U.S. Environmental Protection Agency
Region IX

Total Maximum Daily Loads for Metals and Selenium
San Gabriel River and Impaired Tributaries

Approved by:

[Original signed by] *March 26, 2007*

Alexis Strauss **Date**
Director Water Division
EPA Region 9

LIST OF ACRONYMS

µg/L	Micrograms per liter
ACF	Acute Conversion Factor
AGR	Agricultural Supply
BAT	Best Available Technology
BMP	Best Management Practice
CCC	Criteria Continuous Concentration
CCF	Chronic Conversion Factor
CFR	Code of Federal Regulations
cfs	cubic feet per second
COMM	Commercial and Sport Fishing
CMC	Criteria Maximum Concentration
CTR	California Toxics Rule
CWA	Clean Water Act
EMC	Event Mean Concentration
EST	Estuarine Habitat
FHWA	Federal Highway Administration
GIS	Geographic Information System
GWR	Ground Water Recharge
IND	Industrial Service Supply
JWPCP	Joint Water Pollution Control Plant
LAs	Load Allocations
LACSD	Los Angeles County Sanitation Districts
LADWP	Los Angeles Department of Water and Power
LADPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LSPC	Loading Simulation Program in C++
MAR	Marine Habitat
MCLs	Maximum Contaminant Levels
MGD	Million Gallons Per Day
MIGR	Migration of Aquatic Organisms
MS4	Municipal Separate Storm Sewer System
MUN	Municipal Supply
NAV	Navigation
NPDES	National Pollutant Discharge Elimination System
POTW	Publicly Owned Wastewater Treatment Works
PROC	Industrial Process Supply
RECI	Water Contact Recreation
RECII	Non-contact Water Recreation
SARWQCB	Santa Ana Regional Water Quality Control Board
SCAG	Southern California Association of Governments
SCCWRP	Southern California Coastal Water Research Project
SHELL	Shellfish Harvesting
SIP	State Implementation Plan
SPWN	Spawning, Reproduction, and/or Early Development

SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Loads
USACE	United States Army Corps of Engineers
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WDRs	Waste Discharge Requirements
WER	Water Effect Ratio
WET	Wetland Habitat
WLA	Waste Load Allocation
WRP	Water Reclamation Plant

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1. INTRODUCTION

Segments of the San Gabriel River and its tributaries exceed water quality objectives for copper, lead, selenium, and zinc. These segments (i.e., reaches) of the San Gabriel River have been identified as impaired under Section 303(d) of the Clean Water Act. The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed to address these impairments. Table 1 summarizes the waterbody impairments that are addressed by these TMDLs.

Table 1. Waterbodies identified as impaired for metals in the San Gabriel River watershed

Impaired Reach	Copper	Lead	Zinc	Selenium
San Jose Creek Reach 1				X
San Gabriel River Reach 2		X		
Coyote Creek	X	X	X	
San Gabriel River Estuary	X			

This document provides the background information used by the U.S. Environmental Protection Agency (EPA) and the California Regional Water Quality Control Board, Los Angeles Region (Los Angeles Regional Board) in the development of TMDLs for metals to the San Gabriel River Watershed.

1.1 Regulatory Background

Section 303(d) of the Clean Water Act (CWA) requires that each State "shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in EPA guidance (U.S. EPA, 2000a). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loadings (the Loading Capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis.

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. In California, the State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards are responsible for preparing lists of impaired waterbodies under the 303(d) program and for preparing TMDLs, both subject to EPA approval. If EPA disapproves a TMDL submitted by a state, EPA is required to establish a TMDL for that waterbody. The regional boards also hold regulatory authority for many of the instruments used to implement the TMDLs such as the National Pollutant Discharge Elimination System (NPDES) permits and state-specified Waste Discharge Requirements (WDRs).

The Los Angeles Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWCQB, 1996, 1998). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree approved on March 22, 1999 (Heal the Bay Inc., *et al*. v. Browner C 98-4825 SBA).

For the purpose of scheduling TMDL development, the decree combined the over 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical unit 39 was designed to address metals in the San Gabriel River watershed. Under the consent decree, TMDLs are required to be established for metals in this analytical unit by March 2007. The Regional Board public noticed these TMDLs on May 5, 2006 and adopted them on July 13, 2006. However, because the State will not be able to complete its process for adopting these TMDLs and obtaining EPA approval in time to meet the consent decree deadline, EPA has agreed to establish them.

Analytical unit 39 included impairments of lead in San Jose Creek Reach 2, arsenic in the San Gabriel River Estuary, and silver in Coyote Creek. In 2002, California updated its 303(d) list and removed the listings for arsenic for the San Gabriel River Estuary and silver for Coyote Creek. Under the consent decree, TMDLs are not necessary for waterbody/pollutant combinations that have been delisted. Therefore, these TMDLs do not address arsenic or silver. Additionally, on review of Analytical unit 39, it appears that the lead impairment was wrongly assigned to San Jose Creek Reach 2. This was likely a typographical error in the consent decree as the lead impairment should have been assigned to San Gabriel River Reach 2 in order to be consistent with the 1998 list. These TMDLs address the lead impairment in San Gabriel River Reach 2.

The 303(d) list was updated again in 2006. The only current metals listings are for lead in San Gabriel River Reach 2 and for copper in Coyote Creek. Additional impairments were identified during the preparation of these TMDLs. These include impairments for lead and zinc in Coyote Creek, for selenium in San Jose Creek Reach 1, and for copper in the estuary. These impairments were identified by the State during the preparation of these TMDLs. The Regional Board identified these segments as impaired and took public comment on the these determinations during its public review process. These metals TMDLs will address the new impairments as well as those listed formally in the 2006 303(d) list[1].

[1] The 303(d) list was updated by California in 2004-2006 and submitted to EPA for approval under CWA 303(d). All the waterbody-pollutant combinations addressed in these TMDLs were either included on California's 2004-2006 list and approved by EPA, or added by EPA to the list in its partial disapproval of March 8, 2007. As all these waterbody-pollutant combinations are on the 303(d) list, all require TMDLs.
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1.2 Environmental Setting

The San Gabriel River receives drainage from a 682 square mile area of eastern Los Angeles County and has a main channel length of approximately 58 miles. Its headwaters originate in the San Gabriel Mountains with the East, West, and North Forks. The river flows through a heavily developed commercial and industrial area before emptying into the Pacific Ocean in Long Beach. The main tributaries of the river are Walnut Creek, San Jose Creek, and Coyote Creek (LARWQCB, 2000). A map of the watershed is presented in Figure 1 and the predominant land uses are shown in Figure 2.

Reach 5. The San Gabriel River Main Stem. The upper watershed consists of extensive areas of undisturbed riparian and woodland habitats in its upper reaches, much of which were set aside as wilderness areas by the U.S. Congress in 1968 as Public law 90-318, designating the San Gabriel Wilderness, within and as apart of the Angeles National Forest. Other areas in the upper watershed are subject to heavy recreational use. The upper watershed also contains a series of reservoirs with flood control dams (Cogswell, San Gabriel, and Morris Dams). Below Morris Dam, the river flows out of the San Gabriel Canyon and into the San Gabriel Valley.

About four miles downstream from the mouth of the San Gabriel Canyon is the Santa Fe Dam and Reservoir flood control project. Los Angeles County Department of Public Works (LACDPW) operates and maintains the Santa Fe Reservoir Spreading Grounds through an easement with the United States Army Corps of Engineers (USACE). The spreading grounds recharge water to the Main San Gabriel Basin underlying the San Gabriel Valley and are bounded by the San Gabriel Mountains on the north, the Puente Hills on the south, the San Jose Hills to the east, and the San Rafael Hills to the west. Flow from the upper part of the watershed often does not get past the Santa Fe Dam and its spreading grounds.

The Rio Hondo branches from the San Gabriel River just below Santa Fe Dam and flows westward to Whittier Narrows Reservoir. Flows from the San Gabriel River and Rio Hondo merge at this reservoir during larger flood events. From Whittier Narrows Reservoir, the Rio Hondo flows southwestward towards the Los Angeles River.

Reaches 3 and 4. The area between Santa Fe and Whittier Narrows Dam. The San Gabriel River between Santa Fe Dam and the Whittier Narrows Basin is soft-bottomed with riprap sides. This area is used for infiltration and is primarily dry during most of the year. Reach 4 of the San Gabriel River runs from the Santa Fe Dam to Ramona Boulevard. Reach 3 of the San Gabriel River runs from Ramona Boulevard to the Whittier Narrows Dam.

Walnut Creek is a tributary to San Gabriel River Reach 3. Puddingstone Reservoir is located on upper Walnut Creek and is operated for flood control, water conservation, and recreation. Immediately below Puddingstone Reservoir, the creek is soft-bottomed. The rest of the creek is concrete lined until its confluence with the San Gabriel River. Walnut Creek also receives inputs from Big Dalton Wash.

San Jose Creek enters San Gabriel River Reach 3 below Walnut Creek. The upper portion of San Jose Creek (Reach 2) extends from White Avenue to Temple Avenue. San Jose Creek Reach 1 extends from Temple Avenue to the confluence with the San Gabriel River. Tributaries to San Jose Creek Reach 1 include the South Fork, Diamond Bar Creek, and Puente Creek. The Pomona Water Reclamation Plant (WRP) discharges to the South Fork. San Jose Creek Reach 1 is concrete lined in its upper portion and soft bottomed just before it joins the San Gabriel River. The San Jose Creek WRP discharges to the soft-bottomed portion of the reach.

Waters entering the mainstem from San Jose and Walnut Creeks may be diverted through Whittier Narrows area to the Los Angeles River. Those waters remaining in the San Gabriel River will often recharge at the downstream spreading grounds.

Whittier Narrows Dam. The Whittier Narrows are a natural gap in the hills along the southern boundary of the San Gabriel Valley. The Whittier Narrows Dam is a flood control and water conservation project constructed and operated by the USACE. The Rio Hondo and San Gabriel Rivers flow through Narrows and are impounded by the Dam. The purpose of the project is to collect upstream runoff and releases from the Santa Fe Dam for flood control and water conservation. If the inflow to the reservoir exceeds the groundwater recharge capacity of the spreading grounds or the storage capacity of the water conservation or flood control pools, water is released into the San Gabriel River.

Reach 2. Below Whittier Narrows Dam. The Montebello Forebay is a recharge facility located immediately downstream of Whittier Narrows Dam and allows infiltration into the Central Basin aquifer. It runs from just below the Narrows to Firestone Boulevard (essentially all of Reach 2). Groundwater is recharged either by percolation through the unlined bottom of the river or by the diversion of water to the San Gabriel Coastal Basin Spreading Grounds by way of rubber dams. Water that is not captured in these spreading facilities flows to Reach 1 and the estuary.

Reach 1 and Estuary. The Lower Watershed. The lower part of the river flows through a concrete-lined channel in a heavily urbanized portion of the county. Reach 1 extends from Firestone Boulevard to the Estuary, just above the confluence with Coyote Creek.

Coyote Creek is a concrete-lined channel that flows along the Los Angeles/Orange County border. The upper portion of Coyote Creek is located in Orange County and is under the jurisdiction of the Santa Ana Regional Water Quality Control Board (SARWQCB). The Coyote Creek subwatershed is largely urbanized, but there are areas of open space in the upper watershed, which are mostly used for oil production. (SARWQCB, 2004). Coyote Creek joins the San Gabriel River above the tidal prism in Long Beach south of Willow Street.

The Estuary is approximately 3.4 miles long with a soft bottom and concrete and riprap sides. The Estuary receives flow from San Gabriel Reach 1 and Coyote Creek, tidal exchange, and cooling water discharged from two power plants.

1.3 Sections of this TMDL Report

Sections 2 through 8 of this document are organized as follows:

- **Section 2: Problem Identification.** This section reviews the metals data used to identify the waterbody as impaired under section 303(d) of the Clean Water Act, and summarizes existing conditions using that evidence along with any new information acquired since the listing. This element identifies those reaches that fail to support all designated beneficial uses; the beneficial uses that are not supported for each reach; the water quality objectives designed to protect those beneficial uses; and, in summary, the evidence supporting the decision to list each reach, such as the number and severity of exceedances observed.

- **Section 3: Numeric Targets.** For these TMDLs, the numeric targets are based upon the water quality objectives described in the California Toxics Rule (CTR).
- **Section 4: Source Assessment.** This section estimates metals loadings from point sources and non-point sources to the San Gabriel River and listed tributaries.
- **Section 5: Linkage Analysis.** This analysis shows how the sources of metals compounds into the waterbody are linked to the observed conditions in the impaired waterbody. The linkage analysis addresses the critical conditions of stream flow, loading, and water quality parameters.
- **Section 6: TMDLs and Pollutant Allocations.** This section identifies the total allowable loads that can be discharged without causing water quality exceedances. Each pollutant source is allocated a quantitative load of metals that it can discharge without exceeding numeric targets. Allocations are designed such that the waterbody will not exceed numeric targets for any of the compounds or related effects. Allocations are based on critical conditions, so that the allocated pollutant loads may be expected to achieve water quality standards at all times.
- **Section 7: Implementation Recommendations.** This section describes the plans, regulatory tools, or other mechanisms by which the waste load allocations and load allocations may be achieved.
- **Section 8: Monitoring.** When the Regional Board adopted metals TMDLs for this watershed, they included a requirement for monitoring the waterbody to ensure that the water quality standards are attained. They also describes special studies to address uncertainties in assumptions made in the development of these TMDLs and the process by which new information may be used to refine the TMDL.

2. PROBLEM IDENTIFICATION

This section presents a review of the data used by the Los Angeles Regional Board to identify the San Gabriel River for metals. Where available, additional pertinent data were used to assess the condition of the watershed as impaired.

2.1 Water Quality Standards

California water quality standards consist of the following elements: 1) beneficial uses, 2) narrative and/or numeric water quality objectives, and 3) an antidegradation policy. In California, beneficial uses are defined by the regional boards in their Water Quality Control Plans (Basin Plans). Numeric and narrative objectives are designed to be protective of the beneficial uses specified in the Basin Plan.

2.1.1 Beneficial Uses

The Basin Plan for the Los Angeles Regional Board (LARWQCB, 1994) defines 22 beneficial uses for the San Gabriel River (Table 2-1). These uses are recognized as existing (E), potential (P) or intermittent (I) uses. Metals loading to the San Gabriel River watershed may result in impairments of beneficial uses associated with aquatic life (WILD, WARM, COLD, RARE, EST, MAR, MIGR, SPWN, and WET) and water supply (MUN, IND, AGR, GWR, and PROC).

