Draft Staff Report

COLORADO LAGOON
OC PESTICIDES, PCBS, SEDIMENT TOXICITY, PAHS, AND METALS TMDL

PREPARED BY
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

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DRAFT

TABLE OF CONTENTS

LIST OF ACRONYMS

µg/g	Micrograms per Gram
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
BMPs	Best Management Practices
BPTCP	Bay Protection and Toxic Cleanup Program
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
COMM	Commercial and Sport Fishing
CTR	California Toxics Rule
CWA	Clean Water Act
DL	Detection Limit
EMCs	Event Mean Concentrations
ERL	Effects Range-Low
ERM	Effects Range-Median
EST	Estuarine Habitat
FHWA	Federal Highway Administration
FR	Federal Register
kg	Kilograms
LACDPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LACDBH	Los Angeles County Department OF Beaches and Harbors
MAR	Marine Habitat
MdRH	Marina del Rey Harbor
MGD	Million Gallons per Day
mg/kg	Milligrams per Kilogram
MS4	Municipal Separate Storm Sewer System
MTRL	Maximum Tissue Residue Level
NAV	Navigation
ng/L	Nanograms per Liter
NPDES	National Pollutant Discharge Elimination System
NPTN	National Pesticide Telecommunications Network
O&M	Operation and Maintenance
OEHHA	Office of Environmental Heath Hazard Assessment
PCBs	Polychlorinated biphenyls
PEL	Probable Effects Level
pg/L	Picograms per Liter
ppb	Parts per Billion
ppt	Parts per Thousand
RARE	Rare, Threatened, or Endangered Species
REC1	Water Contact Recreation
REC2	Non-Contact Water Recreation
SHELL	Shellfish Harvesting

SIYB	Shelter Island Yatch Basin
SQGs	Sediment Quality Guidelines
SQOs	Sediment Quality Objectives
TEL	Threshold Effects Level
TMDL	Total Maximum Daily Load
TSMP	Toxic Substances Monitoring Program
US	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WDRs	Waste Discharge Requirements
WILD	Wildlife Habitat
WLAs	Waste Load Allocations
WQA	Water Quality Assessment
WQOs	Water Quality Objectives

1. INTRODUCTION

Colorado Lagoon is listed on the Clean Water Act (CWA), Section 303(d) list of impaired water bodies for Organochlorine (OC) Pesticides, Polychlorinated Biphenyls (PCBs), Sediment Toxicity, Polycyclic Aromatic Hydrocarbons (PAHs), and metals (Table 1-1) in 1996, 1998, 2002, and 2006 of California 303(d) list of impaired waterbodies (LARWQCB, 1996, 1998, 2002, 2006). The CWA requires a Total Maximum Daily Load (TMDL) be developed to restore the impaired waterbodies to their full beneficial uses. This report presents the required elements of the TMDL for OC pesticides, PCBs, PAHs, sediment toxicity, and metals, and summarizes the technical analyses performed by the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), the City of Long Beach, and the United States Environmental Protection Agency, Region 9 (USEPA) to develop this TMDL.

This TMDL complies with 40 CFR 130.2 and 130.7, Section 303(d) of the CWA and USEPA guidance for developing TMDLs in California (USEPA, 2000a). The TMDL determines the causes of listed impairments, allowable loadings for the various sources, and measures required to remove these impairments. In addition to the summary of the information used in its development, the TMDL includes an implementation plan and cost consideration to achieve the waste load allocations (WLAs) and load allocations (LAs), and attain water quality objectives (WQOs) in Colorado Lagoon. The California Water Code (Porter-Cologne Water Quality Control Act) requires that an implementation plan be developed to achieve water quality objectives.

1.1 Regulatory Background

Section 303(d) of the 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 objective 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 the USEPA guidance (USEPA, 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 loads (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 (USEPA, 2000a).

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The USEPA 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 USEPA approval. If USEPA does not approve a TMDL submitted by a state, USEPA 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).

As part of its 1996 and 1998 regional water quality assessments (WQAs), the Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree that was approved on March 22, 1999 (Heal the Bay Inc., et al. v. Browner, et al. C 98-4825 SBA).

For the purpose of scheduling TMDL development, the consent decree combined more than 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical Unit 82 addresses the impairments in Colorado Lagoon associated with DDT, PCBs, Chlordane, Dieldrin and Sediment Toxicity and Analytical Unit 83 addresses the impairments associated with PAHs and metals including Lead and Zinc. Table 1-1 presents the 1998 303(d) list of toxic impairments in Colorado Lagoon.

Table 1-1: 1998 303(d) List of Metal and Organic Compound Impairments for Colorado Lagoon

Media	**Pollutant**	
	Analytical Unit 82	**Analytical Unit 83**
Sediment	Chlordane Sediment Toxicity	PAHs Lead Zinc
Fish Tissue	Chlordane DDT Dieldrin PCBs	

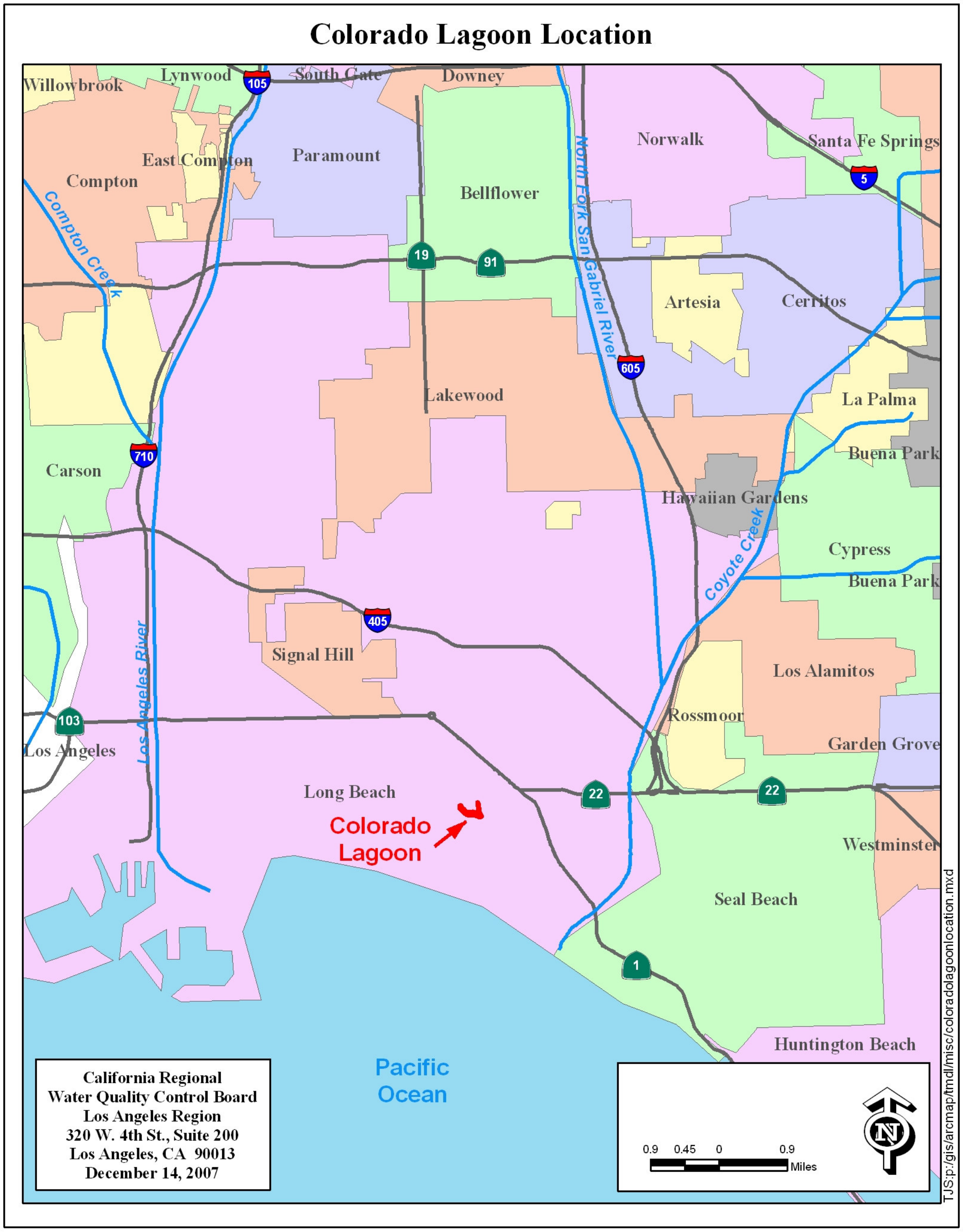
On January 21, 2009, the Regional Board held a California Environmental Quality Act (CEQA) scoping meeting to solicit input from the public and interested stakeholders in determining the scope, content and implementation options of the proposed TMDL for OC Pesticides, PCBs, Sediment Toxicity, PAHs and Metals in Colorado Lagoon. At the scoping meeting, the CEQA checklist of significant environmental issues and mitigation measures were discussed. This meeting fulfilled the requirements under CEQA (Public Resources Code, Section 21083.9).

This TMDL will address impairment of beneficial uses due to elevated concentrations of chlordane, sediment toxicity, PAHs, lead, and zinc in sediments, and chlordane, DDT, dieldrin, and PCBs in fish tissue. The sediment and fish tissues listing will be addressed by the TMDLs waste load allocations (WLAs) and load allocations (LAs) for these pollutants.

1.2 Environmental Setting

The Colorado Lagoon (Lagoon) is located within the City of Long Beach, Southern California as shown in Figure 1-1. The Lagoon is a 15-acre, V-shaped tidal lagoon connected to Alamitos Bay and the Pacific Ocean via a box culvert to Marine Stadium. It serves three main functions: 1) hosting sensitive estuarine habitat; 2) providing public recreation; and 3) retaining and conveying storm flows. The lagoon is abundant in wild life and acts as an important stop for thousands of migratory birds, including endangered species every year. In addition, the lagoon is heavily utilized for recreational activities, including swimming, fishing, wildlife viewing, and picnicking. The Lagoon is used by hundreds of visitors from communities within and surrounding the City of Long Beach.

Figure 1-1: Colorado Lagoon Vicinity Map



The Colorado Lagoon watershed is approximately 1,172 acres and divided into five sub-basins that discharge stormwater and urban dry weather runoff to the Colorado Lagoon (Figure 1-2). Each of the sub-basins are served by a major storm sewer trunklines and supporting appurtenances that collect and transport stormwater and urban dry weather runoff to the Colorado Lagoon**.** Surface water runoff within the watershed occurs as overland runoff into curb inlets and catch basins, and as sheet flow from near shore areas (City of Long Beach, 2004). Each sub-basin discharges to the Colorado Lagoon through individual storm drainage systems (Figure 1-3). The sub-basins are as follows:

- **Sub-basin A.**
  Discharges to Colorado Lagoon via a 63-inch reinforced concrete pipe owned and operated by the Los Angeles County Flood Control District (Project 452 Drain) discharging into the north part of the west arm. The drainage pattern is generally to the south and east. Sub-basin A contains the most commercial activities mainly along Anaheim Street and the northern part of Redondo Avenue.

- **Sub-basin B.**
  Discharges to Colorado Lagoon via a 54-inch reinforced concrete pipe (Line I Storm Drain) discharging into the north part of the north arm. The drainage pattern is generally to the south and west. Sub-basin B is predominately park/golf course open space with some residential areas on the north east corner.

- **Sub-basin C.**
  Discharges to Colorado Lagoon via a 48-inch reinforced concrete pipe (Line K Storm Drain) discharging into the mid-point of the north arm. The drainage pattern is generally to the south and west. Sub-basin C is almost entirely residential with a few commercial activities at the eastern boundary.

- **Sub-basin D.**
  Discharges to Colorado Lagoon via a 24-inch reinforced concrete pipe (Line M Storm Drain) discharging into the south part of the west arm. The drainage pattern is generally to the north and east. Sub-basin D is almost entirely residential with schools and other public facilities.

- **Sub-basin E.**
  Discharges to Colorado Lagoon via a 48-inch reinforced concrete pipe (Termino Avenue Drain) discharging into the west arm. The drainage pattern is generally to the south and east. Sub-basin E is mainly residential with commercial activities located along 7th Street, Coronado and Redondo Avenues to the west, and public facilities to the north.

Several other smaller storm drains serve the areas immediately adjacent to the lagoon. These smaller storm drains can contribute small amounts of contaminants and cause minor impacts to sediment quality of Colorado Lagoon.

Figure 1-2: Colorado Lagoon Sub-basin Areas

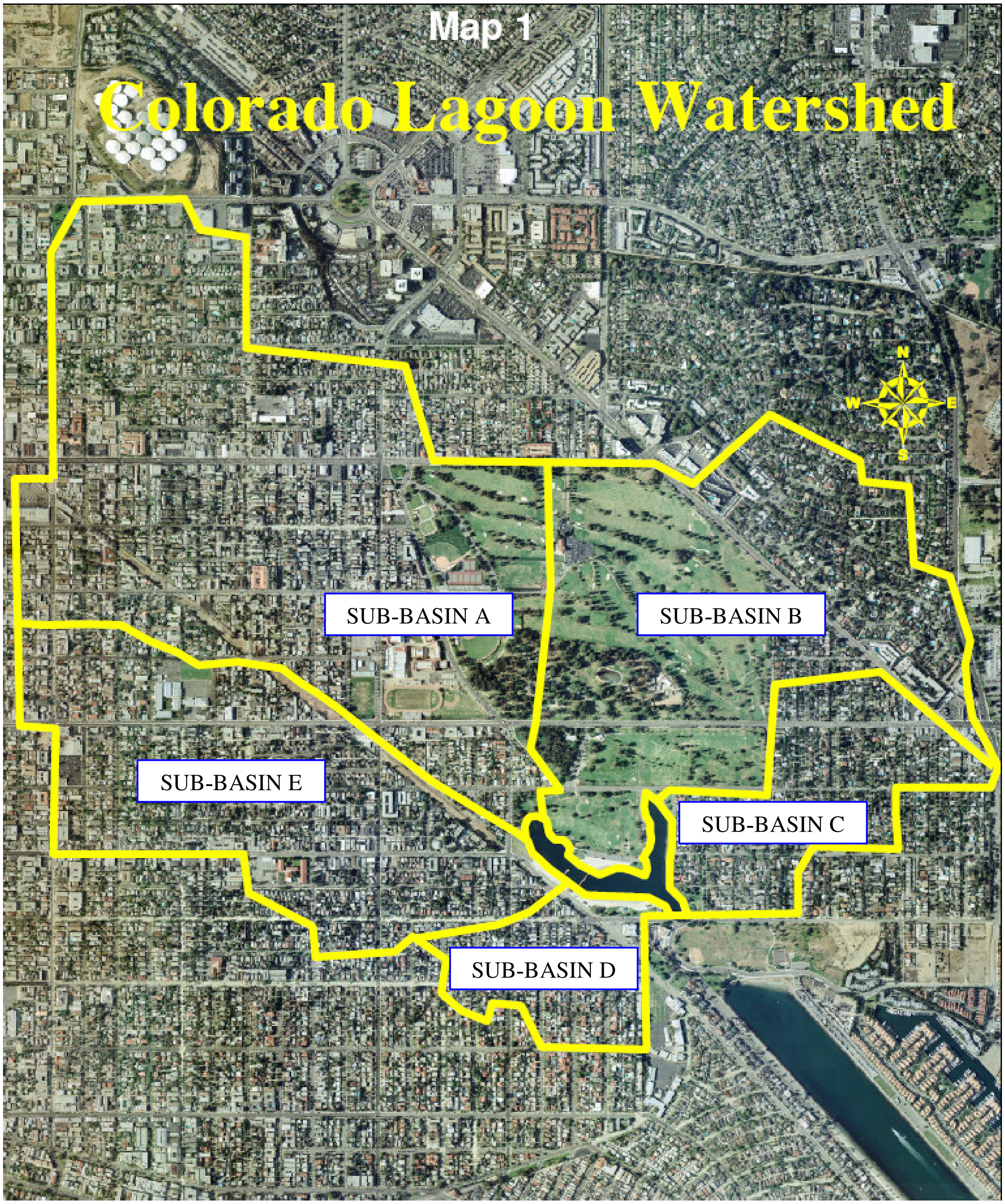
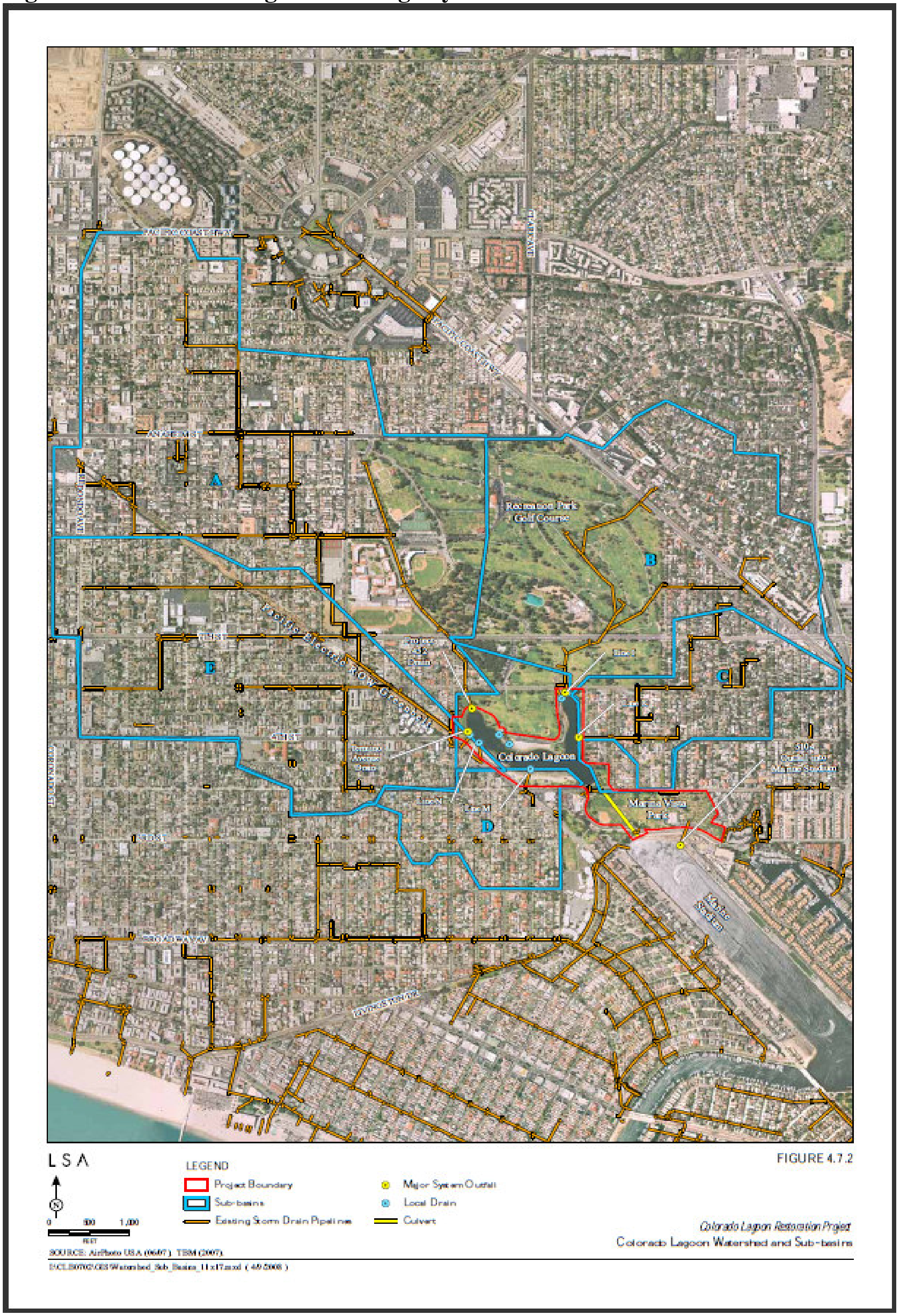


Figure 1-3: Colorado Lagoon Drainage Systems



Climate and Hydrology

The climate in the southern California coastal region is typical of the dry Mediterranean climate. Summers are relatively warm and dry, and winters are mild and wet. Based on daily rainfall data for water years 1996-2006 (County of Los Angeles, 2007), Annual rainfall (1996 to 2006) in the vicinity of City of Long Beach averages 13.27 inches and varies from 4.08 inches (year of 2002) to a maximum of 27.33 inches (year of 2005). Eighty-two percent of the rainfall occurs between November and March with most of the precipitation occurring during just a few major storms. Storm events concentrated in the wet-weather months produce runoff usually ranging in duration from one-half day to several days. Discharge during runoff from storm events is commonly 10 to 100 times greater than at other times. Storm events and the resulting high stream flows are highly seasonal, grouped heavily in the months of November through March, with an occasional major storm as early as September and as late as May. Rainfall is rare in other months, and major storm flows historically have not been observed outside the wet-weather season.

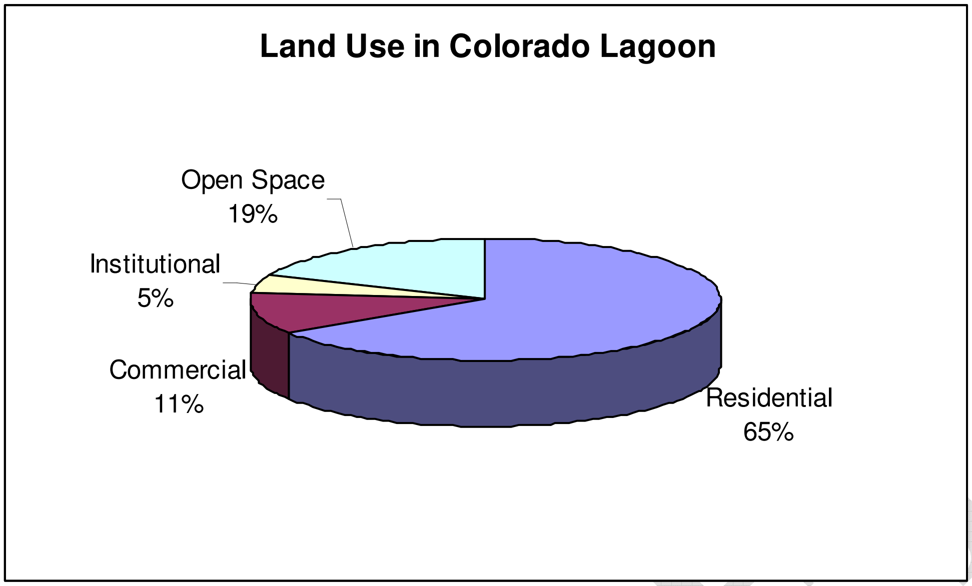
Surface Water Resources

There are no surface water bodies within the Colorado Lagoon watershed other than the lagoon itself. During rain events stormwater runoff is directed to the lagoon through a series of pipelines and overland flow. During dry weather, runoff from activities such as lawn watering, washing down surfaces, and other illicit discharges is directed to the lagoon by the same pipelines.

Land Uses

The land use in the Colorado Lagoon Watershed is primarily residential, open space, commercial, and institutional. Residential is the dominant land use accounting for approximately 65% of the land use. Open space, commercial, and institutional land uses account for 19%, 11%, and 5%, respectively (Figure 1-4). The available open space is parks and golf courses. The watershed does not support space for new development, but redevelopment occurs intermittently throughout (City of Long Beach, 2004).

Figure 1-4: Land Use in Colorado Lagoon Watershed



1.3 Organization of this Document

Guidance from USEPA (1991) identifies seven elements of a TMDL. Sections 2 through 7 of this document present these elements with the analysis and findings of this TMDL. The required elements are as follows:

- **Section 2: Problem Identification.** This section describes the nature of the impairments addressed by this TMDL, and presents historic and curret data to demonstrate the extent of impairment. Beneficial uses of the impaired water bodies and the relevant water quality objectives are also presented.
- **Section 3: Numeric Targets.** This section identifies the numeric targets established for the TMDLs and representing attainment of water quality objectives and beneficial uses.
- **Section 4: Source Assessment.** This section identifies the potential point sources and nonpoint sources of OC pesticides, PCBs, sediment toxicity, PAHs, and metals to Colorado Lagoon.
- **Section 5: Linkage Analysis and Margin of Safety.** Analysis developed to describe the relationship between the input of the pollutants of concern and the subsequent environmental response with regard to listings. The basis for the margin of safety is also included in this section.
- **Section 6: TMDL and Pollutant Allocations.** Identifies the TMDL allocations for point sources (waste load allocations) and nonpoint sources (load allocations) that will result in the attainment of fish tissue, sediment, and water quality objectives.

- **Section 7: Implementation.** This section describes the regulatory tools, plans and other mechanisms available to achieve the WLAs and LAs. This section describes the strategy for implementing the TMDL as well as a brief overview of the strategy for monitoring the effects of implementation actions.

2. PROBLEM IDENTIFICATION

This section provides the context and background for the Colorado Lagoon OC pesticides, PCBs, sediment toxicity, PAHs, and metals TMDL. In addition, this section includes an overview of water quality standards applicable to the watershed and reviews data used to develop the 1996, 1998, and 2002 303(d) listings.

2.1 Water Quality Standards

California state water quality standards consist of the following elements: 1) beneficial uses; 2) narrative and/or numeric water quality objectives; and 3) an anti-degradation policy. In California, the Regional Boards define beneficial uses in the Water Quality Control Plans (Basin Plans). Numeric and narrative objectives are specified in each region's Basin Plan. The objectives are set to be protective of the beneficial uses in each waterbody in the region and/or to protect against degradation. Numeric objectives for toxics can be found in the California Toxics Rule (40 CFR §131.38).

2.1.1 Beneficial Uses

The Basin Plan for the Los Angeles Regional Board (LARWQCB, 1994) defines six beneficial uses for Colorado Lagoon (Table 2-1). These uses are recognized as existing (E) and potential (P). OC Pesticides, PCBs, PAHs, Sediment Toxicity, and Metals loadings to Colorado Lagoon may result in impairments of beneficial uses associated with recreation (REC 1 and REC 2), commercial and sport fishing (COMM), warm freshwater habitat (WARM), wildlife habitat (WILD), and shellfish harvesting (SHELL). The designated beneficial uses identified as impaired due to elevated levels of OC Pesticides, PCBs, PAHs, Sediment Toxicity, and Metals in the Colorado Lagoon are briefly described below.

- **Habitat-Related Uses (WARM and WILD)**

Several habitat-related beneficial uses are designated for Colorado Lagoon. These uses include warm freshwater habitats and wildlife habitat.

- **Human Consumption of Aquatic Organisms (COMM and SHELL)**

Uses of water for commercial or recreational collection of fish, shellfish, or other organisms includes, but are not limited to, uses involving organisms intended for human consumption or bait purposes.

- **Recreational Uses (REC-1 and REC-2)**

Water Contact Recreation (REC-1) and Non-Contact Water Recreation (REC-2) are defined as uses of water for recreational activities involving body contact and proximity to water. Some of these activities include swimming and fishing, where the ingestion of water is reasonably possible.

Table 2-1. Beneficial Uses of Colorado Lagoon (LARWQCB, 1994)

Waterbody	Hydro. Unit No.	REC1	REC2	COMM	WARM	WILD	SHELL
Colorado Lagoon	405.12	E	E	E	P	E	E

Beneficial use designations apply to all tributaries to the indicated waterbody, if not listed separately.
E: Existing beneficial use
P: Potential beneficial use

2.1.2 Water Quality Objectives

As stated in the Basin Plan, water quality objectives (WQOs) are intended to protect the public health and welfare and to maintain or enhance water quality in relation to the designated existing and potential beneficial uses of the water. The Basin Plan specifies both narrative and numeric water quality objectives. The following narrative water quality objectives are the most pertinent to this TMDL. These narrative WQOs may be applied to both the water column and the sediments.

> Chemical Constituents: *Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use.*
>
> Bioaccumulation: *Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels, which are harmful to aquatic life or human health.*
>
> Pesticides: *No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.*
>
> Toxicity: *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.*

The Regional Board's narrative toxicity objective reflects and implements national policy set by the 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, USEPA established numeric water quality objectives for several pollutants addressed in this TMDL in the California Toxics Rule (CTR) (USEPA, 2000b). The CTR establishes numeric aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 92 priority toxic pollutants. These criteria are established to protect human health and the environment, and are applicable to inland surface waters, enclosed bays, and estuaries.

