1	180	212
	1	Individual	1	*Ameiurus catus*	White Catfish	5200.0	576.0	544	576	667.0	667	667
	1	Composite	5	*Cyprinus carpio*	Common Carp	5550.0	623.6	576	716	736.0	646	840
2014												
Belvedere Lake (LALT310)	1	Composite	5	*Cyprinus carpio*	common carp	154.0	187.0	177	208	230.2	218	256
	2	Composite	5	*Cyprinus carpio*	common carp	109.0	168.4	163	177	205.4	197	213
	3	Individual	1	*Cyprinus carpio*	common carp	1800.0	404.0	404	404	493.0	493	493

Table 34. Concentration of contaminants in fish tissues relative to the OEHHA ATL thresholds.

Fish Consumption						
Year	**Common Name**	**Comp. #**	**Mercury (ppb)**	**Selenium (ppb)**	**DDTs (ppb)**	**PCBs (ppb)**
Legg Lake - LALT308						
2012	bluegill	1	23	520	4.1	ND
	redear sunfish	1	34	440	0.9	ND
	redear sunfish	2	16	500	3.4	ND
	redear sunfish	3	20	580	2.7	ND
Lake Balboa - LALT301						
2009	tilapia	1	ND	530	8.1	ND
2013	tilapia	1	ND	640	7.5	ND
	tilapia	2	ND	640	12.1	ND
	white catfish	1	38	260	359.0	4
	common carp	1	13	780	515.0	11
Belvedere Lake - LALT310						
2014	common carp	1	Not Analyzed	530	6.7	4
	common carp	2	Not Analyzed	500	3.1	2
	common carp	3	Not Analyzed	470	7.7	4

Three 8-oz servings a week ATL
Two 8-oz servings a week ATL
One 8-oz serving a week ATL
No consumption ATL.

Chapter Summary

The monitoring design for Question 5 is focused on assessing whether the consumption of recreationally caught fish in the Los Angeles River Watershed is safe. During 2012, 2013, and 2014, 50 individual fish from four species were collected from Legg Lake, Lake Balboa, and Belvedere Lake, respectively. Eleven composite samples were analyzed for total mercury, selenium, total DDT, and total PCB. Tissue concentrations were compared to OEHHA consumption thresholds.

- Of the four contaminants measured in each of the composites of fish tissue, none exceeded the lowest OEHHA ATL thresholds indicating that these fish were safe to eat.
- Of the three lakes where fish were collected, only Lake Balboa had been sampled previously in 2009. Tilapia concentrations in 2009 were similar to concentrations measured in 2013 indicating no increasing or decreasing trend in contaminant concentration.

Conclusion

The Los Angeles River Watershed Monitoring Program (LARWMP) is focused on understanding the conditions of a changing and dynamic river system. The 2012-2014 results for Question 1, as in previous reports, detail a sharp contrast in ecological health and water quality between the more natural sites of the upper watershed and the more urbanized sites of the lower watershed. The exception to this pattern is reproductive toxicity, which was detected in 62% of samples from the upper watershed. Ongoing efforts to detect long-term trends in areas of unique interest reveal the dynamic nature of the river system, recurring patterns ripe for further investigation, and implications for watershed management approaches. For example, from 2009-2014, habitat and biological conditions were below reference conditions at the four fixed target sites and habitat conditions were mostly below reference conditions at the high-value sites that are part of Question 2. Although the status of these sites did not vary greatly over time, they are considered to be unique areas of special concern that will provide baseline information to be used to inform future habitat restoration or protection efforts.

The water chemistry and bacteria data collection for Question 3 was motivated by questions about the concentrations of bacteria and other pollutants both upstream and downstream of major POTWs that discharge into the Los Angeles River in order to assess their impact on receiving waters. The single-sample water quality objective for *E. coli* was met in 55%, 45%, and 25% of downstream samples, compared to 65%, 45%, and 5% of upstream samples, at DCTWRP, LAGWRP, and BWRP, respectively. These figures indicate that receiving waters downstream of the effluent discharge are not substantially different in terms of E. coli density as compared to the ambient waters upstream of the POTWs, with the exception of the City of Burbank POTW. BWRP had more E. coli exceedances upstream of receiving waters and a marked improvement in meeting the single-sample water quality objective downstream of the discharge. Receiving waters generally did not exceed water quality objectives for trihalomethanes, nitrogenous compounds, and metals.

Data for Question 4 regarding fecal indicator bacteria exceedances at swim sites from 2012-2014 suggest that the recreational sites with the highest management priority were Eaton Canyon Natural Area Park and Hansen Dam. Single-sample exceedances of *E. coli* occurred at Eaton Canyon in 35% of samples in 2012 and 55% of samples in 2013, while exceedances occurred at Hansen Dam in 74% of samples in 2013 and 100% of samples in 2014. Both of these sites are lower watershed sites and should be the subject of focus in future restoration or public health notification efforts.

The data from Question 5, "Are the fish safe to eat?" component of the LARWMP program indicate that consumption of fish from the river is generally safe, according to OEHHA ATL thresholds. This ongoing monitoring effort provides valuable information for watershed managers and the public alike to better understand the Los Angeles River and to protect the health of the river itself, as well as the health of communities that depend on it.

Literature Cited

Anderson, B.S., J.W. Hunt, M. Hester, and B.M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. pp. 609-624 in: G.K. Ostrander (ed.), Techniques in aquatic toxicology. CRC Press Inc. Boca Raton, FL.

Bay, M.B., D.J. Greenstein, J.A. Ranasinghe, D.W. Diehl and A.E. Fetscher. 2014. Sediment Quality Assessment Technical Support Manual. Technical Report 777. Southern California Coastal Water Research Project. Costa Mesa, CA.

Bay, S.M., L. Wiborg, D.J. Greenstein, N. Haring, C. Pottios, C. Stransky and K. Schiff. 2015. Southern California Bight 2013 Regional Monitoring Program: Volume I. Sediment Toxicity. SCCWRP Technical Report 899. Southern California Coastal Water Research Project. Costa Mesa, CA.

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. California Rapid Assessment Method (CRAM) for Wetlands. Version 5.0.2. 151 pp.

Cone, M. 28 January 2007. Waiting for the DDT tide to turn. Los Angeles Times. http://articles.latimes.com/2007/jan/28/local/me-fish28

CREST. 2006. Tier 2 Dry Season Bacteria Source Assessment of the Los Angeles River, Analysis of Measured Flow Rates, Water and Sediment Quality, Bacteria Loading Rates, and Land Uses. The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CREST. 2008. Los Angeles River Bacteria Source Identification Study: Final Report. The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CWH. 2008. Los Angeles River Watershed Monitoring Program Annual Report-2008. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources.

CWH. 2009[1]. Los Angeles River Watershed Monitoring Program Plan. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources

CWH. 2009[2]. Los Angeles River Watershed Monitoring Program Annual Report-2009. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources.