Table 2-1. Beneficial uses in the San Gabriel River watershed. (LARWQCB, 1994)

Reach	MUN	GWR	REC1	REC2	WILD	WARM	COLD	RARE	WET	IND	AGR	PROC	IND	SHELL	NAV/ COMM	EST/ MAR	MIGR/ SPWN
San Gabriel River Reach 5 (Mainstem)	E	E	E	E	E	E	E			E	E	E					
San Gabriel River Reach 4 (Santa Fe Dam to Ramona)	E	E	E	E	E	E	E			E	E	E					
San Gabriel River Reach 3 (Ramona to Whittier Narrows)	P[1]	I	I[2]	I	E	I											
Walnut Creek	P[1]	I	I[2]	I	E	I			I								
San Jose Creek Reach 2 (Temple Street to I-10 at White Ave)	P[1]	I	P[2]	I	E	I											
San Jose Creek Reach 1 (Confluence to Temple Street)	P[1]	I	P[2]	I	E	I											
San Gabriel River Reach 2 (Whittier Narrows to Firestone)	P[1]	I	E[2]	E	E	I		E		P		P					
San Gabriel River Reach 1 (Firestone to Estuary)	P[1]		E[2]	E	P	P											
Coyote Creek	P[1]		P[2]	I	P	P		E		P		P					
Estuary			E	E	E			E		E			E	P	E	E	E

1. Use may be reviewed by SWRCB
2. Access restricted by LACDPW

The Basin Plan for the Santa Ana Regional Board (SARWQCB, 1995) defines five beneficial uses for upper Coyote Creek (Table 2-2). These uses are recognized as present or potential uses.

Table 2-2. Beneficial uses in upper Coyote Creek. (SARWQCB, 1995)

Reach	MUN	AGR	IND	GWR	REC1	REC2	COMM	WARM	COLD	BIOL	WILD	RARE
Coyote Creek (within Santa Ana Regional Boundary)	x				x	x		x			x	

2.1.2. Water Quality Objectives

Narrative water quality objectives are specified by the 1994 Los Angeles Regional Board Basin Plan. The following narrative objectives are most pertinent to the metals TMDL:

Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use.

All waters shall be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

Toxic substances shall not be present at levels that will bioaccumulate in aquatic life resources to levels which are harmful to aquatic life or human health.

The Los Angeles Regional Board's narrative toxicity objective reflects and implements national policy set by Congress. The Clean Water Act states that, "it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited." (33 U.S.C. 1251(a)(3)). In 2000, EPA established numeric criteria for certain toxic pollutants, including the metals subject to these TMDLs, in the California Toxics Rule (CTR) (U.S. EPA 2000b). The federal water quality criteria established by the CTR serve as the numeric water quality objectives for the Los Angeles Region. The CTR criteria apply at all times during wet and dry weather to inland surface waters. (See, 40 CFR 131.38(a), (c)(1), and (d)(1).) There is no exception for wet-weather conditions. Aquatic life is present in wet weather conditions and the CTR is legally necessary to protect these uses. In high-volume, wet-weather conditions, if the concentration of a toxic pollutant in a water body exceeds the CTR criterion, the water body is toxic.

The TMDLs for metals in the San Gabriel River are based on the CTR criteria for the protection of aquatic life. The CTR aquatic life criteria for copper (Cu), lead (Pb), selenium (Se), and zinc (Zn) are presented in Table 2-3. The aquatic life-based criteria will ensure that both the aquatic life and water supply beneficial uses for the San Gabriel River are protected. The CTR human health criterion for copper is less stringent than the aquatic life criteria. There are no CTR human health criteria for lead, selenium, or zinc, to compare with aquatic life criteria. However, the CTR aquatic life criteria are at least or more protective than the primary or secondary drinking water limits set forth in Title 22 of the California Code of Regulations.

The CTR establishes short-term (acute) and long-term (chronic) aquatic life criteria for metals in both freshwater and saltwater. The acute criterion, defined in the CTR as the Criteria Maximum Concentration (CMC), equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (one hour) without deleterious effects. The chronic criterion, defined in the CTR as the Criteria Continuous Concentration (CCC), equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. The criteria for copper, lead and zinc in freshwater and saltwater and the criterion for selenium in saltwater are based on the dissolved fraction of metals in water. The criterion for selenium in freshwater is based on the total recoverable fraction.

Freshwater criteria apply to waters in which the salinity is equal to or less than 1 part per thousand (ppt) 95 percent or more of the time. Saltwater criteria apply to waters in which salinity is equal to or greater than 10 ppt 95 percent or more of the time. For waters in which the salinity is between 1 and 10 ppt, the more stringent of the two criteria apply.

Table 2-3. Water quality objectives established in the California Toxic Rule (CTR). Values in table are based on a hardness value of 100 mg/l as $CaCO_3$. (U.S. EPA, 2000b)

Metal	Freshwater Chronic (µg/l)	Freshwater Acute (µg/l)	Saltwater Chronic (µg/l)	Saltwater Acute (µg/l)
Copper	9*	13*	3.1	4.8
Lead	2.5*	65*	8.1	210
Selenium	5**	Reserved	71	290
Zinc	120*	120*	81	90

*Freshwater criteria for dissolved copper, lead, and zinc are hardness dependent.
**Freshwater criterion for selenim is for total recoverable metals

The CTR allows for the adjustment of freshwater and saltwater criteria with a water-effect ratio (WER) to account for site-specific chemical conditions. A WER represents the ratio of metals that are measured to metals that are biologically available and toxic to aquatic life. A WER is a measure of the toxicity of a material in site water divided by the toxicity of the same material in laboratory dilution water. The adjusted criteria are equal to the values in Table 2-3 multiplied by a WER. No site-specific WER has been developed for the San Gabriel River; therefore, a WER default value of 1.0 is assumed.

The freshwater criteria for copper, lead, and zinc are expressed as a function of hardness. Increasing hardness generally has the effect of decreasing the toxicity of metals. The CTR lists criteria based on a hardness value of 100 mg/L as $CaCO_3$ (Table 2-3) and provides hardness dependent equations to calculate the criteria using site-specific hardness data (up to 400 mg/L as $CaCO_3$), as follows:

$$\mathbf{CMC = WER * ACF * EXP[(m_a)(ln(hardness)+b_a]} \qquad \textbf{Equation (1)}$$
$$\mathbf{CCC = WER * CCF * EXP[(m_c)(ln(hardness)+b_c]} \qquad \textbf{Equation (2)}$$

Where:

CMC = Criteria Maximum Concentration
CCC = Criteria Continuous Concentration
WER = Water Effects Ratio (assumed to be 1)
ACF = Acute conversion factor (to convert from total recoverable to dissolved metals)
CCF = Chronic conversion factor (to convert from total recoverable to dissolved metals)
m_A = slope factor for acute criteria
m_C = slope factor for chronic criteria
b_A = y intercept for acute criteria
b_C = y intercept for chronic criteria

The coefficients needed for the calculation of freshwater objectives are provided in the CTR (Table 2-4). The conversion factors for lead are hardness-dependent. The following equations can be used to calculate the lead conversion factors based on site-specific hardness data:

$$\textbf{Lead ACF} = \mathbf{1.46203 - [(ln\{hardness\})(0.145712)]} \qquad \textbf{Equation (3)}$$
$$\textbf{Lead CCF} = \mathbf{1.46203 - [(ln\{hardness\})(0.145712)]} \qquad \textbf{Equation (4)}$$

Table 2-4. Coefficients used in formulas for calculating freshwater CTR standards. (U.S. EPA, 2000b)

Metal	Freshwater ACF	Saltwater ACF	m_A	B_A	Freshwater CCF	Saltwater CCF	m_C	b_C
Copper	0.960	0.83	0.9422	-1.700	0.960	0.83	0.8545	-1.702
Lead	0.791*	0.951	1.2730	-1.460	0.791*	0.951	1.2730	-4.705
Selenium	n/a	0.998	n/a	n/a	n/a	0.998	n/a	n/a
Zinc	0.978	0.946	0.8473	0.884	0.986	0.946	0.8473	0.884

* The Freshwater ACF and CCF for lead are hardness dependent. Conversion factors in this table are based on a hardness value of 100 mg/L as $CaCO_3$.

2.1.3. Antidegradation

State Board Resolution 68-16, “Statement of Policy with Respect to Maintaining High Quality Water” in California, known as the "Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12). The TMDL will not degrade water quality, and will in fact improve water quality as it is designed to achieve compliance with existing, numeric water quality standards.

2.2 Water Quality Data Summary

This section summarizes water quality data pertaining to metals for the San Gabriel River and its tributaries. This section assesses the storm water data that were used in the 2002 and 2006 303(d) listing process, more recent storm water data, and additional dry-weather data. Data were evaluated based on the “Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List” (SWRCB, 2004). Sources of metals and conditions in the river vary dramatically between wet and dry weather (see Section 4). It is therefore essential to conduct the data assessment separately for wet and dry weather.

2.2.1. Dry-weather Data Summary

There are two sources of data that were evaluated to assess dry-weather water quality. The first source is the ambient monitoring data collected by the Los Angeles County Sanitation Districts (LACSD) for the five WRPs located in the San Gabriel River. Locations of the receiving water monitoring stations for the five plants are listed in Table 2-5.

Table 2-5. Location of LACSD ambient monitoring stations.

Reach	Station	Description
San Jose Creek		
1	R-A-P	Below Pomona WRP discharge, at San Jose Street, downstream of Old Brea Road
1	R-C	Below the intersection of the north and south forks of San Jose Creek
1	R-D	End of concrete-lined portion of San Jose Creek -200 yards downstream of 3rd Ave
1	C-1	Above the San Jose Creek WRP discharge point 002
1	C-2	Below the San Jose Creek WRP discharge point 002
San Gabriel River		
Reach	**Station**	**Description**
3	R-10	Above the confluence with San Jose Creek
3	R-11	Upstream of the Whittier Narrows WRP discharge points 001 and 002
3	R-A-WN	Downstream of the Whittier Narrows WRP discharge point 001, approximately 150 feet upstream of Whittier Narrows Dam
1	R-2	Below the San Jose Creek WRP discharge point 001, near Firestone Blvd
1	R-3-1	Upstream of the Los Coyotes WRP
1	R-4	Downstream of the Los Coyotes WRP, at Artesia Boulevard
1	R-9W	At the end of the western low flow channel, near Atherton Street
Estuary	R-A-2	Downstream of the confluence of the eastern and western low flow channels
Estuary	R-6	At Seventh Street
Estuary	R-7	At Westminster Avenue
Estuary	R-8	At Marina Avenue
Coyote Creek		
Reach	**Station**	**Description**
	R-A-1	Upstream of the discharge from Long Beach WRP
	R-A	Downstream of the discharge from Long Beach WRP
	R-9E	At the end of the eastern low flow channel, near Atherton Street

Evaluation of LACSD Data

Data from LACSD samples were compared to chronic CTR criteria. LACSD analyzes for concentrations of total recoverable metals; therefore, CTR criteria were converted to total recoverable metals using default chronic conversion factors (Table 2-4). Data collected from freshwater stations were compared to freshwater CTR criteria, which were adjusted for site-specific hardness values. Where possible, data were compared to criteria that had been adjusted for actual hardness values measured for each sample. Metals data from samples without reported hardness values were compared to CTR criteria based on median hardness values for those sampling stations. Samples from the Estuary were compared to saltwater criteria, which are independent of hardness. These monitoring data provide water quality information for the San Gabriel River Reaches 1 and 3, San Jose Creek, Coyote Creek, and the Estuary (Table 2-6).

Table 2-6. Summary dry-weather ambient data assessment (LACSD data 1995 through 2005). Values in table are the number of samples exceeding chronic CTR criteria over the number of metals samples. Non detects treated as zero.

Reach	Median Hardness	Copper	Lead	Zinc	Selenium[1]
San Jose Creek Reach 1					
R-A-P (below Pomona WRP)	202	1/12	2/12	1/12	0/12
R-C (below Pomona WRP)	373	0/19	0/19	0/19	0/12
R-D (End of concrete-lined portion of Creek)	534[2]	1/19	1/19	0/19	5/12
C-1 (above SJWRP 002)	515[2]	0/33	0/33	0/32	4/30
C-2 (below SJWRP 002)	296	0/12	0/12	0/5	2/12
Total		2/95	3/95	1/82	11/78
San Gabriel Reach 3					
R-10 (above confluence with San Jose Creek)	131	0/3	0/3	0/3	0/3
R-11 (above WNWRP)	250	0/49	0/49	0/48	0/38
R-A-WN (below WNWRP)	212	0/24	0/24	0/24	0/10
Total		0/76	0/76	0/75	0/51
Coyote Creek					
RA1 (above LBWRP)	417	0/49	0/49	0/49	0/29
RA (below LBWRP)	249	0/42	0/42	0/42	0/14
R-9E	278	2/20	1/20	1/20	0/12
Total		2/111	1/111	1/111	0/55
San Gabriel Reach 1					
R-2 (below SJWRP 001)	204	0/12	0/12	0/5	0/12
R-3-1	196	1/20	0/20	0/20	0/21
R-4 (below LCWRP)	217	0/11	0/11	0/11	0/12
R-9W	211	0/19	0/19	0/19	0/12
Total		1/62	0/62	0/55	0/57
Estuary[1]					
R-A-2		2/19	0/19	2/19	0/12
R-6		1/11	0/11	0/11	0/12
R-7		1/11	0/11	0/11	0/12
R-8		1/20	2/19	0/19	0/12
Total		5/61	2/60	2/60	0/48

1) Criteria are independent of hardness.
2) Maximum allowable hardness value to adjust criteria is 400 mg/L as $CaCO_3$.

Dry-Weather Results for San Jose Creek Reach 1

There were occasional exceedances of chronic copper, lead, and selenium criteria in San Jose Creek Reach 1. Two out of 95 samples exceeded the adjusted chronic copper criterion. This does not indicate an impairment in San Jose Creek.

Three out of 95 samples exceeded the adjusted chronic lead criterion. Fourteen of the 95 samples had detection limits greater than adjusted CTR criterion, so it is possible that samples with non-detectable values exceeded the criterion. However, these samples were taken prior to 2001. Since LACSD lowered their detection limits, only three out of 81 samples exceeded the criterion. Three exceedances out of 81 do not indicate an impairment in San Jose Creek.

There were 11 out of 78 samples exceeding the chronic selenium criterion. Detection limits were not an issue for the selenium assessment. This exceedance percentage indicates an impairment. A dry-weather TMDL is required for selenium in San Jose Creek Reach 1.

Dry-Weather Results for San Gabriel River Reach 3

There were no exceedances of chronic copper, lead, zinc or selenium criteria in San Gabriel River Reach 3. Four of the older lead samples had detection limits greater than adjusted CTR criterion, so it is possible that samples with non-detectable values exceeded the criterion. However, no samples have exceeded the criterion since LACSD lowered their detection limits in 2001. There is no evidence of impairments for any metals. No dry-weather TMDLs are required for this reach.