For the protection of aquatic life, the CTR establishes short-term (acute) and long-term (chronic) criteria in both freshwater and saltwater. The acute criterion equals the highest concentration of a pollutant to which aquatic life can be exposed, for a short period of time, without deleterious effects. The chronic criterion 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. 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.

In the CTR, freshwater and saltwater criteria for metals are expressed in terms of the dissolved fraction of the metal in the water column. These criteria were calculated based on methods in USEPA's *Summary of Revisions to Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (50 FR 30792, July 29, 1985), developed under Section 304(a) of the CWA. This methodology is used to calculate the total recoverable fraction of metals in the water column and then appropriate conversion factors, included in the CTR are applied, to calculate the dissolved criteria for metals in the water column.

The human health criteria are established to protect the general population from priority toxic pollutants regulated as carcinogens (cancer-causing substances) and are based on the consumption of water and aquatic organisms or aquatic organisms only, assuming a typical consumption of 6.5 grams per day of fish and shellfish and drinking 2.0 liters per day of water. Table 2-2 summarizes the aquatic life, and human health criteria for metals and organic constituents, covered under this TMDL.

Table 2-2. Water Quality Objectives Established in the CTR for Metals and Organic Compounds

Pollutant	Criteria for the Protection of Aquatic Life		Criteria for the Protection of Human Health	
	Saltwater			
	Acute (µg/L)	Chronic (µg/L)	Water & Organisms (µg/L)	Organisms only (µg/L)
Chlordane	0.09	0.004	0.00057	0.00059
Dieldrin	0.71	0.0019	0.00014	0.00014
Total PCBs[1]	-	0.03	0.00017	0.00017
DDT	0.13	0.001	0.00029	0.00059
Lead (dissolved)	210	8.1	-	-
Zinc (dissolved)	90	81	-	-

[1]Based on total PCBs, the sum of all congener or isomer or homolog or aroclor analyses.

For PCBs, the Basin Plan states that, "*Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach water of the Region, are limited to 70 picograms per liter (pg/L) measured as a 30 day average for protection of human health and 14 nanograms per liter (ng/L) measured as a daily average and 30 ng/L measured as a daily average to protect aquatic life in inland fresh water and estuarine waters, respectively*." The 30-day average aquatic life value for PCBs in the Basin Plan is the same as the 4-day average value in the CTR. However, the human health 30-day average value in the Basin Plan of 70 pg/L is more stringent than the CTR value of 170 pg/L, which is also a 30-day average.

There are no numeric standards for fish tissue in the Basin Plan. The human health criteria in the CTR were developed to ensure that bioaccumulative substances do not concentrate in fish tissue at levels that could impact human health.

There are no numeric standards for sediment in the Basin Plan. The Regional Board applied best professional judgment to define elevated values for metals in sediment during the water quality assessments conducted in 1996, 1998, and 2002. The State Board developed sediment quality objectives (SQOs) for enclosed bays and estuaries as discussed in section 3.1.1

2.1.3 Antidegradation

State Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality Water" in California, known as the "Anti-degradation 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 uses 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 Anti-degradation Policy (40 CFR 131.12).

2.2 Basic for Listing

The basis for development of the 303(d) listings for OC pesticides, PCBs, sediment toxicity, PAHs, and metals in Colorado Lagoon mainly stems from Water Quality Assessments (WQAs) in 1996 conducted by Regional Board staff with the majority the listings first appearing on the 1994 and 1996 303(d) list. Lacking USEPA guidelines for sediment and bioaccumulation, the Regional Board developed assessment guidelines to evaluate sediment chemistry and toxicity, benthic community and bioaccumulation data for water quality assessment report. These general guidelines are described below.

The listings for sediment including metals, PAHs, and sediment toxicity in Colorado Lagoon were based on data generated through the Bay Protection & Toxic Control Program (BPTCP). The most commonly used sediment toxicity test is the amphipod (a crustacean) survival test. A review of all the data for the region reveals the number of tests in which less than 60% of the amphipods survive is much less than the number of tests in which at least 60% or more amphipods survive. Consequently, the "significant toxicity" line is drawn at 60% survival. Below that number it's more likely that impairment is occurring (especially since existing benthic data at those sites support this). Listed in Table 2-3 below are the Los Angeles region's probable "background" numbers for the more common *sediment chemistry* pollutants. These numbers are approximate and based on pollutant levels found in areas removed from direct point sources where impacts do not appear to be occurring in the benthic community. Often background concentrations are due to natural sources or are due to persistent organic chemicals that have not yet biodegraded completely.

Table 2-3 Sediment and Bioaccumulation Chemistry Probable "Background" Levels

Constituents	**Sediment Chemistry: Probable "background" levels in the Region**	**Bioaccumulation: Probable "background" levels in the Region**
PAHs (polycyclic aromatic hydrocarbons)	1 ppm	ND
chlordane	100 ppb	100 ppb
PCBs	200 ppb	300 ppb
DDT	200 ppb	300 ppb
zinc	200 ppm	250 ppm
lead	50 ppm	15 ppm

For bioaccumulation in aquatic organisms, data from the State Mussel Watch (SMW) and Toxic Substances Monitoring (TSM) programs were used. These two state programs provide information about the occurrence of toxic substances in fresh, estuarine, and marine waters through analysis of fish, mussels and other aquatic life referred to as "tissue". Metals, OC pesticides, and PCBs are analyzed from the tissue of these organisms. Bioaccumulation data collected from tissue are compared to criteria such as Maximum Tissue Residue Levels (MTRLs), U. S. Food and Drug Administration (FDA) action levels, Median International Standards (MIS), and the National Academy of Sciences (NAS) recommended guidelines for predator protection (Table 2-4). Fish tissue Elevated Data Level (EDL) values are an internal state comparative measure that ranks a given concentration of a particular substance with previous data from the state programs. EDLs are calculated by ranking all of the results for a given chemical from the highest concentration measured down to and including those records where the chemical was not detected. The 85th percentile (EDL85) was chosen as an indication that a chemical is elevated from the median and the 95th percentile (EDL95) was chosen to indicate values that are highly elevated. EDLs were used in the 1996 Water Quality Assessment as follows: If no other constituents exceed standards, but if one or two constituents were above the EDL85 or EDL95, then those constituents are listed as "fully supporting but threatened." If three or more constituents are above the EDL then those constituents are listed as "partially supporting".

Table 2-4. Standards Used for Tissue Data (State Mussel Watch and Toxic Substances Monitoring Programs)

Constituents	Standards-ppb (see text for explanation of abbreviations)				
	NAS Recommended guideline for freshwater fish	FDA Action level for freshwater and marine fish	MTRLs for inland surface waters	MTRLs for ocean waters	MIS for freshwater fish and marine shellfish (range)
DDT (total)	1000	5000	32.0	9.1	-
PCBs	500	2000	2.2	-	-
Dieldrin	100	300	0.65	0.2	-
Chlordane	100	300	1.1	0.32	-
PCBs	-	-	2.2	0.6	-
PAHs	-	-	0.08	-	-
Lead	-	-	-	-	500-10000
Zinc	-	-	-	-	40000-100000

2.3 303(d) Listing Data

The original recommendations for OC pesticides, PCBs, sediment toxicity, PAHs, and metals listing in Colorado Lagoon were presented in the 1996 WQA and were based on data collected by the SMW and TSM programs. As the original listings were made in 1994 and 1996, only limited data were available to review for the listing cycle. The BPTCP sediment samples were collected in January 1993. For fish tissue, TSM samples were collected in June 1992 and SMW data were collected in 1982, 1985, and 1986. Summaries of the sediment and fish tissue data used to develop 303(d) listings in Colorado Lagoon are shown in Table 2-5. Detail discussion of the data used for listing are provided in Section 2.3.1 and 2.3.2 below.

Table 2-5. Colorado Lagoon, Data Summary for 303(d) Sediment and Tissue Listings

Constituents	Impaired Use Listed	Matrix	n	Criteria Exceeded			
				MTRL	EDL85	EDL95	Background Levels
Chlordane	Aquatic Life, REC1, REC2	Tissue/Sediment	6	X		X	X
DDT	Aquatic Life, REC1, REC2	Tissue	5	X			
Dieldrin	Aquatic Life, REC1, REC2	Tissue	5	X		X	
Lead	Aquatic Life, REC1, REC2	Sediment	1		X		X
PAHs	Aquatic Life, REC1, REC2	Sediment	1				X
PCBs	Aquatic Life, REC1, REC2	Tissue	5	X	X		
Sediment Toxicity	Aquatic Life, REC1, REC2	Sediment	1				X
Zinc	Aquatic Life, REC1, REC2	Sediment	1				X

2.3.1 Bay Protection and Toxics Control Program

The BPTCP sampled superficial sediments collected by divers from one site in the western arm of Colorado Lagoon in January of 1993. BPTCP database is available on the State Water Resources Control Board web site. Data were analyzed in a report by Anderson et al. (1998) titled Sediment Chemistry, Toxicity, and Benthic Community Conditions in Selected Water Bodies of the Los Angeles Region, Final Report. Sediment data from this program was the primary data set used to place Colorado Lagoon on the Regional Board's listed of impaired water bodies. Data are summarized in Table 2-6. The table provides a comparison of the data with Effects Range Low (ERL) and Effects Range Median (ERM) guidelines.

Table 2.6 Comparison of BPTCP Sediment Data with ERL and ERM Guidelines

Constituents	Units	ERL	ERM	1/14/1993 BPTCP
Lead	mg/kg (dry)	47	218	510
Zinc	mg/kg (dry)	150	410	690
Total Low MW PAH	ug/kg (dry)	552	3160	7381
Total High MW PAH	ug/kg (dry)	1700	9600	93011
Total PAH	ug/kg (dry)	4022	44792	100391
4,4'-DDT	ug/kg (dry)	1	7	50.9
Total DDT	ug/kg (dry)	1.58	46.1	181.42
alpha-Chlordane	ug/kg (dry)			70.3
Total Chlordane	ug/kg (dry)	0.5	6	74.32
Dieldrin	ug/kg (dry)	0.02	8	24.3
Total PCBs	ug/kg (dry)	22.7	180	100.5

2.3.2 State Mussel Watch Program

The SMW program collected resident mussels from Colorado Lagoon in the early to mid '80s. California mussels were transplanted to Colorado Lagoon for a 4-month period in 1986. Data from these surveys are summarized in Table 2-7. Comparisons are made to the EDL85s for resident bivalves and transplanted bivalves that were developed based upon 20 years of data from 1977 through 1997. The EDL85 is simply the 85 percentile for each contaminant. In the case of metals, lead was the element that was consistently elevated. Initial levels of lead in resident bivalves were reported as high as 8.73 mg/Kg-wet but declined to 2.91 mg/Kg-wet in 1985. Similar trends are evident for total chlordane and DDT compounds. Most chlordane compounds in resident bivalves remained at levels above the EDL85 during the 1985 survey. They also tended to exceed these levels in the mussels transplanted to Colorado Lagoon in 1986.

Table 2-7 SMW Program Testing Results (1982-1987)

Constituent	Station/Year RBM			RBM EDL85	Station/Year TCM	TCM EDL85
	701	**701**	**701**		**701.2**	
	1982	**1985**	**1986**		**87**	
Pb	**8.73**	**4.17**	**2.91**	1.61	**3.19**	1.57
Zn	14	20.1	17.2	42.9	21.8	55.8
alpha-Chlordane		**1.1**	**1.9**	0.4	2.2	0.4
cis-Chlordane	**79.8**	**14.6**	**17.3**	11.8	**26**	6.9
gamma-Chlordane		1.1	1.4	0.4	0.9	0.2
trans-Chlordane	**69.6**	**16.8**	**14.1**	12.3	**24**	5.6
Total chlordane	**221.9**	**56.4**	**57.5**	37.7	**64.9**	20
o,p'-DDT	ND	ND	ND	3.1	**11.2**	3.4
p,p'-DDT	**13.6**	4.4	3.8	7	1.6	6.4
Total DDT	166.2	37.2	43	233.6	59.9	145.1
Dieldrin	9.7	3.4	3.8	10.5	18.2	5.7
PCB 1248	ND	ND	ND	ND	ND	ND
PCB 1254	110.2	35.8	48.7	127	42	161.9
PCB 1260	ND	ND	ND	ND	ND	ND
Total PCBs	110.2	35.8	48.7	128.7	42	171.3

RBM = Resident Bay Mussel
EDL85 = 85th percentile for samples from 1977-1997 by species
TCM = Transplanted California Mussels

2.4 Current Condition

Recent sediment data from Colorado Lagoon are available from surveys done by Tetra Tech conducted in December 2000, Institute for Integrated Research in Materials Environments and Societies (IIRMES) in 2007, and the Regional Water Quality Control Board/U.S. EPA in 2008. Results indicate high levels of contaminants in the western arm transitioning to lower levels in the northern arm.

Water quality tests conducted as part of Tetra Tech and Regional Board/U.S. EPA studies included analysis of total and dissolved metals, nutrients, TSS, chlorinated pesticides, PCBs, and organophosphate pesticides. Overall, concentrations of most tested constituents were low. All chlorinated pesticides, PCBs and organophosphate pesticides were below detection limits and none of the trace metals exceeded California Toxics Rule criteria.

For bioaccumulation, very limited data were collected recently. California Department of Fish and Game (CDF&G) collected resident mussels from Colorado Lagoon in the early to mid '80s. Another study done by IIRMES in 2007, in-faunal bivalve mollusks were collected for chemical analyses to determine bioaccumulation of toxins and estimate biomagnifications potential to top level predators in the Lagoon. Analyses showed PCB congeners were consistently found in the bivalves inhabiting the sediment and little biomagnifaction of chlorinated pesticides was noted in mollusks (IIRMES Annual Report, 2008). Sediment data for PAHs at different sites are provided in the report. However, detailed data for fish tissues are not provided.

Below are programs and studies and associated data type available for development of the Current Conditions section.

A. Tetra Tech
   - Duration of Study: Single survey, January 2001
   - Parameters: Sediment (Metals, herbicides, semivolatile organics, organochlorine pesticides, particle size) and water (dissolved oxygen, pH, turbidity, temperature, conductivity, suspended solids)

B. Regional Water Quality Control Board/U.S. EPA
   - Duration of Study: Survey in February and May 2008
   - Parameters: Sediment (metals, OC pesticides, PCBs, PAHs, and total organic carbon) and water (metals, OC pesticides, PCBs, PAHs, and total suspended solids)

C. Habitat Assessment for the Colorado Lagoon Restoration Feasibility Study by Moffatt and Nichol
   - Duration of Study: Single survey, July 2004
   - Parameters: Sediment and fish (sediment sampling for invertebrates from coring and fish sampling for seine nets only)

D. Colorado Lagoon Water Quality Assessment Report by Kinnetic Laboratories, Inc. and Moffatt & Nichol
   - Duration of Study: July/August, 2004
   - Parameters: Sediment (Metals, organochlorine pesticides, organophosphate pesticides, particle size); Water (Total and Dissolved Metals, organochlorine pesticides, organophosphate pesticides); Water Quality Profiles of temperature, salinity, dissolved oxygen, and pH.

E. Institute for Integrated Research in Materials, Environments and Societies (IIRMES)/Friends of Colorado Lagoon (FOCL)
   - Duration of Study: Spring 2007
   - Parameter: Sediment and fish tissue for OC pesticides, PCBs, and PAHs

2.4.1 Water Column and Sediment Data

2.4.1.1 Tetra Tech

Tetra Tech, EMI sampled two locations in the Lagoon in December 2000. One station (CLWest) was located in the western arm of the Lagoon. The second (CL-East) was located near the culvert entrance. These sites roughly correspond to Areas CL-1 and CL-3 as shown in Table 2-9 and Figure 2-1. Sediment analyses performed by Tetra Tech were based upon superficial samples. Data are summarized in Table 2-8.

Table 2-8 Comparison of Tetra Tech Sediment Data with ERL and ERM Criteria

Constituents	Units	ERL	ERM	12/8/2000 CL-West	12/8/2000 CL-East
Lead	mg/kg (dry)	47	218	390	180
Zinc	mg/kg (dry)	150	410	600	340
Total Low MW PAH	ug/kg (dry)	552	3160	273	79
Total High MW PAH	ug/kg (dry)	1700	9600	5170	990
Total PAH	ug/kg (dry)	4022	44792	5453	1069
4,4'-DDD	ug/kg (dry)	2	20	46	8.9
4,4'-DDT	ug/kg (dry)	1	7	11	2.7
Total DDT	ug/kg (dry)	1.58	46.1	167	55.6
alpha-Chlordane	ug/kg (dry)			73	13
gamma-Chlordane	ug/kg (dry)			61	15
Heptachlor	ug/kg (dry)			ND (1.3U)	ND (1.2U)
Heptachlor epoxide	ug/kg (dry)			ND (1.3U)	ND (1.2U)
Total Chlordane	ug/kg (dry)	0.5	6	134	28
Dieldrin	ug/kg (dry)	0.02	8	19	3.2
PCB-1242 (Aroclor 1242)	ug/kg (dry)	23	180	ND (25U)	ND (25U)
PCB-1254 (Aroclor 1254)	ug/kg (dry)	23	180	ND (25U)	ND (25U)
PCB-1260 (Aroclor 1260)	ug/kg (dry)	23	180	ND (25U)	ND (25U)
Total PCBs	ug/kg (dry)	22.7	180	ND (25U)	ND (25U)

Contaminant concentrations in sediments from the two sites sampled by Tetra Tech in 2000 indicated a spatial gradient going from high concentrations in the western portion of the Lagoon to lower concentrations in the central portion of the Lagoon.

2.4.1.2 Kinnetic Laboratories, Inc. and Moffatt & Nichol (KLI/M&N)

Sediment data taken in July 2004 were previously reported in KLI/M&N (2004). They are summarized in Table 2-9.

Table 2-9 Comparison of KLI/M&N Sediment Data with ERL and ERM Criteria

Constituent	Units	ERL	ERM	6/30/2004 CL-1 Top	7/1/2004 CL-2 Top	6/30/2004 CL-3 Top
Lead	mg/kg (dry)	47	218	409	81	40
Zinc	mg/kg (dry)	150	410	266	97	46
Total Low MW PAH	ug/kg (dry)	552	3160	282	32	9
Total High MW PAH	ug/kg (dry)	1700	9600	1279	158	73
Total PAH	ug/kg (dry)	4022	44792	1561	190	82
4,4'-DDT	ug/kg (dry)	1	7	14	ND (12U)	ND (11U)
Total DDT	ug/kg (dry)	1.58	46.1	81	20	4.3
alpha-Chlordane	ug/kg (dry)			50	ND (3.1U)	ND (2.8U)
gamma-Chlordane	ug/kg (dry)			55	3.3	ND (2.8U)
Heptachlor	ug/kg (dry)			ND (3.4U)	ND (3.1U)	ND (2.8U)
Heptachlor epoxide	ug/kg (dry)			ND (3.4U)	ND (3.1U)	ND (2.8U)
Total Chlordane	ug/kg (dry)	0.5	6	105	3.3	ND (2.8U)
Dieldrin	ug/kg (dry)	0.02	8	27	ND (3.1U)	ND (2.8U)
PCB-1016 (Aroclor 1016)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1221 (Aroclor 1221)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1232 (Aroclor 1232)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1242 (Aroclor 1242)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1248 (Aroclor 1248)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1254 (Aroclor 1254)	ug/kg (dry)	23	180	ND (34 U)	ND (31U)	ND (28U)
PCB-1260 (Aroclor 1260)	ug/kg (dry)	23	180	98	ND (31U)	ND (28U)
Total PCBs	ug/kg (dry)	22.7	180	98	ND (31U)	ND (28U)

Water quality testing was conducted in association with the sediment testing program (Table 2-10). Sampling was conducted on June 29th, 2004, prior to starting the sediment testing program. Samples were analyzed for the same set of analyses currently included in the Long Beach Stormwater Monitoring Program (KLI 2004). These included total and dissolved metals, nutrients, TSS, chlorinated pesticides, PCBs, and organophosphate pesticides. A fourth sample was taken from a storm drain on the eastern shoreline of the Lagoon. This sample was only tested for nutrients and salinity. This was the only storm drain that exhibited dry weather flows at the time of sampling.

Table 2-10 KLI/M&N Water Quality Testing Results (06/29/2004)

Constituent	Units	ML	CTR Criteria	Lab RL	CL-1-Wat	CL-2-Wat	CL-3-Wat
Lead (Total)	ug/L	0.5	10.2[1]	0	1.28	0.95	1.02
Zinc (Total)	ug/L	1	82.8[2]	0.5	4.1	2.8	3.4
Lead (Dissolved)	ug/L	0.5	8.1	0	0.07	0.5	0.11
Zinc (Dissolved)	ug/L	1	81	0.5	1.8	2.4	1.9
4,4'-DDT	ug/L	0.01	0.001	0.01	0.01U	0.01U	0.01U
Total DDT	ug/L	0.05	NA	N/A	0.05U	0.05U	0.05U
Dieldrin	ug/L	0.01	0.0019	0.01	0.01U	0.01U	0.01U
alpha-Chlordane	ug/L	0.1	NA	0.1	0.1U	0.1U	0.1U
gamma-Chlordane	ug/L	0.1	NA	0.1	0.1U	0.1U	0.1U
Total Chlordane	ug/L	N/A	0.0040	N/A	0.1U	0.1U	0.1U
PCBs							
Aroclor-1016	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1221	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1232	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1242	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1248	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1254	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Aroclor-1260	ug/L	0.5	NA	0.5	0.5U	0.5U	0.5U
Total PCBs	ug/L	0.5	0.030	0.5	0.5U	0.5U	0.5U

2.4.1.3 Regional Water Quality Control Board (RWQCB)/ U.S. EPA

RWQCB/U.S. EPA sampled three locations in the Lagoon and one in Marine Stadium at the outlet of the Lagoon on February 28 and May 20, 2008. CL-1 station was located in the western arm of the lagoon, CL-2 in the northern arm, CL-3 near the culvert entrance, and MS-1 on the Marine Stadium side near the outlet of the culvert (Figure 2-1). Sediment analyses performed by U.S. EPA were based on superficial samples. High metals concentration were detected at Western Arm, Eastern Arm, and Central Lagoon in both sampling events. Water quality testing was also conducted in association with the sediment testing and performed by U.S. EPA. Water testing results showed no exceedance of water quality objectives. Data are summarized in Tables 2-11 and 2-12. Results for MS-1 are not included in the tables or shown in the figure.

[1] Saltwater criteria for lead is expressed in the CTR interm of the dissoved fraction of lead in water column. A conversion factor of 0.791 is used to convert dissovled fraction of lead to total of lead in water column. This convertion factor is based on hardness of 100 mg/L as calcium carbonate ($CaCO_3$)

[2] Saltwater criteria for zinc is expressed in the CTR interm of the dissoved fraction of zinc in water column. A conversion factor of 0.978 is used to convert dissovled fraction of zinc to total of zinc in water column. This convertion factor is based on hardness of 100 mg/L as calcium carbonate ($CaCO_3$)

Figure 2-1 Map of Colorado Lagoon and Sampling Locations

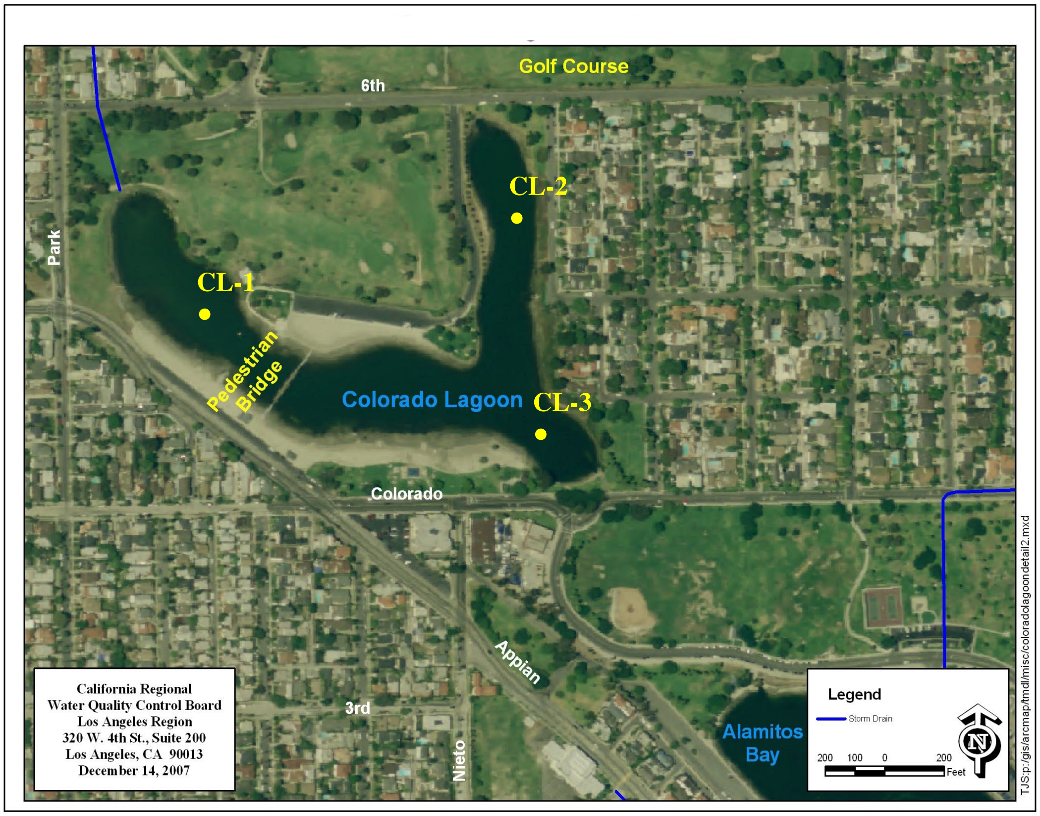


Table 2-11 RWQCB/U.S. EPA Sediment Quality Testing Results (02/28/08-05/20/08)

Constituent	Unit	CL-1 Top		CL-2 Top		CL-3 Top	
		02/28/08	05/20/08	02/28/08	05/20/08	02/28/08	05/20/08
Alpha-BHC	ug/L	ND	ND	ND	ND	ND	ND
Beta-BHC	ug/L	ND	ND	ND	ND	ND	ND
Delta-BHC	ug/L	ND	ND	ND	ND	ND	ND
Gamma-BHC	ug/L	ND	ND	ND	ND	ND	ND
Heptachlor	ug/L	ND	ND	ND	ND	ND	ND
Aldrin	ug/L	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/L	ND	17	ND	ND	ND	ND
Dieldrin	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDE	ug/L	ND	ND	ND	ND	ND	ND
Endrin	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDD	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDT	ug/L	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/L	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/L	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ug/L	ND	ND	ND	ND	ND	ND
Alpha-Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Gamma-Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Toxaphene	ug/L	ND	ND	ND	ND	ND	ND
Lead	mg/kg dry	240	230	200	170	210	130
Zinc	mg/kg dry	530	500	360	320	370	270
Total PAHs	mg/kg dry	710	507	176	130	164	49
PCBs							
Aroclor 1016	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1221	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1232	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1242	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1248	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1254	ug/kg dry	ND	ND	ND	ND	ND	ND
Aroclor 1260	ug/kg dry	ND	ND	33	ND	ND	ND
Aroclor 1262	ug/kg dry	ND	ND	ND	ND	ND	ND
Total Organic Carbon	% Weight dry	6.9	5.7	4.5	3.3	3.1	2.3

Table 2-12 RWQCB/U.S. EPA Water Quality Testing Results (02/28/08-05/20/08)

Constituent	Unit	CL-1 Top		CL-2 Top		CL-3 Top	
		02/28/08	05/20/08	02/28/08	05/20/08	02/28/08	05/20/08
Alpha-BHC	ug/L	ND	ND	ND	ND	ND	ND
Beta-BHC	ug/L	ND	ND	ND	ND	ND	ND
Delta-BHC	ug/L	ND	ND	ND	ND	ND	ND
Gamma-BHC	ug/L	ND	ND	ND	ND	ND	ND
Heptachlor	ug/L	ND	ND	ND	ND	ND	ND
Aldrin	ug/L	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan I	ug/L	ND	ND	ND	ND	ND	ND
Dieldrin	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDE	ug/L	ND	ND	ND	ND	ND	ND
Endrin	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan II	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDD	ug/L	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ug/L	ND	ND	ND	ND	ND	ND
4,4'-DDT	ug/L	ND	ND	ND	ND	ND	ND
Methoxychlor	ug/L	ND	ND	ND	ND	ND	ND
Endrin ketone	ug/L	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ug/L	ND	ND	ND	ND	ND	ND
Alpha-Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Gamma-Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Chlordane	ug/L	ND	ND	ND	ND	ND	ND
Toxaphene	ug/L	ND	ND	ND	ND	ND	ND
Lead	ug/L	ND	ND	ND	ND	ND	ND
Zinc	ug/L	29	13	27	12	26	12
PCBs							
Aroclor 1016	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1221	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1232	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1242	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1248	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1254	ug/L	ND	ND	ND	ND	ND	ND
Aroclor 1260	ug/L	ND	ND	33	ND	ND	ND
Aroclor 1262	ug/L	ND	ND	ND	ND	ND	ND
Total Suspended Solids	mg/L	ND	24	ND	15	ND	20

2.4.1.4 Institute for Integrated Research Materials, Environments and Societies (IIRMES)/Friends of Colorado Lagoon (FOCL)

IIRMES and FOCL joined together to conduct preliminary gas chromatography-mass spectrometry (GC-MS) and inductively coupled plasma mass spectrometry (ICP-MS) analyses for metals, PAHs, PCBs, pesticides and chlorinated hydrocarbons in sediment and in-fauna of the lagoon. Samples were collected at 16 different sites in the lagoon. Sediment data are summarized in Table 2-12. Analyses showed varying concentrations of pollutants in the sediment with the highest concentrations of most metals and cis-nonoclor, alpha-chlordane, 4,4'DDE, 4,4' DDD and PCB congeners 95, 101, 151, 149, 153, 141, 138, 187, 183 occurring in the north east arm of the Lagoon. Only PCB congeners 149, 153, 138 were consistently found in the bivalves inhabiting the sediment. With the exception of 4,4' DDE, and 4,4' DDD, little biomagnification of chlorinated pesticides was noted in the mollusks. Elevated levels of sediment PAHs were noted in a number of sites (Table 2-13) (IIRMES Annual Report, 2008).