CWH. 2010. Los Angeles River Watershed Monitoring Program Annual Report-2010. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources.

CWH. 2011. Los Angeles River Watershed Monitoring Program Annual Report-2011. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources.

CWH. 2013. State of the Los Angeles River Watershed Report, 2008 to 2012. Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources

CWH. 2014. Los Angeles River Watershed Monitoring Program Quality Assurance Project Plan. Prepared for Council for Watershed Health, Los Angeles, CA. https://www.watershedhealth.org/resources

California Wetlands Monitoring Workgroup (CWMW). 2012. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.0 pp.95.

California Wetlands Monitoring Workgroup (CWMW). 2013. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.1 pp.67.

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. California Rapid Assessment (CRAM) for Wetlands, v5.0.2. 157 pp. San Francisco Estuary Institute. Oakland, CA.

Fetscher, E.A. and K. McLaughlin. 2008. Incorporating bioassessment using freshwater algae into California's surface water ambient monitoring program (SWAMP). Technical Report 563. California Water Boards, Surface Water Ambient Monitoring Program (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.348.4657&rep=rep1&type=pdf .

Fetscher, A.E., L. Busse, and P. R. Ode. 2009. Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 002. (updated May 2010)

Fetscher, A.E., M.D. Howard, R. Stancheva, R. Kudela, E.D. Stein, M.A. Sutula, L.B. Busse, and R.G. Sheath. 2015. Wadeable Streams as widespread sources of benthic cyanotoxins in California, USA. Harmful Algae. 49: 105-116.

French R.P. and M.N. Morgan. 1995. Preference of redear sunfish on zebra mussels and ramshorn snails. Journal of Freshwater Ecology, Vol 10:1, pp 49-55.

LARWQCB. 2014. Water Quality Control Plan, Los Angeles Region. Los Angeles Regional Water Quality Control Board, Los Angeles, CA. http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, WA.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Mazor, R.D. 2015. Bioassessment of Perennial Streams in Southern California: A Report on the First Five Years of the Stormwater Monitoring Coalition's Regional Stream Survey. Technical Report 844. Southern California Coastal Water Research Project. Costa Mesa, CA.

McGinnis, S.M. 1984. Freshwater Fishes of California. Los Angeles: Univ. California Press. California Natural History Guide #49.

Ode, R.E., A.C. Rehn, and J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management, Vol. 35, No. 4, pp. 493-504.

Ode, R.E. 2007. Standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

OEHHA (Office of Environmental Health Hazard Assessment). 2005. General protocol for sport fish sampling and analysis. Gassel, M. and R.K. Brodberg. Pesticide and

Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 11 pg.

OEHHA. Klasing, S. and R. Brodberg. 2008. Development of fish contaminant goals and advisory tissue levels for common contaminants in California sport fish: chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 115 pp.

Page, L.M. and B.M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Phillips B.M., B.S. Anderson, J.W. Hunt, B. Thompson, S. Lowe, R. Hoenicke, and R.S. Tjeerdema. 2003. Causes of sediment toxicity to *Mytilus galloprovincialis* in San Francisco Bay, California. *Arch. Environ Contam. Toxicol.* 45: 486-491.Ricca, D.M. and J.J. Cooney. 1998. Coliphages and indicator bacteria in birds around Boston Harbor. *Journal of Industrial Microbiology & Biotechnology* 21:28-30.

Rehn, A.C., R.D. Mazor, P.R. Ode. 2015. The California Stream Condition Indices (CSCI): A New Statewide Biological Scoring Tool for Assessing the Health of Freshwater Streams. SWAMP Technical Memorandum.SWAMP-TM-2015-0002.

Richards, A.B. and D.C. Rogers. 2006. List of freshwater macroinvertebrate taxa from California and adjacent states including standard taxonomic effort levels. Southwest Association of Freshwater Invertebrate Taxonomists. http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf

SCCWRP. 2008. Southern California Bight 2008 Regional Marine Monitoring Survey (Bight'08) Field Operations Manual. Prepared by Southern California Water Research Project, Costa Mesa, CA.

SCCWRP. 2009. Southern California Regional Watersheds Monitoring Program, Bioassessment Quality Assurance Project Plan, version 1.0. Prepared by Southern California Coastal Water Research Project, Costa Mesa, CA.

SGRRMP. 2009. San Gabriel River Regional Monitoring Program, Annual Report on Monitoring Activities for 2008. Technical report: www.sgrrmp.org.

USEPA 600/4-91-003. 1994. Short-Term methods for estimating the chronic toxicity of effluents and receiving water to marine and estuarine organisms. Second Edition, July 1994. [(NSCEP or CD ROM or NEPI.

http://www.epa.gov/clariton/clhtml/pubtitleORD.html), superseded by EPA 821/R-02-014]

USEPA 600/R-94-025.1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. (NTIS /PB95-177374 or NEPIS: http://www.epa.gov/clariton/clhtml/pubtitleORD.html or http://www.epa.gov/ost/library/sediment/)

USEPA. 2000. Estimated per capita fish consumption in the United States: based on data collected by the United States Department of Agriculture's 1994-1996 continuing survey of food intake by individuals. Office of Science and Technology, Office of Water, Washington, DC. March.

USEPA 816-F-02-013. 2002. List of Contaminants and their MCLs.

USEPA 821/R-02-013. 2002. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving

USEPA 823-B-96-007. Kinerson, R.S., J.S. Mattice, and J.F. Stine. 1996. The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From A Dissolved Criterion [PDF]. Office of Water. 67 pp. https://www3.epa.gov/npdes/pubs/metals_translator.pdf

Vannote, R.L, G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Ca. J. Fish. Aquat. Sci. 37: 130-137.

Wiener, J. G., R. A. Bodaly, S. S. Brown, M. Lucotte, M.C. Newman, D. B. Porcella, R. J. Reash, and E. B. Swain. 2007. Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. Chapter 4 in R. C. Harris, D. P. Krabbenhoft, R. P. Mason, M. W. Murray, R. J. Reash, and T. Saltman (editors), Ecosystem Responses to Mercury Contamination: Indicators of Change. CRC Press/Taylor and Francis, Boca Raton, Florida. pp. 87-12.

Appendix A – Quality Assurance/Quality Control

The LARWMP includes an emphasis on QA/QC for each phase of the program including the standardization of data formats so that monitoring results can be shared with local, state, and federal agencies. The data quality objectives for the program are outlined in the LARWMP QAPP and were finalized prior to the 2009 survey and it was updated each year thereafter (https://www.watershedhealth.org/resources). Therefore, the data reported herein from the 2008 survey were based on field sampling and laboratory analysis protocols agreed upon by the participants.