Dry-Weather Results for San Gabriel River Reach 1

There were no exceedances of chronic criteria for lead, zinc, or selenium criteria in San Gabriel River Reach 1. One out of 62 samples exceeded the copper criterion. This exceedance percentage does not indicate an impairment. There were no exceedances of lead criteria in the 62 samples. Eight of these samples had detection limits above CTR criterion, so it is possible that samples with non-detectable values of metals exceeded the criterion. However these samples were taken prior to 2002. Since LACSD lowered their detection limits, none of the 54 samples exceeded the criterion. With zero exceedances, there is no evidence of impairment in this reach and no dry-weather TMDLs are required.

Dry-Weather Results for Coyote Creek

There were few to no exceedances of the chronic selenium criteria and a few exceedances of the chronic for copper, lead and zinc, or selenium criteria in Coyote Creek. Two out of 111 samples exceeded the copper criterion, which does not indicate an impairment. One out of 111 samples exceeded the chronic zinc criterion, which does not indicate an impairment. One out of 111 samples exceeded the chronic lead criterion. Twenty of the lead samples had detection limits above CTR criterion, so it is possible that samples with non-detectable values of metals exceeded the criterion. Twenty of these samples were taken prior to 2002. Since LACSD lowered their detection limits, one out of 91 samples exceeded the criterion for lead. With one exceedance, there is no evidence of impairment in this reach. No dry-weather TMDLs are required for this reach.

Dry-Weather Results for the Estuary

There are occasional exceedances of copper, lead, and zinc in samples from the Estuary. There were no exceedances of the selenium criteria. Two out of the 60 samples exceeded the chronic lead criterion for saltwater. Twenty-two of these samples had detection limits (or estimated values) greater than the CTR criterion. When the detection limits were less than CTR, one out of 38 samples exceeded the criterion. The data do not indicate an impairment for lead.

Two out of 60 samples exceeded the chronic zinc criterion for saltwater. Seven of the 60 samples had detection limits greater than CTR criterion. When the detection limits were less than CTR, two out of 40 samples exceeded the criterion. The data do not indicate an impairment for zinc.

Five out of 61 samples exceeded the chronic copper criterion for saltwater. Fifty-four of these samples had detection limits greater than CTR criterion. In 2003, the detection limits were lowered from 80 μg/L to 8 μg/L, which is still greater than the adjusted CTR saltwater criterion (3.7μg/L). Since LACSD lowered their detection limits to 8 μg/L, five out of 40 samples exceed the criterion. It cannot be assumed that nondetectable values in the older data were less than CTR criterion. More weight is therefore given to the more recent data. Furthermore, when copper was detected in the samples, the criterion was exceeded by three to eight times, which demonstrates that the magnitude of exceedances is significant. Five out of 40 exceedances indicates an impairment for copper in the Estuary. Based on the weight of evidence, a dry-weather TMDL is required for copper in the Estuary.

Evaluation of Los Angeles County Department of Public Works (LACDPW) Dry-Weather Data

The second source of dry-weather water quality data is the Los Angeles County Department of Public Works (LACDPW) storm water mass emission stations at Coyote Creek (S13) and San Gabriel River Reach 2 (S14). LACDPW collects composite samples during storm events and dry weather for hardness, dissolved metals, and total recoverable metals. Dissolved metals data collected during dry weather were compared to hardness adjusted chronic CTR criteria to assess dry-weather impairments (Table 2-7).

Table 2-7. Summary of chronic metals criteria exceedances in LACDPW dry-weather data for San Gabriel River Reach 2 (Station S14) and Coyote Creek (Station S13) from October 1997 to June 2005.

San Gabriel Reach 2	Number of Samples	Exceedances of Chronic Criteria
Copper (dissolved)	10	0
Lead (dissolved)	10	0
Selenium (total recoverable)	10	0
Zinc (dissolved)	10	0
Coyote Creek	**Number of Samples**	**Exceedances of Chronic Criteria**
Copper (dissolved)	8	0
Lead (dissolved)	8	0
Selenium (total recoverable)	8	1
Zinc (dissolved)	8	0

Based on the LACDPW dry-weather data, there are a no exceedances of chronic copper, lead, or zinc criteria in San Gabriel River Reach 2 or Coyote Creek. There is one exceedance of the selenium criterion in Coyote Creek. There are no impairments for any of these metals and no dry-weather TMDLs are required for these reaches.

2.2.2 Wet-weather Data Summary

To assess wet-weather water quality, LACDPW storm water data were evaluated. Dissolved metals data from storm events were compared to hardness adjusted dissolved chronic and acute CTR criteria to assess wet-weather impairments (Table 2-8).

Table 2-8. Summary of acute and chronic criteria exceedances in LACDPW storm water data for San Gabriel River Reach 2 (Station S14) and Coyote Creek (Station S13) from November 1997 to January 2005.

San Gabriel Reach 2	Number of Samples	Exceedances of Acute Criteria	Exceedances of Chronic Criteria
Copper (dissolved)	58	2	4
Lead (dissolved)	58	0	5
Selenium (total recoverable)	58	-	1
Zinc (dissolved)	58	3	3
Coyote Creek	**Number of Samples**	**Exceedances of Acute Criteria**	**Exceedances of Chronic Criteria**
Copper (dissolved)	62	9	19
Lead (dissolved)	62	0	7
Selenium (total recoverable)	62	-	4
Zinc (dissolved)	62	6	6

Detection limits for all metals were below the CTR acute and chronic criteria. Therefore, if metals were not detected in a sample, CTR criteria were not exceeded.

Wet-Weather Results for San Gabriel River Reach 2

There were five out of 58 samples that exceeded the chronic lead criterion, which indicates an impairment. There were four out of 58 exceedances of the chronic copper criterion and three out of 58 exceedances of the chronic zinc criterion. This does not indicate impairments for these metals. A wet-weather TMDL is required for lead in San Gabriel River Reach 2.

Wet-Weather Results for Coyote Creek

In Coyote Creek, there were 19 out of 62 samples exceeding the chronic copper criterion, seven out of 62 samples exceeding the chronic lead criterion, and six out of 62 samples exceeding the chronic zinc criterion. This indicates impairments for these metals. There were four out of 62 exceedances of the chronic selenium criteria. This does not indicate an impairment. Wet-weather TMDLs are required for copper, lead, and zinc in Coyote Creek.

2.2.3. Conclusions

The available data provide an overall picture of water quality during both dry and wet weather. The data review confirms the existence of impairments for some of the metals identified in the 1998 and 2002 303(d) lists. The more recent data indicate additional dry-weather impairments not included on the 303(d) list. Based on the conclusions drawn from the data review, TMDLs are developed for the pollutant-water body combinations shown in Table 2-9.

Table 2-9. Summary of dry-weather and wet-weather impairments.

Reaches	Copper	Lead	Zinc	Selenium
San Jose Creek Reach 1				Dry
San Gabriel River Reach 2		Wet		
Coyote Creek	Wet	Wet	Wet	
Estuary	Dry			

Dry-weather TMDLs will be developed for copper in the Estuary and selenium in San Jose Creek Reach 1. Allocations will be developed for upstream reaches and tributaries to meet TMDLs in downstream reaches. Discharges to upstream reaches can cause or contribute to exceedances of water quality standards and contribute to impairments downstream. Dry-weather allocations will be assigned to San Gabriel River Reach 1 and Coyote Creek and its tributaries to meet the copper TMDL in the Estuary. No dry-weather copper allocations are required for San Gabriel River Reaches 2, 3, 4, 5, San Jose Creek, or Walnut Creek because they do not drain to the Estuary during dry weather. Dry-weather allocations will be assigned to San Jose Creek Reach 2 to meet the selenium TMDL in San Jose Creek Reach 1.

Wet-weather TMDLs will be developed for lead in San Gabriel River Reach 2 and for copper, lead, and zinc in Coyote Creek. Wet-weather allocations will be developed for all upstream reaches and tributaries in the watershed that drain to impaired reaches during wet weather. Discharges to these upstream reaches can cause or contribute to exceedances of water quality standards in San Gabriel River Reach 2 and Coyote Creek and thus contribute to impairments.

There are no available data to assess water quality in Reaches 4, or 5 of the San Gabriel River or Walnut Creek. There are no wet-weather data for Reach 1 and it is not possible to assess wet-weather water quality at the bottom of the watershed. Additional data representing wet-weather conditions in Reach 1 and the Estuary are needed. No TMDLs or waste load allocations have been developed for Reach 1 or the Estuary during wet-weather, but wet-weather monitoring is recommended as part of the implementation of these TMDLs.

3. NUMERIC TARGETS

Numeric targets for the TMDL are based on CTR criteria. As stated in section 2.1.2, CTR criteria are expressed as dissolved metals because dissolved metals more closely approximate the bioavailable fraction of metals in the water column. However, sources of metals loading to the watershed include metals associated with particulate matter. Once discharged to the river, particulate metals could dissolve, causing the criteria to be exceeded. The TMDL targets, and resulting waste load allocations, are expressed in terms of total recoverable metals to address the potential for dissolution of particulate metals in the receiving water. Attainment of numeric targets expressed as total recoverable metals will ensure attainment of the dissolved CTR criteria.

Separate numeric targets are developed for dry and wet weather because hardness values and the fractionation between total recoverable and dissolved metals vary between dry and wet weather. As in other TMDLs (e.g., the Los Angeles River Metals TMDL), the distinction between wet and dry weather is operationally defined as the 90th percentile flow in the river. Because separate wet-weather TMDLs are required for San Gabriel Reach 2 and Coyote Creek, the distinction between wet- and dry-weather is separately defined for these two reaches.

To determine the distinction between wet and dry weather, historical flows were obtained from flow gauge stations located in the watershed (Figure 3). LACDPW flow gauge station F262C-R is located in San Gabriel River Reach 2. Very little flow is measured at this gauge because much of Reach 2 is used for groundwater recharge; the median flow is 0.0 cubic feet per second (cfs) and the 90th percentile flow is 1.0 cfs based on flow records from 1990 to 2005. There is a United States Geological Survey (USGS) gauge station located at the bottom of Reach 3 just above Whittier Narrows Dam (station 1108500). The flow gauge above the dam is the best indicator of wet-weather conditions (i.e., sufficient runoff is generated to cause a response in the river flow and to wash off pollutants from the watershed land surface). Furthermore, when flows reach the 90th percentile at USGS station 11085000, the upper and lower portions of the watershed are most likely connected (i.e., flows of this magnitude will likely exceed the dam's capacity). The 90th percentile flow based on flow records from 1990 to 2005 is 260 cfs (Figure 4). Wet-weather targets for Reach 2 will apply when the maximum daily flow is equal to or greater than 260 cfs.

In Coyote Creek, the delineation between wet and dry weather occurs when the maximum daily flow at LACDPW flow gauge station F354-R, located at the bottom of the creek is 156 cfs. This is the 90th percentile flow based on flow records from 1990 to 2005 (Figure 5). Wet-weather targets for Coyote Creek will apply when the maximum daily flow in the creek is equal to or greater than 156 cfs.

3.1 Dry-Weather Targets

Dry-weather numeric targets are developed for copper in the Estuary and selenium in San Jose Creek Reach 1 (Table 3-1). Numeric targets are based on chronic CTR criteria because these are the most protective criteria and the most applicable during dry-weather conditions. The dry-weather target for selenium in San Jose Creek Reach 1 is based on the freshwater CTR value of 5 ug/l.

The target for copper in the estuary is based on CTR saltwater criteria because the salinity in the estuary is greater than 10 parts per thousand 95% or more of the time. A CTR default conversion factor is applied as a translator to convert the copper target from dissolved to total recoverable metals.

Table 3-1. Dry-weather numeric targets expressed as μg/L total recoverable metals.

	Copper			Selenium		
Reach	Chronic Saltwater Criteria (μg/L dissolved)	CCF	Numeric Target (μg/L total)	Chronic Freshwater Criteria (μg/L total)	CCF	Numeric Target (μg/L total)
San Jose Creek Reach 1	--	--	--	5	--	5
San Gabriel River Estuary	3.1	0.83	3.7	--	--	--

Based on monitoring conducted by City of Los Angeles Watershed Monitoring Program data in Los Angeles River, which has similar watershed characteristics and sources of flow and pollutant loading, the default conversion factors tend to overestimate the fraction of copper that is in the dissolved form. The use of the default conversion factors is applied to the margin of safety.

3.2 Wet Weather Targets

CTR acute criteria are the basis for the wet-weather targets because they are protective of aquatic life during the generally short-term and episodic storm conditions that exist in the San Gabriel River watershed. Median hardness values from LACDPW storm water data (Table 3-2) were used to calculate reach specific targets for lead in San Gabriel River Reach 2 and copper, lead and zinc in Coyote Creek.

Table 3-2. Wet-weather hardness values (mg/L as $CaCO_3$) from LACDPW storm water data (1997-2005).

Reach	Number of samples	10^{th} percentile hardness	50^{th} percentile hardness	90^{th} percentile hardness
San Gabriel Reach 2	58	99	175	282
Coyote Creek	61	51	105	210

The data collected by LACDPW were also used to evaluate the relationship between dissolved and total recoverable metals in storm water. Figures 6 through 9 plot measured values of dissolved metals against measured values of total metals. Most of the measured values fell below the line CTR-based trend lines indicating that use of CTR default conversion factors would overestimate the dissolved portion of metals in storm water samples. Data from literature confirm this and suggest that there is an even smaller portion of dissolved metals in wet weather. Young et al. 1980 estimated that only 10% of the cadmium, copper, lead, and zinc in storm water samples were dissolved. McPherson et al. 2004 found similar results in storm water from nearby Ballona Creek. In that study, only 17% of the cadmium, 37% of the copper, and 14% of the lead were dissolved. Regressions generally suggest a relationship between the total and dissolved fraction. The slope of the regressions reflects the ratio of the dissolved to total recoverable concentration. The R^2 value gives an indication of the strength of the relationship. The results of the regression analyses are presented in Table 3-3. We found reasonable relationships for copper, lead and zinc in Coyote Creek and these were used translators in the TMDL. The relationship for lead in San Gabriel was very weak and not suitable for developing a translator.

Table 3-3. Relationship between dissolved and total recoverable metals in storm water data in San Gabriel River Reach 2 and Coyote Creek (1997-2005) and CTR default conversion factors.

Metal	LACDPW Storm water data in SGR Reach 2			ACF	LACDPW Storm water data in Coyote Creek			ACF
	N	Slope	R^2		N	Slope	R^2	
Copper	27	0.31	0.09	0.960	44	0.53	0.62	0.960
Lead	11	0.39	0.28	0.709*	15	0.64	0.99	0.784*
Zinc	24	0.47	0.25	0.978	26	0.78	0.73	0.978

*ACF for cadmium and lead are hardness dependent and were calculated based on the hardness in SGR Reach 2 (175 mg/L as Ca CO_3) and Coyote Creek (105 mg/L as Ca CO_3).