Table 2-13 Sediment PAH Concentrations (ppm) at Different Sites in Colorado Lagoon (IIRMES Annual Report, 2008)

Sediment PAH (Sites)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Napthalene	6.06	9.72	12.29	3.28	4.36	2.03	2.52	49.16	119.98	3.87	3.25	4.11	12.46	12.04	5.70	16.19
2-Methylnapthalene	2.20	7.68	6.62	1.74	2.00	2.56	2.81	46.38	80.23	3.39	2.12	2.50	9.02	8.22	4.54	13.24
1-Methylnapthalene	2.02	4.39	2.67	1.09	2.23	N.D.	N.D.	18.02	30.51	1.78	1.81	2.02	4.20	3.77	2.54	6.11
Biphenyl	N.D.	6.95	5.49	1.65	1.27	1.37	0.95	14.64	13.85	1.62	1.33	1.37	8.48	6.28	1.90	5.74
2,6-Dimethylnaphthalene	N.D.	16.15	1.50	1.33	N.D.	N.D.	N.D.	19.38	19.80	N.D.	N.D.	N.D.	5.47	3.39	N.D.	6.46
Acenaphthylene	N.D.	4.57	2.93	N.D.	N.D.	N.D.	N.D.	11.49	19.64	1.40	N.D.	N.D.	2.57	3.04	4.96	3.37
Acenaphthene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	15.47	25.71	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3.75
2,3,5-Trimethylnaphthlene	N.D.	16.01	N.D.	N.D.	N.D.	N.D.	N.D.	11.54	16.20	N.D.	2.19	N.D.	3.44	N.D.	N.D.	4.30
Fluorene	N.D.	11.14	3.54	N.D.	N.D.	N.D.	N.D.	27.37	29.72	N.D.	1.95	N.D.	2.60	3.47	2.58	6.85
Phenanthrene	3.94	62.75	43.87	3.31	9.36	2.01	2.41	360.84	312.03	1.55	5.19	7.11	20.48	63.06	30.15	34.61
Anthracene	N.D.	N.D.	5.44	N.D.	N.D.	N.D.	N.D.	81.19	74.16	N.D.	1.44	N.D.	7.28	7.67	9.91	10.61
1-Methylphenanthrene	N.D.	42.59	N.D.	N.D.	N.D.	N.D.	N.D.	37.29	27.73	N.D.	N.D.	N.D.	N.D.	7.99	5.01	N.D.
Fluoranthene	2.65	30.49	70.07	3.75	7.25	2.10	2.30	638.56	613.64	7.73	4.41	11.07	43.38	71.88	67.83	64.78
Pyrene	3.14	42.56	N.D.	N.D.	6.06	2.93	2.43	672.75	609.05	11.74	7.68	11.64	40.32	68.84	57.92	73.63
Benz [a] anthracene	N.D.	10.20	28.11	N.D.	N.D.	N.D.	N.D.	232.00	210.76	5.71	2.70	4.90	20.75	10.78	22.56	21.52
Chrysene	N.D.	47.55	42.00	N.D.	N.D.	N.D.	N.D.	356.65	352.51	10.13	4.67	8.64	31.46	40.91	28.83	42.60
Benzo [b] fluoranthene	N.D.	58.91	24.31	N.D.	N.D.	N.D.	N.D.	164.70	211.80	7.77	3.74	5.15	21.83	19.52	20.50	32.73
Benzo [k] fluoranthene	N.D.	N.D.	39.23	N.D.	N.D.	N.D.	N.D.	271.17	222.23	8.24	4.23	5.39	27.90	20.43	16.03	30.10
Benzo [e] pyrene	N.D.	13.04	23.59	N.D.	N.D.	N.D.	N.D.	173.57	178.27	6.97	3.64	6.61	17.45	19.74	13.22	28.04
Benzo [a] pyrene	N.D.	69.93	25.58	N.D.	N.D.	N.D.	N.D.	140.63	115.15	4.12	2.39	N.D.	12.12	7.90	12.39	18.05
Perylene	N.D.	N.D.	7.45	N.D.	N.D.	N.D.	N.D.	110.60	86.84	N.D.	N.D.	N.D.	6.30	8.03	15.97	12.22
Indeno [1,2,3-c,d] pyrene	N.D.	N.D.	8.03	N.D.	N.D.	N.D.	N.D.	88.54	73.06	4.52	N.D.	N.D.	8.80	10.39	12.32	13.71
Dibenz [a,h] anthracene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	76.56	72.37	N.D.	N.D.	N.D.	9.01	8.98	N.D.	10.62
Benzo [g,h,i] perylene	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	100.03	114.78	9.67	N.D.	N.D.	16.03	18.89	12.01	22.51

2.4.2 Fish Tissue Data

2.4.2.1 Habitat Assessment for the Colorado Lagoon Restoration Feasibility Study

The City of Long Beach is developing a restoration project for Colorado Lagoon and the Chambers Group Inc. was retained to conduct a biological survey at Colorado Lagoon. The purpose of the survey was to describe the existing biological resources and habitat quality as it occurs at Colorado Lagoon, and to identify opportunities to improve the habitat. A field survey of marine resources was conducted on July 1, 2004. Survey methods included underwater reconnaissance, sediment sampling for invertebrates from coring, and fish sampling.

The most abundant epifaunal invertebrate observed on the bottom during the July reconnaissance dive was the gelatinous colonial bryozoan *Zoobotryton verticullatum*. The solitary tunicate *Styela plicata* was also common on the bottom of the lagoon. Other invertebrates observed during the survey included the introduced mussel *Muscilsita senhouesi* and the bubble snail *Bulla gouldiana*. The California horn snail was very abundant along the intertidal edges of the lagoon. Four species of clam were collected along the shores of Colorado Lagoon including smooth chione, common littleneck, California jackknife clam, and Philippine cockle.

The water quality data indicate that Colorado Lagoon does not experience extreme temperature or salinity levels but that dissolved oxygen levels are low during summer time. Heavy cover of benthic algae was observed over the bottom. In the northeastern part of the lagoon, the dominant algae were primarily *Eneteromorpha intestinalis* and *Ulva lobata*. In the western part of the lagoon, red algae were the dominant bottom vegetation.

In general, Colorado Lagoon supports a relatively diverse benthic invertebrate community in the central and northeast portions of the lagoon. The benthic invertebrate community if impoverished in the western arm. The lack of invertebrate diversity in the western arm may be related to toxicity in sediments or to relatively low dissolved oxygen levels in this part of the Lagoon. A comparison of the 1973 study with the July 2004 survey suggests that in general the fish community in Colorado lagoon in 2004 is similar to that in 1973.

3 NUMERIC TARGETS

Numeric targets identify specific goals for the OC pesticides, PCBs, Sediment Toxicity, and Metals TMDL which equate to attainment of water quality standards and provide the basis for data analysis and final TMDL allocations. Multiple numeric targets are often employed when there is uncertainty that a single numeric target is sufficient to ensure protection of designated beneficial uses. The 2006 303(d) list for the Colorado Lagoon contains listings for sediment toxicity, PAHs, lead, and zinc in sediment; DDT, Dieldrin, and PCBs in fish tissue; and chlordane in fish tissue and sediment. In order to address these listings, water column, fish tissue and sediment targets are selected. The sediment target is the primary numeric target, which is used to calculate the TMDL and allocations. Water quality objectives and fish tissue guidelines are secondary targets that will provide additional means of assessing success in attaining sediment, fish tissue, and water quality standards.

Achievement of the water, tissue, and sediment targets named above will adequately protect benthic and aquatic organisms, wildlife, and human health from potentially harmful effects associated with metals and selenium. Numeric targets are presented in Table 3-1, and explained in detail further below.

Table 3.1 Numeric Targets for Water, Fish Tissue, and Sediment for OC Pesticide, PCBs, PAHs, and Metals.

Constituents	Water Quality Target[1] (ug/L)	Fish Tissue Target[2] (ug/kg)	ERL Sediment Target[3] (ug/dry Kg)
Chlordane	0.00059	5.60	0.50
Total DDT	0.00059	21.00	1.58
Dieldrin	0.00014	0.46	0.02
PCBs	0.00007[4]	3.60[5]	22.70
Total PAHs[6]	0.0088[7]	5.47	4,022.00
Total LPAHs[8]	NA	NA	552.00
Total HPAHs[9]	NA	NA	1,700.00
Lead	8.10	NA	46,700.00
Zinc	81.00	NA	150,000.00

3.1 Sediment Numeric Targets

3.1.1 State Board Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality

On February 19, 2008, the State Board adopted a Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality to integrate chemical and biological measures to determine if the sediment dependent biota are protected or degraded as a result of exposure to toxic pollutants in sediment and to protect human health. Part 1 of the Water Quality Control Plan for Enclosed Bays and Estuaries

[1] Basin Plan criteria for PCBs is selected to protect human health. CTR water quality criteria for consumption of organisms only are applied for Chlordane, total DDT, and Dieldrin for protection of human health. CTR human health criteria are not developed for PAHs, so California Ocean Plan criteria for water is selected for PAHs. The CTR aquatic life criteria for saltwater are selected as numeric targets for protection of both fresh and marine life for lead and zinc.

[2] Office of Environmental health Hazard Assessment (OEHHA) Fish Contaminant Goals are applied for Chlordane, DDTs, Dieldrin, and PCBs. United State Environmental Protection Agency (USEPA) screening value is applied for total PAHs.

[3] Effect Range Low (ERL) sediment criteria from National Oceanic and Atmospheric Administration (NOAA) Sediment Quality Guidelines are applied.

[4] PCBs in water are measured as the sum of seven Aroclors.

[5] PCBs in fish tissue and sediment are measured as sum of all congeners.

[6] PAHs: Polycyclic aromatic hydrocarbons (sum of acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene).

[7] California Ocean Plan water quality objectives for human health protection (thirty-day average, fish consumption only).

[8] LPAHs: Low molecular weight PAHs.

[9] HPAHs: High molecular weight PAHs.

[24] See CWC section 13263(g).

includes narrative sediment quality objectives (SQOs) for the protection of aquatic life and human health described below:

a. Aquatic Life – Benthic Community Protection

Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California. This narrative objective shall be implemented using the integration of multiple lines of evidence (MLOE). The assessment of sediment quality consists of the measurement and integration of three lines of evidence (LOE). The LOE are:

- Sediment Toxicity: Sediment toxicity is a measure of the response of invertebrates exposed to superficial sediments under controlled laboratory conditions. The sediment toxicity LOE is used to assess both pollutant related biological effects and exposure. Sediment toxicity tests are of short durations and may not duplicate exposure conditions in natural systems. This LOE provides a measure of exposure to all pollutants present, including non-traditional or unmeasured chemicals.
- Benthic Community Condition: Benthic community condition is a measure of the species composition, abundance and diversity of the sediment-dwelling invertebrates inhabiting superficial sediments. The benthic community LOE is used to assess impacts to the primary receptors targeted for protection of aquatic life. Benthic community composition is a measure of the biological effects of both natural and anthropogenic stressors.
- Sediment Chemistry: Sediment chemistry is the measurement of the concentration of chemicals of concern in superficial sediments. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in superficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

b. Human Health

Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health. The narrative human health objective shall be implemented on a case-by-case basis, based upon a human health risk assessment. In conducting a risk assessment, the Water Boards shall consider any applicable and relevant information, including California Environmental Protection Agency's (Cal/EPA), Office of Environmental Health Hazard Assessment (OEHHA) policies for fish consumption and risk assessment, Cal/EPA's Department of Toxic Substances Control (DTSC) Risk Assessment, and USEPA Human Health Risk Assessment policies.

Part 1 supersedes all applicable narrative water quality objectives and related implementation provisions in the Basin Plan to the extent that the objectives and provisions are applied to protect bay or estuarine benthic communities from toxic pollutants in sediments. The supersession provision in above does not apply to existing sediment cleanup activities where a site assessment was completed and submitted to the Regional Water Board by February 19, 2008.

As stated in the SQOs, none of the individual LOE is sufficiently reliable when used alone to assess sediment quality impacts due to toxic pollutants. Within a given site, the LOEs applied to assess exposure may underestimate or overestimate the risk to benthic communities and do not indicate causality of specific chemicals. The LOEs applied to assess biological effects can respond to stresses associated with natural or physical factors, such as sediment grain size, physical disturbance, or organic enrichment. Each LOE produces specific information that, when integrated with the other LOEs, provides a more confident assessment of sediment quality relative to the narrative objective. When the exposure and effects tools are integrated, the approach can quantify protection through effects measures and also provide predictive capability through the exposure assessment.

3.1.2 Selected Numeric Targets for Sediment

Numeric targets that are protective of aquatic life beneficial uses are developed for OC pesticides, PCBs, PAHs, and metals in sediments. While DDT, Dieldrin, and PCB impairments occur in fish tissue only, sediment targets are necessary as they are directly associated with sediments which are the transport mechanism of these compounds. The State Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 provides objectives based on multiple LOEs that can be applied to sediments but does not provide individual numeric targets for sediment quality. To develop a TMDL, it is necessary to translate the narrative objectives in the Basin Plan and the MLOEs in the SQOs into numeric targets that identify the measurable endpoint or goal of the TMDL and represent attainment of applicable numeric and narrative sediment and water quality standards. Sediment quality guidelines compiled by National Oceanic and Atmospheric Administration (NOAA) are used in evaluating waterbodies within the Los Angeles Region for development of the 303(d) list. The sediment quality guidelines are applicable numeric targets because the impairments and the 303(d) listings are primarily based on sediment quality data. In addition, the pollutants being addressed have a high affinity for particles and the delivery of these pollutants is generally associated with the transport of suspended solids from the watershed or from sediments within the lagoon.

The Effect Range Low (Long et al., 1995) guidelines are used to establish the numeric targets for sediments in Colorado Lagoon, as summarized in Table 3.1. The State Board listing policy recommends the use of the Effect Range Medians (ERMs), Probable Effect Levels (PELs), and other sediment quality guidelines (SQGs) as a threshold for listing. ERM and PEL values are interpreted as levels above which the adverse biological effects are expected, which make them applicable in the determination of impairment. The Effect Range Low (ERL) values, on the other hand, represent the levels below which adverse biological effects are not expected to occur, and are more applicable to the prevention of impairment. The goal of the TMDL is to remove impairment and restore beneficial uses; therefore, the ERLs for marine sediment are selected as numeric targets over the ERMs to limit adverse effects to aquatic life. The selection of the ERLs, which are lower than ERMs, provides an implicit margin of safety.

3.2 Water Quality Criteria

For PCBs, the 30-day average criterion of 70 pg/L in the Basin Plan is selected to protect human health. The CTR human health criteria for consumption of organism are selected as numeric target for chlordane, DDT, and dieldrin to protect the beneficial uses including recreation (REC-1 and REC-2) and sport fishing (COMM). Basin Plan and CTR human health criteria are not developed for PAHs, so California Ocean Plan criteria for water is selected for PAHs. The CTR aquatic life criteria for saltwater are selected as numeric targets for protection of both fresh and marine life for lead and zinc. Chronic criteria (Criteria Continuous Concentration, or CCC) are applied when available. In the absence of chronic criteria, acute criteria (Criteria Maximum Concentration, or CMC) are applied. When neither chronic nor acute criteria are defined by the CTR for a given constituent, no numeric target is presented (since no other appropriate water criteria exist for protection of aquatic life from toxicity).

The Basin Plan and CTR state that the salinity characteristics (i.e., freshwater versus saltwater) of the receiving water shall be considered in determining the applicable water quality criteria. Freshwater criteria shall apply to discharges to waters with salinities equal to or less than 1 part per thousand (ppt) at least 95 percent of the time. Saltwater criteria shall apply to discharges to waters with salinities equal to or greater than 10 ppt at least 95 percent of the time in a normal water year. For discharges to waters with salinities in between these two categories, or tidally influenced fresh waters that support estuarine beneficial uses, the criteria shall be the lower of the saltwater or freshwater criteria (freshwater criteria are calculated based on ambient hardness) for each substance. The latter of these scenarios applies to the Colorado Lagoon due to tidal influence as a result of high salinity water.

3.3 Fish Tissue Target

Fish tissue targets for OC pesticides and PCBs are selected from *"Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chlordane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene"*, which are recently developed by OEHHA in June 2008 to assist other agencies to develop fish tissue-based criteria with a goal toward pollution mitigation or elimination and protect humans from consumption of contaminated fish or other aquatic organisms(OEHHA 2008). Use of fish tissue targets is appropriate to account for uncertainty in the relationship between pollutant loadings and beneficial use effects (EPA, Newport Bay TMDL, 2002) and directly addresses potential human health impacts from consumption of contaminated fish or other aquatic organisms. Use of fish tissue targets also allows the TMDL analysis to more completely use site-specific data where limited water column data are available, consistent with the provisions of 40 CFR 130.7(c)(1)(i). Thus, use of Fish Contaminant Goals (FCGs) provides an effective method for accurately quantifying achievement of the water quality objectives/standards. FCGs and CTR human health criteria for PAHs are not available. In the absence of FCGs and CTR criteria, USEPA screening value is applied for PAHs.

4 SOURCE ASSESSMENT

This section identifies the potential sources of OC Pesticides, PCBs, Sediment Toxicity, PAHs and Metals compounds to Colorado Lagoon. OC pesticides, PCBs, PAHs, metals and toxic pollutants can enter surface waters from both point and nonpoint sources. Pollutants that enter Colorado Lagoon through direct, piped, and channeled discharges such as storm drains are classified as point sources. These types of discharges are regulated through the federal National Pollutant Discharge Elimination System (NPDES) program, which the Regional Boards have been delegated to implement through the issuance of Waste Discharge Requirements (WDRs). In the City of Long Beach, urban runoff to Colorado Lagoon is regulated under stormwater NPDES permits, which is a point source discharge. Nonpoint sources, by definition, include pollutants that reach surface waters from a number of diffuse land uses and source activities that are not regulated through NPDES permits. Nonpoint sources that are found to be major contributors to sediment pollution in Colorado Lagoon are runoff from paved street and parking lots, construction sites, soil erosion, pesticide/herbicide application, wash down from residential and commercial sites, minor industrial operations such as oil well production, and atmospheric deposition.

4.1 Background on Toxic Pollutants

The following sections provide background information on the toxic pollutants addressed in this TMDL, including their properties and uses.

4.1.1 Organic Pollutants

- **Chlordane**

  Chlordane was first produced in 1947 and used as a pesticide to control insects on agricultural crops, residential lawns and gardens, and in buildings, particularly for termite control. In 1978, because of concerns on cancer risk, evidence of human exposure and danger to wildlife, EPA canceled its use on food crops and phased out its other above-ground uses. In 1988, all chlordane uses, except for fire ant control, were voluntarily canceled in the United States (NPTN, 2008a). Chlordane can still be legally manufactured in the United States for sale or use in foreign countries. Although it is no longer used in the United States, chlordane persists in the environment, adhering strongly to soil particles. It is assumed that the only source of chlordane in the watershed is stormwater runoff carrying historically deposited chlordane most likely attached to eroded sediment particles.

- **Dieldrin**

Dieldrin was used as a pesticide from 1950 to 1970. It was used to control insects on agricultural crops such as corn and cotton. Because of concerns about damage to the environment and the potential harm to human health, EPA banned all uses of dieldrin in 1974 except to control termites. In 1987, EPA banned all uses. Dieldrin binds tightly to soil and slowly evaporates to the air. Dieldrin breaks down very slowly. Unfortunately, the residues of the chemicals are still present in the environment. Elevated levels have been found in several fish species, and sediment tests show that the legacy pesticides are still present in the fields and storm drains.

- **DDT**

  DDT was first used as a pesticide in 1939. It was widely used to control insects in agriculture and insects that carry diseases such as malaria. During World War II (1939-1945), it was extensively employed for the control of malaria, typhus, and other insect-transmitted diseases. The use of DDT was prohibited in the United States in 1973. Unfortunately, the residues of the chemicals are still present in the environment. Elevated levels have been found in several fish species, and sediment tests show that the legacy pesticides are still present in the fields and storm drains.

- **Polycyclic Aromatic Hydrocarbons (PAHs)**

  PAHs are a group of over 200 different chemicals that are both naturally occurring and anthropogenically derived. These ringed hydrocarbons are found in nature in coal and crude oil, and in emissions from combustion of fossil fuels, forest fires and volcano eruption. They are persistent in the environment, hydrophobic (i.e., partition out of water to sediment), and toxic to wildlife and carcinogenic to humans. Hydrophobicity increases with the molecular weight of the PAHs, while acute toxicity is greater with the lower molecular weight PAHs (LPAHs; Nagpal, 1993; Smith et al, 2000). Several high molecular weight PAHs (HPAHs) are carcinogenic. They are transported by air and deposited as wet or dry deposition on land, resulting in worldwide occurrence at trace levels. Concentrations of PAHs in air increase in proximity to urban areas. Important sources of PAHs in surface waters include deposition of airborne PAHs, municipal waste water discharge, urban stormwater runoff particularly from roads, runoff from coal storage areas, effluents from wood treatment plants and other industries, oil spills, and petroleum pressing (ATSDR, 1995).

- **Polychlorinated Biphenyls (PCBs)**

  PCBs are mixtures of up to 209 individual chlorinated compounds (known as congeners). They were used in a wide variety of applications, including dielectric fluids in transformers and capacitors, heat transfer fluids, and lubricants. In 1976, the manufacture of PCBs was prohibited because of evidence they build up in the environment and can cause harmful health effects. Although it is now illegal to manufacture, distribute, or use PCBs, these synthetic oils were used for many years as insulating fluids in electrical transformers and in other products such as cutting oils. Products made before 1977, which may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils. Historically, PCBs have been introduced into the environment through discharges from point sources and through spills and accidental releases. Although point source contributions are now controlled, nonpoint sources may still exist, for example, refuse sites and abandoned facilities may still contribute PCBs to the environment. Once in a waterbody, PCBs become associated with solid particles and typically enter sediments (U.S. EPA, 2002).

4.1.2 Metals

- **Lead**

  The single largest use of lead is in the production of lead-zinc batteries. Lead and its compounds are used in electroplating, metallurgy, construction materials, coating and dyes, electronic equipment, plastics, veterinary medicines, fuels and radiation shielding. Lead is also used for ammunition, corrosive-liquid containers, paints, glassware, fabricating storage tank linings, transporting radioactive materials, solder, piping, cable sheathing, and roofing (MacDonald, 1994). Prior to the phasing out of leaded gasoline, lead additives in gasoline were a significant source of lead in the environment. Since the phasing out of leaded gasoline, there has been a gradual decline of lead concentrations in the environment.

- **Zinc**

  Zinc is primarily used as a coating on iron and steel to protect against corrosion, in alloys for die-casting, in brass, in dry batteries, in roofing and exterior fittings for buildings, and in some printing processes (America Zinc Association, 2008). The principal sources of zinc in the environment include smelting and refining activities, wood combustion, waste incineration, iron and steel production, and tire wear (MacDonald, 1994). At neutral pH, zinc may be deposited in sediments by sorption to hydrous iron and manganese oxides, clay minerals and organic matter, however, adsorption is very low at pH below six. Iron and manganese oxides/hydroxides appear to be the most important scavengers of zinc in coarse sediments that are low in organic matter. However, sorption to organic matter appears to be the most important environmental fate process in fine grained sediments (MacDonald, 1994).

4.2 Point Sources

A point source, according to 40 Code of Federal Regulations (CFR) 122.3, is defined as "any discernable, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged." The NPDES Program, under Clean Water Act sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. The NPDES permit in the Colorado Lagoon

Watershed includes the Municipal Separate Storm Sewer System (MS4) Permits for the County of Los Angeles, the City of Long Beach, and the California Department of Transportation (Caltrans). There are no major individual, minor individual, or general NPDES Permits adopted by the Regional Board in the Colorado Lagoon watershed.

4.2.1 Stormwater Runofff

Stormwater runoff is regulated through a number of permits. The MS4 permits were separately issued to the City of Long Beach and the County of Los Angeles. Another permit is the statewide stormwater permit issued for Caltrans. Stormwater runoff is also regulated statewide under Construction Activities Stormwater General Permit and Industrial Activities Stormwater General Permit. The permitting process defines these discharges as point sources because the stormwater discharges from the end of a stormwater conveyance system. Since the industrial and construction stormwater discharges are enrolled under NPDES permits, these discharges are treated as point sources in this TMDL.

- MS4 Stormwater Permits

  In 1990 EPA developed rules establishing Phase 1 of the NPDES stormwater program, designed to prevent pollutants from being washed by stormwater runoff into the MS4 (or from being directly discharged into the MS4) and then discharged into local waterbodies. Phase 1 of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a stormwater management program as a means to control polluted discharges. The County of Los Angeles MS4 permit was amended on August 9, 2007 (Order No. 01-182, NPDES No. CAS0041). The City of Long Beach MS4 Permit was renewed on June 30, 1999 (Regional Board Order No. 99-060, NPDES No. CAS004003) and was on a five-year renewal cycle. At the end of the previous five-year cycle the City of Long Beach was directed by the Regional Board to continue operating under the 1999 permit until further notice.

- Caltrans Stormwater Permit

  Discharges from roadways under the jurisdiction of Caltrans are regulated by a statewide stormwater discharge permit that covers all municipal stormwater activities and construction activities (State Board Order No. 99-06-DWQ). The Caltrans stormwater permit authorizes stormwater discharges from Caltrans properties such as the state highway system, park and ride facilities, and maintenance yards. The stormwater discharges from most of these Caltrans properties and facilities eventually end up in a municipal storm drain, which then discharges to Colorado Lagoon.