Measurement or Data Quality Objectives (MQOs or DQOs) are quantitative or qualitative statements that specify the tolerable levels of potential errors in the data and ensure that the data generated meet the quantity and quality of data required to support the study objectives. The DQOs for the LARWMP are detailed in the Program QAPP (CWH 2014). The MQOs for the processing and identification of benthic macroinvertebrate samples are summarized in the LARWMP QAPP and detailed in the Southern California Regional Watershed Monitoring Program: Bioassessment Quality Assurance Project Plan, Version 1.0 (SCCWRP 2009). The DQOs and MQOs focused on five aspects of data quality: completeness, precision, accuracy, representativeness, and sensitivity.

Completeness

Completeness describes the success of sample collection and laboratory analysis (biology, chemistry, and toxicity) which should be sufficient to fulfill the statistical criteria of the project. Sampling completeness between 2012 and 2014 was well within the 90% DQO. One estuary, 3 lakes, 10 randomly selected, and 4 targeted sites were identified for sampling between 2012 and 2014; and 3 postfire sites were sampled in 2012 and 2013. A total of 4221 parameters were analyzed during the assessment period (Table A-1, A-2 and A-3).

Freshwater targeted and random analysis completeness ranged between 0 and 100%. Freshwater general chemistry and metals completeness was nearly 100%, except for hardness and total suspended solids in 2012 (72%) and arsenic and chromium in 2012 (61 and 78 %, respectively). Nutrient and major ion completeness was 100% complete during the sampling period. Organophosphorus pesticides completeness was nearly 100% in 2012 and 2013, except for Demeton-s in 2012 and 2013 and dimethoate in 2013; organophosphorus pesticides were dropped from analysis in 2014. Pyrethroid completeness was 100% in 2013 and 2014 and ranged from 86.6 to 100% complete in 2012 (Table A-1).

Estuary sediment completeness was 100% for nutrients and nearly 100 % for metals (iron and mercury were not analyzed in 2012). Organochlorine completeness was 100% in 2012, in 2013 completeness was nearly 100%; however, cis- and trans- chlordane, and cis- and trans- nonachlor were not analyzed. The laboratory did not analyze organochlorine pesticides in 2014; therefore, completeness was 0%. PCB completeness was 100% in 2012; however, the laboratory did not analyze PCBs in 2013 and 2014 and completeness was 0%. PAH completeness in estuary sediment was 100% for 16 analytes and 0% for 7 analytes in 2012 and 2013. The laboratory did not analyze PAHs in 2014, and completeness was 0% (Table A-2).

Percent completeness for bioaccumulation samples were nearly 100% between 2012 and 2014. Mercury was not analyzed in 2014; however, all other analytes had 100% completeness.

The sampling team and laboratories were notified of the completeness deficiencies and two meetings were held between the QA/QC officer and the chemistry laboratories to ensure 100% compliance in the upcoming sampling seasons.

Accuracy

Accuracy provides an estimate of how close a laboratory or field measurement of a parameter is to the true value. Field sampling accuracy was assessed by calibration of the water quality probes with standards of known concentration. The accuracy of physical habitat measurements was assessed during a field audit conducted by the Southern California Coastal Water Research Project (SCCWRP) as part of the Stormwater Monitoring Coalitions (SMC) Southern California Regional Monitoring Survey, field calibration exercise. BMI sorting accuracy was assessed by a recount of 10% of sorted materials. The MQO of 95% was met for each lab reporting results for this program. Taxonomic identification accuracy was assessed through the independent re-identification of 10% of samples by the Department of Fish and Games Aquatic Biology Laboratory. MQOs for taxa count, taxonomic identification and individual identification rates were met.

Analytical chemistry accuracy measures how close measurements are to the true value. For analytical chemistry samples Certified Reference Materials (CRM), matrix spike / matrix spike duplicates and laboratory control standards are used to assess method accuracy. The LARWMP followed SWAMP protocols, which allow one of these elements to fail in a batch and still be compliant. If more than one element fails, that analyte is listed as estimated for the entire batch. Several analytes had a single-accuracy failure between 2012 and 2014, but none were rejected (Table A-4).

Accuracy of toxicity test results is assessed by ensuring that EPA control response standards are met and that DMR inter-laboratory test results were within test acceptability criteria for each test. Each of these criteria was met between 2012 and 2014 for the toxicity tests reported for this program.

Precision

Field duplicates were collected for chemistry, toxicity, and benthic macroinvertebrates at 10% of the random sites visited in 2010. The MQO for field duplicates was a relative percent difference (RPDs) <25%, except for benthic macroinvertebrates. At this time, no MQO has been developed for benthic macroinvertebrate duplicate samples. For analytical chemistry results matrix spike (MS), matrix spike duplicates (MSD), and laboratory duplicates (DUP) were used to assess laboratory precision. RPDs <25% for either the MS/MSD or DUPs were considered acceptable. Of thousands of analytes measured in 2011, twenty exceeded the precision criteria (Table A-4).

Toxicity testing precision is measured through the development of control charts that include 20 reference toxicant tests for each organism. Each new reference toxicant test must fall within ± 2 standard deviations (SD) of the control chart average to be acceptable. All tests met this criterion.

Taxonomic precision was assessed using three error rates: random errors which are misidentifications that are made inconsistently within a taxon; systemic errors occur when a specific taxon is consistently misidentified; taxonomic resolution errors occur when taxa are not identified to the proper taxonomic level. Error rates of <10% are considered acceptable and all precision requirements were met.

Laboratory Blanks

Laboratory blanks were used to demonstrate that the analytical procedures do not result in sample contamination. The MQO for laboratory blanks were those with values less than the reporting limit (RL) for the analyte. During the 2012 and 2013 surveys, three metals and two organochlorine pesticide had laboratory blanks with concentrations above the RL (Table A-5). There were no analytes with laboratory blanks above detection in 2014.

Program Improvements and Standardization

An intercalibration study was conducted in 2006 sampling season by the Stormwater Monitoring Coalition's (SMC) Chemistry Workgroup. This intercalibration included all participating laboratories and covered nutrient and metal analyses. Intercalibration studies will be ongoing as part of the SMC Regional Monitoring Program.

Sampling procedures for each field team collecting samples for the LARWMP were audited by biologists from the Southern California Coastal Water Research Project during summer surveys. The audit covered the SWAMP bioassessment and physical habitat protocols, including algae and benthic macroinvertebrate collection, and CRAM assessment (Ode, 2007, Fetscher *et al.,* 2009, CWMW 2012, and CWMW 2013). Each team passed their audit.

Table A-1. Percent completeness and nondetects by watershed subregion for water chemistry samples collected in 2012-2014.