The translators should be viewed as provisional since they are based on limited data. The site-specific translators will, on average, overestimate the dissolved fraction since a number of samples a number of samples with measurable total recoverable values but reported undetectable dissolved concentrations were eliminated from the regression analysis. This represented roughly 30% to 40% of the samples from Coyote Creek and roughly 40% to 50% of the samples from San Gabriel River. In this sense the translators will provide a conservative margin of safety. Further study is recommended to revisit the development and application of site-specific translators. The resulting wet-weather numeric targets are presented in Table 3-4.

Table 3-4. Wet-weather numeric targets expressed as μg/L total recoverable metals.

		Copper		Lead		Zinc	
Reach	Median Hardness (mg/L as $CaCO_3$)	Translator	Numeric Target (μg/L)	Translator	Numeric Target (μg/L)	Translator	Numeric Target (μg/L)
San Gabriel Reach 2	175	--	**--**	0.709	**166**	--	--
Coyote Creek	105	0.53	**27**	0.64	**106**	0.78	**158**

*Site-specific translators used for copper, lead and zinc in Coyote Creek. ACF used for translator for lead in San Gabriel Reach 2 assuming hardness value of 175.

4. SOURCE ASSESSMENT

This section identifies the potential sources of metals in the San Gabriel River watershed. In the context of TMDLs, pollutant sources are either point sources or nonpoint sources. Point sources include discharges for which there are defined outfalls such as wastewater treatment plants, industrial discharges, and storm drain outlets. These discharges are regulated through National Pollutant Discharge Elimination System (NPDES) permits. Nonpoint sources, by definition, include pollutants that reach waters from a number of diffuse land uses and source activities that are not regulated through NPDES permits.

4.1 Point Sources

The NPDES permits in the San Gabriel River Watershed include municipal separate storm sewer system (MS4) permits, the Caltrans storm water permit, general construction storm water permits, general industrial storm water permits, major NPDES permits (including publicly owned treatment works), minor NPDES permits, and general NPDES permits. The permits under the jurisdiction of the Los Angeles Regional Board are presented in Table 4-1.

Table 4-1. Summary of Los Angeles Regional Board issued NPDES permits in San Gabriel River watershed. (SOURCE: LARWQCB, 2006).

Type of Discharge	Estuary	Reach 1	Coyote Creek	Reach 2	San Jose Creek	Reach 3 and Above	Total Permits
Municipal Storm Water*	2	2	2	2	2	2	2
Caltrans Storm Water*	1	1	1	1	1	1	1
Industrial Storm Water	-	45	203	8	177	166	599
Construction Storm Water	2	20	36	18	136	132	344
Publicly Owned Treatment Works	--	1	1	--	2	1	5
Major NDPES Discharges	2	--	--	--	--	--	2
Minor NPDES Discharges	--	--	5	1	3	2	11
General NPDES Discharges	5	7	22	4	11	7	56
Construction Dewatering	1	2	4	--	8	1	16
Petroleum Fuel Cleanup Sites	--	--	4	1	--	--	5
VOC Cleanup Sites	--	1	2	--	--	1	4
Hydrostatic Test Water	2	--	1	--	1	--	4
Non-Process Wastewater	--	--	3	--	--	--	3
Potable Water	2	4	8	3	2	5	24

*Municipal and Caltrans permits discharge to all reaches.

The upper portion of Coyote Creek and a portion of the watershed draining to the Estuary are located in Orange County and are under the jurisdiction of the Santa Ana Regional Board. The permits under the jurisdiction of the Santa Ana Regional Board are presented in Table 4-2.

Table 4-2. Summary of Santa Ana Regional Board issued NPDES permits in the Coyote Creek and Estuary subwatersheds (SOURCE: SARWQCB, 2006).

Type of Discharge	No. of Permits
Municipal Storm Water	1
Caltrans Storm Water	1
Industrial Storm Water	207
Construction Storm Water	184
Publicly Owned Treatment Works	0
Major NDPES Discharges	0
Minor NPDES Discharges	2
General NPDES Discharges	
De Minimus Discharges	2
Petroleum and Solvents Cleanup Sites	3

4.1.1. Storm water Permits

Storm water runoff in the San Gabriel River Watershed is regulated through the Los Angeles County MS4 permit, the Long Beach MS4 permit, the Orange County MS4 permit, the statewide storm water permit issued to Caltrans, the statewide Construction Activities Storm Water General Permit and the statewide Industrial Activities Storm Water General Permit.

MS4 Storm Water Permits

In 1990, EPA developed rules establishing Phase I of the NPDES storm water program, designed to prevent pollutants from being washed by storm water runoff into the MS4 (or from being discharged directly into the MS4) and then discharged into local waterbodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a storm water management program as a means to control polluted discharges. Individual sources of metals within the watershed, which are collected by MS4s and discharged to the river, include automobile break pads, vehicle wear, building materials, pesticides, erosion of paint and deposition of air emissions from fuel combustion and industrial facilities.

The Los Angeles County MS4 permit was renewed in December 2001 as Order No. R4-01-182 and is on a five-year renewal cycle. There are 85 co-permittees covered by this permit, including 84 incorporated cities and the County of Los Angeles. The City of Long Beach MS4 permit was renewed on June 30, 1999 as Order No. R4-99-060 and is on a five-year renewal cycle. It solely covers the City of Long Beach. The Orange County MS4 permit was renewed on January 18, 2002 as Order No. R8-2002-0010. Co-permittees covered by this permit include 25 incorporated cities and Orange County.

Caltrans Storm Water Permit

Caltrans is regulated by a statewide storm water discharge permit that covers all municipal storm water activities and construction activities (State Board Order No. 99-06-DWQ). The Caltrans storm water permit authorizes storm water discharges from Caltrans properties such as the state highway system, park and ride facilities, and maintenance yards. The storm water discharges from most of these Caltrans properties and facilities eventually end up in either a city or county storm drain which are then discharged to the river.

General Storm Water Permits

In 1990, EPA issued regulations for controlling pollutants in storm water discharges from industrial sites (40 CFR Parts 122, 123, and 124) equal to or greater than five acres. The regulations require discharges of storm water associated with industrial activity to obtain an NPDES permit and to implement Best Available Technology Economically Achievable (BAT) to reduce or prevent nonconventional and toxic pollutants associated with industrial activity, including metals, in storm water discharges and authorized non-storm discharges. In 1999, EPA expanded the program to include storm water discharges from construction sites that resulted in land disturbances equal to or greater than one acre (40 CFR Parts 122, 123, and 124).

On April 17, 1997, State Board issued a statewide general NPDES permit for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ, NPDES Permit Nos. CAS000001). As of the writing of these TMDLs, there are approximately 804 dischargers enrolled under the general industrial storm water permit in this watershed (596 under the jurisdiction of the Los Angeles Board and 208 under the jurisdiction of the Santa Ana Regional Board). The potential for metals loading via runoff from these sites is high, especially at metal plating, transit, and recycling facilities. Stenstrom et al. (2005) found that although the data collected by the industrial monitoring program were highly variable, the mean values for copper, lead and zinc were 1010, 2960, and 4960 µg/L, respectively, greatly exceeding applicable CTR values. However, during dry weather, the potential contribution of metals loading from industrial sites is low, because non-storm water discharges are prohibited or controlled by the permit.

On August 19, 1999, State Board issued a statewide general NPDES permit for Discharges of Storm Water Runoff Associated with Construction Activities (Order No. 99-08-DQW, NPDES Permit Nos. CAS000002). As of the writing of these TMDLs, there are 537 dischargers enrolled under the general construction storm water permit in the watershed (350 under the jurisdiction of the Los Angeles Board and 187 under the jurisdiction of the Santa Ana Regional Board). Sources of metals from construction sites include sediment containing metals, construction materials, and equipment used on construction sites. Raskin et al. (2004) found that building materials and construction waste exposed to storm water can leach metals and contribute metals to waterways. However, during dry weather, the potential contribution of metals loading is low because non-storm water discharges are prohibited or controlled by the permit.

4.1.2. Publicly Owned Treatment Works (POTWs)

The LACSD Joint Outfall System is an integrated network of facilities that includes seven treatment plants, five of which are associated with the San Gabriel River Watershed. These five treatment plants (Whittier Narrows, Pomona, Long Beach, Los Coyotes, and San Jose Creek) are connected to the Joint Water Pollution Control Plant (JWPCP) which discharges off of the Palos

Verdes Peninsula. This system allows for the diversion of desired flows into or around each "upstream" plant.

- The most upstream plant is the Pomona WRP (Order No. R4-2004-0099). It has a design capacity of 15 million gallons per day (MGD) and discharges tertiary-treated municipal and industrial wastewater to the South Fork of San Jose Creek. During dry weather, virtually all of the treated effluent is reclaimed for landscape and crop irrigation, as well as for industrial processes.

- The San Jose Creek WRP (Order No. R4-2004-0097) has a design capacity of 100 MGD. It discharges an average of 80 MGD of tertiary-treated municipal and industrial wastewater via three discharge points. Discharge No. 001 to San Gabriel River Reach 1 is the primary discharge outfall for both east and west plants, which is eight miles south of the plant near Firestone Blvd. The river is concrete-lined from the discharge point to the Estuary, about nine miles downstream. A turnout located approximately midway down the pipe is used to divert reclaimed water to spreading grounds. Discharge No. 002 to San Jose Creek is used for groundwater recharge at Rio Hondo and the San Gabriel Coastal Spreading Grounds. San Jose Creek is unlined from the discharge point to the San Gabriel River. Discharge No. 003 delivers treated effluent to the unlined portion of the San Gabriel River Reach 3 as well as the Rio Hondo and San Gabriel Coastal Spreading Grounds.

- The Whittier Narrows WRP (Order No. R4-2002-0142) has a design capacity of 15 MGD. There is one discharge point to the San Gabriel River. Discharge No. 001 discharges to the river about 700 feet upstream from the Whittier Narrows Dam. The tertiary-treated municipal and industrial wastewater generally flows down the river to the San Gabriel River Spreading Grounds.

- The Los Coyotes WRP (Order No. R4-2002-0121) has a design capacity of 37.5 MGD. Tertiary-treated municipal and industrial wastewater is discharged into the San Gabriel River Reach 1, 1,230 feet upstream of the Artesia freeway. About 12% of the total treated effluent is reclaimed for irrigation.

- The Long Beach WRP (Order No. R4-2002-0123) has a design capacity of 25 MGD. Tertiary-treated municipal and industrial wastewater is discharged to Coyote Creek at a point 2,200 feet upstream from the confluence with the San Gabriel River, above the Estuary. A portion of the treated effluent is reclaimed for irrigation.

4.1.3 Major Individual NPDES Permits

Major discharges are POTWs with yearly average flows over 0.5 MGD, industrial sources with yearly average flows over 0.1 MGD, and those with lesser flows but with acute or potential adverse environmental impacts. In addition to the POTWs, there are two major discharges in the watershed, the Haynes generating station, operated by the City of Los Angeles Department of Water and Power (LADWP) and the generating station operated by AES Alamitos, L.L.C. Both plants draw in water from the nearby Los Cerritos Watershed Management Area and discharge into the tidal prism just north of Second St. (Westminster Ave.). The Alamitos plant draws in water from Los Cerritos Channel and is permitted to discharge up to 1,283 MGD. The Haynes plant draws in water from Alamitos Bay and is permitted to discharge up to 1,014 MGD. The Alamitos and Haynes stations have limits for copper, lead, selenium, and zinc, but they are based on California Ocean Plan objectives. The Ocean Plan objectives are less stringent than the CTR saltwater criteria so there is the potential for the facilities to discharge metals in exceedance of the numeric targets. A memorandum sent from the State Board to the Los Angeles Regional Board (SWRCB 2002) redefined the two power plants as falling under the jurisdiction of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) and the CTR. These permits are scheduled for renewal in 2006.

4.1.4 Minor Individual NPDES Permits

Minor discharges are all other discharges that are not categorized as a Major. Many of these permits are for episodic discharges rather than continuous flows. Minor permits cover miscellaneous wastes such as ground water dewatering, swimming pool wastes, and ground water seepage. Some of these permits contain effluent limits for metals. However, some of these permits were issued prior to the adoption of CTR and there is the potential for these facilities to discharge metals in exceedance of the numeric targets in these TMDLs. There are 11 minor NPDES permits in the San Gabriel River watershed.

4.1.5 General NPDES Permits

Pursuant to 40 CFR parts 122 and 123, the State Board and the Regional Boards have the authority to issue general NPDES permits to regulate a category of point sources if the sources: involve the same or substantially similar types of operations; discharge the same type of waste; required the same type of effluent limitations; and require similar monitoring. The Los Angeles Regional Board has issued general NPDES permits in the San Gabriel River watershed for the following categories of discharges: construction dewatering, non-process wastewater; petroleum fuel cleanup sites; VOC cleanup sites; potable water; and hydrostatic test water.

There are 16 discharges enrolled under Los Angeles Regional Board Order Nos. R4-2003-0111, 97-043, and 97-045 for construction dewatering. There are three discharges enrolled under Los Angeles Regional Board Order Nos. R4-2004-0058 and 98-055 for non-process wastewater. These permits include CTR-based effluent limitations for metals.

There are five dischargers enrolled under Los Angeles Regional Board Order No. R4-2002-0125 for treated groundwater and other wastewaters from petroleum fuel-contaminated sites. There are four dischargers enrolled under Los Angeles Regional Board Order No. R4-2002-0107 for treated groundwater from VOC-contaminated sites. To enroll under these permits, dischargers must demonstrate that treated groundwater does not exceed the CTR-based water quality criteria for metals. Once enrolled under the permit, dischargers must continue to demonstrate compliance with CTR-based effluent limitations for lead.

There are 24 dischargers enrolled under Los Angeles Regional Board Order No. R4-2003-0108 for groundwater from potable water supply wells. There are four dischargers enrolled under Los Angeles Regional Board Order Nos. R4-2004-0109 and 97-047 for low threat hydrostatic test water. Discharges enrolled under these permits must meet maximum contaminant levels (MCLs) adopted by the California Department of Health Services. In general, the MCLs for metals are greater than the numeric targets.

The Santa Ana Regional Board has issued general NPDES permits in the Coyote Creek subwatershed for de minimus discharges and for petroleum and solvent cleanup sites. There are two discharges enrolled under Santa Ana Regional Board Order No.03-061 for de minimus threats to water quality. The order states that discharges enrolled under the general permit are not expected to cause toxicity; therefore no toxicity limits are included in the general permit. There are three discharges enrolled under Santa Ana Regional Board Order No. 02-007 for discharges of extracted and treated groundwater from petroleum and solvent cleanup sites. The Order includes CTR-based effluent limitations for lead for freshwater and saltwater discharges from those sites polluted with leaded gasoline.