- Other NPDES Permits

There are no major individual, minor individual or general NPDES permits adopted by the Regional Board for the Colorado Lagoon Watershed. Below is the summary of existing industrial, commercial, and municipal facilities that currently operate and may be potential sources of pollutants in the watershed, which could be addressed by the MS4 or other stormwater permits.

a. Industrial operations: There are limited industrial sources within the Colorado Lagoon watershed. Industrial sources of contamination are limited to industrial pipeline and well drilling operations. Oil wells, including operating and abandoned production and exploratory wells and dry wells are limited. Production wells are located next to Recreation Park Golf Course Maintenance area in sub-basin. Leaky production wells or improperly capped wells can allow contaminants such as petroleum, metals, acid, minerals, and other hazardous and non-hazardous chemicals to enter surface runoff to the lagoon.

b. Commercial facilities: Commercial sources in Colorado Lagoon are primarily commercial offices and buildings, retail stores and service shops. Specific commercial facilities include the following: auto repair shops, barber and beauty shops, car washes, gasoline service stations, golf courses, hardware and lumber stores, garden nurseries, florists, laundromats, dry cleaners, medical institutions, publishing operations, and veterinary services. General commercial sources are mainly retail establishments that may have potential contaminants in inventory but are not exposed to rainfall.

c. Municipal facilities: Potential sources of contaminants from municipal sources include runoff from institutions, school and government offices, park lands, public and residential areas. Improper storage and waste handling can contribute to contamination of the watershed.

4.2.2 Wet-Weather Pollutant Load Calculation

A Simple Method developed by Schueler (1987) was used to estimate pollutant loading from the Colorado Lagoon watershed. Pollutant loading was calculated by multiplying the estimated mean concentration of each pollutant of concern in stormwater with an average annual runoff over the period of 1996- 2006 in the City of Long Beach (LACDPW, 2008). The detailed calculations are included in Table 4-1. The imperviousness of each land use was analyzed by the Los Angeles County Department of Public Works (LACDPW, 2006) as shown in Table 4-2. The loadings for metals were calculated based on the stormwater cumulative event mean concentrations (EMCs) analyzed by the LACDPW from 1994 to 2000 for eight land use types (LACDPW, 2000). The average EMCs values for PAHs were estimated by Stein et al. (2006). EMCs values for organochlorine pesticides and PCBs were not available due to non-detectable levels in stormwater. The results for annual pollutant loading by each land use for metals and PAHs are shown in Table 4-3. Further research is expected to resolve some of the uncertainty in this simple model.

Table 4-1. Summary of the Simple Method (Schueler, 1987)

Simple Method

1. Calculation of the runoff coefficient, Rv (unitless)
   Rv = 0.05 + 0.009(I), where I = Site imperviousness

2. Calculation of annual runoff, R (inches)
   R = P×Pj×Rv
   Where P = Annual rainfall (inches), Long Beach (1996-2006) = 13.27 inches
   Pj = Fraction of annual rainfall events that produce runoff (0.9)

3. Calculation of annual pollutant loads, L (lbs/yr)
   L = R×C×A×0.226
   Where C = Flow-weighted mean concentration of the pollutant (mg/L)
   A = Area (acres)
   0.226 = unit conversion factor

Table 4-2. Area and Percent Impervious for each Land Use in the Colorado Lagoon Watershed

Land Use	Area (acres)	% Impervious
High Density Residential	678	42
Commercial	79	96
Industrial	2	91
Public Facilities	6	91
Education	52	82
Mixed Urban	9	59
Recreation	260	10

Table 4-3. Annual Loading from Stormwater Runoff from Land Uses into Colorado Lagoon for Metals and PAHs (lbs/year)

Land Use	Total Suspended Solids	Total Lead	Total Zinc	Total PAHs
High Density Residential	81,936	7.51	62.91	3.44
Commercial	13,081	2.24	46.3	0.23
Industrial	1,114	0.07	2.75	0.01
Public Facilities	1,397	0.13	1.07	0.06
Education	11,335	0.50	13.61	0.48
Mixed Urban	1,029	0.13	2.75	0.01
Recreation	10,301	0.94	7.91	0.05
TOTAL	**12,0193**	**11.52**	**137.30**	**4.28**

4.2.3 Dry-Weather Pollutant Load Calculation

Pollutant loading of dry-weather discharges to Colorado Lagoon from four different storm drain systems (as shown as Figure 4-1) was calculated by multiplying the volume of runoff with the average concentration of each pollutant of concern (POC). The mean daily flow and the average concentration of each POC were obtained from the study by Kinnetic Laboratories, Inc (2006). The dry-weather days were 326 days in 2005 (LACDPW, 2008). The results for annual pollutant loading from dry-weather discharges from each storm drain are shown in Table 4-4. The dry-weather pollutant loadings are not significant in comparison with wet-weather pollutant loading.

Figure 4-1. Sampling Sites of Colorado Lagoon Dry-Weather Flow (Kinnetic Laboratories, Inc. 2006)

Table 4-4. 2005 Annual Loadings from Dry-Weather Discharges in Storm Drains for Metals and PAHs

		Average Pollutant Conc.			Annual Pollutant Loadings		
Storm Drain	Flow Rate (cf/d)	Total Lead (µg/L)	Total Zinc (µg/L)	Total PAHs (µg/L)	Total Lead (lbs)	Total Zinc (lbs)	Total PAHs (lbs)
Site A	1365	0.905	24	0.013	0.03	0.67	0.0004
Site B	5967	3	54	0.074	0.36	6.55	0.0090
Site C	7216	0.67	17	0.035	0.10	2.50	0.0051
Site D	1275	0.95	25.5	0.05	0.02	0.66	0.0013
Total					0.51	10.38	0.016

4.2.4 Point Sources Summary

Urban stormwater has been recognized as a substantial source of metals (Characklis and Wiesner, 1997; Davis et al., 2001; Buffleben et al., 2002) and organic pollutants such as PAHs and organochlorine compounds (Shaver et al., 2007). This is reflected in routine stormwater monitoring performed by City of Long Beach under the MS4 permit. Studies have also shown that dry-weather pollutant loadings are not significant (McPherson et al., 2002).

The total loadings of metals and organic pollutants reflect the sum of inputs from urban runoff within the watershed (see Table 5-3). In the Colorado Lagoon Watershed, stormwater discharges are regulated under the MS4 permits, the Caltrans permit, the general industrial stormwater permit and the general construction stormwater permit.

The most prevalent metals in urban stormwater (i.e., lead and zinc) are consistently associated with suspended solids (Sansalone and Buchberger, 1997; Davis et al., 2001). These metals are typically associated with fine particles in stormwater runoff (Characklis and Wiesner, 1997; Liebens, 2001), and have the potential to accumulate in the lagoon's bottom sediments, posing a risk of toxicity (Kinnetic Laboratories, Inc. & Moffatt & Nichol, 2004).

The organic contaminants in stormwater are also associated with suspended solids and the particulate fraction. Noblet et al. (2001) have shown that there is toxicity associated with suspended solids in urban runoff discharges, as well as with the receiving water sediments. This toxicity was likely attributed to metals and PAHs associated with the suspended sediments.

Based on this source analysis, the major contributor of associated metals, organochlorine compounds, PCBs and PAHs to Colorado Lagoon is assumed to be wet-weather runoff discharged from the stormwater conveyance system. While the loadings of metals (lead and zinc) and PAHs are attributable to ongoing activities in the watershed, the loadings of chlordane, DDT, and PCBs, reflect historic uses. Although the uses of these compounds are banned, these legacy pollutants continue to remain elevated in sediments. DDT and PCB loadings appear to have declined over the last 30 years (Stein et al., 2003).

4.3 Nonpoint Sources

4.3.1. Urban Runoff

Surface water runoff within the watershed occurs as sheet flow near the shores of the lagoon. The Colorado Lagoon watershed is predominately impervious surface due to urban development. The capacity of the soil vegetation to absorb water from precipitation is minimal and occurs mainly in sub-basin B within the confines of the Recreation Park. The water-retention capacity is low and runoff passes through soil quickly. Since precipitation-generated runoff is the major transport mechanism for nonpoint source pollution, a direct relationship exists between the timing and magnitude of precipitation events and the resulting level of nonpoint source pollution. Factors that affect the rate at which precipitation becomes runoff include the soil moisture conditions at the time of the precipitation event, vegetation type and density, and urbanization with its associated impervious surfaces. As most of the watershed is impervious, when "first flush" occurs the majority of pollutants are scoured and carried downstream rapidly. The more days between rainfall events, the more pollutant would build up. When the first rainfall event occurs, the first flush normally exhibits a heavy spike in concentration discharged to the lagoon. Therefore, climatic conditions preceding the precipitation event and the timing of the event are important factors in determining the amount of precipitation that will be available for the "first flush" of the watershed. Generally, the first 30 minutes of a 0.10- inch rainfall event typically removes most of the pollutants from the watershed, but this varies based on the intensity of the rainfall event. As the rainfall event exceeds 30 minutes, pollutant concentrations will decrease significantly.

Nonpoint source inputs not only occur from the runoff of precipitation, but also from precipitation falling directly onto the land surface or the lagoon. Precipitation occurs as wet deposition (wet-fall) of rain droplets, and dry deposition (dry-fall) of particulate matter. In the atmosphere, the mixture of gases, water vapor, particulate matter, and wind currents form a dynamic environment in which changes in chemical composition of precipitation can frequently occur. Precipitation can carry significant amounts of inorganic contaminants and sediments to the lagoon.

4.3.2. Atmospheric Deposition

Atmospheric deposition may be a potential nonpoint source of metals and PAHs to the watershed, through either direct or indirect deposition. Atmospheric pollutants may be deposited directly onto the surface of a waterbody or may reach the waterbody indirectly through deposition onto the land surface and subsequent wash off during rain events (Sabin et al., 2006). PAHs are released to the atmosphere through natural and synthetic sources of emissions. The largest sources of PAHs to the atmosphere are from synthetic sources, including wood burning in homes, automobile and truck emissions, and hazardous waste sites such as abandoned wood treatment plants (sources of creosote) and former gas manufacturing sites (sources of coal tar).

Atmospheric deposition of metals during dry weather was quantified by multiplying the surface area of the waterbody with the mean deposition flux and the number of days without rain fall (Sabin et al., 2006). The average seasonal dry deposition fluxes at urban sites in the Los Angeles coastal region are 15.8 ($\mu g/m^2/d$) and 127.5 ($\mu g/m^2/d$) for lead and zinc, respectively. The average dry days without rainfall are 335 days in the vicinity of City of Long Beach during 1996 to 2005 (LACDPW, 2008). The metal loadings are shown in Table 5-5. The metal loadings from dry atmospheric deposition to the land surface of the Colorado Lagoon Watershed were greater than the estimated metal loadings from urban stormwater runoff to the watershed. The area of Colorado Lagoon is small, approximately 15 acres or 1% of the watershed. Therefore, annual atmospheric deposition of metals to the lagoon is insignificant relative to the annual atmospheric deposition to the watershed and the annual stormwater loading.

No information was available regarding the amount of PAHs that would be directly deposited to the Los Angeles coastal region through dry atmospheric deposition.

Table 4-5. Estimated Annual atmospheric dry deposition of lead and zinc to Colorado Lagoon Watershed and Colorado Lagoon

Pollutant	Watershed	Lagoon
Total Lead (lbs/yr)	51.06	0.71
Total Zinc (lbs/yr)	413.35	5.71

4.4 Sediment Loading from Point Sources and Nonpoint Sources

Contaminated sediment enters Colorado Lagoon following erosion of approximately 1,172 acres of watershed through the storm drain system and runoff directly to the lagoon. While silt size particles may move under all flow conditions, larger particles will only move during flood flows. Further, while the particles larger than sand are readily deposited as floods ebb, the silt and clay particles may remain as suspended sediment throughout their transport to the ocean. Sediment was formerly collected largely in Colorado Lagoon. Due to the fact that the watershed is mainly impervious, sediments are transported quickly to the storm drain system during rain events which is considered as a point source, and carried to the lagoon during the "first flush." Sediment loadings from nonpoint sources to Colorado Lagoon are mainly runoff from urban, recreation park areas including two golf courses and adjacent park areas, the Pacific Electric right-of-way greenbelt, and the picnic and park areas surrounding Colorado Lagoon.

5 LINKAGE ANALYSIS

The linkage analysis connects loads of OC pesticides, PCBs, PAHs, and metals to the numeric targets and protection of beneficial uses. Protection of beneficial uses from impairment by OC pesticides, PCBs, PAHs, and metals is fundamentally about reducing OC pesticides, PCBs, PAHs, and metals concentrations in aquatic biota to acceptable levels, which necessitates reductions in water and sediment. The numeric targets selected for OC pesticides, PCBs, PAHs, and metals in fish tissue, water, and sediments define acceptable levels for protection of human health, fish, benthic organisms, and wildlife.

This TMDL analysis also makes the simplifying assumption that the relationship between OC pesticides and PCBs concentrations in fish and sediments is linear, with the slope of the line being the overall sediment–organism bioaccumulation factor (BAF). It is possible that a non-linear relationship between sediments and fish tissue exists. This is an acknowledged uncertainty in the TMDL analysis. It is important to note that there is reasonable certainty that lower OC pesticides and PCBs concentrations in sediments will lead to lower OC pesticides and PCBs concentrations in the food chain.

For particle-associated pollutants, the pollutant concentration in water is calculated by multiplying the TSS concentration of the water with the pollutant concentration on the TSS. This is fundamental to many particle-associated TMDLs, such as the adopted TMDL for mercury in San Francisco Bay (SFBRWQCB, 2004).

The impairing contaminants in sediment are associated with fine-grained particles that are delivered to the sediments through suspended solids in stormwater. It is expected that reductions in loadings of these pollutants will lead to reductions in sediment concentrations over time. The existing contaminants in surface sediments will be removed in dredging operations and reduced over time as sediments are scoured during storms. For the legacy pollutants (chlordane and PCBs), some losses will also occur through the slow decay and breakdown of these organic compounds. Concentrations in surface sediments will be reduced through mixing with cleaner sediments. Attenuation of pollutant concentration levels in sediment is expected to result in reductions in fish tissue contaminant levels.

This section will describe the development of a model for use in the Colorado Lagoon which is used to evaluate the results of different input scenarios for the restoration plan in Section 9. To represent the linkage between source contributions and in-lagoon water response, a dynamic water quality model was developed to simulate source loadings and transport of the listed pollutants in the Colorado Lagoon. This model simulates the metals, PAHs, PCBs, and DDT concentrations in the receiving water to evaluate potential management scenarios and to identify waste load allocations to support water quality management decisions in the Colorado Lagoon.

5.1 Model Development

The Environmental Fluid Dynamics Code (EFDC) was selected to model the listed pollutants in the Colorado Lagoon. Fundamentals of theory, description of the model, calibration of the sediment and water quality model, estimation of loading capacity, and simulations of the proposed restoration scenarios for metals, PAHs, PCBs, and DDT (used to represent all OC pesticides) in the Colorado Lagoon are presented this section.

The model used in the hydrodynamic simulation including grid set-up and model parameters are presented in the following sections. Hydrodynamic, water quality, and sediment transport was developed to simulate the dynamic interaction between Marine Stadium and Colorado Lagoon.

EFDC is a multidimensional (i.e., 1-D, 2-D, or 3-D) hydrodynamic and water quality model that has been used by EPA for TMDL development in river, lake, estuary, wetland, and coastal regions throughout the United States. The model has three primary components (hydrodynamics, sediment-toxic transport and fate, and water quality) integrated into a single model. The hydrodynamic component is dynamically coupled to salinity and temperature transport as well as to sediment-toxic transport and water quality components.

EFDC was originally developed by Dr. John Hamrick at the Virginia Institute of Marine Science. At present, the EFDC model is a public domain model, maintained by Tetra Tech, Inc. for the EPA with continuing research and development to expand the capabilities of the model. EFDC solves the 3-D Reynold-averaged Navier-Stokes equations assuming incompressible flow and hydrostatic pressure distribution with dynamically coupled salinity and temperature transport, which accounts for density variations. Turbulent closure via horizontal and vertical eddy viscosities is based on the Mellor-Yamada level 2.5 turbulence closure scheme (EFDC Technical Memorandum 2002).

The water quality component of EFDC simulates eutrophication and sediment biogeochemical (diagenesis) processes. The eutrophication kinetics and sediment processes are similar to those in the USACE CE-QUAL-ICM or Chesapeake Bay water quality model. EFDC can simulate multiple classes of cohesive and non-cohesive sediment such as suspended loads and bed loads as well as sediment deposition and re-suspension. The sediment transport is linked to toxic or contaminant transport and fate components. EFDC is capable of simulating an arbitrary number of contaminants, including metals and hydrophobic organics, adsorbed to any sediments class.

5.1.1 Hydrodynamic Model

- Computational Grid and Model Parameters

A horizontal computational grid layout was set up for hydrodynamic and water and sediment quality simulations for the model area covering Marine Stadium and Colorado Lagoon as shown in Figure 5.1. The modeling area was simulated with four cells vertically. The vertical cells were spaced at 25% of the total depth. The mesh size of the grid was chosen in such a way to provide a satisfactory resolution of the water elevation and water quality distribution in the Colorado Lagoon. The bottom elevations of the Colorado Lagoon and the bathymetry in the Marine Stadium area were obtained from the report entitled “Tidal and Flood Hydraulics Study” prepared by Moffatt & Nichol for the Department of Public Works, City of Long Beach. According to that report, the bathymetry of Colorado Lagoon and a portion of the Marine Stadium were based on a February 2004 survey by the Los Angeles County Department of Public Works (LACDPW).

The value of Manning’s n used in the hydrodynamic simulation to calculate the bottom friction was 0.03 in the Lagoon area and Marine Stadium area. The computation time step Δt was 3 seconds for the computational grid. Wind induced surface stresses are of less importance, so their effects were not simulated.

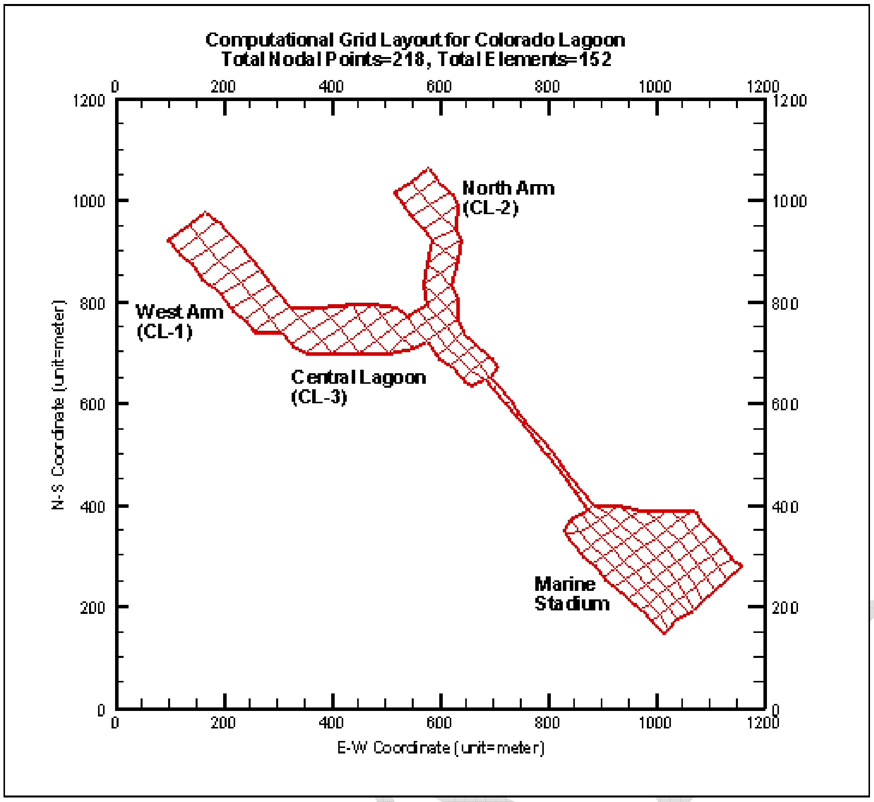


Figure 5.1 Computational Grid Set-up for Colorado Lagoon Model

- Boundary Conditions of Hydrodynamic Model

For initial conditions, velocities u, v (x and y components) and water elevations have to be specified for every point in the model region. The model may be started from either a cold condition or a pre-starting function. For the case of a cold start, velocities at all the nodal points are set to be zero and the water elevations are level.

The simulations for this analysis adopted a cold start, which means that the water elevations were level and velocities were zero everywhere in the computational grid system.

At the solid boundaries, zero normal flow was assumed as a corresponding boundary condition. Water elevations were specified at boundary nodal points to drive the simulation of tidal circulation within the Colorado Lagoon. No tidal elevation data was available at the boundaries of the study area, so the predicated tidal elevations were used. The predicted tide data (National Oceanographic Data Center, 2004 and 2008) at Los Angeles Harbor outer breakwater were used as the basis of water elevations along the boundaries.

5.1.2 Water Quality Model

- Water Quality Model Parameters

The computation time step used in water quality simulation was the same as that used in the hydrodynamic model.

The turbulent diffusion coefficients are among the major controlling factors in solving the pollutant transport equation. It is very important to take into consideration their physical meanings and numerical implications when values are selected for the modeling. In general, the diffusion coefficients vary locally according to velocity distribution, water depth, bottom roughness, etc. The turbulent diffusion coefficients were selected from the San Gabriel River Estuary Model, which was calibrated through salinity and temperature results (RWQCB, 2006). The turbulent diffusion coefficient for horizontal eddy viscosity is 0.5m^2/sec, for vertical kinematic viscosity is 3.0E-5 m^2/sec, and for vertical eddy diffusivity is 5.0E-5 m^2/sec.

- Boundary Conditions of Water Quality Model

Water quality simulation was based on the flow field resulting from the hydrodynamic simulation using the same computational grid system. The model requires a proper initial condition, which will specify water quality at every nodal point in the simulation domain at time zero. Usually, the model starts with a uniform water quality distribution with a typical value for the modeling area. At the land boundary nodes, perpendicular flux was assumed to be zero except for the boundaries at storm drains which were specified as a constant flux with measured flow rate and concentration for each simulation case.

5.2 Model Calibration

5.2.1 Calibration of the Hydrodynamic Model

After the model was set-up or configured, model calibration was performed. This is generally a two-phase process, with hydrodynamic calibration completed before repeating the process for water quality. Upon completion of the calibration at selected locations, a calibrated dataset containing parameter values was developed.

Hydrodynamics or hydrology was the first model component calibrated because simulation of water quality loading relies heavily on flow prediction. The hydrology calibration involves a comparison of model results to flow observations at selected locations. After comparing the results, key hydrologic parameters were adjusted and additional model simulations were performed. This iterative process was repeated until the simulated results closely represented the system and reproduced observed flow patterns and magnitudes.

For model calibration, predicted tidal elevations over the measurement period were obtained at Marine Stadium and were applied at the model boundary as shown in Figure 5.2. Tidal elevations simulated by the model were compared with those measured at the Colorado Lagoon gage as shown in Figure 5.3. It can be seen that the model results predicted at low tides were cut off about 0.7m compared to the ocean tide. Tidal elevation in the lagoon is significantly reduced by the culvert compared to Marine Stadium. This can be explained by the fact that the gate at the culvert connecting with Marine Stadium was not open during the low tides.

Due to insufficient field data of water elevation and flow velocity in the modeling area, the hydrodynamic model developed for the Colorado Lagoon can only be compared with limited tidal elevations. As can be seen from the comparison indicated in Figure 5.3, the hydrodynamic model provides a good foundation for the simulation of water quality for the Colorado Lagoon.

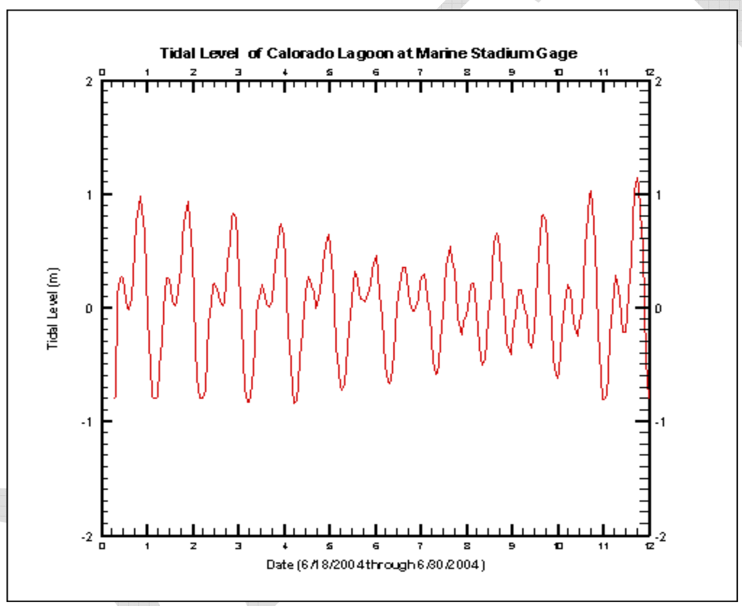


Figure 5.2 Tidal Elevations at Marine Stadium Gage Used as Ocean Boundary Condition (June 18, 2004 through June 30, 2004)

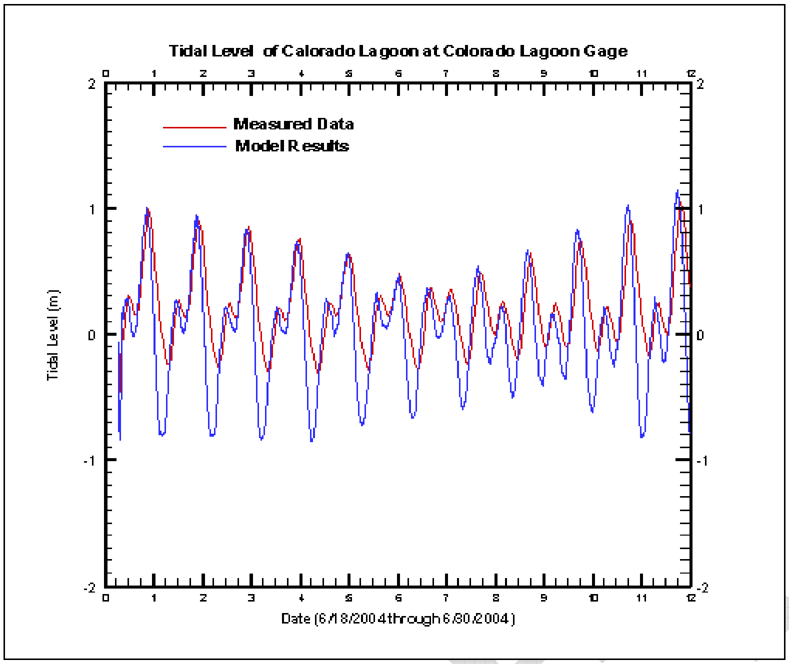


Figure 5.3 Comparison of Predicted Tidal Elevations with Measured Tide at Colorado Lagoon Gage (June 18, 2004 through June 30, 2004)

5.2.2 Calibration of the Water Quality Model

Initial concentrations and boundary conditions for the simulated metals and other pollutants were required for the modeling. In the EFDC model, these concentrations were specified based on available data. The zero initial concentration in the water column was used in the model. The initial concentrations in sediment bed are based on available information. These values are based on the average concentration of data taken in December 2000, July 2004, February 2008 and May 2008 at Colorado Lagoon. The concentrations in the water and sediment bed at Marine Stadium were used as the ocean boundary condition.

To calibrate the water quality model, the model results were compared with four observed data sets at three stations (CL-1, Cl-2, and CL-3). The input data used for calibration are summarized in Table 5.1.