	2012						2013						2014					
			Number of Non-Detects (<MDL)						Number of Non-Detects (<MDL)						Number of Non-Detects (<MDL)			
Analyte	Number of Sites	Completeness (%)	Effluent	Natural	Urban	Total	Number of Sites	Completeness (%)	Effluent	Natural	Urban	Total	Number of Sites	Completeness (%)	Effluent	Natural	Urban	Total
Genreal Chemistry																		
Alkalinity as CaCO3	18	100	0	0	0	0	15	100	0	0	0	0	17	100	0	0	0	0
Hardness as CaCO3	18	72	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Total Suspended Solids	18	72	0	0	0	0	15	93	0	2	0	2	15	100	0	2	0	2
Chlorophyll a	10	100	0	0	0	0	7	100	0	0	0	0	13	100	0	0	0	0
Ash-Free Dry Mass	10	100	0	0	0	0	7	100	0	0	0	0	13	100	0	0	0	0
Nutrients																		
Ammonia as N	18	100	0	8	7	15	15	100	1	4	6	11	17	100	0	4	4	8
Dissolved Organic Carbon	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Nitrate as N	18	100	0	6	3	9	15	100	0	4	3	7	17	100	0	5	6	11
Nitrite as N	18	100	1	8	9	18	15	100	0	4	7	11	17	100	1	8	8	17
OrthoPhosphate as P	18	100	1	5	3	9	15	100	0	4	3	7	17	100	0	2	5	7
Phosphorus as P	18	100	0	5	0	5	15	100	0	3	1	4	17	100	0	3	2	5
Total Nitrogen (calculated)	18	100	0	0	0	0	15	100	0	1	0	1	17	100	0	1	0	1
Total Organic Carbon	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Major Ions																		
Chloride	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Sulfate	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Silica	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Metals																		
Dissolved Arsenic	18	61	0	1	0	1	15	100	0	1	0	1	15	100	0	1	3	4
Dissolved Cadmium	18	100	0	7	2	9	15	100	0	2	0	2	15	100	0	4	2	6
Dissolved Chromium	18	78	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Dissolved Copper	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Dissolved Iron	18	100	0	2	0	2	15	100	0	0	0	0	15	100	0	2	3	5
Dissolved Lead	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	1	0	1
Dissolved Mercury	18	100	1	6	8	15	15	100	0	4	7	11	15	100	1	6	8	15
Dissolved Nickel	18	100	0	2	0	2	15	100	0	0	0	0	15	100	0	0	0	0
Dissolved Selenium	18	100	0	1	0	1	15	100	0	3	0	3	15	100	1	6	3	10
Dissolved Zinc	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Total Arsenic	18	100	0	1	1	2	15	100	0	1	1	2	15	100	0	4	3	7
Total Cadmium	18	100	0	5	2	7	15	100	0	1	0	1	15	100	0	3	2	5
Total Chromium	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Total Copper	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Total Iron	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0
Total Lead	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	1	0	1
Total Mercury	18	100	1	2	4	7	15	100	1	4	6	11	15	100	1	5	2	8
Total Nickel	18	100	0	2	0	2	15	100	0	0	0	0	15	100	0	0	0	0
Total Selenium	18	100	0	3	0	3	15	100	0	3	0	3	15	100	0	6	4	10
Total Zinc	18	100	0	0	0	0	15	100	0	0	0	0	15	100	0	0	0	0

Table A-1. Continued.

Analyte	2012						2013						2014					
	Number of Sites	Complete ness (%)	Number of Non-Detects (<MDL) Effluent	Natural	Urban	Total	Number of Sites	Complete ness (%)	Number of Non-Detects (<MDL) Effluent	Natural	Urban	Total	Number of Sites	Complet eness (%)	Number of Non-Detects (<MDL) Effluent	Natural	Urban	Total
Organophosphorus[1.]																		
Bolstar	18	100	1	8	9	18	15	100	1	4	10	15	NA	NA	NA	NA	NA	NA
Chlorpyrifos	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Demeton-s	18	0	NA	NA	NA	NA	15	0	NA	NA	NA	0	NA	NA	NA	NA	NA	NA
Diazinon	18	100	1	3	9	13	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Dichlorvos	18	100	1	3	9	13	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Dimethoate	18	100	1	8	9	18	15	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Disulfoton	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Ethoprop	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Fenchlorophos	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Fensulfothion	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Fenthion	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Malathion	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Merphos	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Mevinphos	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Parathion, Methyl	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Phorate	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Tetrachlorvinphos	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Tokuthion	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Trichloronate	18	100	1	8	9	18	15	100	1	3	9	13	NA	NA	NA	NA	NA	NA
Pyrethroid Pesticides																		
Bifenthrin	15	86.6	1	3	9	13	15	100	1	4	3	8	15	100	1	6	7	14
Cyfluthrin, Total	15	86.6	1	3	9	13	15	100	1	4	10	15	15	100	1	6	8	15
Cyhalothrin, Lambda, Total	15	86.6	1	3	9	13	15	100	1	4	8	13	15	100	1	6	8	15
Cypermethrin, Total	15	86.6	1	3	9	13	15	100	1	4	9	14	15	100	1	6	8	15
Deltamethrin	15	86.6	1	3	9	13	15	100	1	4	9	14	15	100	1	6	8	15
Esfenvalerate	15	86.6	1	3	9	13	15	100	1	4	10	15	15	100	1	6	8	15
Fenvalerate	15	86.6	1	3	9	13	15	100	1	4	10	15	15	100	1	6	8	15
Permethrin, Total	15	100	1	5	9	15	15	100	1	4	9	14	15	100	1	6	8	15
Permethrin-cis	15	100	1	5	9	15	15	100	1	4	10	15	15	100	1	6	8	15
Permethrin-trans	15	100	1	5	9	15	15	100	1	4	9	14	15	100	1	6	8	15
Toxicity																		
Ceriodaphnia dubia Reproduction	18	100	NA	NA	NA	NA	15	100	NA	NA	NA	NA	15	100	NA	NA	NA	NA
Ceriodaphnia dubia Survival	18	100	NA	NA	NA	NA	15	100	NA	NA	NA	NA	15	100	NA	NA	NA	NA
Bioassessment																		
Benthic Macroinvertebrate ID	18	100	NA	NA	NA	NA	15	100	NA	NA	NA	NA	17	100	NA	NA	NA	NA

1. Organophosphorus compounds were dropped from the analyte list in 2014.

Table A-2. Percent completeness and nondetects for water chemistry and sediment samples collected in the estuary during 2012-2014.