4.2 Non-point Sources

Atmospheric deposition is a potential nonpoint source of metals to the watershed. Sabin et al. estimated the mass of dry-atmospheric deposition for the Los Angeles River watershed (Sabin et al., 2004). For the purpose of this source assessment, the numbers for the Los Angeles River watershed were extrapolated to the San Gabriel River watershed based on the relative area of each watershed and the relative amount of surface water in each watershed (Table 4-2). Direct atmospheric deposition is the amount of metals deposited directly onto the surface of the river. These numbers are generally small because the actual surface area of the river system is small. Indirect deposition is the amount of metals deposited onto the entire watershed. Metals deposited on the land surface of the watershed may be washed off during rain events and delivered to the river system. The amount of deposited metals available for transport to the river (i.e., not infiltrated) is unknown. In a separate study, Sabin et al. found that for a small impervious catchment, atmospheric deposition could potentially account for 57-100% of the metals in storm runoff generated in the study area (Sabin et al., 2005). This study assumes that all the metals deposited on the catchment were available for removal. However, in large, varied watersheds, such as the Los Angeles River and San Gabriel River watersheds, not all metals deposited on the land surface may be available for removal by runoff. Estimates of metals deposited on land (Table 4-3) are much higher than estimates of storm water loading to the river system (Table 4-10). The loading of metals associated with indirect atmospheric deposition are accounted for in the estimates of the storm water loading. Once metals are deposited on land under the jurisdiction of a storm water permittee, they are within a permittee’s control.

Table 4-3. Estimates of dry weather direct and indirect deposition (derived from Sabin et al., 2004).

	Area (square miles)	% Water	Copper (kg/year)	Lead (kg/year)	Zinc (kg/year)
Los Angeles River Watershed	834	0.21%			
Indirect Deposition			16,000	12,000	80,000
Direct Deposition			3	2	10
San Gabriel River Watershed	682	0.36%			
Indirect Deposition			13,084	9,813	65,419
Direct Deposition			4.1	2.8	13.8

Natural background loading of metals is another potential source. This is an unlikely source during dry weather. Natural or open spaces are primarily located in the upper portion of the watershed in the Angeles National Forest (Figure 2). The flow from these areas is relatively small during dry weather and much of it is captured behind dams. The levels of metals concentrations in flow from these areas are also likely to be low. Stein and Yoon (2005) found that metals concentrations from natural areas in Southern California, including two sites in the upper San Gabriel watershed, were below CTR criteria and below concentrations found at developed sites. The mean concentrations for the natural areas were 0.465 μg/L copper, 0.052 μg/L lead, 0.618 μg/L selenium, and 0.471 μg/L zinc during dry weather.

During wet-weather, flow from the upper portion of the watershed can potentially reach the lower portion of the watershed. Stein and Yoon (2005) also found that metals concentrations from natural areas in wet-weather were below CTR criteria and below concentrations found at developed sites. During wet weather, the mean concentrations for the natural areas were 5.27 μg/L copper, 1.42 μg/L lead, 0.77 μg/L selenium, and 21.5 μg/L zinc. Natural sources will be assigned load allocations to address any potential loading during dry and wet weather.

4.3 Quantification of Sources

The San Gabriel River has two distinct flow conditions. During wet-weather periods, flow in the river is generated by storm water runoff in the watershed, which can quickly reach thousands of cubic feet per second. During dry weather, flows are significantly lower and less variable. The major sources of flow are point source discharges, urban runoff, and groundwater baseflow.

4.3.1. Dry-Weather Loading

The total metals loads from the San Jose, Pomona, Whittier Narrows, Los Coyotes, and Long Beach WRPs were estimated using monthly flow and effluent concentration data provided as part of the annual self monitoring reports (Table 4-4). On an annual basis, these POTWs contribute approximately 1,781 kg/year of copper, 1,477 kg/year of lead, 188 kg/year of selenium and 10,992 kg/year of zinc to the San Gabriel River. Much of the water from the Pomona, Whittier Narrows, and San Jose Creek WRPs is recharged; thus, while these values reflect metals loading to the system, some of the metal loadings are lost to recharge.

Table 4-4. Total annual metals loading from POTWs (kg/yr). Data are from LACSD.

Facility	Reach	1997	1998	1999	2000	2001	2002	2003	2004	Ave
Copper										
Pomona	SJC	36	30	31	44	42	26	22	32	33
San Jose Creek 001e and 002	SGR 1 SJC	703	736	711	784	695	656	655	651	699
San Jose Creek 001w and 003	SGR 1 SGR 3	399	403	398	410	326	189	282	359	346
Whittier Narrows*	SGR 3	119	139	141	104	109	110	106	85	114
Los Coyotes	SGR 1	450	483	462	437	410	310	328	330	401
Long Beach	CC	181	236	197	218	218	136	158	161	188
Total WRP										**1781**
Lead										
Pomona	SJC	40	30	63	44	42	5	5	12	30
San Jose Creek 001e and 002	SGR 1 SJC	703	515	711	784	417	131	131	130	440
San Jose Creek 001w and 003	SGR 1 SGR 3	359	282	398	410	195	38	56	72	226
Whittier Narrows*	SGR 3	131	97	141	104	87	22	32	21	79
Los Coyotes	SGR 1	900	967	923	437	455	116	82	83	495
Long Beach	CC	362	472	296	218	194	34	40	40	207
Total WRP										**1477**
Selenium										
Pomona	SJC	4	3	3	4	4	3	3	4	3
San Jose Creek 001e and 002	SGR 1 SJC	77	74	71	78	70	66	66	65	71
San Jose Creek 001w and 003	SGR 1 SGR 3	60	40	40	41	33	19	28	36	37
Whittier Narrows*	SGR 3	12	14	14	10	11	11	11	11	12
Los Coyotes	SGR 1	45	48	46	44	46	39	41	41	44
Long Beach	CC	18	24	20	22	24	17	20	20	21
Total WRP										**188**
Zinc										
Pomona	SJC	253	182	315	264	210	157	247	373	250
San Jose Creek 001e and 002	SGR 1 SJC	4217	3678	3556	3919	3477	3278	5241	4554	3990
San Jose Creek 001w and 003	SGR 1 SGR 3	3587	2417	2788	2869	1955	1324	2822	2869	2579
Whittier Narrows*	SGR 3	535	1039	988	832	761	767	1064	844	854
Los Coyotes	SGR 1	3601	3866	2769	3062	2732	2713	4506	3300	3319
Long Beach	CC	1321	1062	1379	1306	1211	1020	1960	1471	1341
Total WRP										**10,992**

*The majority of Whittier Narrows flow is discharged to the Rio Hondo, which is part of the Los Angeles River watershed.

The amount of metals loading from POTWs is well defined. The amount of metals loading from storm drains and dry weather runoff is not well defined. In order to evaluate all dry-weather sources of metals in the San Gabriel River watershed, the Southern California Coastal Research Project (SCCWRP) conducted two monitoring events in September 2002 and September 2003 (Ackerman et al., 2004a). The monitoring consisted of synoptic sampling of flow and metals concentrations from WRPs, storm drains and open channels. The first monitoring event was conducted on September 29 and 30, 2002, and the second was conducted on September 14 through 16, 2003. The data collected represent snapshots of the flow distribution and water quality conditions throughout the watershed. During the sampling events, all observed sources of flow to the San Gabriel River system were from storm drains, tributaries, and the Los Coyotes, Long Beach, San Jose, and Pomona WRPs (Table 4-5).

Table 4-5. Measured flow inputs (cfs) to the San Gabriel River (Ackerman et al, 2004a).

	Coyote Creek	San Gabriel	San Jose Creek	Walnut Creek	Total
2002					
Storm drains	10.6	3.1	14.3	1.2	29.2
Tributaries	8.30	-	1.0	6.0	15.3
WRPs	0.04	97.5	58.3	-	155.8
Total	19.0	100.5	73.7	7.23	200.3
2003					
Storm drains	11.9	1.6	13.5	1.7	28.7
Tributaries	7.44	-	6.66	3.9	18.0
WRPs	18.7	104.4	87.3	-	210.4
Total	38.0	106.0	107.4	5.64	257.1

Overall, WRPs contribute about 80% of the flow in the river system during dry-weather. Walnut Creek receives no WRP flow. The Whittier Narrows WRP did not contribute to flow in the San Gabriel River during the two dry-weather sampling events.

The measured concentrations of metals varied between storm drains, open channels, and WRPs (Table 4-6). The concentrations of all metals were greater in storm drains than in WRP discharges. The concentrations of all metals except zinc were greater in open channels than in WRP discharges. This indicates that dry-weather runoff or nuisance flow and/or discharges from other NPDES permitted sources are a significant source of metals in the San Gabriel watershed.

Table 4-6. Mean observed metals concentrations by source (Ackerman et al., 2004a).

	Detection Limit (μg/L)	Storm Drains (μg/L)	Open Channels (μg/L)	WRPs (μg/L)
2002				
Copper	8	15	7.0	nd
Lead	2	2.6	3.0	nd
Selenium	1	1.3	1.9	nd
Zinc	10	134	28	45
2003				
Copper	8	8.0	3.0	nd
Lead	2	1.6	1.9	nd
Selenium	1	1.4	2.7	nd
Zinc	10	99	57	72

nd = non-detectable value

The average concentrations reported in Table 4-6 for copper, lead, and nickel are sometimes less than the detection limit because non-detectable concentrations were treated as zero. Loads were calculated by multiplying the measured flows and concentrations at each sample location. Table 4-7 provides the summary results in terms of total mass emissions of each metal and the relative contribution from each major source.

Table 4-7. Metals loading by source. Samples with non-detectable values treated as zero (Ackerman et al., 2004a).

	Storm Drains	Large Tributaries	WRPs
2002			
Copper	38%	62%	0%
Lead	29%	71%	0%
Selenium	57%	43%	0%
Zinc	14%	8%	78%
2003			
Copper	100%	0%	0%
Lead	25%	75%	0%
Selenium	69%	31%	0%
Zinc	11%	7%	82%

The SCCWRP study assumed all non-detectable values were zero. For WRPs, which contribute the dominant source of flow in the river, minor changes in concentrations can have a major effect on loading estimates. If non-detectable values were treated as ½ the detection limit, for example, the WRPs would appear as the dominant source of loading.

Table 4-8 provides the SCCWRP study results in terms of total mass emissions of each metal and the relative emissions to the four streams in the San Gabriel River system. According to the SCCWRP study, Walnut Creek contributes a large percentage of copper and lead loading. This indicates that additional monitoring is needed for Walnut Creek. There was not enough data to assess potential metals impairments in Walnut Creek (Section 2.2.1).

Table 4-8. Metals loading by reach/tributary Samples with non-detectable values treated as zero (Ackerman et al., 2004a).

	Coyote Creek (%)	San Gabriel River (%)	San Jose Creek (%)	Walnut Creek (%)
2002				
Copper	22%	12%	20%	46%
Lead	55%	14%	8%	24%
Selenium	43%	1%	51%	6%
Zinc	8%	53%	36%	3%
2003				
Copper	49%	2%	29%	20%
Lead	11%	1%	39%	50%
Selenium	4%	0%	93%	2%
Zinc	16%	43%	38%	3%

4.3.2. Dry-Weather Loading to the Estuary

Sources of flow to the Estuary include upstream inputs to Reach 1 and Coyote Creek, the two generating stations, and tidal exchange with the ocean. Upstream sources were evaluated in section 4.3.1. The total metals loads from the Los Alamitos and Haynes generating stations were estimated using effluent monitoring from the two plants (Table 4-9). Both plants sample for monthly flow and semi-annual metals concentrations. Annual average flows were calculated from the monthly average maximum flows, then multiplied by the average effluent concentration to estimate annual loading. On an annual basis, the generating stations contribute approximately 20,000 kg/year of copper, 2,700 kg/year of lead, and 56,000 kg/year of zinc to the Estuary.

Table 4-9. Metals loading to the San Gabriel River Estuary (kg/year total recoverable metals) from the Los Alamitos and Haynes generating stations.

Haynes Station	2000	2001	2002	2003	2004	Average
Flow (MGD)	729	779	848	761*	689	761
Copper (kg/year)	ND	26,583	23,621	10,419	16,752	15,475
Lead (kg/year)	5,238	1,864	ND	1,016	832	1,790
Zinc (kg/year)	16,620	16,334	18,370	21,815	72,489	29,126
Alamitos Station	**2000**	**2001**	**2002**	**2003**	**2004**	**Average**
Flow (MGD)	914	981	735	680	953	853
Copper (kg/year)	6,690	4,200	3,800	3,701	3,972	4,473
Lead (kg/year)	ND	986	841	1,626	1,152	921
Zinc (kg/year)	42,204	23,111	14,359	37,076	15,729	26,496
Total - Both Plants	**2000**	**2001**	**2002**	**2003**	**2004**	**Average**
Copper (kg/year)	6,690	30,784	27,422	14,120	20,725	19,948
Lead (kg/year)	5,238	2,850	841	2,642	1,984	2,711
Zinc (kg/year)	58,824	39,445	32,729	58,891	88,218	55,621

*Flow unavailable for 2003. Average flow used.

Metals loadings from the power plants are approximately ten times greater than the metals loading from POTWs that discharge to Coyote Creek and Reach 1 (Table 4-4).

4.3.4. Wet-Weather Loading

Wet-weather sources of metals are generally associated with the accumulation and wash-off of metals on the land surface during rain events. Metals washed off the land surface are delivered to the river through creeks and storm water collection systems. Wet-weather loading varies depending on the amount of rainfall and size of storms in a given year.

Wet-weather pollutant loading is estimated from the storm water monitoring data collected at the mass emission stations in Coyote Creek and San Gabriel River Reach 2 (LACDPW, 2000-2005). The total runoff volume for a storm season is multiplied by the average metals concentrations for that season (Table 4-10).

Table 4-10. Wet-weather storm water metals loading to the San Gabriel River watershed (kg total recoverable metals). Data are from LACDPW.

San Gabriel River Reach 2	97/98	98/99	99/00	00/01	01/02	02/03	03/04	Average
No. storms sampled for metals	9	13	10	9	6	4	3	--
Total runoff volume (acre-ft)	32,800	12,700	3,777	8,404	3,258	9,684	25,694	--
Copper loading (kg)	990	115	34	89	51	323	403	286
Lead loading (kg)	607	--	--	29	8	161	57	172
Selenium loading (kg)	--	--	--	26	7	32	69	33
Zinc loading (kg)	6,708	785	--	406	120	1,528	1,664	1,868
Coyote Creek	**97/98**	**98/99**	**99/00**	**00/01**	**01/02**	**02/03**	**03/04**	**Average**
No. storms sampled for metals	10	14	12	10	5	4	3	--
Total runoff volume (acre-ft)	60,500	11,500	22,937	14,616	3,672	26,608	43,689	--
Copper loading (kg)	3,224	201	291	166	77	578	1,746	898
Lead loading (kg)	2,166	--	--	45	10	150	850	644
Selenium loading (kg)	--	68	--	45	11	78	195	80
Zinc loading (kg)	25,656	946	1,027	647	203	2,563	7,965	5,573

Average annual metals loading from WRPs (Table 4-4) can be compared to average wet-weather storm water loading (Table 4-10) to provide an indication of the relative contributions from these sources. This comparison can only be made in Coyote Creek because it is the only reach that receives direct POTW discharge (Long Beach WRP) and has a LACDPW storm water mass emission station. On an annual basis, storm water contributes about 83% of the copper loading, 76% of the lead loading, 80% of the zinc loading, and 79% of the selenium loading in Coyote Creek. Wet-weather storm water runoff is thus the dominant source of annual metals loading, which agrees with previous studies in the Los Angeles River and Ballona Creek watersheds (Stein et al., 2003).