Table 5.1 Sediment Quality and Water Quality of Sampling Data in Colorado Lagoon and at Marine Stadium

Constituents	Locations	12/08 *1 2000	6/30- 7/01 *2 2004	2/28 *3 2008	5/20 *4 2008	*Average of 2008*
Lead (mg/Kg) in sediment ERL: 46.7	at CL-1	390	409	240	230	235
	at CL-2	180	40	200	170	185
	at CL-3	NA	81	110	130	120
	at Marine Stadium	NA	NA	2.9	50	26.5
Zinc (mg/Kg) in sediment ERL:150	at CL-1	600	266	530	500	515
	at CL-2	340	46	360	320	340
	at CL-3	NA	97	230	270	250
	at Marine Stadium	NA	NA	13	88	50.5
PAH (µg/Kg) in sediment Total PAHs:4022	at CL-1	5453	1561	710	507	608.5
	at CL-2	1069	82	176	130	153
	at CL-3	NA	190	164	49	106.5
	at Marine Stadium	NA	NA	7.2	149	78.1
PCB (µg/Kg) in sediment ERL:22.7	at CL-1	ND (25U)	98	14	17	15.1
	at CL-2	ND (25U)	ND (28U)	ND	ND	ND
	at CL-3	NA	ND (31U)	ND	ND	ND
	at Marine Stadium	NA	NA	ND	ND	ND
DDT (µg/Kg) in sediment ERL:1.0	at CL-1	167	81	ND	ND	ND
	at CL-2	55.6	4.3	ND	ND	ND
	at CL-3	NA	20	ND	ND	ND
	at Marine Stadium	NA	NA	ND	ND	ND
%Solid	at CL-1	39	59	42	35	38.5
	at CL-2	41	71.4	41	39	40
	at CL-3	NA	65.4	47	40	43.5
	at Marine Stadium	NA	NA	81	78	79.5
TSS (mg/L) in water	at CL-1	NA	4.5	ND	24	
	at CL-2	NA	2.5	ND	15	
	at CL-3	NA	5.0	ND	20	
	at Marine Stadium	NA	NA	ND	32	
Lead (µg/L) in water CTR:8.1	at CL-1	NA	1.28	ND	NA	
	at CL-2	NA	1.02	ND	NA	
	at CL-3	NA	0.95	ND	NA	
	at Marine Stadium	NA	NA	ND	NA	
Zinc ((µg/L) in water CTR:81	at CL-1	NA	4.1	29	NA	
	at CL-2	NA	3.4	27	NA	
	at CL-3	NA	2.8	26	NA	
	at Marine Stadium	NA	NA	25	NA	
PCB (µg/L) in water CTR:0.03	at CL-1	NA	ND (0.5U)	NA	NA	
	at CL-2	NA	ND (0.5U)	NA	NA	
	at CL-3	NA	ND (0.5U)	NA	NA	
DDT (µg/L) in water CTR:0.001	at CL-1	NA	ND (0.05U)	NA	NA	
	at CL-2	NA	ND (0.05U)	NA	NA	
	at CL-3	*NA*	*ND (0.05U)*	*NA*	*NA*	

During water quality simulations, sufficient simulation time was used in each run to assure quasi steady-state conditions. It was found that the solutions reach steady state after about one to two days of continuous discharge from storm drains. The results of total zinc concentrations in sediment bed with measured data at three stations are presented in Figure 5.4. The results of water quality simulations for total zinc with measured data are presented in Figure 5.5. Similarly, the comparison of predicted results with measured data in sediment bed and water column for total lead, PAHs, PCBs and DDT are presented in Figure 5.6 through Figure 5.16. In these Figures, time series of three calibration runs are shown and the patterns between modeled metals (total zinc and total lead) and other pollutants PAHs, PCBs, DDT at three stations during three sampling events is agreeable. The comparisons of measured data and predicted values for total zinc concentrations in sediment bed and water column are presented in Figure 5.17 and Figure 5.18. Similarly, the comparison of measured data and predicted values for total lead concentrations in sediment bed and water column are presented in Figure 5.19 and Figure 5.20.

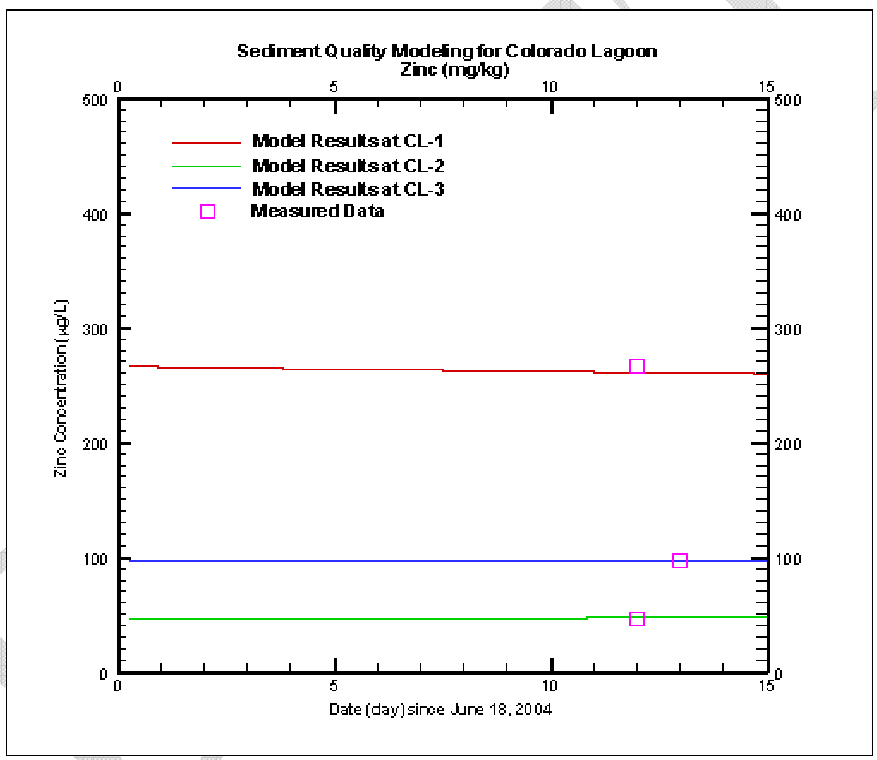


Figure 5-4 Comparison of Predicted Total Zinc in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

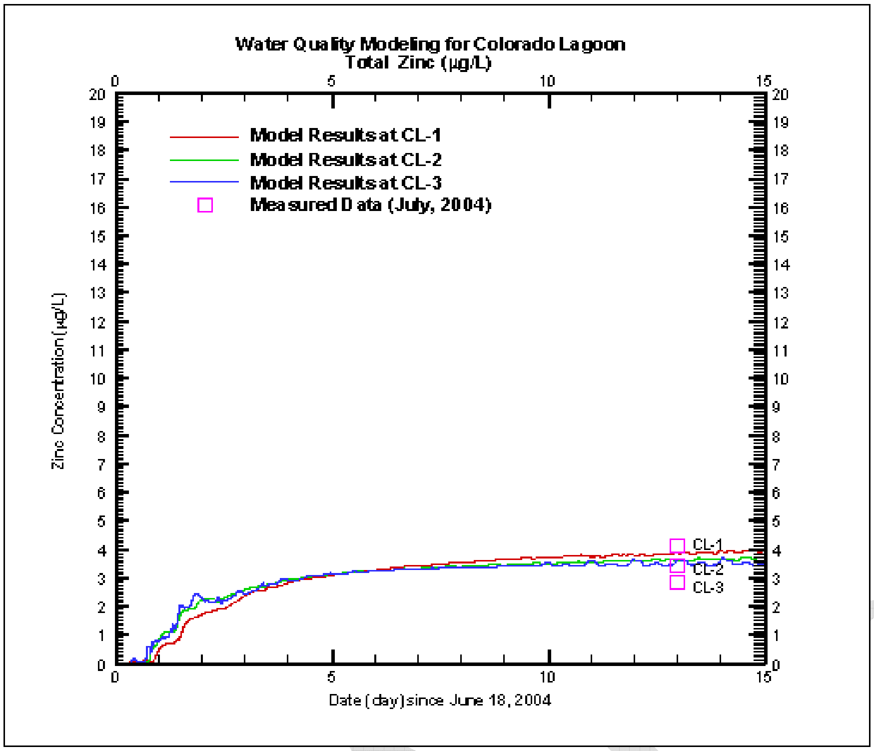


Figure 5-5 Comparison of Predicted Total Zinc in Water Column with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

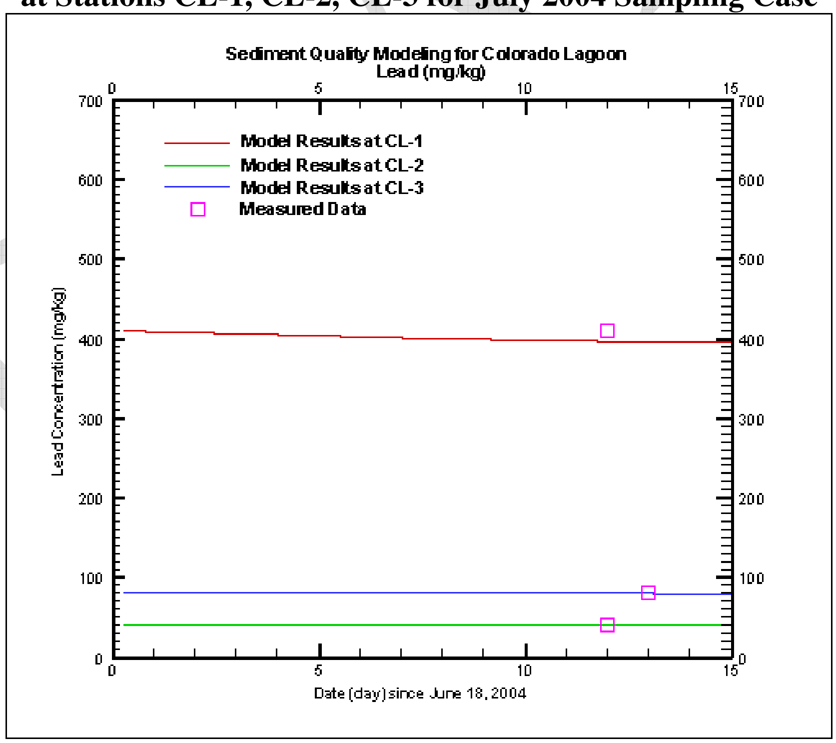


Figure 5-6 Comparison of Predicted Total Lead in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

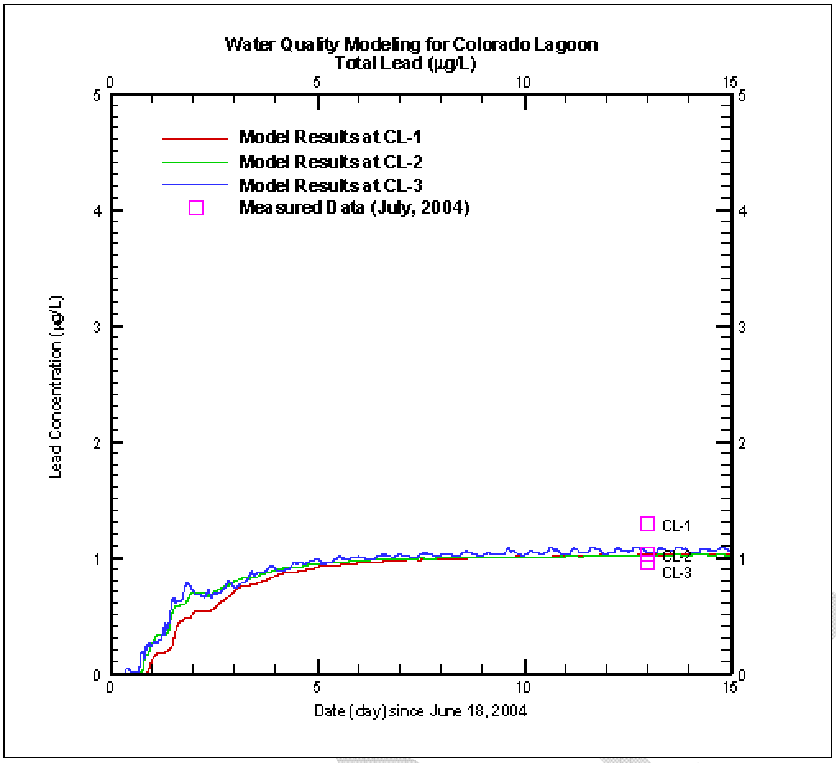
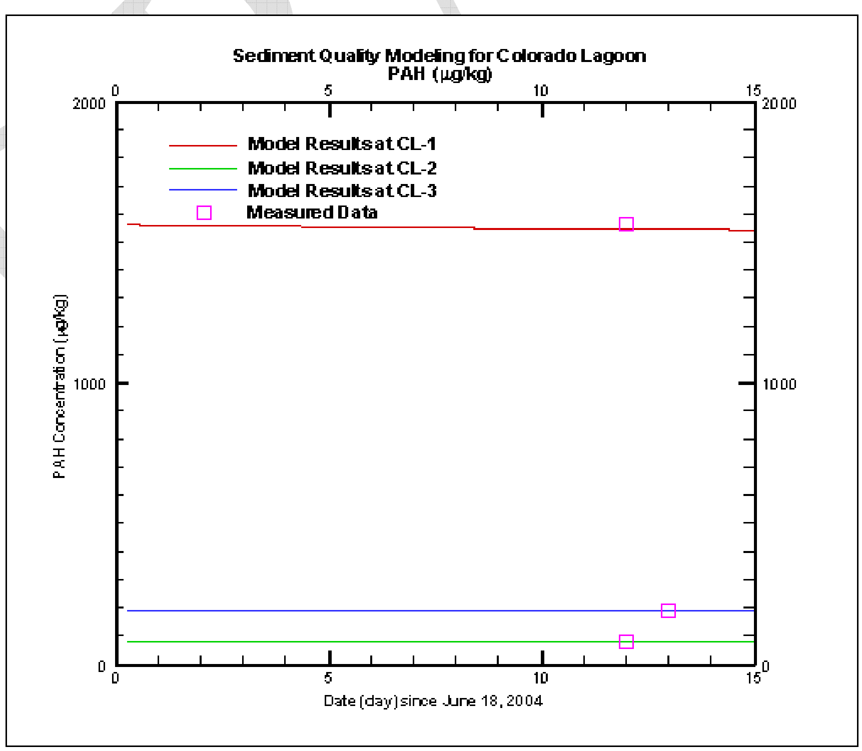


Figure 5-7 Comparison of Predicted Total Lead in Water Column with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case



5-8 Comparison of Predicted PAHs in Sediment Bed with Measured Data

at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

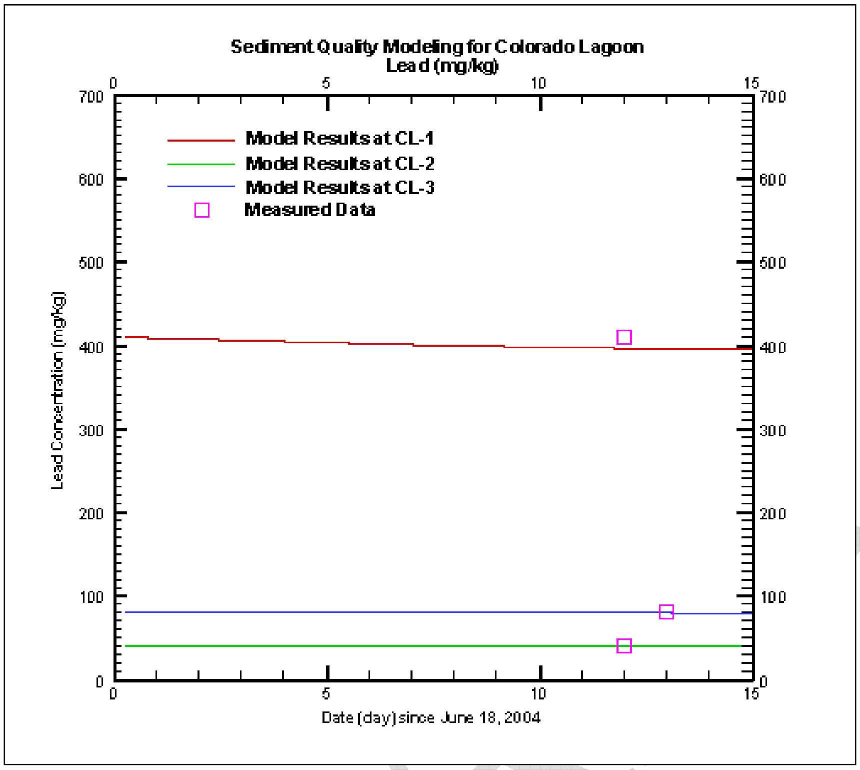


Figure 5-9 Comparison of Predicted PCBs in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

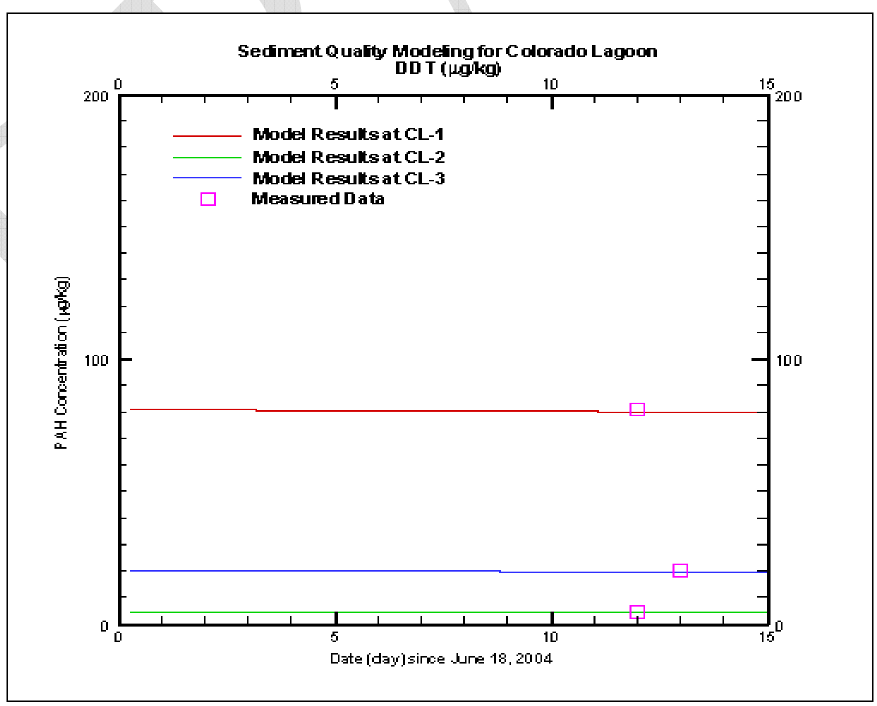


Figure 5-10 Comparison of Predicted DDT in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for July 2004 Sampling Case

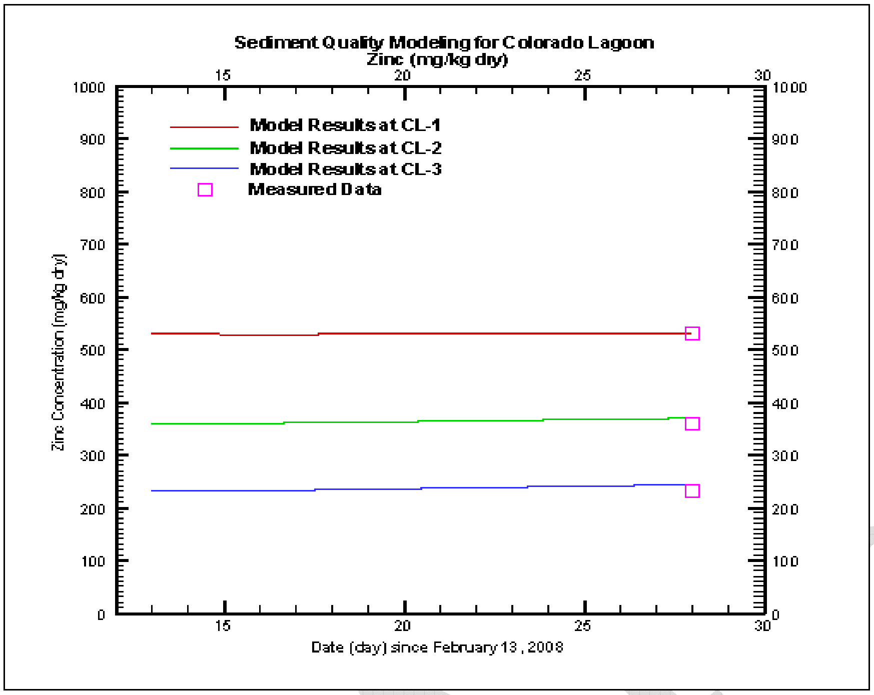
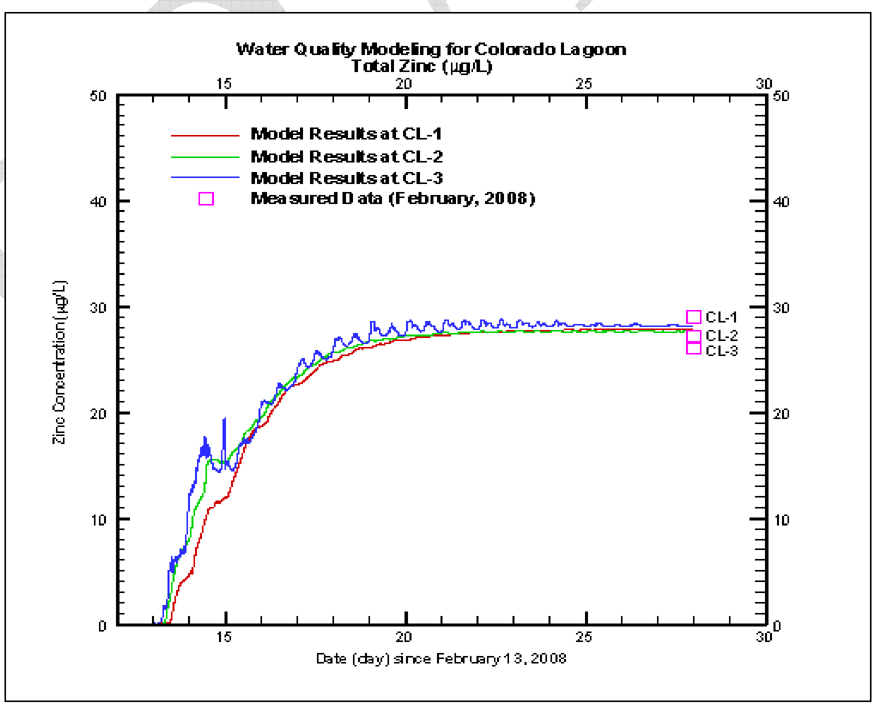


Figure 5-11 Comparison of Predicted Total Zinc in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for February 2008 Sampling Case



5-12 Comparison of Predicted Total Zinc in Water Column with Measured Data at Stations CL-1, CL-2, CL-3 for February 2008 Sampling Case

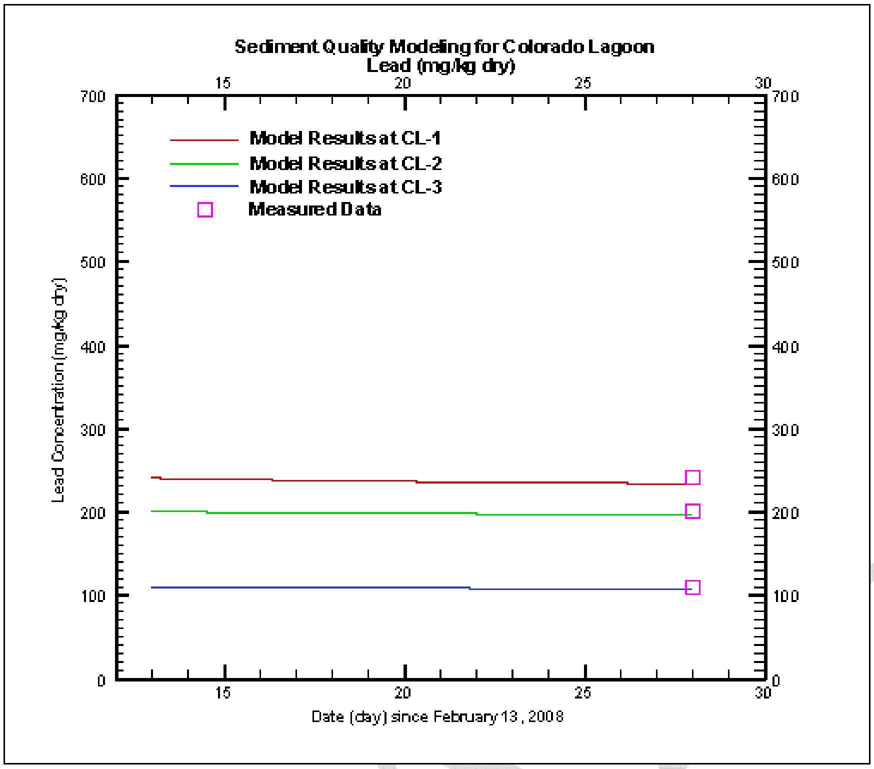


Figure 5-13 Comparison of Predicted Total Lead in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for February 2008 Sampling Case

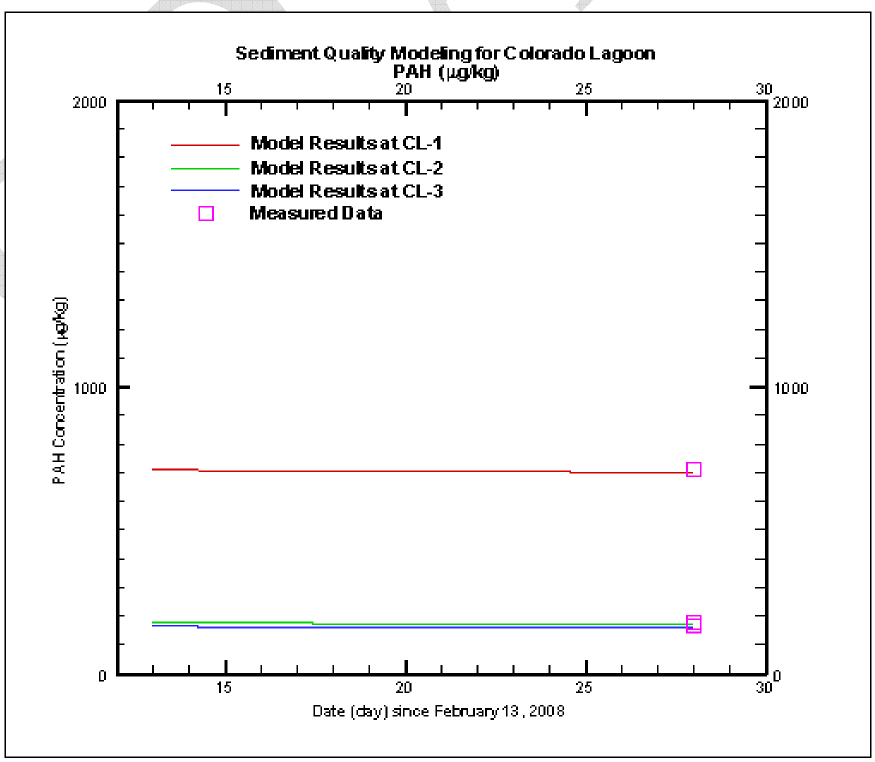


Figure 5-14 Comparison of Predicted PAHs in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for February 2008 Sampling Case

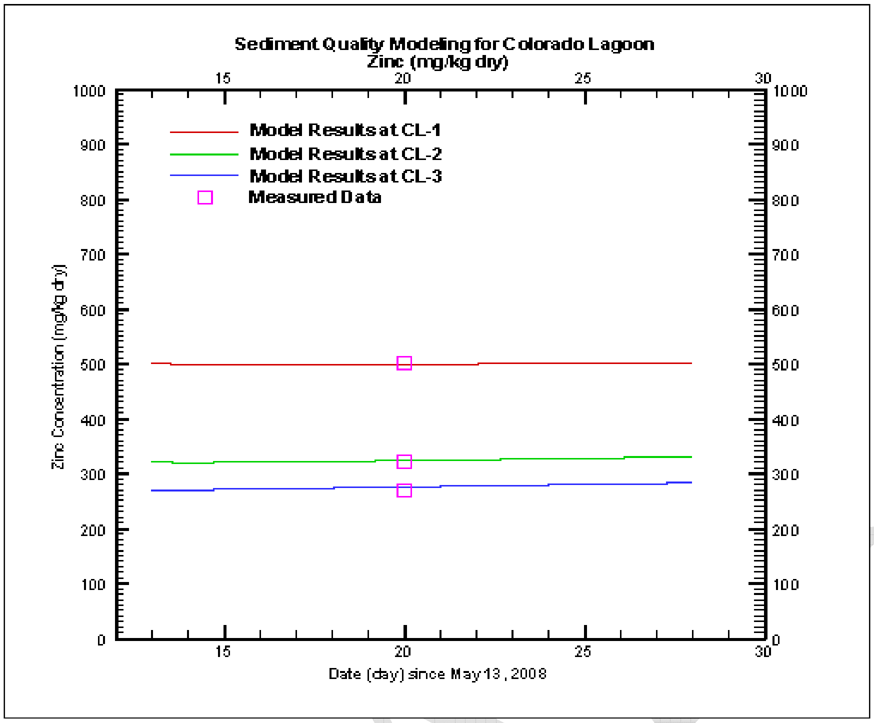


Figure 5-15 Comparison of Predicted Total Zinc in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for May 2008 Sampling Case