Estuary Sediment	Number of Sites	2012 % Completeness	2012 Number of Non-Detects (<MDL)	2013 % Completeness	2013 Number of Non-Detects (<MDL)	2014 % Completeness	2014 Number of Non-Detects (<MDL)
Nutrients							
Phosphorus as P	1	100	0	100	0	100	0
Total Kjeldahl Nitrogen	1	100	0	100	0	100	0
Total Organic Carbon	1	100	0	100	0	100	0
Metals							
Arsenic	1	100	0	100	0	100	0
Cadmium	1	100	0	100	0	100	0
Chromium	1	100	0	100	0	100	0
Copper	1	100	0	100	0	100	0
Iron	1	0	0	100	0	100	0
Lead	1	100	0	100	0	100	0
Mercury	1	0	0	100	0	100	0
Nickel	1	100	0	100	0	100	0
Selenium	1	100	1	100	1	100	1
Zinc	1	100	0	100	0	100	0
Organochlorine Pesticides							
Aldrin	1	100	1	100	1	0	NA
Chlordane, cis-	1	100	0	0	NA	0	NA
Chlordane, trans-	1	100	0	0	NA	0	NA
DDD(o,p')	1	100	1	100	1	0	NA
DDD(p,p')	1	100	1	100	0	0	NA
DDE(o,p')	1	100	1	100	1	0	NA
DDE(p,p')	1	100	1	100	0	0	NA
DDT(o,p')	1	100	0	100	1	0	NA
DDT(p,p')	1	100	0	100	1	0	NA
Dieldrin	1	100	1	100	1	0	NA
Endosulfan I	1	100	0	100	0	0	NA
Endosulfan II	1	100	0	100	0	0	NA
Endrin	1	100	0	100	0	0	NA
Endrin Aldehyde	1	100	0	100	0	0	NA
HCH, alpha	1	100	0	100	0	0	NA
HCH, beta	1	100	0	100	0	0	NA
HCH, delta	1	100	0	100	0	0	NA
HCH, gamma	1	100	0	100	0	0	NA
Heptachlor	1	100	0	100	0	0	NA
Heptachlor Epoxide	1	100	0	100	0	0	NA
Methoxychlor	1	100	0	100	0	0	NA
Mirex	1	100	0	100	0	0	NA
Nonachlor, cis-	1	100	0	0	NA	0	NA
Nonachlor, trans-	1	100	1	0	NA	0	NA
Oxychlordane	1	100	0	0	NA	0	NA
Toxaphene	1	100	0	100	0	0	NA

Table A-2. Continued.

Estuary Sediment	Number of Sites	2012 % Completeness	2012 Number of Non-Detects (<MDL)	2013 % Completeness	2013 Number of Non-Detects (<MDL)	2014 % Completeness	2014 Number of Non-Detects (<MDL)
PCBs							
PCB018	1	100	1	0	NA	0	NA
PCB028	1	100	1	0	NA	0	NA
PCB037	1	100	1	0	NA	0	NA
PCB044	1	100	1	0	NA	0	NA
PCB049	1	100	0	0	NA	0	NA
PCB052	1	100	1	0	NA	0	NA
PCB066	1	100	0	0	NA	0	NA
PCB070	1	100	0	0	NA	0	NA
PCB074	1	100	1	0	NA	0	NA
PCB077	1	100	0	0	NA	0	NA
PCB081	1	100	1	0	NA	0	NA
PCB087	1	100	0	0	NA	0	NA
PCB099	1	100	1	0	NA	0	NA
PCB101	1	100	0	0	NA	0	NA
PCB105	1	100	1	0	NA	0	NA
PCB110	1	100	0	0	NA	0	NA
PCB114	1	100	0	0	NA	0	NA
PCB118	1	100	0	0	NA	0	NA
PCB119	1	100	1	0	NA	0	NA
PCB123	1	100	0	0	NA	0	NA
PCB126	1	100	1	0	NA	0	NA
PCB128	1	100	1	0	NA	0	NA
PCB138	1	100	0	0	NA	0	NA
PCB149	1	100	0	0	NA	0	NA
PCB151	1	100	0	0	NA	0	NA
PCB153+168	1	100	0	0	NA	0	NA
PCB156	1	100	1	0	NA	0	NA
PCB157	1	100	1	0	NA	0	NA
PCB158	1	100	1	0	NA	0	NA
PCB167	1	100	1	0	NA	0	NA
PCB169	1	100	1	0	NA	0	NA
PCB170	1	100	0	0	NA	0	NA
PCB177	1	100	1	0	NA	0	NA
PCB180	1	100	1	0	NA	0	NA
PCB183	1	100	1	0	NA	0	NA
PCB187	1	100	1	0	NA	0	NA
PCB189	1	100	1	0	NA	0	NA
PCB194	1	100	1	0	NA	0	NA
PCB200	1	100	1	0	NA	0	NA
PCB201	1	100	0	0	NA	0	NA
PCB206	1	100	1	0	NA	0	NA

Table A-2. Continued.

Estuary Sediment	Number of Sites	2012 % Completeness	2012 Number of Non-Detects (<MDL)	2013 % Completeness	2013 Number of Non-Detects (<MDL)	2014 % Completeness	2014 Number of Non-Detects (<MDL)
PAHs							
1-Methylnaphthalene	1	0	NA	0	NA	0	NA
1-Methylphenanthrene	1	0	NA	0	NA	0	NA
2,6-Dimethylnaphthalene	1	0	1	0	NA	0	NA
2-Methylnaphthalene	1	0	1	0	NA	0	NA
Acenaphthene	1	100	1	100	1	0	NA
Acenaphthylene	1	100	1	100	1	0	NA
Anthracene	1	100	1	100	1	0	NA
Benz[a]anthracene	1	100	1	100	1	0	NA
Benzo[a]pyrene	1	100	1	100	1	0	NA
Benzo[b]fluoranthene	1	100	1	100	1	0	NA
Benzo[e]pyrene	1	0	NA	0	NA	0	NA
Benzo[g,h,i]perylene	1	100	1	100	1	0	NA
Benzo[k]fluoranthene	1	100	1	100	1	0	NA
Biphenyl	1	0	NA	0	NA	0	NA
Chrysene	1	100	0	100	0	0	NA
Dibenz[a,h]anthracene	1	100	1	100	1	0	NA
Fluoranthene	1	100	0	100	0	0	NA
Fluorene	1	100	1	100	1	0	NA
Indeno[1,2,3-c,d]pyrene	1	100	1	100	1	0	NA
Naphthalene	1	100	1	100	1	0	NA
Perylene	1	0	NA	0	NA	0	NA
Phenanthrene	1	100	0	100	0	0	NA
Pyrene	1	100	0	100	0	0	NA
Toxicity							
Eohaustorius sp	1	100	NA	100	NA	100	NA
Mytilus embryo development	1	100	NA	100	NA	100	NA
Benthic Infauna							
Benthic Infauna ID	1	100	NA	100	NA	100	NA

Table A-3. Percent completeness and nondetects for bioaccumulation samples collected during 2012-2014.