5. LINKAGE ANALYSIS

Information on sources of pollutants provides one part of the TMDL equation. To determine the effects of these sources on water quality, it is necessary to determine the assimilative capacity of the receiving water. Variations between wet and dry weather can strongly affect the delivery of metals to the San Gabriel River and the assimilative capacity of the river to accommodate this loading so that water quality standards are met. Therefore, two distinct approaches for the linkage analysis were taken for wet and dry weather. Hydrodynamic and water quality models were used to assess the effects of metals loadings in the San Gabriel River on water quality under both dry- and wet- weather conditions. To estimate the assimilative capacity of the Estuary, a linkage is made based on the volume of water in the Estuary and the influence of tidal exchange.

5.1 Development of the Dry-Weather Model

The dry-weather model was developed to assess in-stream concentrations and sources of copper, lead, and zinc in low-flow conditions. It is included as Appendix I (Tetratech, 2005a). The modeling system consisted of a hydrodynamic model linked with a separate water quality model of the river system. For simulation of hydrodynamics, the one-dimensional (1-D) version of the Environmental Fluid Dynamics Code (EFDC) was used. Stream channel geometry, topographic data, meteorological data, and sources of flow and metals loading were input into the model. Model setup of the river system included the following reaches:

- San Gabriel River
- Coyote Creek
- San Jose Creek
- Walnut Creek

During low-flow conditions, these reaches are rarely linked due to various controls and features in the watershed that impede or divert flows. Therefore, these river reaches were modeled independently for the dry-weather simulation periods.

Data from the two synoptic monitoring events conducted by SCCWRP in September 2002 and September 2003 were used to support the model development. The data were used as model input as well as for comparison to model results. Flow and water quality measurements taken from the storm drains and WRPs were used as inputs to the hydrodynamic and water quality model simulations. The resulting simulated in-stream water quality results were compared with the measured in-stream water quality at corresponding locations from the SCCWRP study.

5.2 Dry-Weather Model Results

Model predictions of in-stream water quality were compared to observed in-stream water quality data, without any additional calibration of modeling parameters to improve the comparison. Based on the comparison, the model was considered successful if the magnitudes and trends of the simulated and observed water quality were similar.

The model results were noticeably impacted by input data with non-detectable values of metals. For the purposes of modeling, inflow data with non-detected metals were assigned values equal to half the detection limit. A sensitivity analysis was then performed in which the data were assigned a value of zero. Assigning values of zero to non-detectable metals in inflow data resulted in lower simulated concentrations of metals in the river.

Overall, the magnitude of simulated in-stream concentrations was similar to the magnitude of observed in-stream concentrations. However, the simulated concentrations do not always compare consistently with the observed in-stream concentrations. This may be due to observed in-stream concentrations that were below detection limits or due to the influence of other factors and sources that are not accounted for in the model.

5.3 Development of the Wet-Weather Model

The wet-weather modeling report is included as Appendix II (Tetratech, 2005b). Metals loading can be associated with sediment loading because of the sorptive properties of metals. To assess the link between sources of metals and the impairment of waters during wet weather, a modeling system was developed to simulate land-use-based sources of sediment and associated metals loads and the hydrologic and hydraulic processes that affect their delivery to the San Gabriel River system. EPA's Loading Simulation Program in C++ (LSPC) was selected to simulate the hydrologic water quality conditions in the San Gabriel River watershed.

The San Gabriel River watershed was divided into 139 sub-watersheds for appropriate hydrologic connectivity and representation (Figure 10). Meteorological data, soils data, stream reach characteristics, hydrologic data, and land use coverage were input into the model. The model was used to simulate total suspended solids and then to simulate metals associated with total suspended solids using potency factors equal to the ratio of metals to total suspended solids. These potency factors were successfully applied in Ballona Creek (Ackerman et al., 2004b) and the Los Angeles River (Tetra Tech, Inc, 2004) and are considered regionally calibrated.

5.4 Wet Weather Model Results

Hydrology is the first model component that was calibrated and validated because an estimation of wet-weather metals loading relies heavily on flow prediction. January 1990 through December 2002 was selected as the hydrology simulation period. Twelve LACDPW and USGS flow gauging stations were used for calibration and/or validation of the model (Figure 3). To account for the extensive hydrological alterations in the watershed, the model was first calibrated for minimally controlled subwatersheds, then calibrated for more controlled subwatersheds, so that observed flow variability could be attributed to man-made alterations. Calibration was assessed through graphical comparison, regression analysis, and relative error in volume of model results and observed data. The model accurately predicted average monthly flow patterns and predicted total and seasonal volumes within an acceptable range of error for the relatively unaltered subwatersheds. The model over-predicted flow in certain cases and under-predicted flow in the more controlled subwatersheds due to hydraulic controls, localized rainfall events, and unaccounted flow discharges from dams.

After calibration, a validation of hydrologic parameters was made through a comparison of model output to observed flows and volumes at selected gages. As was the case for calibration, validation results were assessed through graphical comparison, regression analysis, and relative error in volume of model results and observed data. Overall, the model accurately predicted storm peaks in minimally controlled river segments. For the more-controlled river segments, model results were less accurate due to the lack of data on hydraulic controls in these sub watersheds. In addition, because runoff and resulting flow are highly dependent on rainfall, occasional storms were over-predicted or under-predicted depending on the distance between meteorological and flow gauge stations.

The water quality model was calibrated by comparing model output with pollutographs (plots of concentration vs. time) for total suspended solids, copper, lead, and zinc observed at the LACDPW mass emission stations in San Gabriel River Reach 2 (S14) and Coyote Creek (S13). To assess the predictive capability of the model, the output was graphically compared to observed data. (Attachment C to Appendix II) Pollutographs indicated that the model generally captured the range of observed values for a storm event, but did not always predict the shape of the pollutograph. Misrepresentation of flows in the hydrology model affected predictions of pollutographs and resulting event mean concentrations (EMCs) in the water quality model. To provide additional assessment, observed EMCs were compared to EMCs calculated using hourly model output.

Once calibrated, the water quality model was validated by comparing predicted EMCs with historically observed EMCs at the two LACDPW mass emission stations. During certain periods, observed values of zinc, lead and copper appeared to stay constant because they were reported as non-detects. Non-detects were replaced with one-half the detection limit for comparison with modeled data. Overall, the magnitude of predicted concentrations was similar to the magnitude of observed concentrations. Deviations from the observed data may be caused by localized storms that resulted in higher or lower metals loading, which is determined by the associated modeled flow. This flow is dependent on the proximity of the storm to the meteorological station and model subwatersheds. The model is adequate for predicting EMCs but not refined enough for predicting changes in concentration that occur over the course of the storm.

5.5 Linkage Analysis for the Estuary

The data assessment only indicates the need for water column TMDLs (section 2.2). There is no evidence of sediment impairment in the Estuary. Therefore, if discharges to the Estuary are limited by concentration-based waste load allocations, water quality numeric targets for the Estuary will be attained.

The assimilative capacity of the Estuary is a function of the volume of the Estuary and the tidal prism, which is the volume of water exchanged between an Estuary and the open sea during one tidal period. The head of the Estuary was considered at the 405 freeway, 4900 ft upstream of 7th Street. The tidal range was considered to vary linearly from zero at this location to a maximum of 3.4 ft at the mouth. The tide at the mouth was assumed the same as the Los Patos station ID 427 (Tides & Currents, 2005). Based on the LACDPW Estuary profile plan in Figure 11, the Estuary was divided into two reaches. The first reach is from the mouth, considered at Ocean

Avenue Bridge, to 7th Street. The second reach is between 7th Street and the 405 freeway. The characteristics of the reaches estimated from Figure 11 are presented in Table 5-1.

Table 5-1. San Gabriel River Estuary geometry.

Reach	Length (ft) L	Bottom width (ft) B	Average water depth (ft) H	Levee slope S
1	13000	300	15	3:1
2	4900	300	10	2:1

Based on the data in Table 5-1, the volume of the Estuary is calculated as V = H*L*(B+S*H), giving the volume of each reach as:

$V_1 = 6.73 \times 10^7\ ft^3$
$V_2 = 1.57 \times 10^7\ ft^3$

With a total average volume of:

$V = 8.3 \times 10^7\ ft^3$

Based on the assumption that the tidal range varies linearly from a maximum at the mouth of 3.4 feet to no tide at the 405 freeway, and considering the relative length of each reach, the average tidal ranges (i.e., tidal range at the center of each reach) are:

$R_1 = 2.17$ ft
$R_2 = 0.47$ ft

With the information in Table 5-1, the water surface area for each reach, A = L*(B+2*H*S), is:

$A_1 = 5.07 \times 10^6\ ft^2$
$A_2 = 1.67 \times 10^6\ ft^2$

The tidal prism, P, calculated as P = A*R (equation (II-6-12) in USACE's Coastal Engineering Manual), at each reach was estimated as:

$P_1 = 1.1 \times 10^7\ ft^3$
$P_2 = 0.78 \times 10^6\ ft^3$

Giving a total tidal prism for the Estuary of:

$P = 1.18 \times 10^7\ ft^3$

The volume at high tide, $V_{HT} = V + P/2$, is therefore:

$V_{HT} = 8.89 \times 10^7\ ft^3$, or 665 million gallons

And the volume at low tide, $V_{LT} = V - P/2$, is therefore:

$V_{LT} = 7.71 \times 10^7 \text{ ft}^3$, or 576 million gallons.

Given the flow from the power plants (1614 MGD from Table 4-9) and the volume of water in Estuary at low tide, it can be assumed that the power plant flow displaces all ocean water in the Estuary at the critical condition and that ocean water provides no excess assimilative capacity.

These findings are consistent with findings in Flow Science (2007), USGS (Rosenberger et al., 2007) and SCCWRP (Ackerman and Stein., In Prep). The conclusions of these studies suggest that most of the flow in the estuary is from the power plant, there is little dilution from ocean water, the net flow is largely unidirectional toward the ocean, and the residence time for a parcel of water is short. USGS estimated the tidal prism to be roughly 2.78×10^7 cubic feet. This corresponds to a tidal flow of 1236 cfs over the course of a 6.21 tidal cycle. The mean discharge from the power plants during the study was 777 cfs but could be as high as 3560 cfs (based on a design flow of 2.3 billion gallons per day). Since dry-weather lows from the rivers are around 156 cfs, the power plant discharge represents about 80 to 95% of the flow.

More sophisticated models may be developed in the future which will account for upstream inputs, tidal exchange, and mixing and will help to better characterize the relative sources and fate and transport of metals loading to the Estuary. The Southern California Coastal Water Research Project is developing a watershed model that may be useful in verifying the loading capacities determined in this TMDL. However until that time the simplest and most straight forward approach to ensuring water quality standards are attained is to ensure that effluent concentrations from the power plants are at or below the water quality standard.

5.6 Summary of Linkage Analysis

The dry- and wet-weather models provide an understanding of the relationship between metals loading and targets. The dry-weather model is able to predict the overall magnitude of in-stream concentrations but not able to consistently predict the instantaneous concentrations at any given time. The wet-weather model was able to predict flow and magnitudes of concentrations in the minimally controlled river segments but less able in the more-controlled river segments. Because they could not predict concentrations on short time scales, neither the dry- or wet-models were used to develop loading capacity, but they provide an understanding of the relationship between metals loading and targets. While not used to develop loading capacity, the models should prove useful in evaluating management scenarios to help achieve load reductions in TMDL implementation. For the Estuary, the linkage analysis demonstrates that power plant flow comprises the majority of the volume of water in the Estuary and that the ocean water provides no excess assimilative capacity.

6. TOTAL MAXIMUM DAILY LOADS

This section explains the development of the loading capacities (i.e., TMDLs) and allocations for metals in the San Gabriel River watershed. EPA regulations require that a TMDL include waste load allocations (WLAs), which identify the portion of the loading capacity allocated to existing and future point sources (40 CFR 130.2(h)) and load allocations (LAs), which identify the portion of the loading capacity allocated to nonpoint sources (40 CFR 130.2(g)). As appropriate, waste load allocations are assigned to wastewater treatment plants, storm water discharges, and other NPDES discharges. Load allocations are assigned to open space and atmospheric deposition. As discussed in previous sections, the flows, sources, and the relative magnitude of inputs vary between dry-weather and wet-weather conditions. TMDLs are therefore developed to address dry- and wet-weather conditions separately.

6.1 Wet-Weather TMDLs for Copper, Lead and Zinc

During wet weather, the allowable load is a function of the volume of water in the river. Given the variability in wet-weather flows, the concept of a single critical flow is not justified. Instead, a load-duration curve approach is used to establish the wet-weather loading capacity. A load-duration curve is developed by multiplying the wet-weather flows by the in-stream numeric target. The result is a curve that identifies the allowable load for a given flow. Table 6-1 presents the equations used to calculate the load duration curves. The wet-weather TMDLs for metals are defined by these load-duration curves.

Separate wet-weather TMDLs are developed for San Gabriel Reach 2 and Coyote Creek. In San Gabriel River Reach 2, wet-weather TMDLs apply when the maximum daily flow in the river is equal to or greater than 260 cfs as measured at USGS station 11085000, located at the bottom of Reach 3 just above the Whittier Narrows Dam (see Section 3, Numeric Targets). In Coyote Creek, wet-weather TMDLs apply when the maximum daily flow in the creek is equal to or greater than 156 cfs as measured at LACDPW flow gauge station F354-R, located at the bottom of the creek, just above the Long Beach WRP.

Table 6-1. Wet-weather loading capacities (TMDLs) for metals (total recoverable metals).

Reach	Copper (kg/day)	Lead (kg/day)	Zinc (kg/day)
San Gabriel Reach 2	--	Daily storm volume x 166 µg/L	--
Coyote Creek	Daily storm volume x 27 µg/L	Daily storm volume x 106 µg/L	Daily storm volume x 158 µg/L

The daily storm volume is equal to the total daily flow either in San Gabriel River Reach 2 or Coyote Creek.

Wet-weather allocations are assigned to all upstream reaches and tributaries of San Gabriel River Reach 2 and Coyote Creek because they potentially drain to these impaired reaches during wet weather. Allocations are assigned to both point and nonpoint sources. Concentration-based waste load allocations are developed for the POTWs and other non-storm water point sources. Mass-based load allocations are developed for open space and direct atmospheric deposition. A grouped mass-based waste load allocation is developed for storm water permittees (MS4s, Caltrans, General Industrial, and General Construction) by subtracting the load allocations from the total loading capacity. These wet-weather allocations are presented in tables 6-2 and 6-3.