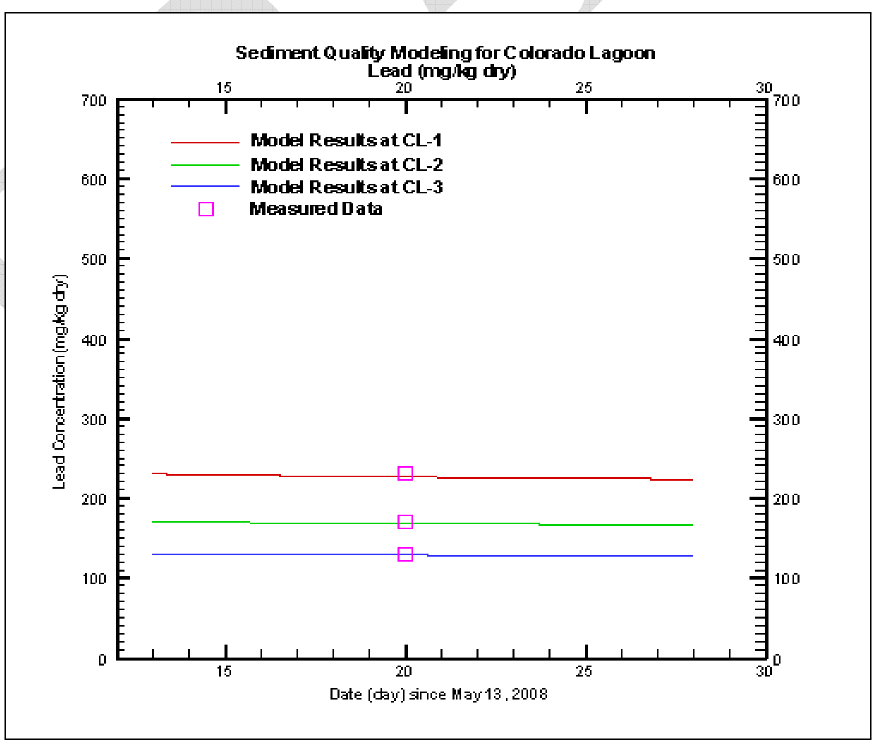


Figure 5-16 Comparison of Predicted Total Lead in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for May 2008 Sampling Case

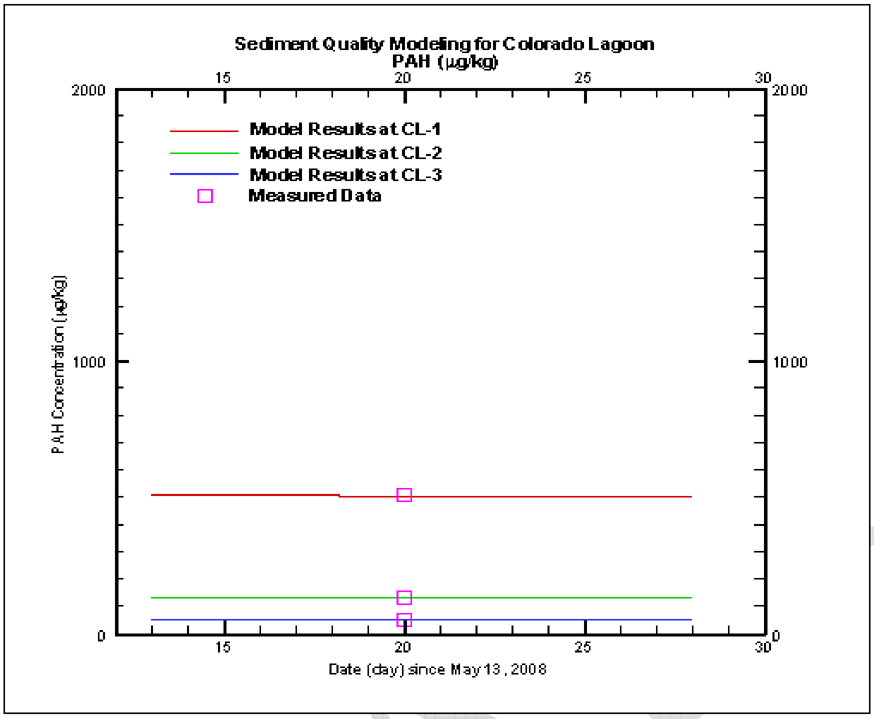


Figure 5-16 Comparison of Predicted PAHs in Sediment Bed with Measured Data at Stations CL-1, CL-2, CL-3 for May 2008 Sampling Case

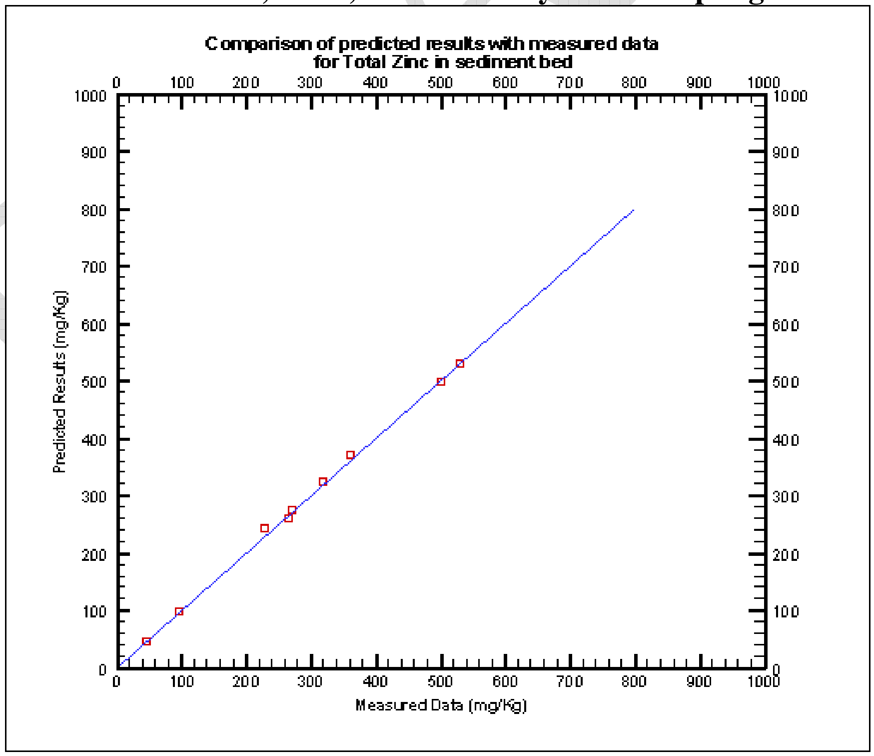


Figure 5-17 Comparison of Predicted Results with Measured Data for Total Zinc in Sediment Bed

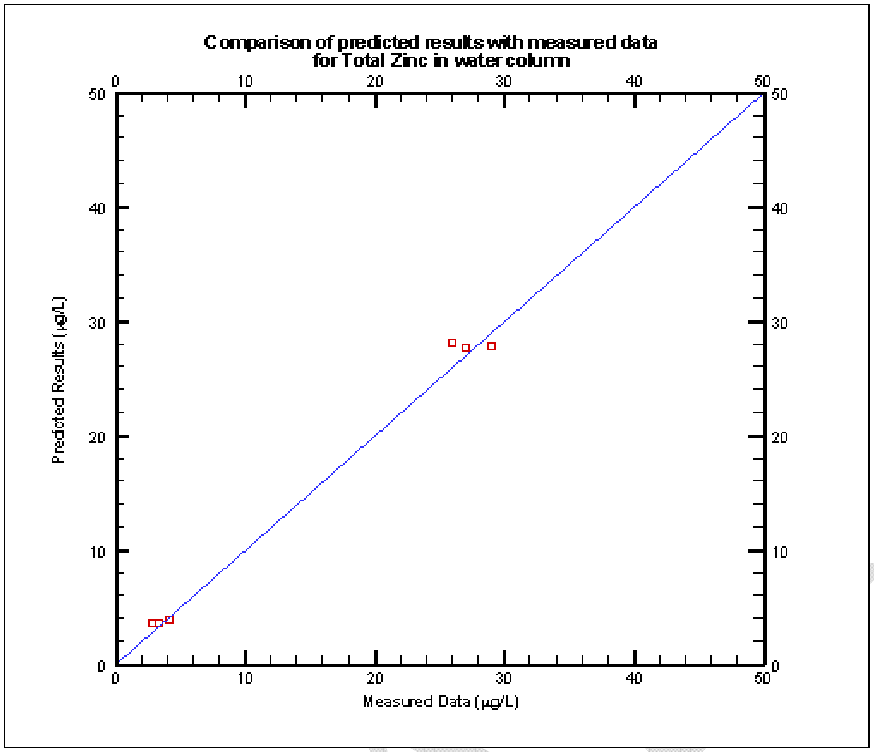


Figure 5-18 Comparison of Predicted Results with Measured Data for Total Zinc in Water Column

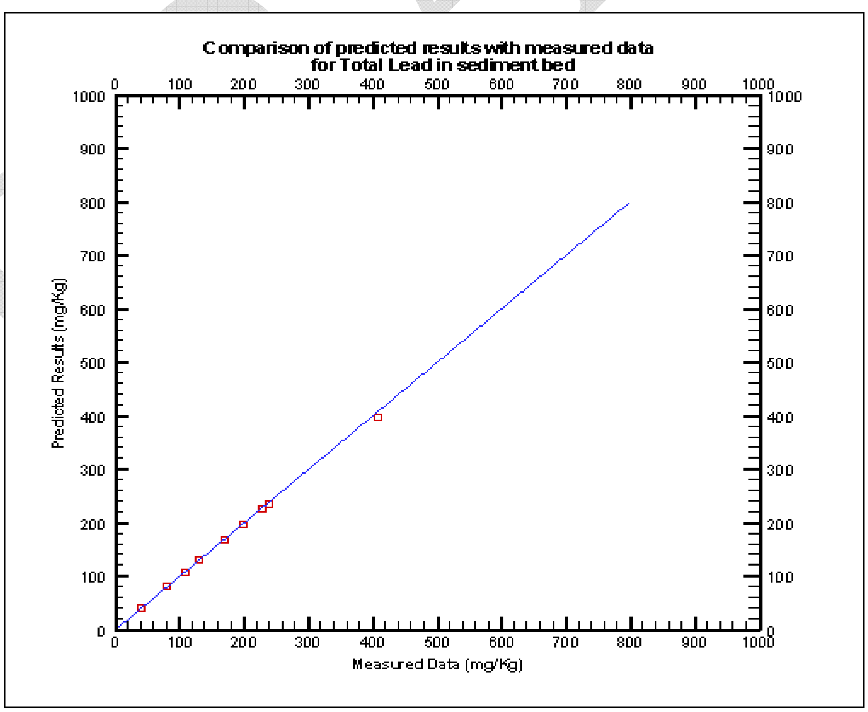


Figure 5-19 Comparison of Predicted Results with Measured Data for Total Lead in Sediment Bed

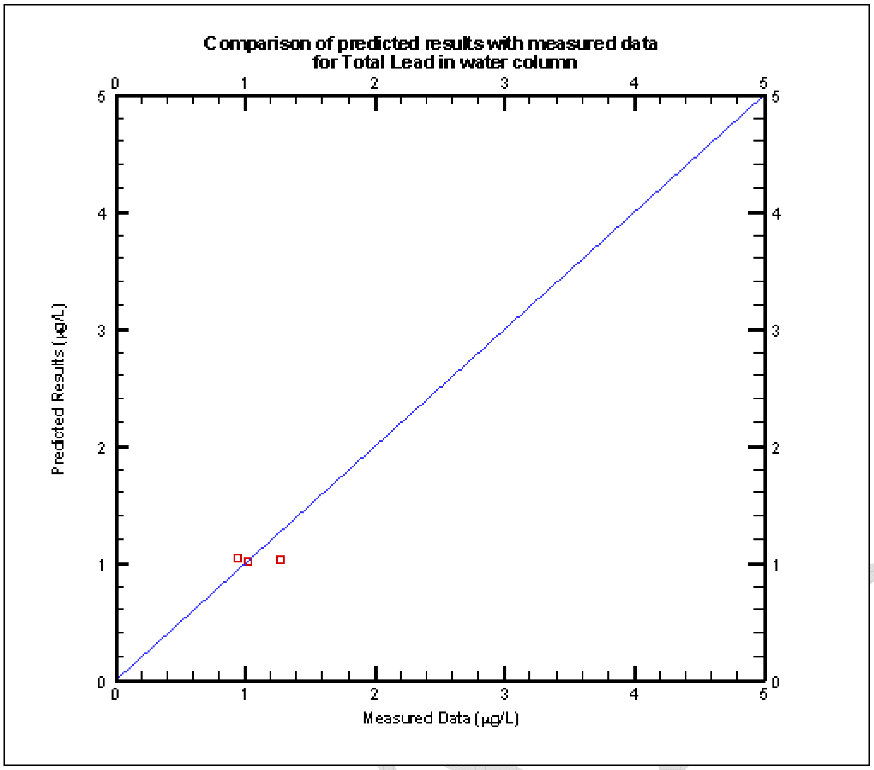


Figure 5-20 Comparison of Predicted Results with Measured Data for Total Lead in Water Column

Overall, the calibration results of metals, PAHs, PCBs, and DDT concentrations in sediment bed and water column showed a good correlation between modeled and observed values, thus confirming the applicability of the calibrated hydrodynamic and water quality parameters to the Colorado Lagoon. Based on model results and physical and chemical properties of pollutants, reducing pollutant concentrations in sediment and water loaded to the lagoon will result in attainment of sediment and fish tissue targets.

5.3 Loading Capacity

Due to insufficient sediment quality data in the Colorado Lagoon and from the storm drains, it is difficult to estimate the loading capacity of the sediments using the model. As such, the loading capacity of the sediments was estimated from the annual average total suspended solids (TSS) loadings to the Colorado Lagoon from 1994-2000 (Los Angeles County 1994-2000 Integrated Receiving Water Impact Report), as shown in Table 5-2. While the TSS load may not represent the total sediment loading to the Colorado Lagoon, it represents the finer material with which pollutants are more readily associated.

Table 5.2 Average Annual Total Suspended Solids (TSS) Loadings to Colorado Lagoon

Subbasins	TSS (lbs/year)	TSS (kg/year)
Project 452 Storm Drain	25,330	11,490
Line I Storm Drain	18,093	8,207
Termino Ave. Storm Drain	60,310	27,357
Line K Storm Drain	9,650	4,377
Line M Storm Drain	3,619	1,642
Project 5104 Storm Drain	3,919	1,642
Total	**120,620**	**54,715**

Assuming fine sediments carried by stormwater to be the main source of contaminated sediments to the Colorado Lagoon, pollutant specific loading capacity was calculated by multiplying the average annual total suspended solids load 54,715 kg/yr or 12,0620 lbs/year discharged to the Colorado Lagoon by the numeric sediment targets. The resultant numbers of sediment loading capacity are presented in Table 5-3. The TMDL for sediment is set equal to the loading capacity.

Table 5.3. Sediment Loading Capacity Expressed as Mass per Year

Metals	Numeric Target (ERL) (mg/kg)	Loading capacity TMDL (kg/year)	Loading Capacity TMDL (lb/year)
Zinc	150	8.2	18.08
Lead	46.7	2.6	5.63
Organics	**ERL (µg/kg)**	**TMDL (g/year)**	**TMDL (lb/year)**
Chlordane	0.5	0.027	6.03x10^{-05}
Dieldrin	0.02	0.001	2.41x10^{-06}
PAHs	4022	220	0.485
PCBs	22.7	1.24	0.0027
DDT	1.58	0.09	0.00019

5.4 Critical Conditions

The Clean Water Act stipulates a TMDL must take into account critical conditions and seasonal variation. No correlations with flow or seasonality were found to exist in sediment or tissue data, although a relationship between concentrations in sediment, water, and fish tissue exists based on the physical and chemical properties of these constituents. Given that allocations for this TMDL are expressed in terms of OC pesticides, PCBs, PAHs, and metals concentrations in sediment, a critical condition is not identified based upon flow or seasonality.

Since the potential effects of OC pesticides, PCBs, PAHs, and metals are related to bioaccumulation in the food chain and sediment accumulation over long periods of time, short term variations in concentration are not likely to cause significant impacts upon beneficial uses. Thus, average concentrations on an annual timescale are hereby defined as the critical condition.

5.5 Margin of Safety

A margin of safety for the TMDL is designed to address any uncertainty in the analysis that could result in targets not being achieved in the waterbodies. To identify whether an explicit margin of safety is necessary for each constituent, a summary of the significant uncertainty in the TMDL analysis was developed and compared to the conservative assumptions used to address the uncertainty in the analysis. The most significant uncertainty is related to the following:

- Large proportion of non-detected values present in the database, which are difficult to quantify with certainty (see Current Conditions section);
- Assumption of equal percent reduction is used for translation of fish tissue concentration reductions to appropriate sediment concentration reductions; and
- Assumption of natural removal of sediment at the bottom of the lagoon especially at the northern arm of the lagoon where dredging is not currently planned to remove contaminated sediment may not result in compliance with the sediment quality objectives.

Implicit margin of safety exists in the final WLAs and LAs for this TMDL, which results from the cumulative effect of several conservative methods employed during development of the TMDL, summarized below:

- Selection of multiple numeric targets including water, fish tissue and sediment targets to protect human health which are most protective of water, fish tissue, and sediment guidelines; and
- Selection of ERLs as numeric targets for sediment, which are the most protective of the potentially applicable sediment guidelines available.

A 10% margin of safety is also included to address uncertainty in the analysis of the TMDL. Compliance monitoring outlined in the Implementation Plan will examine the effectiveness of the WLAs and LAs over time, and adjustments will be made if necessary to ensure achievement of standards.

6 TMDL AND POLLUTANT ALLOCATION

The goals of this TMDL are to reduce OC pesticides, PCBs, PAHs, and metals concentrations in fish tissue to levels safe for consumption by humans and wildlife, and to assure sediment and water column concentrations are protective of aquatic life. Contaminated sediment generated in the watershed is transported to Colorado Lagoon through the stormwater conveyance system. These are regulated directly in the NPDES process through stormwater permits or indirectly through the issuance of NPDES permits for discharges to the stormwater system. A sediment mass-based load allocation was developed for direct atmospheric deposition. Sediment mass-based waste load allocations were developed for stormwater permittees (Los Angeles County and City of Long Beach MS4, and Caltrans) by subtracting the mass-based load allocations from the total loading capacity according to the following equation:

TMDL = Direct Atmospheric Deposition + Combined Stormwater Sources (6-1)

Concentration-based sediment waste load allocations are developed for other potential future point sources in the watershed. These other point sources have intermittent flows and should discharge little to no sediment. These sources will have a minor impact on sediment loading if they are limited by concentration to the applicable ERL-based waste load allocations.

6.1 Load Allocation

A mass-based load allocation is assigned for direct atmospheric deposition. An estimate of direct atmospheric deposition was developed based on the percent area of surface water, which is approximately 15 acres or 1.3% of the total watershed area. The load allocation for atmospheric deposition (Table 6-1) is calculated by multiplying this percentage by the total loading capacity, as illustrated in the following equation:

Direct Atmospheric Deposition = 0.013 x TMDL (6-2)

Table 6-1 Mass-Based Load Allocation for Direct Atmospheric Deposition

Constituent	Load Allocations (mg/year)
Chlordane	0.36
Dieldrin	0.014
Lead	33,217.48
Zinc	106,694.25
PAHs	2,860.83
PCBs	16.15
DDT	0.71

The loadings associated with indirect atmospheric deposition are included in the stormwater waste load allocations.

6.2 Wasteload Allocation

6.2.1 Waste Load Allocation for Stormwater Permittees

A. Mass-based Waste Load Allocation for Stormwater Permittees

The mass-based waste load allocations for the impairing pollutants in sediment are assigned to the stormwater permittees according to the following equation:

Combined Stormwater Sources = TMDL - Direct Atmospheric Deposition (6-3)

Since the direct atmospheric deposition is calculated as a percentage of the total loading capacity, equation 6-3 becomes:

Combined Stormwater Sources = TMDL – 0. 013 TMDL (6-4)

Combined Stormwater Sources = 0.987 x TMDL (6-5)

The mass-based waste load allocations for MS4 permittees including Los Angeles County Flood Control District, the City of Long Beach, and Caltrans are allocated to major storm drains outfalls that currently discharge to the lagoon. The waste load allocations are calculated by multiplying the estimated annual average TSS loading with total flows from major storm drains outfalls. Since Colorado Lagoon is located completely in the City of Long Beach and land area serviced by stormdrain systems that currently discharge stormwater to the lagoon is under the jurisdiction of the City of Long Beach, the WLAs are assigned primarily to the City of Long Beach. Caltrans shall jointly responsible to meet the WLAs assigned to Line I Storm Drain as it conveys stormwater from Caltrans' facilities and the City of Long Beach. The Los Angeles County Flood Control District owns and operates Project 452 Storm Drain, therefore jointly responsible to meets the WLAs assigned to Project 452 Storm Drain. Line N Storm Drain discharges insignificant amount of stormwater to the Lagoon, therefore WLAs is not assigned to Line N Storm Drain. The resulting allocations are presented in Table 6-2.

Table 6-2. Mass-based Waste Load Allocation for Stormwater Discharges

Constituent	Final Mass-based WLAs (mg/yr)				
	Project 452	Line I	Termino Ave	Line K	Line M
Chlordane	5.67	4.05	13.50	2.16	0.81
Dieldrin	0.23	0.16	0.54	0.09	0.03
Lead	529,607.42	378,284.43	1,260,963.47	201,748.62	75,684.54
Zinc	1,701,094.50	1,215,046.35	4,050,203.85	648,014.85	243,098.10
PAHs	45,612.01	32,579.44	108,599.47	17,375.44	6,518.27
PCBs	257.43	183.88	612.93	98.07	36.79
DDT	17.92	12.80	42.66	6.83	2.56

B. Concentration-based Waste Load Allocation for Stormwater Permittees

Concentration-based WLAs for sediment are assigned to MS4 permittees including the Los Angeles County Flood Control District and the City of Long Beach, and Caltrans. Concentration-based WLAs for sediment are applied as monthly limits. Concentration-based interim WLAs for sediment are set to allow time for removal of contaminated sediment attribute to proposed implementation actions before incorporating final WLAs into the permits. Interim WLAs are based on the 95th percentile value of sediment data collected from 2000 to 2008. The use of 95th percentile values to develop interim WLAs is consistent with current NPDES permitting methodology. If the 95th percentile is equal to or lower than the numeric target, the interim WLA is equal to the final WLA. Interim and final WLAs will be included in stormwater permits in accordance with NPDES guidance and requirements. Concentration-based interim and final WLAs for stormwater permittees are presented in Table 6-3.

Table 6-3. Concentration-based Waste Load Allocations for Storm Water Discharges

Constituent	Concentration-based WLAs	
	Interim WLAs (ug/dry kg)	Final WLAs (ug/dry kg)
Chlordane	129.65	0.5
Dieldrin	26.2	0.02
Lead	399,500	46,700
Zinc	565,000	150,000
PAHs	4,022	4,022
PCBs	89.9	22.7
DDT	149.8	1.58

USEPA requires that waste load allocations be developed for NPDES-regulated stormwater discharges. Allocations for NPDES-regulated stormwater discharges from multiple point sources may be expressed as a single categorical waste load allocation when data and information are insufficient to assign each source or outfall individual allocations. The mass-based WLAs are assigned to NPDES Permits for (1) the County of Los Angeles, Order No. 01-182, NPDES No. CAS004001, (2) the City of Long Beach, Regional Board Order No. 99-060, NPDES No. CAS004003, and (3) NPDES Permit for Stormwater Discharges from the Caltrans Properties, Facilities, and Activities, Order No. 99-06-DWQ. The mass-based and concentration based WLAs will be assigned to MS4 and Caltrans stormwater permits as specified in Tables 6-2 and 6-3.

6.2.2 Sediment Waste Load Allocation for Other Point Sources

Concentration-based waste load allocations are assigned to the minor NPDES permits, other stormwater, and non-stormwater permittees. Any future minor NPDES permits or enrollees under a general non-stormwater NPDES permit will also be subject to the concentration-based waste load allocations to ensure sediment quality is obtained and maintained. Concentration-based WLAs for other point sources are presented in Table 6-4.

Table 6-4. Concentration-based Waste Load Allocations for Other Point Sources

Constituents	Waste Load Allocation (ug/dry kg)
Chlordane	0.50
Dieldrin	0.02
Lead	46,700.00
Zinc	150,000.00
PAHs	4,022.00
PCBs	22.70
DDT	1.58

7 IMPLEMENTATION

California Water Code section 13360 precludes the Regional Board from specifying the method of compliance with waste discharge requirements. However California Water Code section 13242 requires that the Basin Plan includes an implementation plan to describe the nature of actions to be taken to achieve water quality objectives and a time schedule for action. This section describes the proposed implementation plan to meet numeric targets for OC pesticides, PCBs, metals, and PAHs in Colorado Lagoon.

As discussed in the source analysis and allocations section of this TMDL, the major contributor of associated metals, OC pesticides, PCBs and PAHs loading to Colorado Lagoon is assumed to be stormwater runoff discharged from the stormwater conveyance system. Colorado Lagoon serves main functions of hosting sensitive habitat and providing public recreation. The implementation plan includes discussion of implementation actions to manage stormwater and improve water and sediment quality.

The Los Angeles County Flood Control District, City of Long Beach, and Caltrans are jointly responsible for meeting the waste load allocations. Since Colorado Lagoon is located completely in the City of Long Beach, the City of Long Beach is the primary jurisdiction.

The Porter Cologne Water Quality Control Act prohibits the Regional Board from prescribing the method of achieving compliance with water quality standards, and likewise TMDLs. Below staff have identified potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the allowable loadings for OC pesticides, PCBs, metals, and PAHs are not exceeded.

7.1 Regulation by the Regional Board

The Porter-Cologne Water Quality Control Act provides that "All discharges of waste into the waters of the State are privileges, not rights."[24] Furthermore, all discharges are subject to regulation under the Porter-Cologne Act including both point and nonpoint source discharges.[1] In obligating the State Board and Regional Boards to address all

[1] See CWC sections 13260 and 13376.

discharges of waste that can affect water quality, the legislature provided the State Board and Regional Boards with authority in the form of administrative tools (waste discharge requirements (WDRs), waivers of WDRs, and Basin Plan waste discharge prohibitions) to address ongoing and proposed waste discharges. Hence, all current and proposed discharges must be regulated under WDRs, waivers of WDRs, a prohibition, or some combination of these administrative tools. Since the USEPA delegated responsibility to the State and Regional Boards for implementation of the National Pollutant Discharge Elimination System (NPDES) program, WDRs for discharges to surface waters also serve as NPDES permits.

7.1.1 Stormwater Discharges

As required by the federal Clean Water Act, discharges of pollutants to Colorado Lagoon from municipal stormwater conveyances are prohibited, unless the discharges are in compliance with a NPDES permit. The regulatory mechanisms used to implement the TMDL will include the MS4 stormwater permits for the Los Angeles County Flood Control District, the City of Long Beach, the Caltrans stormwater permit, and potential general industrial stormwater permits, general construction stormwater permits, and non-stormwater NPDES permits. Each NPDES permit assigned WLAs shall be reopened or amended at re-issuance, in accordance with applicable laws, to address implementation and monitoring of this TMDL and to be consistent with the waste load allocations of this TMDL.

The concentration-based WLAs for the potential future stormwater, non-stormwater NPDES permits, and minor NPDES permits will be implemented through NPDES permit conditions.

The MS4 and Caltrans permittees shall be allowed a phased implementation schedule to achieve the waste load allocations. A phased implementation approach, using a combination of non-structural and structural BMPs could be used to achieve compliance with the waste load allocations. The administrative record and the fact sheets for the MS4 and Caltrans stormwater permits must provide reasonable assurance that the BMPs selected will be sufficient to implement the WLAs in the TMDL.