Bioaccumulation	2012			2013			2014		
	Number of Samples	% Completeness	Number of Non-Detects (<MDL)	Number of Samples	% Completeness	Number of Non-Detects (<MDL)	Number of Samples	% Completeness	Number of Non-Detects (<MDL)
General Chemistry									
Lipids	4	100	0	4	100	0	3	100	0
Metals									
Mercury	4	100	0	4	100	2	3	0	NA
Selenium	4	100	4	4	100	4	3	100	3
Organochlorine Pesticides									
Aldrin	4	100	4	4	100	0	3	100	3
Chlordane, cis-	4	100	4	4	100	2	3	100	3
Chlordane, trans-	4	100	4	4	100	2	3	100	1
DDD(o,p')	4	100	4	4	100	0	3	100	2
DDD(p,p')	4	100	4	4	100	4	3	100	3
DDE(o,p')	4	100	4	4	100	0	3	100	0
DDE(p,p')	4	100	0	4	100	4	3	100	3
DDT(o,p')	4	100	4	4	100	4	3	100	3
DDT(p,p')	4	100	4	4	100	4	3	100	3
Dieldrin	4	100	4	4	100	4	3	100	3
Endosulfan I	4	100	4	4	100	4	3	100	3
Endosulfan II	4	100	4	4	100	4	3	100	3
Endrin	4	100	4	4	100	4	3	100	3
Endrin Aldehyde	4	100	4	4	100	4	3	100	3
HCH, alpha	4	100	4	4	100	4	3	100	3
HCH, beta	4	100	4	4	100	4	3	100	3
HCH, delta	4	100	4	4	100	4	3	100	3
HCH, gamma	4	100	4	4	100	4	3	100	3
Heptachlor	4	100	4	4	100	4	3	100	3
Heptachlor Epoxide	4	100	4	4	100	4	3	100	3
Methoxychlor	4	100	4	4	100	4	3	100	3
Mirex	4	100	4	4	100	4	3	100	3
Nonachlor, cis-	4	100	4	4	100	2	3	100	3
Nonachlor, trans-	4	100	4	4	100	3	3	100	3
Oxychlordane	4	100	4	4	100	4	3	100	3
Toxaphene	4	100	4	4	100	4	3	100	3

Table A-3. Continued.

Bioaccumulation	2012 Number of Samples	2012 % Completeness	2012 Number of Non-Detects (<MDL)	2013 Number of Samples	2013 % Completeness	2013 Number of Non-Detects (<MDL)	2014 Number of Samples	2014 % Completeness	2014 Number of Non-Detects (<MDL)
PCBs									
PCB018	4	100	4	4	100	4	3	100	3
PCB028	4	100	4	4	100	4	3	100	3
PCB037	4	100	4	4	100	4	3	100	3
PCB044	4	100	4	4	100	4	3	100	3
PCB049	4	100	4	4	100	3	3	100	3
PCB052	4	100	4	4	100	4	3	100	3
PCB066	4	100	4	4	100	3	3	100	2
PCB070	4	100	4	4	100	3	3	100	3
PCB074	4	100	4	4	100	4	3	100	3
PCB077	4	100	4	4	100	4	3	100	3
PCB081	4	100	4	4	100	4	3	100	3
PCB087	4	100	4	4	100	4	3	100	3
PCB099	4	100	4	4	100	4	3	100	3
PCB101	4	100	4	4	100	3	3	100	0
PCB105	4	100	4	4	100	4	3	100	3
PCB110	4	100	4	4	100	3	3	100	0
PCB114	4	100	4	4	100	4	3	100	3
PCB118	4	100	4	4	100	4	3	100	3
PCB119	4	100	4	4	100	4	3	100	3
PCB123	4	100	4	4	100	4	3	100	3
PCB126	4	100	4	4	100	4	3	100	3
PCB128	4	100	4	4	100	4	3	100	3
PCB138	4	100	4	4	100	4	3	100	3
PCB149	4	100	4	4	100	4	3	100	3
PCB153+168	4	100	4	4	100	2	3	100	3
PCB156	4	100	4	4	100	4	3	100	3
PCB157	4	100	4	4	100	4	3	100	3
PCB158	4	100	4	4	100	4	3	100	3
PCB167	4	100	4	4	100	4	3	100	3
PCB169	4	100	4	4	100	4	3	100	3
PCB170	4	100	4	4	100	4	3	100	3
PCB177	4	100	4	4	100	4	3	100	3
PCB180	4	100	4	4	100	4	3	100	3
PCB183	4	100	4	4	100	4	3	100	3
PCB187	4	100	4	4	100	3	3	100	2
PCB189	4	100	4	4	100	4	3	100	3
PCB194	4	100	4	4	100	4	3	100	3
PCB201	4	100	4	4	100	4	3	100	3
PCB206	4	100	4	4	100	4	3	100	3

Table A-4. QA/QC Table. Matrix spikes, matrix spike duplicates (MS), laboratory control samples, laboratory control sample duplicates (LCS), blank spikes certified reference material (CRM), laboratory suplicates (Lab Dup), percent recoveries, and relative percent differences (RPD) that did not meet data quality objectives (DQO). Boldface type indicates values that did not meet quality control criteria.

Analyte	Station ID	Sample Date	Batch ID	Sample Type	Recovery DQO	% Recovery	Dup % Recovery	RPD	RPD DQO
General Chemistry (sediment)									
Total Organic Carbon	LAREST2	29-Aug-12	WG274347C	MS	80 - 120 %	**133**	**96**	**47**	25%
Metals (samplewater)									
Cadmium	LAREST2	29-Aug-12	WG304115	MS	75 - 125 %	**44**	**49**	11	25%
Copper	LAREST2	29-Aug-12	WG304115	MS	75 - 125 %	**16**	**26**	**48**	25%
Lead	LAREST2	29-Aug-12	WG304115	MS	75 - 125 %	**32**	**47**	**39**	25%
Zinc	LAREST2	29-Aug-12	WG304115	MS	75 - 125 %	**27**	**17**	**42**	25%
Metals (sediment)									
Iron	000NONPJ	17-Jul-13	WG318960	MS	75 - 125 %	**4992**	**8286**	**50**	25%
Iron	LAREST2	14-Jul-14	WG344970	MS	75 - 125 %	**0**	**0**	0	25%
Zinc	000NONPJ	22-Aug-13	WG318960	MS	75 - 125 %	**67**	77	13	25%
Organochlorine (sediment)									
HCH, alpha	LABQA	1-Jan-13	WG317858	LCS	50 - 150 %	**30**	NA	NA	25%
HCH, delta	LABQA	1-Jan-13	WG317858	LCS	50 - 150 %	**7**	NA	NA	25%
HCH, gamma	LABQA	1-Jan-13	WG317858	LCS	50 - 150 %	**56**	NA	NA	25%
HCH, alpha	000NONPJ	1-Jan-13	WG317858	MS	50 - 150 %	**33**	**33**	0	25%
HCH, delta	000NONPJ	1-Jan-13	WG317858	MS	50 - 150 %	**10**	**10**	0	25%
Organochlorine (tissue)									
Endrin Aldehyde	LABQA	1-Jan-12	WG301520	LCS	50 - 150 %	**50**	NA	NA	25%
Toxaphene	LABQA	1-Jan-12	WG301520	LCS	50 - 150 %	**920**	NA	NA	25%
DDE(p,p')	000NONPJ	16-Oct-14	WG349551	MS	50 - 150 %	**607**	803	28	
Organophosphorus (samplewater)									
Trichloronate	LABQA	1-Jan-12	IIRMES_TO-03-085_W_PEST	LCS	50 - 150 %	65	84	**26**	25%
Chlorpyrifos	LABQA	1-Jan-13	IIRMES_TO-04-005_W_OPP	LCS	50 - 150 %	86	123	**35**	25%
Diazinon	LABQA	1-Jan-13	IIRMES_TO-04-005_W_OPP	Blank Spike	50 - 150 %	110	85	**26**	25%
Fensulfothion	LABQA	1-Jan-13	IIRMES_TO-04-005_W_OPP	Blank Spike	50 - 150 %	**283**	**189**	**40**	25%

Table A-4 Continued.