Table 6-2. Wet-weather allocations for lead in San Gabriel River Reach 2. Concentration-based allocations apply to non-stormwater NPDES discharges. Stormwater allocations are expressed as a percent of load duration curve. Mass-based values presented in table are based on a flow of 260 cfs (daily storm volume = 6.4 x10^8 liters).

Waste Load Allocations (San Gabriel River Reach 2)	Percent area	Lead Allocations	Mass- based Values
POTWs	NA	166 ug/l	0.7 kg/d
Other NPDES	NA	166 ug/l	NA
Municipal Stormwater	49%	49% * 166 ug/l * Daily Storm Volume	51.8 kg/d
Industrial Stormwater	2.2%	2.2% * 166 ug/l * Daily Storm Volume	2.3 kg/d
Construction Stormwater	0.7%	0.7% * 166 ug/l * Daily Storm Volume	0.8 kg/d
Load Allocations (San Gabriel River Reach 2)			
Open Space	48%	48% * 166 ug/l * Daily Storm Volume	50.2 kg/d
Air Deposition	0.4%	0.4% * 166 ug/l * Daily Storm Volume	0.4 kg/d

Table 6-3. Wet-weather allocations for copper lead and zinc in Coyote Creek. Concentration-based allocations apply to non-stormwater NPDES discharges. Stormwater allocations are expressed as a percent of load duration curve. Mass-based values presented in table are based on a flow of 156 cfs (daily storm volume = 3.8 x10^8 liters).

Waste Load Allocations (Coyote Creek)	Percent area	Copper	Lead	Zinc
POTWs	NA	27 ug/l	106 ug/l	158 ug/l
Other NPDES	NA	27 ug/l	106 ug/l	158 ug/l
Municipal Stormwater	91.5%	9.41 kg/d	36.9 kg/d	55.0 kg/d
Industrial Stormwater	3.5%	0.356 kg/d	1.40 kg/d	2.1 kg/d
Construction Stormwater	5.0%	0.513 kg/d	2.07 kg/d	3.0 kg/d
Load Allocations (Coyote Creek)				
Open Space	0%	0	0	0
Air Deposition	0.2%	0.022 kg/d	0.09 kg/d	0.1 kg/d

6.1.1. Wet-weather load allocations

An estimate of direct atmospheric deposition is developed based on the percent area of surface water in the watershed. Approximately 0.4% of the watershed area draining to San Gabriel River Reach 2 is comprised of water and approximately 0.2% of the watershed area draining to Coyote Creek is comprised of water. The load allocation for atmospheric deposition is calculated by multiplying these percentages by total loading capacities. The loadings associated with indirect deposition are included in the wet-weather storm water waste load allocations. Once metals are deposited on land under the jurisdiction of a storm water permittee, they are within a permittee's control. As was done for dry-weather, open space load allocations are calculated by multiplying the percent area of open space in the watershed not served by storm drains by the total loading capacity. Open space comprises 0% of the Coyote Creek subwatershed and approximately 47% of the San Gabriel River watershed that drains to Reach 2 [2].

[2] As determined by Regional Board staff through GIS mapping using County storm drain layers.

6.1.2. Wet-weather waste load allocations for storm water permittees

Wet-weather waste load allocations for storm water permittees are calculated by subtracting the load allocations for open space and direct air deposition from the total loading capacity Allocations for NPDES-regulated municipal storm water discharges from multiple point sources can be expressed as a single categorical waste load allocation when data and information are insufficient to assign each source or outfall an individual allocation. The storm water allocations may be fairly rudimentary because of data limitations and variability in the system. The combined storm water waste load allocation is further allocated to the general industrial, general construction, MS4 and Caltrans permits based on their percent area of the developed portion of the watershed. The developed portion of the watershed includes all land uses except open space and water. The total area covered by facilities enrolled under the general construction and industrial storm water permits was obtained from the State Board database. This was subtracted from the total developed area to obtain a rough estimate of the area covered by the MS4 and Caltrans permittees. The areas associated with each permit type were then divided by the total developed area to obtain the percentages in Tables 6-2 and 6-3. The MS4 permittees and Caltrans share a waste load allocation because there is not enough data on the relative reach-specific extent of MS4 and Caltrans areas.

6.1.3. Wet-weather waste load allocations for POTWs and other NPDES permits.

Concentration-based WLAs (Table 6-2 and 6-3) are established for the POTWs and other non-storm water permits to ensure that these sources do not contribute to exceedances of wet-weather numeric targets.

6.2 Dry-Weather TMDL for Copper in San Gabriel River Estuary

Dry-weather allocations are assigned to sources that discharge directly to the estuary and to upstream sources that discharge indirectly to the estuary via San Gabriel River Reach 1 and Coyote Creek (Table 6-4).

Table 6-4. Direct and indirect sources discharging to the San Gabriel River Estuary

Upstream Sources (San Gabriel River Reach 1 and Coyote Creek)	Direct Sources (Estuary)
WRPs	Power Plants
Non-Storm Water Point Sources	Non-Storm Water Point Sources
Storm Water	Storm Water
Direct Air	Direct Air

The dry-weather TMDL for the estuary is calculated by multiplying the numeric target by the volume of flow to the estuary. Tidal exchanges provide limited if any assimilative capacity because the flow from the power plants is sufficient to displace all ocean water in the estuary. Therefore, the concentration of total copper in the estuary is a function of upstream and direct sources (Equation 5).

$$\mathbf{TMDL = C_t * Q_t = C_{us} * Q_{us} + C_{ds} * Q_{ds}} \qquad \textbf{Equation (5)}$$

Where:

C_t = Numeric target for total copper in the estuary = 3.7 μg/L
Q_t = Total flow to estuary
C_{us} = Concentration of copper in upstream sources
Q_{us} = Upstream flow
C_{ds} = Concentration of copper in direct sources
Q_{ds} = Direct source flow

Concentration-based allocations were first developed for upstream source which discharge to the estuary indirectly based on the freshwater CTR criteria for San Gabriel Reach 1 and Coyote Creek (discussed in 6.2.1). Concentrations-based allocations for direct sources were back-calculated using equation 5 (discussed in 6.2.2).

6.2.1 Upstream Sources: Dry-weather Copper Allocations for San Gabriel River Reach 1 and Coyote Creek

San Gabriel River Reach 1 and Coyote Creek discharge to the estuary. Waste load allocations and load allocations for copper are developed to address point and nonpoint sources which discharge into these reaches.

Non-storm water point sources that discharge to Reach 1 and Coyote Creek receive copper allocations based on freshwater criteria and upstream median dry-weather hardness values[3] to ensure that these sources do not contribute to copper exceedances in the estuary while considering their relative contribution of flow. This results in concentration-based copper allocations equal to 18 µg/L for Reach 1 sources and 20 µg/L for Coyote Creek sources.

Storm water permittees that discharge to San Gabriel Reach 1 are assigned the same concentration-based copper allocations as the non-storm water discharges (18µg/L) because flow in Reach 1 is comprised almost entirely of WRP flow and any non-WRP urban runoff is insignificant[4]. In Coyote Creek the non-WRP urban runoff is much more significant. The median non-WRP Coyote Creek flow is equal to 19 cfs, measured at LACDPW Station F354-R. A mass-based loading capacity of 0.943 kg/d was calculated by multiplying the target of 20 ug/l by by the median non-WRP flow. A dry-weather stormwater allocation of 0.941 kg/d was assigned after accounting for potential loadings from direct atmospheric deposition.

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[3] Median dry-weather hardness at receiving water station R-4, below San Jose Creek and Los Coyotes WRP outfalls in Reach 1 is 217 mg/L as $CaCO_3$. Median dry-weather hardness at receiving water station R-A, below Long Beach WRP outfall in Coyote Creek is 249 mg/L as $CaCO_3$.

[4] Reach 1 flows were obtained from long-term flow records (1990-2005) at LACDPW station F42B-R, located just above Spring Street and below the Los Coyotes and San Jose Creek outfalls. The median flow at this gauge is 114 cfs. Since the gauge is below the WRP outfalls, the average annual WRP flow (obtained from San Jose Creek and Los Coyotes 2000-2005 annual reports) is subtracted from the median gauge flow to obtain the non-WRP flow. The total average annual flow from the WRPs is 115 cfs, which is greater than the flow measured at station F42B-R. The difference between the WRP flow and the measured flow is within the error of the flow gauge.

As shown in Table 4-3, dry-weather direct atmospheric deposition rates for copper were extrapolated to the San Gabriel River watershed based on previous studies in the Los Angeles River watershed (Sabin et al., 2004). To calculate reach-specific direct deposition, direct deposition for the entire watershed (0.0113 kg/day) is multiplied by the relative area of water in the Reach 1 and Coyote Creek subwatersheds as compared to the area of water in the entire watershed[5]. Indirect deposition of metals is accounted for in the allocations to storm water. Once metals are deposited on land under the jurisdiction of a storm water permittee, they are within a permittee's control.

"Open space" refers to opens space that discharges directly to the river and not through the storm drain system. Once drainage from open space is collected by the storm drain system it becomes a point source and is included with the storm water allocation. There is no open space in the Reach 1, or Coyote Creek subwatersheds that is not served by storm drains [6]. Open space therefore receives a load allocation equal to zero. Copper allocations for all sources in Reach 1 and Coyote Creek are shown in Table 6-5.

Table 6-5 Dry-weather copper waste load and load allocations for San Gabriel Reach 1, and Coyote Creek (total recoverable metals).

Waste Load Allocations	San Gabriel River Reach 1	Coyote Creek
POTWs	18 ug/l	20 ug/l
Other NPDES	18 ug/l	20 ug/l
Municipal Stormwater	18 ug/l	0.941 kg/d
Industrial Stormwater	0	0 kg/d
Construction Stormwater	0	0 kg/d
Load Allocations		
Open Space	0 kg/d	0 kg/d
Air Deposition	0.0027 kg/d	0.002 kg/d
TMDL		**0.943 kg/d**

*Also applies to storm water sources in San Gabriel River Reach 1.

For accounting purposes, it is assumed that Caltrans and the general storm water permittees discharge entirely to the MS4 system. This assumption has been supported though review of the permits. A zero waste load allocation is assigned to all industrial and construction stormwater permits during dry weather. NPDES Permit Nos. CAS000001 and CAS000002 already prohibit non-storm water discharges with few exceptions as discussed in Section 4.1.1. The dry-weather storm water allocation is shared by the MS4 permittees and Caltrans. It is not possible to divide this allocation because there are not enough data on the relative reach-specific extent of MS4 and Caltrans areas.

[5] There are 1555 acres of water in the entire watershed, 37.4 acres of water in the Reach 1 subwatershed (2.4%), and 269 acres in the Coyote Creek subwatershed (17%).

[6] As determined through GIS mapping using County storm drain layers.

6.2.2 Direct Sources: Dry-weather Allocations for Sources that discharge to the Estuary

The upstream indirect dischargers' relative contribution of flow is small compared to the power plants, which discharge directly to the Estuary. Upstream flow is approximately 157 cfs or 101 MGD[7]. The combined power plant design flow is 2297 MGD. Due to their differences in flow, the metals loading from the power plants is approximately ten times greater than the metals loading from the WRPs. Based on Equation 5, given the allocations assigned to upstream sources and a combined power plant design flow of 2297 MGD, the power plants must receive a concentration-based waste load allocation for copper equal to 3.1 µg/L in order to meet the numeric target of 3.7 µg/L for the estuary.

It is possible that the source water used by the plant may be the source of the copper contamination. For the Alamitos plant, which draws in once-through cooling water from Los Cerritos Channel, the intake water has an average copper concentration of 2.1 µg/L. Three out of 22 samples of intake water (from 2000-2004) had copper concentrations greater than the waste load allocation of 3.1 µg/L. For the Haynes plant, which draws in once-through cooling water from Alamitos Bay, the concentration of copper in the intake water averaged 12.2 µg/L, with all samples (from 2001-2005) exceeding the waste load allocation of 3.1 µg/L. Special studies could be conducted to assess the quality of the source water and identify ways to alleviate the problem. Special studies may also be conducted to develop a site-specific water effects ratio for copper in the estuary.

The other direct discharges to the Estuary, including storm water and non-storm water point sources, are assigned concentration-based waste load allocations equal to the Estuary copper numeric target of 3.7 µg/L. Their relative flow of these sources is unknown, so it is not possible to assign them mass-based waste load allocations.

Atmospheric deposition can be calculated from previous studies and scaled to the estuary subwatershed based on the relative area of water in the Estuary as compared to the area of water in the entire watershed (6.8 %), resulting in an allocation of 7.75×10^{-4} kg/day. This load allocation is insignificant compared to loading from other sources. For example, if the power plants were assigned a mass-based allocation based on their design flow (3560 cfs), the allocation would be 27 kg/day. The load allocation for direct air is essentially zero.

There is no open space in the Estuary subwatershed that is not served by storm drains [8]. Open space therefore receives a load allocation equal to zero. A zero waste load allocation is assigned to all industrial and construction stormwater permits during dry weather. The dry-weather storm water allocation is shared by the MS4 and Caltrans permittees. Dry-weather allocations for all sources in the San Gabriel River Estuary are presented in Table 6-6.

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[7] Equal to the combined median flow at LACDPW gauge F42B-R (114 cfs), located at the bottom of Reach 1 (below the San Jose Creek and Los Coyotes Outfalls), median flow at LACDPW flow gauge F354-R (19 cfs), located near the bottom of Coyote Creek (above the Long Beach WRP outfall), and median Long Beach WRP flow (24 cfs).

[8] As determined through GIS mapping using County storm drain layers.

Table 6-6 Dry-weather copper waste load and load allocations for the Estuary (total recoverable metals).

Point Sources (San Gabriel River Estuary)	Waste Load Allocations
Power Plants	3.1 ug/l
Other NPDES	3.7 ug/l
Municipal Stormwater	3.7 ug/l
Industrial Stormwater	0
Construction Stormwater	0
Non Point Sources (San Gabriel River Estuary)	**Load Allocations**
Open Space	0 kg/d
Air Deposition	<0.001 kg/d

6.3 Dry-Weather Selenium TMDL for San Jose Creek

The dry-weather selenium TMDL for San Jose Creek is concentration based. Concentrations based allocations are assigned to point and nonpoint sources in San Jose Creek Reach 1 and Reach 2 to meet the selenium target of 5 ug/l in San Jose Creek Reach 1. This approach was taken because selenium is a naturally occurring element that is present in marine sedimentary soils that are present in the area (Orange County 2006). In addition, many of the non-storm water point sources have intermittent flow making calculation of mass-based allocations difficult. The lack of consistent dry-weather flows throughout the reach and the number of episodic discharges make the application of mass-based allocations for this reach impractical. Providing concentration-based limits are designed to ensure that numeric targets will be attained.