We expect that reductions to be achieved by each BMP will be documented and that sufficient monitoring will be put in place to verify that the required reductions are achieved. The permits should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance. If proposed structural and non-structural BMPs adequately implement the waste load allocations then additional controls are not necessary. Alternatively, if the proposed structural and non-structural BMPs selected prove to be inadequate then additional structural and non-structural BMPs or additional controls may be required.

MS4 permittees, Caltrans, and other NPDES dischargers will be required to meet the WLAs at the designated assessment locations as defined in the TMDL monitoring plan.

To achieve the necessary reductions to meet the allowable waste load allocations, permittees could balance short-term capital investments directed to addressing this and other TMDLs in the Colorado Lagoon watershed with long-term planning activities for stormwater management in the region as a whole. It should be emphasized that the potential implementation strategies discussed below may contribute to the implementation of other TMDL for Colorado Lagoon. Likewise, implementation of other TMDL in the Colorado Lagoon Watershed may contribute to the implementation of this TMDL.

7.2 Potential Implementation Strategies

The implementation strategy selected will need to control the loading of polluted stormwater and contaminated sediments to Colorado Lagoon during dry and wet weather. OC pesticides, PCBs, PAHs, and metals are predominately bound to sediment, which are mainly transported with storm runoff. TMDL implementation will be carried out by responsible agencies including, but not limited to, the Los Angeles County Flood Control District, the City of Long Beach, and Caltrans to control water and sediment loadings. Responsible agencies may employ a variety of implementation strategies such as non-structural and structural BMPs to meet the required waste load allocations. The implementation actions described in this section represent a range of activities that are proposed by the Los Angeles County Flood Control District and City of Long Beach in the *Los Angeles County Termino Avenue Drain Project* and *Colorado Lagoon Restoration Project* which could be conducted to control polluted stormwater and contaminated sediments to Colorado Lagoon, attain water and sediment quality standards, and protect beneficial uses. The lead agencies for proposed and subsequent projects would be obligated to mitigate any impacts they identify. The Los Angeles County Flood Control District and the City of Long Beach have prepared Environmental Impact Reports (EIRs) for the two projects mentioned above. Detailed discussion of the EIRs is included in the Substitute Environmental Document for the Colorado Lagoon OC Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals TMDL.

7.2.1 Non-Structural Best Management Practices

The non-structural BMPs are based on the premise that specific land uses or critical sources can be targeted to achieve the TMDL waste load allocations. Non-structural BMPs provide several advantages over structural BMPs. Typically non-structural BMPs can be implemented in a relatively short period of time. The capital investment required to implement non-structural BMPs is generally less than for structural BMPs. However, the labor costs associated with non-structural BMPs may be higher, therefore, the non-structural BMPs may be more costly in the long run. Examples of non-structural controls include better sediment control at construction sites and improved street cleaning by upgrading to vacuum type sweepers, storm drain cleaning, and public education and out reach.

The golf course located adjacent to the lagoon is commonly referred as “Little Rec”. The lagoon is impacted by irrigation runoff from the course in the dry season. Improvements to the golf course operation including reducing watering needs and elimination of pesticide and herbicide use should also be considered to protect lagoon resources. Installation of soil moisture meters is recommended to provide sufficient data to enable the course operation to reduce watering and resultant runoff.

7.2.2 Structural Best Management Practices

7.2.2.1 Relocation of the Termino Avenue Drain

There are 11 storm drains that currently discharge into the Lagoon. Four of these are major system outfalls, serving large areas of the watershed. One of the major system outfall structures, the Termino Avenue Drain, is currently proposed by the Los Angeles County Flood Control District to be modified to no longer discharge into the Lagoon. As proposed in the County of Los Angeles Termino Avenue Drain Project (TADP) the drain would bypass the Lagoon and discharge stormwater flows into Marine Stadium and dry weather flows into the sanitary sewer system. This project would also redirect flows from three other storm drains located on the south shore of the Lagoon that currently discharge into the Lagoon. The existing outfalls and indicated drains that would be diverted by the TADP are shown on Figure 7.1.

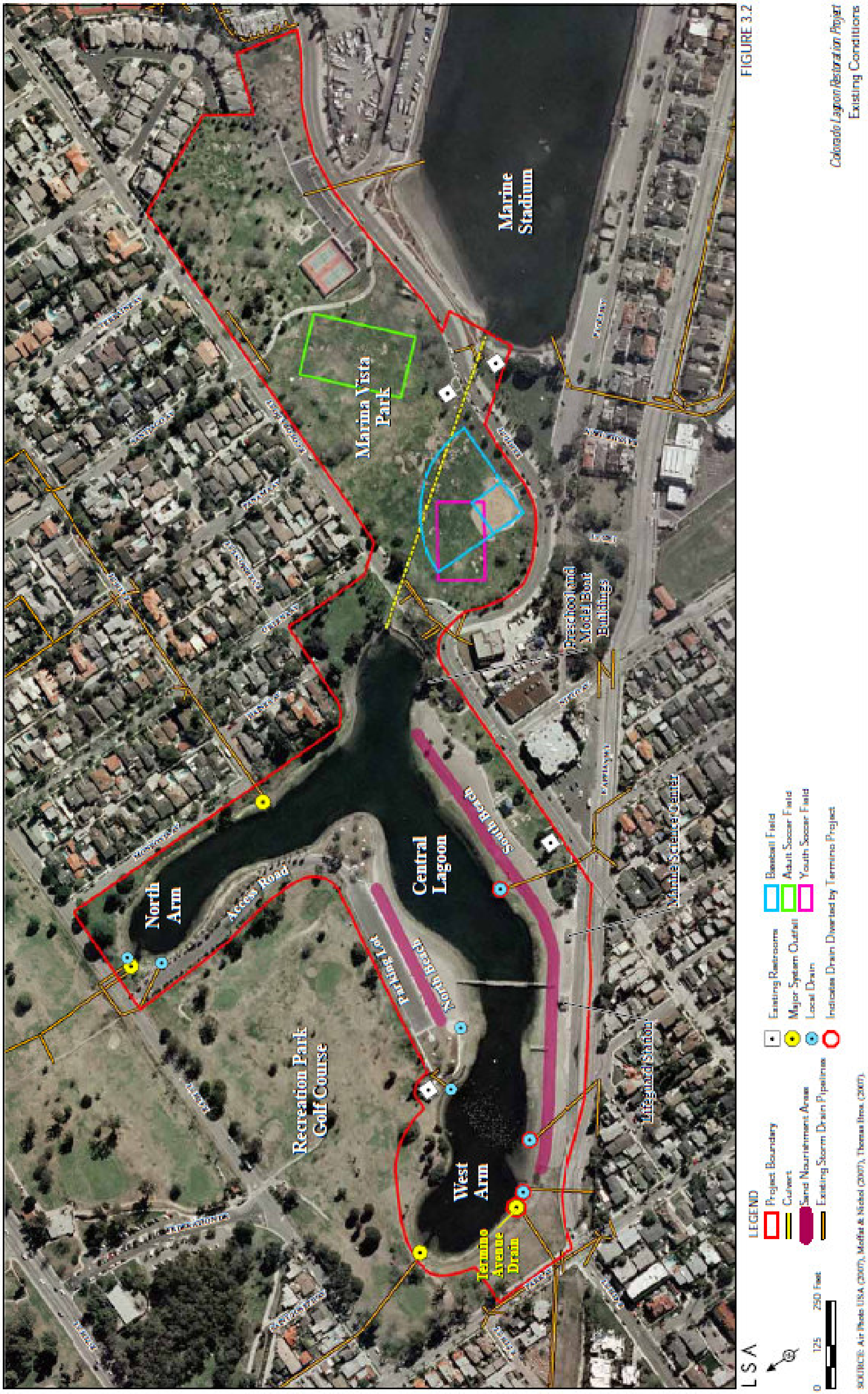


Figure 7.1 Existing Condition and Storm Drain Outfalls Currently Discharged to Colorado Lagoon

The project would result in reduced low flows during the dry season as the nuisance effluent would be diverted to the sanitary sewer. Routing the outlet to Marine Stadium will reduce storm flows and associated pollutants contributed to the Colorado Lagoon ecosystem. Better water and sediment quality will be attained and maintained with reduction of sediments, trash and debris discharged into the lagoon during storm events.

7.2.2.2 Low Flow Diversion and Trash Separation Device

The storm drain upgrade components of the Colorado Lagoon Restoration Project would divert low storm drain flows from the remaining three major storm drain system outfalls and install trash separation devices to trap trash and debris prior to entering the wet well for the diverted runoff (Figure 7.2). These components of the Colorado Lagoon Restoration Project would redirect or treat low flows from these drains to minimize contamination of water and sediment.

Diversion structures/mechanisms would be installed a short distance upstream of the discharge ends of the three major system outfalls to divert low storm drain flows. The diversion system would be designed so that storm flows would bypass the diversion and discharge directly into the Lagoon, whereas the dry weather runoff discharge would be diverted to a wet well. The diversion system would include flow meters and valve control devices such that during a large storm event, the control device would shut off when the meter indicated that the flow had reached the upset limit of the available storage within the wet well. One-way flap gates would be installed at the end of these storm drain pipes so as to preclude tidal saltwater from entering into the storm drain and potentially the sanitary sewer diversion system while allowing storm flows to discharge into the Lagoon. The runoff collected in the wet well would be pumped via the County sewer line.

7.2.2.3 Vegetated Bioswale Installation

The flows from the remaining four local storm drains would be treated via a vegetated bioswale. A bioswale would also be developed on the north shore between the Lagoon and Recreation Park Golf Course. The vegetated bioswale would treat stormwater and dry weather runoff through filtration to remove sediment and pollutants prior to discharge into the Lagoon. One long bioswale would be located adjacent to the fence line between the Lagoon and the golf course and would treat the discharge from the two local drains on the tip of the north arm and any runoff from the golf course. Two smaller bioswales would treat the discharge from the two local drains on the north shore of the Lagoon to the west of the foot bridge. The locations of these drains and proposed bioswales are shown on Figure 7.2

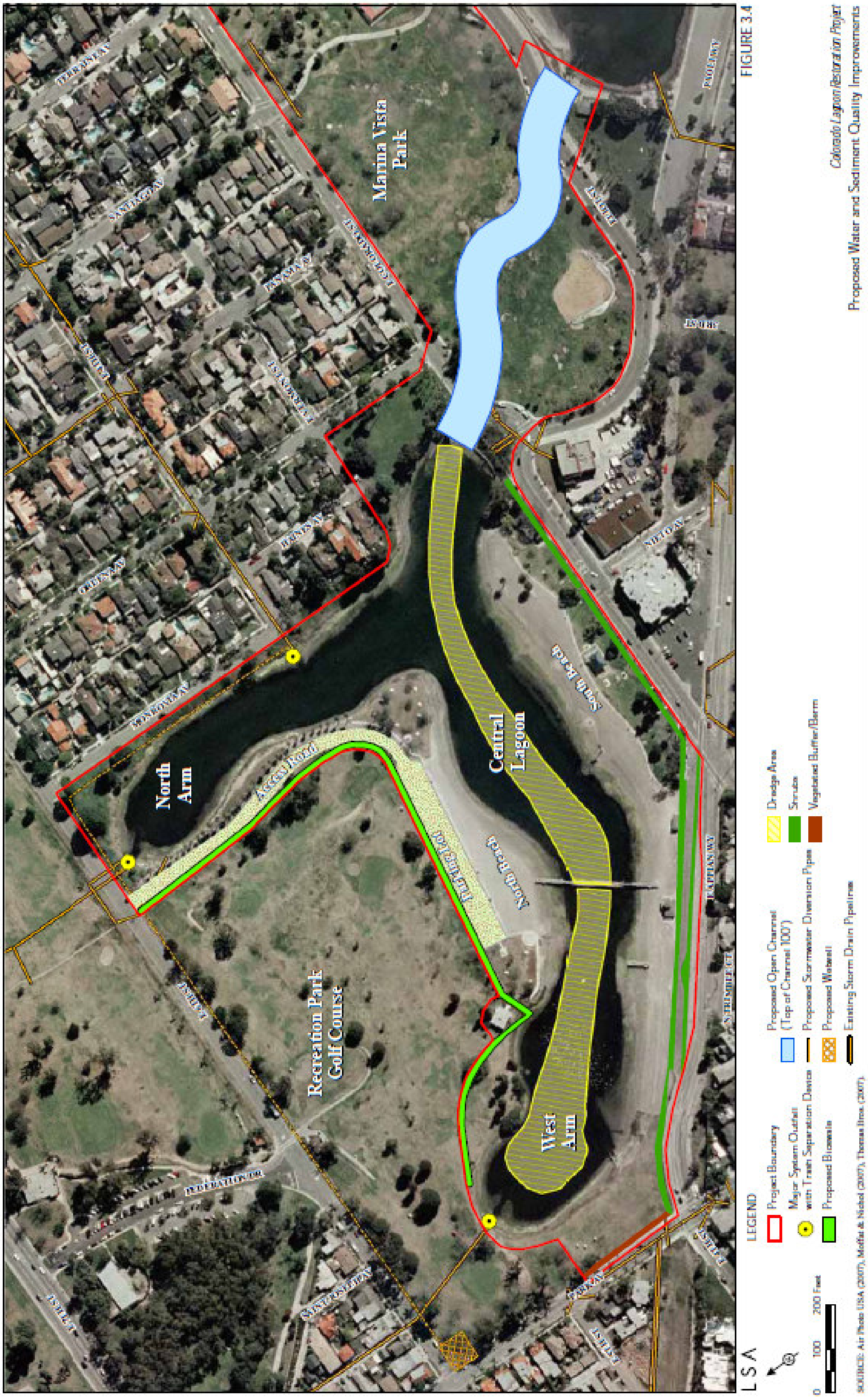


Figure 7.2 Proposed Storm Drain Upgrades, Dredging, Bioswales, and Open Channel

7.2.2.4 Clean Culvert, Repair Tidal Gates, and Remove Sill/Structural Impedances

The Colorado Lagoon is connected to Alamitos Bay and the Pacific Ocean through an underground tidal culvert to Marine Stadium. The existing culvert has not been cleaned since it was built in the 1960s. Because of this, the culvert is impeded by sediment that has accumulated on the bottom, extensive marine growth that has accumulated on the sides and ceiling, and debris that is trapped within the trash racks on the tide gate screens at both ends of the culvert. These existing conditions limit the Lagoon's tidal range and tidal flushing, which results in increased degradation of water quality.

This short-term project component would clean the existing culvert and trash racks, repair the tidal gates, and remove the sill and structural impedances within and around the existing culvert. Implementation of this component of the Colorado Lagoon Restoration Project would result in an increase in the tidal range and tidal flushing, resulting in increased water circulation and an improvement in water and sediment quality.

7.2.2.5 Build Open Channel or Underground Culvert Between Lagoon and Marine Stadium.

This proposed project consists of replacing the existing concrete box culvert with an open channel that would run from the Lagoon through Marina Vista Park to Marine Stadium in a location generally parallel to the existing culvert. The open channel will be characterized by gently sloping banks, rock riprap construction, native landscaping, and a trail along the banks. Creating an open channel would improve tidal flushing by an increase in the tidal range, and result in a corresponding improvement in water and sediment quality. In addition, it would provide improved flood flow conveyance. Note that at this time the certified EIR for the Colorado Restoration Project only includes Phase 1 of the project which does not include the Open Channel/Underground Culvert portion. Update on this portion of the project will be provided in the progress report.

7.2.2.6 Remove Contaminated Sediment in the Western Arm.

OC pesticides, PCBs, PAHs, and metals were deposited over time from the particulates in the runoff brought to the Lagoon through the existing storm drains. There were two surveys conducted in 2004 and 2006 and both surveys confirmed the presence of the 303(d) list constituents and strongly indicated a contamination gradient with high levels of contaminants in the western arm of the Lagoon, transitioning to much lower levels toward the central Lagoon area. It is estimated that the layer of contaminated sediment reaches 4 to 5 ft deep. The City of Long Beach proposes to remove sediment to a depth of 6 ft to provide a safeguard that only clean sediment remains. The excavation depth gradually decreases toward the footbridge. This component of the Colorado Lagoon Restoration Project would remove approximately 16,000 cubic yards (cy) of contaminated sediment within the western arm of the Lagoon.

7.2.2.7 Remove Contaminated Sediment in the Central Lagoon.

Similar to the discussion in section 7.2.2.5, this portion of the Colorado Lagoon Restoration Project would remove sediment and sand that has eroded and been deposited into the Lagoon waters over years and create a larger subtidal area. Approximately 5,500 cy of sediment would be removed from the central Lagoon. Sediment removal from the central area of the lagoon would create a channel through the center of the central Lagoon to connect the dredge areas in the western arm to the existing culvert or proposed open channel. Removal of this sediment would also provide additional area for water circulation and tidal flushing.

8 MONITORING

The Colorado Lagoon TMDL Monitoring Plan (CLTMP) is designed to monitor and evaluate implementation of this TMDL and refine the understanding of current water and sediment loadings. The information presented in this section is intended to be a brief overview of the goals of the CLTMP. Special studies may be planned to improve understanding of key aspects related to achievement of WLAs and to assist in the modification of structural and non-structural BMPs if necessary. The CLTMP is also intended to parallel monitoring efforts of the this TMDL and the Bacteria TMDL that may be developed for Colorado Lagoon to minimize duplicative sampling efforts between required monitoring programs. The goals of the CLTMP include:

1. To determine compliance with OC pesticides, PCBs, metals, and PAHs waste load and load allocations.

2. To monitor the effect of implementation actions proposed by Los Angeles County Flood Control District and the City of Long Beach on water and sediment quality.

3. To monitor contaminated sediment level in the Lagoon especially in the North Arm of the Lagoon and determine if additional implementation action such as dredging should be required.
4.

5. To implement the CLTMP in a manner consistent with other TMDL implementation plans and regulatory actions within the Colorado Lagoon watershed.

The monitoring program and any required technical reports will be established pursuant to a subsequent order issued by the Executive Officer. As a planning document, the TMDL identifies the type of information necessary to refine and update it, and to assess its effectiveness. The Executive Officer will comply with any necessary legal requirements in developing the monitoring program, requiring technical reports, and establishing special studies.

8.1 Water, Sediment, and Fish Tissue Monitoring

Monitoring will begin within one year of the effective date of the Colorado Lagoon OC pesticides, PCBs, Sediment Toxicity, PAHs, and metals TMDL pending approval of the monitoring plan by the Executive Officer. Water column, sediment, and fish tissue samples shall be collected at the West, Central, and North Arms of the lagoon and at the outlet of the lagoon to Marine Stadium. The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans are jointly responsible for conducting water, sediment and fish tissue testing.

Water quality samples and the total suspended solids samples shall be collected quarterly and analyzed for TSS, Chlordane, Dieldrin, OC pesticides, and total PCBs at detection limits that are at or below the minimum levels. The minimum levels are those published by the State Water Resources Control Board in Appendix 4 of the Policy for the Implementation of Toxic Standards for Inland Surface Water, Enclosed Bays, and Estuaries of California, March 2, 2000. If these can not be achieved with conventional techniques, then a special study should be proposed to evaluate concentrations of these constituents.

Water quality samples shall also be collected quarterly and analyzed for general water quality constituents, total recoverable and dissolved PAHs, lead, and zinc. Total suspended solid samples shall also be collected to analyze for PAHs, lead, and zinc. For metals in water column, methods that allow for (1) the removal of salt matrix to reduce interference and avoid inaccurate results prior to the analysis; and (2) the use of trace metal clean sampling techniques, should be applied. Examples of such methods include EPA Method 1669 for sample collection and handling, and EPA Method 1640 for sample preparation and analysis.

Sediment samples will be collected annually for analysis of general sediment quality constituents (GSQC), OC pesticides, PCBs, sediment toxicity, PAHs, and metals. Lead, zinc, chlordane, dieldrin, and total PCBs shall be analyzed at detection limits that are lower than the ERLs. The sediment toxicity testing shall include testings of multiple species, a minimum of three, for lethal and non-lethal endpoints. Toxicity testing may include: the 28-day and 10-day amphipod mortality test, the sea urchin fertilization testing of sediment pore water, and the bivalve embryo testing of the sediment/water interface. The chronic 28-day and shorter-term 10-day amphipod tests may be conducted in the first year of quarterly testing and the results compared. If there is no significant difference in the tests, then the less expensive 10-day test can be used throughout the rest of the monitoring, with some periodic 28-day testings. Initial sediment toxicity monitoring should be conducted quarterly in the first year of the TMDL to define the baseline and semi-annually, thereafter, to provide sufficient data over the implementation timeframe to evaluate changes in sediment quality due to implementation actions.

Fish tissue samples will be collected annually and analyzed for chlordane, Dieldrin, DDT, and PCBs to assess changes in concentrations of target organic constituents. Fish tissue samples will be collected every year in Colorado Lagoon. The same reasoning used for establishing sediments sampling frequency was used to establish fish tissue sample collection frequency. For Colorado Lagoon, species with the potential for human and wildlife consumption will be targeted. In freshwater systems, estuary fish species compositions can be variable from year to year. For this reason, it is proposed that target species in the lagoon are selected based on the local abundances and fish size at the time of field collection. Fish targeted to evaluate potential impacts to human health will be limited to species more commonly consumed by humans. Tissues analyzed will be based on most common preparation for the selected fish species, so for larger species such as bass and halibut, muscle tissue will be filleted and analyzed with skin on, while smaller species such as sand dab, will be cleaned with head, guts and tails removed before analysis (SWRCB, 1998). To further assess potential human impacts, tissues from resident California or bay mussels will also be evaluated.

8.2 Special Studies

Special studies listed below are optional and can be used to develop the necessary information to identify areas with high concentrations and effectiveness of sediment allocations in protecting the beneficial uses of Colorado Lagoon if deemed necessary by the stakeholders in the Colorado Lagoon watershed.

- Special Study #1 – Investigation of Soil Concentrations and Identification of 'Hot Spots'

  The purpose of this special study is to identify terrestrial areas with high concentrations of OC pesticides, PCBs, and metals either due to anthropogenic sources or other potential sources. Use of detailed soil maps for the watershed in combination with field survey and soil sampling may lead to identification of areas important for reducing overall loads to the lagoon. Identification of any areas with elevated soil concentrations of metals and/or selenium would create an opportunity for efficient and targeted implementation actions, such as remediation or erosion control.

- Special Study #2 – Evaluation of the effectiveness of sediment allocations in protecting the beneficial uses of Colorado Lagoon

  Convene a Science Advisory Panel to evaluate the effectiveness of all sediment allocations in protecting the beneficial uses of Colorado Lagoon. The Science Advisory Panel can evaluate the historic and current habitat and sediment conditions in Colorado Lagoon, and may recommend sediment, biological, and habitat condition to protect habitat related beneficial uses.

9. EVALUATION OF IMPLEMENTATION PLAN AND ALLOCATIONS

The allocations provided in Section 6 are calculated using the numeric targets for the TMDL. These allocations are anticipated to achieve the sediment and fish tissue objectives. The City of Long Beach has proposed the following scenarios to implement the TMDL through proposed implementation actions provided in Section 7 of this TMDL:

Scenario 1:

This scenario includes dredging of west arm and central arm, relocation of Termino Ave. drain, low flow diversion, vegetated bioswale installation, and open channel construction.

Scenario 2:

This scenario includes dredging of west arm and central arm, cleaning of existing culvert, relocation of Termino drain, low flow diversion, vegetated bioswale installation.

Scenario 3:

This scenario includes dredging of west arm, cleaning of existing culvert, relocation of Termino drain, low flow diversion, vegetated bioswale installation.

The proposed scenarios were put into the EFDC model to estimate the results of meeting the TMDL allocations.

The dredging of west arm and central arm will dredge the sediment bed to a depth of 6ft and provide a safeguard that only clean sediment remains in the west arm and central arm. Therefore, zero background concentration is assumed in the initial sediment bed for the simulation of this dredging scenario. Relocation of storm drains and low flow diversion include the relocation of Termino Avenue Drain and discharge of storm drain water flows into Marine Stadium and the redirection of dry weather flows from all other storm drains into the sanitary sewer system. The vegetated bioswale would treat stormwater and dry weather runoff through filtration to remove sediment and pollutants prior to discharge into the Lagoon. Based on the U.S. EPA 1999 report, a 60% removal rate of zinc, lead and hydrocarbon pollutants for vegetated bioswale treatment is assumed in the model. Building an open channel will replace the existing concrete box culvert with an open channel that would run from the Lagoon through Marina Vista Park to Marina Stadium in generally the same alignment as the existing culvert. The open channel would be 14 ft deep, have 3:1 (H:V) side-slopes, and would be approximately 100 ft across at the top. The Manning's roughness of the channel bed is assumed 0.03 in the model simulation. The existing culvert has not been cleaned since it was built in the 1960's. Because of this, the culvert is impeded by sediment that has accumulated on the bottom. Cleaning the existing culvert will reduce the flow roughness and the Manning's n in culvert bed is assumed to be reduced from 0.05 to 0.04 in the model.

The dry weather input of flow rates and water quality concentrations from storm drains is presented in Table 9.1. For proposed restoration scenarios, the input flow rates and water quality concentrations are presented in Table 9.2. The annual loads that are estimated by using the flow rates and water quality concentrations are provided in Table 9.3 and Table 9.4 for existing storm drains and proposed scenarios respectively.