Analyte	Station ID	Sample Date	Batch ID	Sample Type	Recovery DQO	% Recovery	Dup % Recovery	RPD	RPD DQO
Organophosphorus (samplewater, Continued)									
Fensulfothion	LAR02488	3-Jun-13	IIRMES_TO-04-005_W_OPP	MS	50 - 150 %	**308**	**375**	20	25%
Tokuthion	LABQA	1-Jan-13	IIRMES_TO-04-005_W_OPP	Blank Spike	50 - 150 %	**147**	105	26	25%
Fensulfothion	LABQA	1-Jan-13	IIRMES_TO-04-006_W_OPP	Blank Spike	50 - 150 %	**175**	**155**	12	25%
Fensulfothion	LAR05640	17-Jun-13	IIRMES_TO-04-006_W_OPP	MS	50 - 150 %	**165**	**165**	1	25%
Dichlorvos	LAR05020	15-Jul-13	IIRMES_TO-04-011_W_OPP	MS	50 - 150 %	61	81	**28**	25%
PAHs (sediment)									
Acenaphthene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**43**	65	**39**	25%
Acenaphthylene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**40**	61	**40**	25%
Benzo(a)pyrene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**48**	60	23	25%
Benzo(g,h,i)perylene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**42**	50	18	25%
Dibenz(a,h)anthracene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**41**	51	20	25%
Indeno(1,2,3-c,d)pyrene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**40**	51	23	25%
Naphthalene	LAREST2	29-Aug-12	WG297175	MS	50 - 150 %	**29**	**45**	**41**	25%
PCBs (Sediment)									
PCB 153/168	LAREST2	29-Aug-12	WG276948	MS	50 - 150 %	88	67	**27**	25%
PCB 167	LAREST2	29-Aug-12	WG276948	MS	50 - 150 %	95	**48**	**65**	25%
PCBs (Tissue)									
PCB 183	000NONPJ	1-Jan-12	WG302192	MS	50 - 150 %	**134**	**163**	20	25%
PCB 187	000NONPJ	1-Jan-12	WG302192	MS	50 - 150 %	**131**	**158**	18	25%
Pyrethroids									
Trichloronate	LABQA	1-Jan-12	IIRMES_TO-03-085_W_PEST	LCS	50 - 150 %	65	84	**26**	25%
Permethrin-1	LABQA	1-Jan-13	IIRMES_TO-04-006_W_PYR	Blank Spike	50 - 150 %	137	100	**31**	25%
Cyhalothrin, lambda, total	SMC02488	3-Jun-13	IIRMES_TO-04-005_W_PYR	Lab Dup	50 - 150 %	NA	NA	**78**	25%
Permethrin, total	SMC02488	3-Jun-13	IIRMES_TO-04-005_W_PYR	Lab Dup	50 - 150 %	NA	NA	**58**	25%
Permethrin-2	SMC02488	3-Jun-13	IIRMES_TO-04-005_W_PYR	Lab Dup	50 - 150 %	NA	NA	**58**	25%

Table A-5. Laboratory blanks with concentrations above detection for samples collected between 2012 and 2014.

Analyte	Sampling Year	Sample Type	Batch ID	Result	Unit	Minimum Detection Limit	Reporting Limit
Metals							
Total Chromium	2013	LabBlank	WG316522	0.656	ug/l	0.13	0.5
Total Chromium	2013	LabBlank	WG318114	1.1	ug/l	0.13	0.5
Total Zinc	2013	LabBlank	WG312298	1.79	ug/l	0.15	1
Organochlorine Pesticides							
DDE(p,p')	2012	LabBlank	WG301520	4.1	ug/kg ww	0.6	1.7
DDE(p,p')	2013	LabBlank	WG317858	3.36	ug/Kg dw	0.23	1

Appendix B – Biotic Condition Index Scores for the CSCI & CRAM

Table B-1. CSCI and CRAM scores, including sub-metrics, for each random station sampled from 2009 to 2014.