The LACDPW flow gauge F312B-R was used to estimate dry-weather flows in San Jose Creek Reach 1. This gauge is located at 7th Avenue, above San Jose Creek WRP outfall No. 002 but well below the Pomona WRP which discharges to the South Fork of San Jose Creek. During dry-weather most of the effluent flow from the Pomona plant is reclaimed for landscape, crop irrigation, or industrial processes. The median flow at this station is 19 cfs. This station is dry about 10% of the time. Since nearly all Pomona flow is reused and does not enter San Jose Creek, the long-term median flow at this station 19cfs provides an estimate of dry-weather urban runoff.

Concentration-based waste load allocations of 5 ug/l are assigned to the Pomona WRP, the San Jose Creek WRP and to all other non-storm water point sources. Selenium concentrations in the effluent from these two WRP are generally less than 1 ug/l. The permit for Pomona does not currently have an effluent limit for selenium. This was based on an analysis of effluent data that show no reasonable potential for exceedances of the selenium criteria. Selenium concentrations from the San Jose WRP effluent are also low. However, selenium concentrations in the receiving water near the plant at times will exceed the selenium criteria (See Table 2-6). Therefore, effluent limits for selenium have been established for the San Jose Creek WRP. The use of concentration-based allocations allows the two WRPs to expand to their design capacity while meeting numeric targets.

A mass-based loading capacity for the non-WRP dry-weather urban runoff can be calculated by multiplying the selenium target of 5 ug/l by a median flow of 19 cfs obtained from long-term flow data at LACDPW flow gauge F312B-R to obtain a value of 0.232 kg/d. The contribution from open space which represents about 1.8% of the area with the San Jose Creek subwatershed[9] is estimated to be 0.004 kg/d. The remainder of the loadings (0.228 kg/d) are attributed to dry-weather urban runoff from stormwater which are regulated through stormwater permits (MS4s, Caltrans, General Industrial, and General Construction). As discussed in Section 4.1.1, the stormwater permits for general industrial and construction activities (NPDES Nos. CAS000001 and CAS000002) generally prohibit dry-weather discharges.

No studies on atmospheric deposition of selenium have been conducted, but it is believed to be an insignificant source. Selenium is present in local marine sedimentary rocks (Orange County, 2006). It is presumed that much of the selenium results from natural soils in the watershed. This assumption is corroborated by the fact that many of the impairments in San Jose Creek occur after the channel becomes soft-bottomed.

Special studies will allow further assessment of sources of selenium in San Jose Creek. Other potential sources of selenium include activities that mobilize groundwater to the surface (e.g. dewatering activities), irrigation of soils that are naturally high in selenium, and discharges from petroleum-related activities (EPA, 2000).

In the interim, concentration-based wasteload allocations are assigned to all point sources. The resulting allocations for all sources in San Jose Creek Reach 1 and Reach 2 are presented in Table 6-7.

Table 6-7 Selenium allocations for San Jose Creek Reach 1 and Reach 2 (total recoverable metals).

Point Sources (San Jose Creek Reach 1 and 2)	**Waste Load Allocations**
POTWs	5 ug/l
Other NPDES	5 ug/l
Municipal Stormwater	5 ug/ll
Industrial Stormwater	5 ug/l
Construction Stormwater	5 ug/l
Nonpoint Sources (San Jose Creek Reach 1 and 2)	**Load Allocations**
Open Space	5 ug/l
Air Deposition	0

6.4 Margin of Safety

TMDLs must include a margin of safety to account for any lack of knowledge concerning the relationships between pollutant loads and their effect on water quality. This uncertainty is limited because the TMDLs are simply equal to the numeric targets multiplied by the median flow in dry weather and the numeric targets multiplied by actual flow in wet-weather. The primary sources of uncertainty are related to assumptions made in developing numeric targets. The use of default conversion factors is an implicitly conservative assumption, which is applied to the margin of safety. The conversion factors are defined as the fraction of dissolved metals divided by the total metals concentration. For the dry-weather copper target, it has been shown in previous TMDLs that the default conversion factor overestimates the fraction of copper in the dissolved form. For the wet-weather copper, lead, and zinc targets, evaluation of the storm water data compared to

[9] As determined through GIS mapping using County storm drain layers.

the default conversion factor showed that the default conversion factor overestimates the fraction of metal in the dissolved form. The default translator was applied to wet-weather in San Gabriel Reach 2. The site specific translators are developed in this TMDL for copper, lead and zinc in Coyote Creek are somewhat less conservative than the default CTR values. However based on studies from the scientific literature they also tend to overestimate the dissolved fraction in stormwater. This difference provides an implicit margin of safety.

7. IMPLEMENTATION RECOMMENDATIONS

This section describes the implementation procedures and regulatory mechanisms that could be used to provide reasonable assurances that water quality standards will be met.

7.1. Nonpoint Sources

Nonpoint sources may be regulated through the authority contained in sections 13263 and 13269 of the Water Code, in conformance with the State Water Resources Control Board's Nonpoint Source Implementation and Enforcement Policy, and the Conditional Waiver for Discharges from Irrigated Lands, adopted by the Los Angeles Regional Water Quality Control Board on November 3, 2005.

7.2. POTWs and Other Non-storm Water NPDES Permits

NPDES permit limitations will need to be consistent with the concentration-based WLAs established for the POTWs and other point sources in these TMDLs. Permit limits would need to meet the water quality targets established in these TMDLs and maintain water quality standards in the San Gabriel River. Permit writers could translate waste load allocations into effluent limits by applying the SIP procedures or other applicable engineering practices authorized under federal regulations. Wet-weather WLAs will not be used to determine monthly permit limits but will only be used in a determination of a daily limit. For permits subject to both dry- and wet-weather WLAs, EPA expects that permit writers would write a monthly limit based on the dry-weather WLA and two separate daily maximum limits based on dry- and wet-weather WLAs.

7.3 General Industrial Storm Water Permits

The dry-weather waste load allocation equal to zero applies to unauthorized non-storm water flows, which are prohibited by NPDES Permit Nos. CAS000001. It is anticipated that the dry-weather waste load allocations will be implemented in future general permits through the requirement of improved BMPs to eliminate the discharge of non-storm water flows.

The wet-weather mass-based waste load allocations for the general industrial storm water permittees may be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board

7.4 General Construction Storm Water Permits

Waste load allocations for the general construction storm water permits may be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board.

7.5 MS4 and Caltrans Storm Water Permits

Grouped dry-weather and wet-weather waste load allocations apply to the MS4 and Caltrans permits (Tables 6-1, 6-2, 6-3, 6-5, 6-6 and 6-7). EPA regulation allows allocations for NPDES-regulated storm water discharges from multiple point sources to be expressed as a single categorical waste load allocation when the data and information are insufficient to assign each source or outfall individual WLAs. The shared allocations could be incorporated into the

Caltrans permit and all NPDES-regulated municipal storm water discharges in the San Gabriel River watershed, including municipalities enrolled under the Los Angeles County MS4 permit, the City of Long Beach MS4 permit, and the Orange County MS4 permit. Figure 12 shows the municipalities located in each San Gabriel River subwatershed. Table 7-1 identifies the cities in the San Gabriel Watershed by watershed subbasin.

Table 7-1. List of cities in San Gabriel Watershed by watershed subbasin.

	Walnut Creek	San Jose Creek	San Gabriel Reach 5	San Gabriel Reach 4	San Gabriel Reach 3	San Gabriel Reach 2	San Gabriel Reach 1	Coyote Creek
Anaheim								X
Arcadia				X				
Artesia							X	X
Azusa	X		X					
Baldwin Park	X			X	X			
Bellflower							X	
Brea								X
Buena Park								X
Cerritos							X	X
Chino Hills								X
Claremont	X	X						
Covina	X							
Cypress								X
Diamond Bar		X						X
Downey						X	X	
Duarte			X					
El Monte				X	X			
Fullerton								X
Garden Grove							X	X
Glendora	X		X					
Hacienda Heights								X
Hawaiian Gardens								X
Industry	X	X			X	X		
Irwindale	X		X	X	X			
La Habra								X
La Habra Heights		X						X
La Mirada								X
La Palma								X
La Puente	X	X			X			
La Verne	X	X						
Lakewood							X	X
Long Beach							X	X
Los Alamitos							X	X
Norwalk							X	X
Paramount							X	
Pico Rivera					X	X		
Placentia								X
Pomona	X	X						
San Dimas	X	X						
Santa Fe Springs						X	X	X
Seal Beach							X	
South El Monte					X			
Walnut	X	X						
West Covina	X	X						
Whittier		X			X	X		X
Yorba Linda								X

8. MONITORING

When the Regional Board adopted metals TMDLs for this watershed, they included a monitoring plan. We consider the monitoring plan to be appropriate and recommend that the Regional Board implement it. Under the Regional Board plan, there are three objectives of monitoring associated with the TMDL. The first is to collect data (e.g., hardness, flow, and background concentrations) to evaluate the uncertainties and assumptions made in development of the TMDL. The second is to collect data to assess compliance with the waste load allocations. The third is to collect data to evaluate potential management scenarios. To achieve these objectives, a monitoring program will need to be developed for the TMDL that consists of three components: (1) ambient monitoring, (2) compliance assessment monitoring and (3) special studies.

8.1 Ambient Monitoring

According to the Regional Board, an ambient monitoring program throughout the San Gabriel River and its tributaries is necessary to ensure that water quality standards are attained and to track trends in water quality improvements. Another goal is to provide background information on hardness values and the partitioning of metals between the total recoverable and dissolved fraction to refine load and waste load allocations.

The MS4 and Caltrans NPDES permittees assigned waste load allocations are jointly responsible for implementing the ambient monitoring program. The ambient monitoring program shall contain monitoring in all reaches and major tributaries of the San Gabriel River, including but not limited to additional dry- and wet-weather monitoring in the San Gabriel River Reaches 4 and 5 and Walnut Creek, additional dry-weather monitoring in San Gabriel River Reach 2, and additional wet-weather monitoring in San Jose Creek, San Gabriel River Reaches 1 and 3, and the Estuary.

Ambient monitoring efforts are already underway in the watershed. As part of their NPDES permit requirements for the Long Beach, Los Coyotes, Whittier Narrows, San Jose Creek and Pomona WRPs, LACSD developed a watershed-wide monitoring program for the San Gabriel River watershed. The project is funded by LACSD and managed through SCCWRP and the Los Angeles and San Gabriel Rivers Watershed Council with participation of a multistakeholder workgroup. Participants in the workgroup include LACDPW and other Los Angeles and Orange County MS4 permittees. The program design includes expanded ambient monitoring, coordinated multi-agency monitoring efforts, and a framework for periodic and comprehensive assessments of conditions in the watershed. These efforts are being coordinated and integrated with LACSD's ongoing NPDES sampling in San Jose Creek, San Gabriel River Reach 3 and Reach 1 and Coyote Creek (Table 2-5). Integration of monitoring programs to reduce redundancy and increase efficiency is a major goal of the San Gabriel watershed-wide program. The MS4 and Caltrans NPDES permittees are encouraged to participate in the San Gabriel watershed-wide monitoring program efforts to leverage resources.

8.2 TMDL Effectiveness Monitoring

TMDL effectiveness monitoring requirements should be specified in permits to determine if the waste load allocations are achieved. For the POTWs and power plants, daily and monthly effluent monitoring requirements should be developed to ensure compliance with waste load allocations.

Stormwater permittees should be encouraged to develop a monitoring program that will not only assess individual compliance, but will assess the effectiveness of chosen BMPs to reduce pollutant loading on an industry-wide or permit category basis. MS4 permittees and those enrolled under industrial and construction stormwater permits should be encouraged to participate in such programs. Responsible parties are encouraged to coordinate with the San Gabriel watershed-wide monitoring program to avoid duplication and reduce costs.

8.2.1 Dry-weather TMDL Effectiveness Monitoring

Under the Regional Board plan, the storm water NPDES permittees will be found to be effectively meeting the dry-weather waste load allocations if the in-stream pollutant concentration or load at the first downstream effectiveness monitoring location is equal to or less than the corresponding concentration- or load-based waste load allocation. Alternatively, effectiveness of the TMDL may be assessed at the storm drain outlet based on the numeric target for the receiving water. For storm drains that discharge to other storm drains, effectiveness will be based on the waste load allocation for the ultimate receiving water for that storm drain system. The final dry-weather monitoring stations shall be located in San Jose Creek Reach 1 and the Estuary. At a minimum the sampling frequency should be sufficient to generate enough samples to evaluate status of the waterbody relative to the State Board listing policy.

8.2.2 Wet-weather TMDL Effectiveness Monitoring

Under the Regional Board plan, the storm water NPDES permittees will be found to be effectively meeting wet-weather waste load allocations if the load at the downstream monitoring location is equal to or less then the loading capacity (Table 6-1). For practical purposes, this is when the EMC for a flow-weighted composite is less than or equal to the numeric target. Responsible agencies shall sample at least 4 wet-weather events where flow meets wet-weather conditions (260 cfs in San Gabriel River Reach 2 and 156 cfs in Coyote Creek) in a given storm season (November to March). Final wet-weather TMDL effectiveness monitoring stations may be located at the existing LACDPW mass emission sites in San Gabriel Reach 2 and Coyote Creek.

8.3 Special Studies

Additional monitoring and special studies may be needed to evaluate the uncertainties and the assumptions made in development of these TMDLs. The results of special studies may be used to reevaluate waste load allocations if the TMDLs are reconsidered by the Regional Board.

Special studies may be warranted to evaluate the numeric targets. Studies on background concentrations of total recoverable versus dissolved metals concentrations, total suspended solids, and organic carbon will help with the refinement of metals conversion factors. A WER study may be warranted to calculate a site-specific copper objective for the Estuary.

Special studies may be warranted to better characterize sources. Studies may be developed to refine estimates of metals loading from open space and natural sources. Studies may also be developed to assess natural soils as a potential background source of selenium in San Jose Creek Reach 1. Studies should be considered to evaluate the potential contribution of atmospheric deposition to metals loading and sources of atmospheric deposition in the watershed.

Special studies may be warranted to refine some of the assumptions used in the modeling, specifically source representation in dry-weather, the relationship between total recoverable and dissolved metals in storm water, the assumption that metals loading are closely associated with suspended sediments, the accuracy and robustness of the potency factors, the uncertainties in the understanding sediment washoff and transport, and the representation of reservoirs, spreading grounds, and other hydromodifications in the watershed. The assumptions made in model development are detailed in Appendices I and II.

A study should be designed to better understand the mixing of fresh and salt waters in the Estuary and to assess the effect of upstream freshwater discharges on water quality and aquatic life beneficial uses in the Estuary. The purpose of the study would be to refine the assumptions made in establishing the copper waste load allocations for discharges to the Estuary and discharges to those reaches tributary to the Estuary. Special studies may be conducted to assess sources of copper in power plant intake water and possible source reduction strategies.

Special studies should be considered to evaluate the effectiveness of various structural and non-structural BMPs in removing metals and meeting waste load allocations.

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