Stratum	Station	Station Description	CSCI	CSCI Percentile	MMI	MMI Percentile	O/E	O/E Percentile	Overall Score	Biotic Structure	Buffer and Landscape Context	Hydrology	Physical Structure
2009													
Effluent	LAR00436	Los Angeles River	0.62	0.01	0.49	0	0.74	0.09	27	8	6	12	6
	LAR02228	Los Angeles River	0.70	0.03	0.55	0.01	0.84	0.21	27	8	6	12	6
Urban	LAR00440	Aliso Canyon Wash	0.80	0.1	0.60	0.01	0.99	0.48	64	25	21	18	12
	LAR00756	Tujunga Wash	0.68	0.02	0.51	0	0.85	0.21	37	8	15	12	6
	LAR01004	Arroyo Seco	0.67	0.02	0.51	0	0.83	0.19	29	8	8	12	6
Natural	LAR00476	Little Bear Canyon	1.22	0.92	1.16	0.82	1.28	0.93	99	34	24	36	24
	LAR00520	Big Tujunga Creek	1.02	0.55	0.77	0.1	1.27	0.92	80	33	20	21	21
	LAR00924	Arroyo Seco	1.35	0.99	1.43	0.99	1.27	0.93	87	33	20	30	21
	LAR01040	Big Tujunga Creek	1.21	0.91	1.10	0.72	1.32	0.95	89	33	24	27	21
	LAR06216	Big Tujunga Creek	0.85	0.17	0.73	0.07	0.97	0.43	64	23	20	21	12
2010													
Effluent	LAR00318	Los Angeles River	0.35	0	0.19	0	0.51	0.01	36	8	16	9	6
	LAR02622	Los Angeles River	0.44	0	0.37	0	0.52	0.01	36	8	16	9	6
Urban	LAR01208	Los Angeles River	0.54	0	0.58	0.01	0.50	0	38	8	16	12	6
	LAR01452	Eaton Wash	0.37	0	0.30	0	0.44	0	36	10	16	9	6
	LAR01716	Bull Creek	0.43	0	0.48	0	0.39	0	38	8	16	12	6
	LAR01972	Bull Creek	0.42	0	0.44	0	0.40	0	38	8	16	12	6
Natural	LAR00080	Lynx Gulch	0.75	0.06	0.64	0.02	0.86	0.23	55	17	18	21	9
	LAR00520	Big Tujunga Creek	0.75	0.06	0.73	0.07	0.76	0.11	63	15	22	24	12
	LAR00924	Arroyo Seco	0.68	0.02	0.55	0.01	0.81	0.16	70	20	24	27	12
	LAR01096	Big Tujunga Creek	0.65	0.01	0.59	0.01	0.71	0.06	63	15	20	27	12
	LAR01196	Big Tujunga Creek	0.82	0.13	0.79	0.12	0.85	0.21	65	21	22	21	12
	LAR01320	Big Tujunga Creek	0.69	0.03	0.62	0.02	0.77	0.12	66	21	22	27	9
	LAR01544	Big Tujunga Creek	0.84	0.15	0.77	0.1	0.90	0.3	66	18	22	30	9
2011													
Effluent	LAR02804	Los Angeles River	0.72	0.04	0.55	0.01	0.88	0.27	39	13	15	12	6
Urban	LAR00632	Tarzana	0.44	0	0.33	0	0.55	0.01	32	15	7	12	6
	LAR00684	Rio Hondo Spillway	0.44	0	0.43	0	0.44	0	38	8	16	12	6
	LAR00748	Rubio Wash, Rosemead	0.25	0	0.27	0	0.24	0	35	10	15	9	6
	LAR00830	Rio Hondo	0.43	0	0.47	0	0.39	0	38	8	16	12	6
	LAR01358	Compton Creek	0.37	0	0.23	0	0.51	0.01	37	8	15	12	6
Natural	LAR00080	Lynx Gulch	0.89	0.25	0.81	0.14	0.98	0.45	78	20	22	36	15
	LAR00520	Big Tujunga Creek	0.80	0.1	0.75	0.08	0.85	0.21	71	15	20	30	18
	LAR00924	Arroyo Seco	0.79	0.1	0.80	0.13	0.79	0.13	76	19	22	30	18
	LAR01692	Arroyo Seco	0.83	0.15	0.67	0.03	0.99	0.48	63	16	18	30	12
	LAR01808	Alder Creek	0.87	0.21	0.80	0.14	0.93	0.37	86	26	23	36	18
	LAR02088	Big Tujunga Creek	0.86	0.2	0.71	0.05	1.02	0.54	66	14	20	33	12
	LAR02092	Big Tujunga Creek	0.88	0.23	0.72	0.06	1.04	0.58	77	21	22	30	18
2012													
Effluent	LAR04532	Los Angelese River	0.68	0.02	0.51	0	0.85	0.21	47	13	16	21	6
Urban	LAR01464	Aliso Canyon Wash	0.70	0.03	0.60	0.01	0.80	0.14	34	8	7	21	6
	LAR01656	Cabarello Creek	0.69	0.03	0.52	0	0.86	0.22	36	13	12	12	6
	LAR01772	Alhambra Wash	0.60	0.01	0.52	0	0.67	0.04	39	12	15	12	6
	LAR01912	Santa Susana Creek	0.36	0	0.32	0	0.39	0	34	8	13	12	6
	LAR02028	Arroyo Seco	0.68	0.02	0.57	0.01	0.78	0.13	34	10	12	12	6
Natural	LAR00080	Lynx Gulch	0.85	0.17	0.85	0.2	0.85	0.21	79	25	24	30	15
	LAR00520	Big Tujunga Creek	1.01	0.52	1.03	0.57	0.99	0.47	61	16	18	27	12
	LAR00924	Arroyo Seco	0.82	0.13	0.87	0.23	0.77	0.11	74	20	22	30	15
	LAR02568	Big Tujunga Creek	0.97	0.42	0.91	0.31	1.02	0.55	79	23	22	30	18
	LAR02712	Pacoima Canyon	1.04	0.59	0.84	0.18	1.24	0.89	77	21	24	27	18
	LAR04204	Santa Anita Wash	0.99	0.48	0.81	0.14	1.18	0.83	69	25	22	27	9
	LAR04880	Big Tujunga Creek	1.04	0.6	0.83	0.17	1.25	0.91	82	20	23	36	18

Table B-1. continued.

Stratum	Station	Station Description	CSCI	CSCI Percentile	MMI	MMI Percentile	O/E	O/E Percentile	Overall Score	Biotic Structure	Buffer and Landscape Context	Hydrology	Physical Structure
2013													
Effluent	LAR03646	Los Angeles River	0.61	0.01	0.48	0	0.73	0.08	38	25	67.67	33.33	25
Urban	LAR02232	Limekiln Canyon Wash	0.24	0	0.30	0	0.18	0	40	25	50	58.33	25
	LAR02484	Tujunga Wash	0.56	0	0.55	0.01	0.56	0.01	30	36.11	25	33.33	25
	LAR02488	Wilbur Wash	0.21	0	0.30	0	0.12	0	40	25	50	58.33	25
	LAR02796	Rubio Wash	0.28	0	0.28	0	0.29	0	27	25	25	33.33	25
	LAR02936	Bell Creek Tributary	0.46	0	0.46	0	0.46	0	37	27.78	55.17	41.67	25
Natural	LAR05020	Arroyo Seco	0.95	0.37	0.90	0.29	1.00	0.49	84	69.44	93.29	100	75
	LAR05640	Big Tujunga Creek	0.92	0.31	0.95	0.39	0.89	0.29	81	77.78	93.29	91.67	62.5
	LAR05848	Gold Creek	0.91	0.28	0.87	0.23	0.95	0.4	84	77.78	100	83.33	75
	LAR06044	Arroyo Seco	1.13	0.79	1.10	0.72	1.15	0.79	84	75	93.29	91.67	75
2014													
Effluent	LAR05694	Los Angeles River	0.45	0	0.45	0	0.45	0	35	25	58.54	33.33	25
Urban	LAR02680	Los Angeles River	0.41	0	0.34	0	0.48	0	38	25	67.67	33.33	25
	LAR02988	Sawpit Wash	0.70	0.03	0.69	0.04	0.72	0.07	36	25	62.5	33.33	25
	LAR02996	Big Tujunga Wash	0.47	0	0.38	0	0.55	0.01	34	25	62.5	25	25
Natural	LAR00520	Big Tujunga Creek	0.86	0.2	0.81	0.14	0.92	0.34	74	61.11	90.29	83.33	62.5
	LAR00924	Arroyo Seco	1.13	0.79	1.02	0.55	1.24	0.89	81	86.11	93.29	83.33	62.5
	LAR06188	Big Tujunga Wash	1.11	0.75	0.95	0.38	1.27	0.92	83	97.22	93.29	66.67	75
	LAR06216	Big Tujunga Creek	0.92	0.31	0.84	0.18	1.01	0.51	81	88.89	90.29	83.33	62.5
	LAR06252	Santa Anita Wash	0.82	0.13	0.88	0.25	0.76	0.1	83	83.33	85.38	75	87.5
	LAR07128	Pacoima Canyon	1.05	0.63	0.99	0.48	1.11	0.72	90	97.22	96.54	91.67	75