Table 9.1 Wet Weather Loads from Storm Drains Due to Watershed Runoff for Proposed Restoration Scenarios in Colorado Lagoon

	#1	#2	#3	#4	#5	#6	Sum of Storm Drains
	Project 452 Storm Drain	Line I Storm Drain	Termino Ave Storm Drain	Line K Storm Drain	Line M Storm Drain	Project 5104 Storm Drain	
Fractions	0.21	0.15	0.50	0.08	0.03	0.03	1.00
Area (acres)	228.06	162.90	543.00	86.88	32.58	32.58	1086.00
Wet Flow (CMS)	0.018	0.013	0	0.0069	0	0.0064	0.044
Total Flow (m3/year)	46,622.98	33,302.13	0	17,761.14	0	16,651.07	114,337.32
TSS (mg/L)	39.44	39.44	0	39.44	0	98.56	
Total Lead (ug/L)	4.32	4.32	0	4.32	0	10.81	
Total Zinc (ug/L)	45.55	45.55	0	45.55	0	113.87	
Total PAHs (ug/L)	1.41	1.41	0	1.41	0	3.52	
Total PCBs (ug/L)	0.0012	0.0012	0	0.0012	0	0.003	
Total DDT (ug/L)	0.0018	0.0018	0	0.0018	0	0.0045	
TSS (lbs/year)	4,054.58	2,896.13	0	1,544.60	0	3,618.69	12,113.99
Total Lead (lbs/year)	0.44	0.32	0	0.17	0	0.40	1.33
Total Zinc (lbs/year)	4.68	3.34	0	1.78	0	4.18	13.99
Total PAHS (lbs/year)	0.14	0.10	0	0.055	0	0.13	0.43
Total PCBs (lbs/year)	0.00012	8.8E-05	0	4.7E-05	0	0.00011	0.00037
Total DDT (lbs/year)	0.00019	0.00013	0	7.0E-05	0	0.00017	0.00055

Table 9.2 Wet Weather Loads from Storm Drains Due to Watershed Runoff for Proposed Restoration Scenarios in Colorado Lagoon

	#1	#2	#3	#4	#5	#6	Sum of Storm Drains
	Project 452 Storm Drain	Line I Storm Drain	Termino Ave Storm Drain	Line K Storm Drain	Line M Storm Drain	Project 5104 Storm Drain	
Fractions	0.21	0.15	0.5	0.08	0.03	0.03	1
Area (acres)	228.06	162.9	543	86.88	32.58	32.58	1,086
Wet Flow (CMS)	0.018	0.013	0	0.0069	0	0.0064	0.044
TSS (mg/L)	39.44	39.44	0	39.44	0	98.56	
Total Lead (ug/L)	4.32	4.32	0	4.32	0	10.81	
Total Zinc (ug/L)	45.55	45.55	0	45.55	0	113.87	
Total PAHs (ug/L)	1.41	1.41	0	1.41	0	3.52	
Total PCBs (ug/L)	0.0012	0.0012	0	0.0012	0	0.003	
Total DDT (ug/L)	0.0018	0.0018	0	0.0018	0	0.0045	
Total Flow (m3/year)	46,622.98	33,302.13	0	17,761.14	0	16,651.07	114,337.32
TSS (lbs/year)	4,054.58	2,896.13	0	1,544.60	0	3,618.69	12,113.99
Total Lead (lbs/year)	0.44	0.32	0	0.17	0	0.40	1.33
Total Zinc (lbs/year)	4.68	3.34	0	1.78	0	4.18	13.99
Total PAHS (lbs/year)	0.14	0.10	0	0.055	0	0.13	0.43

	#1	#2	#3	#4	#5	#6	Sum of Storm Drains
	Project 452 Storm Drain	Line I Storm Drain	Termino Ave Storm Drain	Line K Storm Drain	Line M Storm Drain	Project 5104 Storm Drain	
Total PCBs (lbs/year)	0.00012	8.8E-05	0	4.7E-05	0	0.00011	0.00037
Total DDT (lbs/year)	0.00019	0.00013	0	7.0E-05	0	0.00017	0.00055

Table 9.3 Annual Loads from Storm Drains for Existing Condition in Colorado Lagoon

	#1	#2	#3	#4	#5	#6	Sum of Storm Drains
	Project 452 Storm Drain	Line I Storm Drain	Termino Ave Storm Drain	Line K Storm Drain	Line M Storm Drain	Project 5104 Storm Drain	
Flow volume (m3/year)	173,287.70	151,563.17	289,674.24	57,427.64	16,651.07	16,651.07	705,254.88
TSS (lbs/year)	25,330.26	18,093.04	60,310.15	9,649.62	3,618.61	3,618.61	120,620.29
Total Lead (lbs/year)	3.15	2.09	6.64	1.08	0.40	0.40	13.76
Total Zinc (lbs/year)	36.02	23.46	70.36	11.84	4.18	4.18	150.05
Total PAHs (lbs/year)	0.91	0.65	2.15	0.34	0.13	0.13	4.32
Total PCBs (lbs/year)	0.00077	0.00055	0.0018	0.00029	0.00011	0.00011	0.0037
Total DDT (lbs/year)	0.0012	0.00082	0.0028	0.00044	0.00017	0.00017	0.0055

Table 9.4 Annual Loads from Storm Drains for Proposed Restoration Scenarios in Colorado Lagoon

	#1	#2	#3	#4	#5	#6	Sum of Storm Drains
	Project 452 Storm Drain	Line I Storm Drain	Termino Ave Storm Drain	Line K Storm Drain	Line M Storm Drain	Project 5104 Storm Drain	
Flow volume (m3/year)	46,622.98	33,302.13	0	17,761.14	0	16,651.07	114,337.32
TSS (lbs/year)	4,054.58	2,896.13	0	1,544.60	0	3,618.69	12,113.99
Total Lead (lbs/year)	0.44	0.32	0	0.17	0	0.40	1.33
Total Zinc (lbs/year)	4.68	3.34	0	1.78	0	4.18	13.99
Total PAHs (lbs/year)	0.14	0.10	0	0.055	0	0.13	0.43
Total PCBs (lbs/year)	0.00012	8.8E-05	0	4.7E-05	0	0.00011	0.00037
Total DDT (lbs/year)	0.00019	0.00013	0	7.0E-05	0	0.00017	0.00055

The computational grid for the proposed scenario with open channel is shown in Figure 9.1. The tidal elevations specified as the ocean boundary along the ocean portion at Marina Stadium in the computational grid for existing and all scenario simulations are presented in Figure 9.2. The flow from watershed runoff that is discharged into Colorado Lagoon was obtained by using rational formulas, land use, precipitation data from 2001 at Long Beach Reclamation Plant. The flow rates from January 1 to April 30, 2001 are presented in Figure 9.3.

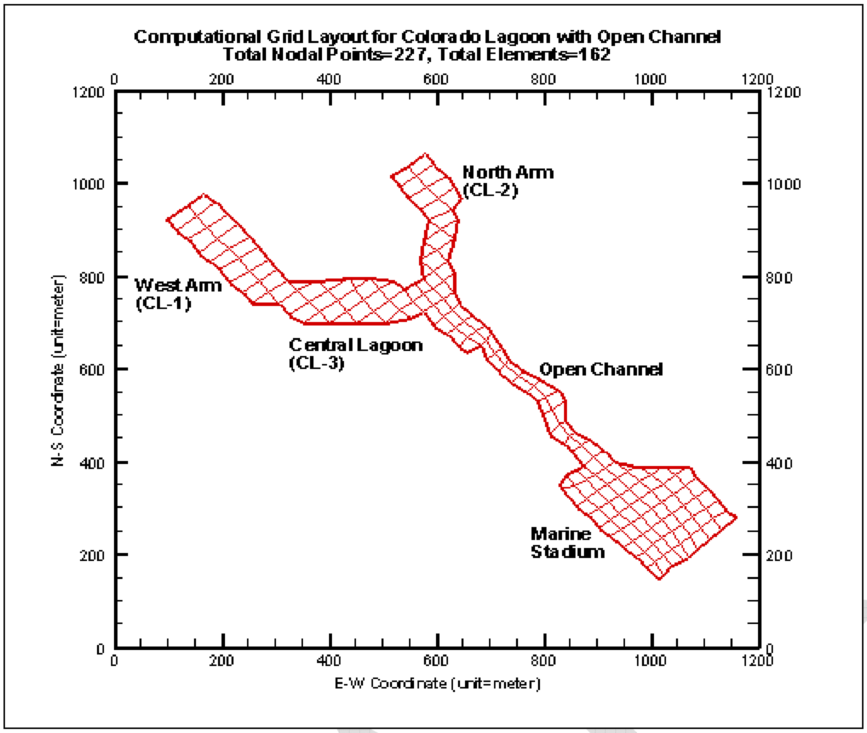


Figure 9.1 Computational Grid Set-up for Scenario 1 in Colorado Lagoon Model

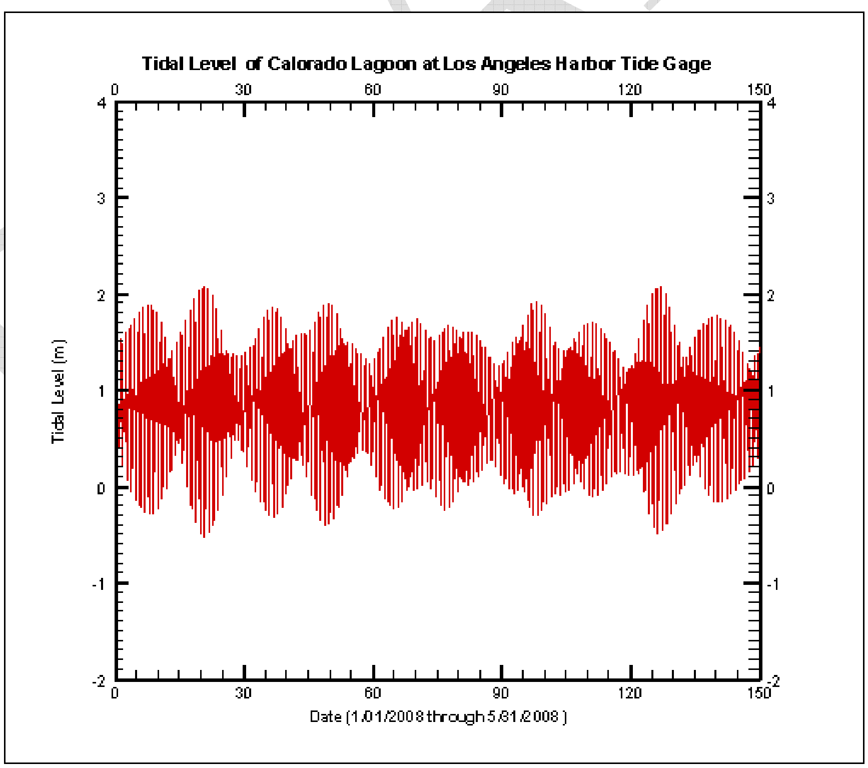


Figure 9.2 Tidal Elevations at Los Angeles Outer Harbor Tide Gage Used as Ocean Boundary Conditions (January 1, 2008 through May 31, 2008)

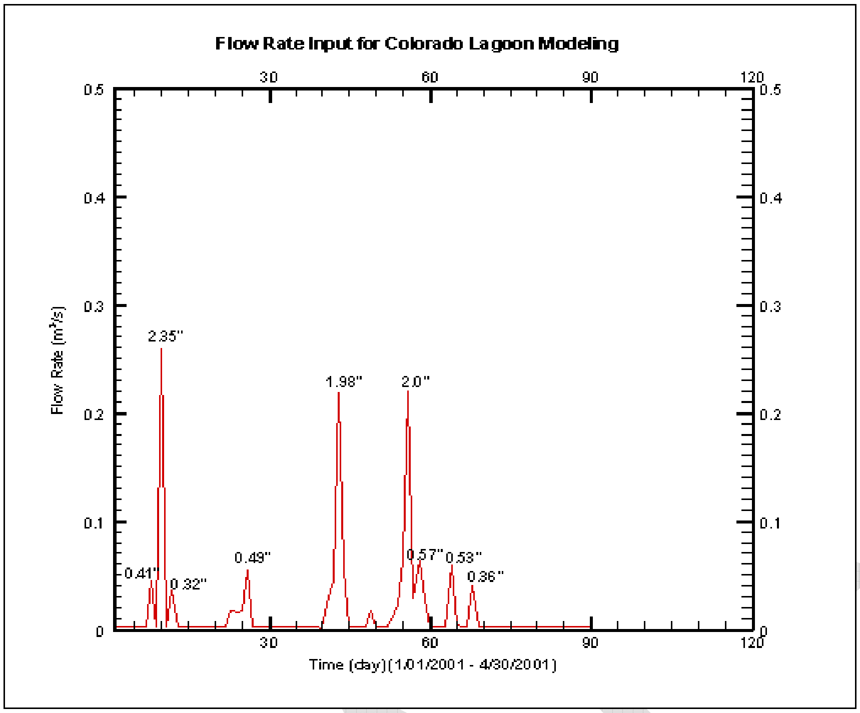


Figure 9.3 Flow Rate Input from Watershed into Colorado Lagoon (January 1, 2001 through April 30, 2001)

For the existing storm drain discharge condition and three restoration scenarios, the predicted concentrations in the sediment bed for total Zinc are presented in Figure 9.4 through Figure 9.7. The predicted results of total lead are presented in Figure 9.8 through Figure 9.11. The model results of PAHs, PCBs, and DDT are also shown in Figure 9.12 through Figure 9.23. The concentrations of these constituents for the existing condition and all scenarios are obtained from the model results shown in Figure 9.4 through Figure 9.23 and presented in Table 9.5. The background concentrations in the sediment bed presented in Table 9.6 are estimated by assuming that 10% of existing sediment concentrations will remain in the sediment bed after dredging of the sediment bed in the proposed restoration scenarios. The existing concentrations in sediment bed are based on the average values of two sampling events conducted in 2008. As such, the final sediment concentrations of all simulation scenarios are obtained by adding the increased concentrations due to annual loading as shown in Table 9.5 to the background concentrations indicated in Table 9.6; the resultant final sediment concentrations are presented in Table 9.7. The values in red shown in these Tables are exceedances of the numeric targets, which are indicated in these Tables as well. It can be seen from these results that the proposed restoration scenarios can effectively maintain the concentrations in the sediment bed at levels less than numeric targets after annual loading from storm drains into Colorado Lagoon are considered. Comparing the annual loads from proposed restoration scenarios, the annual loadings into Colorado Lagoon for the proposed scenarios are within the loading capacity (TMDL). The model results also demonstrate that the final sediment concentrations after annual loading are still less than numeric targets and no exceedances exit except in the North Arm (CL-2) where no dredging of the sediments is proposed.

The water quality model developed for Colorado Lagoon has been calibrated and closely predicts observed data. The model is capable of simulating metals and other pollutants like PAHs, PCBs and DDT transport in Colorado Lagoon. The model results demonstrate that the proposed restoration scenarios with an open channel or without an open channel can maintain sediment concentrations within numeric targets. The model results also indicate that relocation of storm drains and dredging of the sediments are the two most effective approaches in the restoration plan to improve the sediment and water quality for Colorado Lagoon. It is recommended that the dredging of the sediments in the Northern Arm should be considered if high sediment concentrations still remain after proposed actions are implemented.

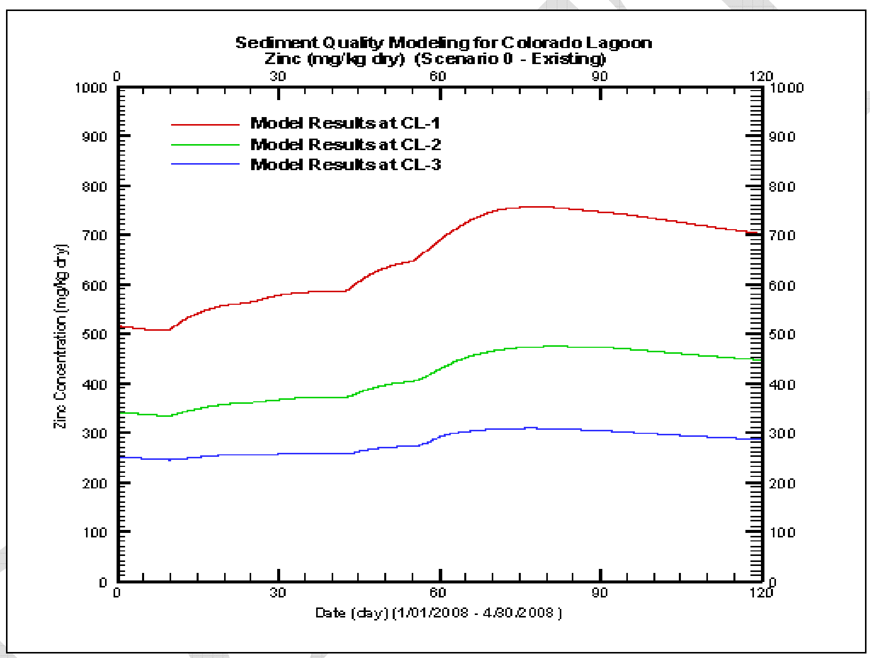


Figure 9.4 Predicted Concentrations of Total Zinc in Sediment Bed at Stations CL-1, CL-2, CL-3 for Existing Conditions

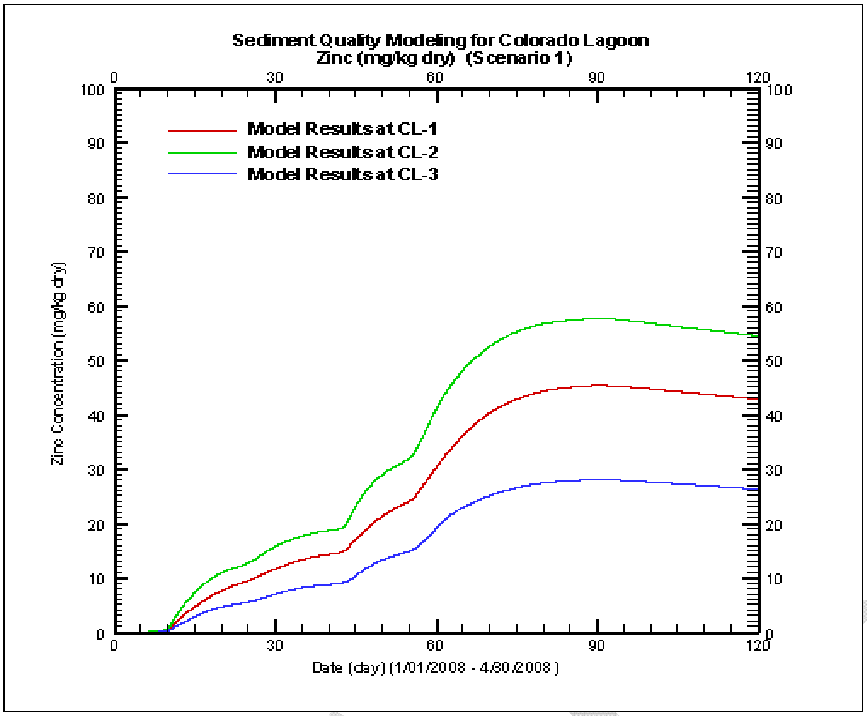


Figure 9.5 Predicted Concentrations of Total Zinc in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 1

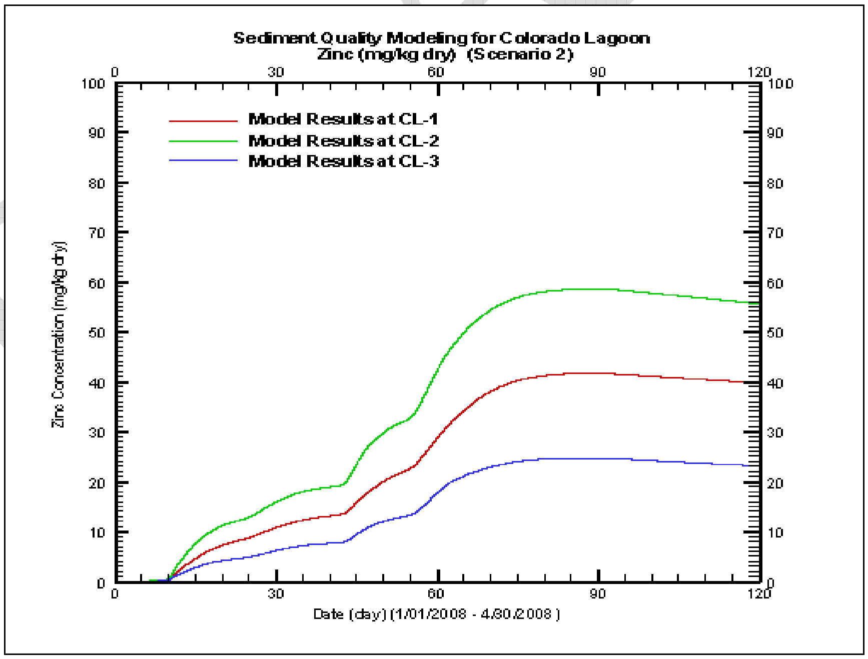


Figure 9.6 Predicted Concentrations of Total Zinc in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 2

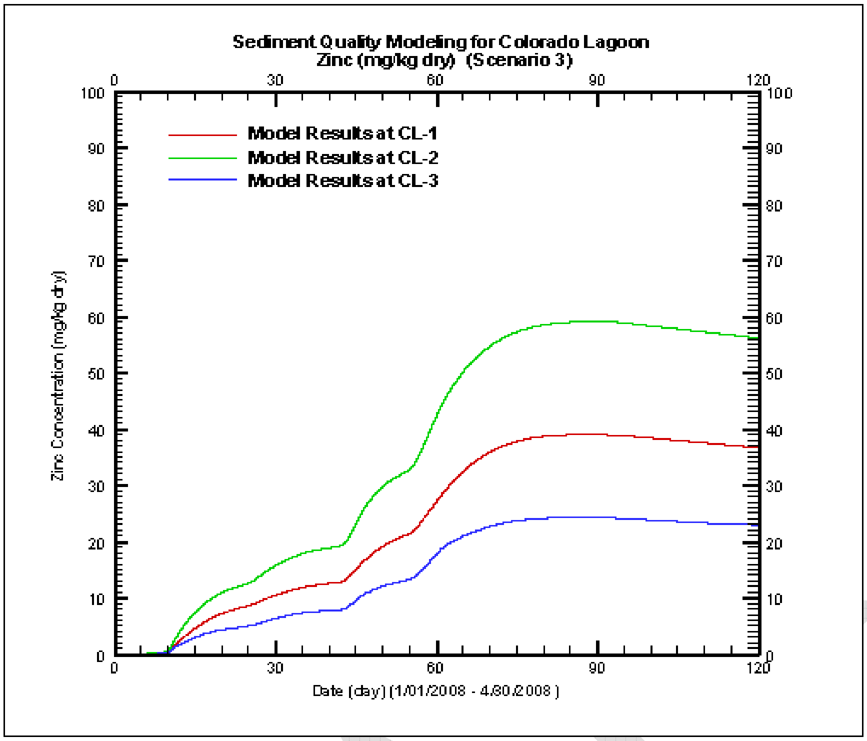


Figure 9.7 Predicted Concentrations of Total Zinc in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 3

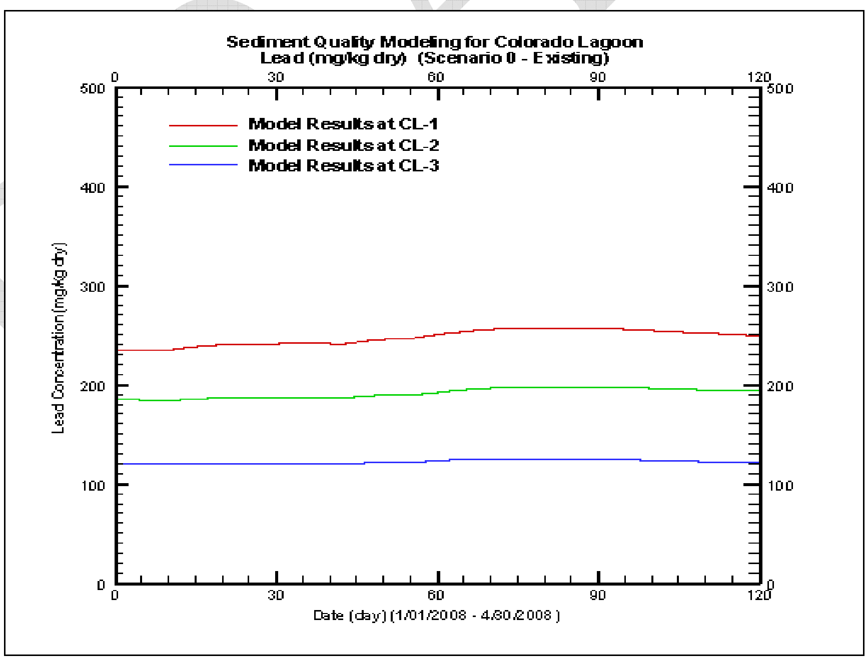


Figure 9.8 Predicted Concentrations of Total Lead in Sediment Bed at Stations CL-1, CL-2, CL-3 for Existing Conditions

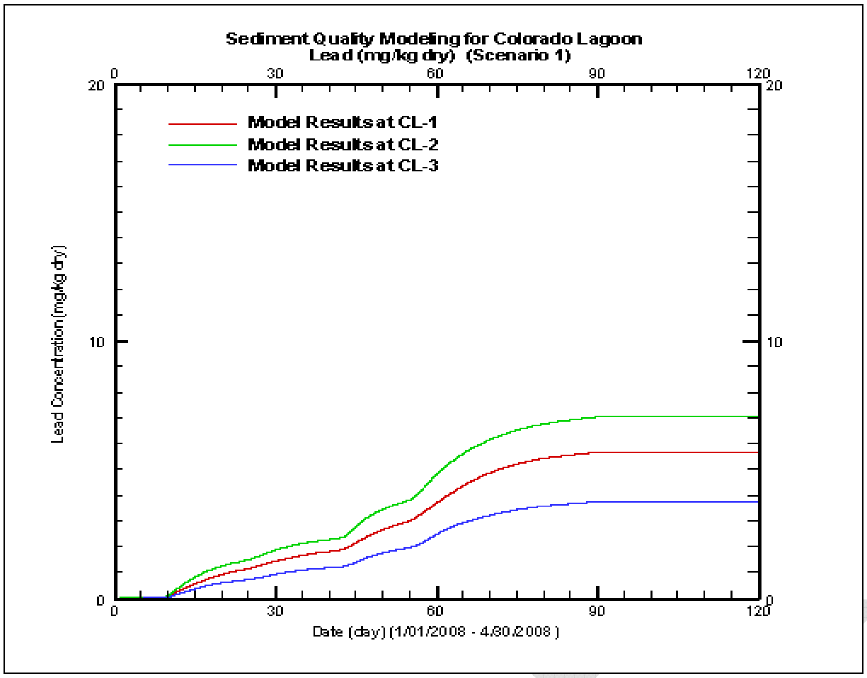


Figure 9.9 Predicted Concentrations of Total Lead in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 1

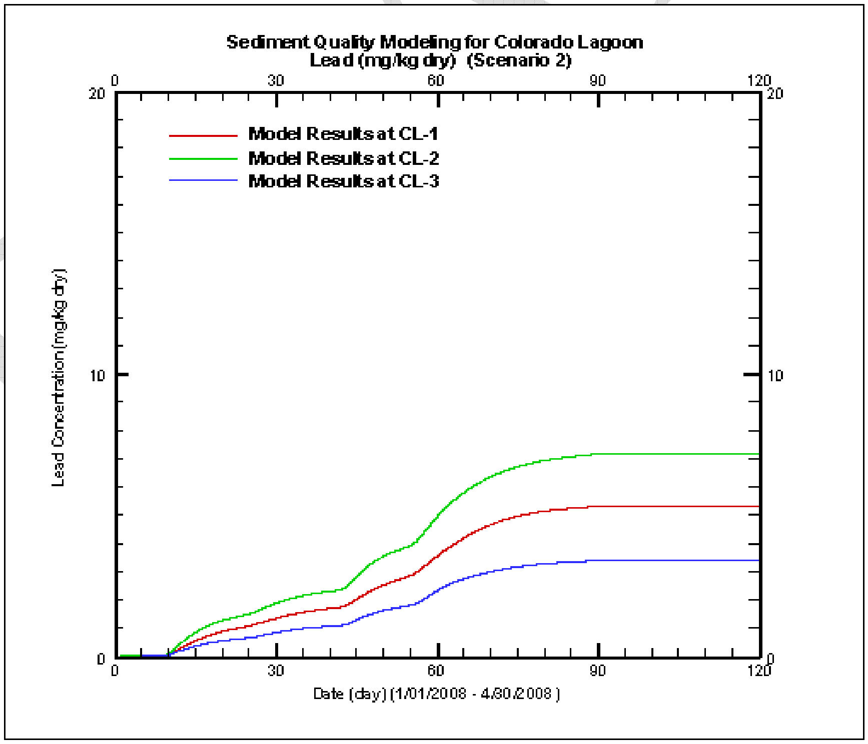


Figure 9.10 Predicted Concentrations of Total Lead in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 2

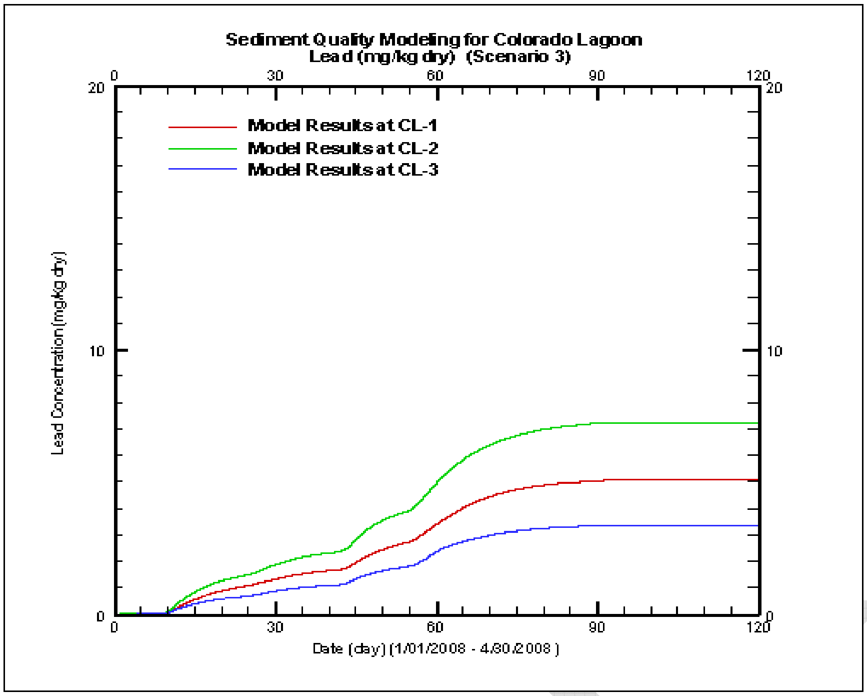


Figure 9.11 Predicted Concentrations of Total Lead in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 3

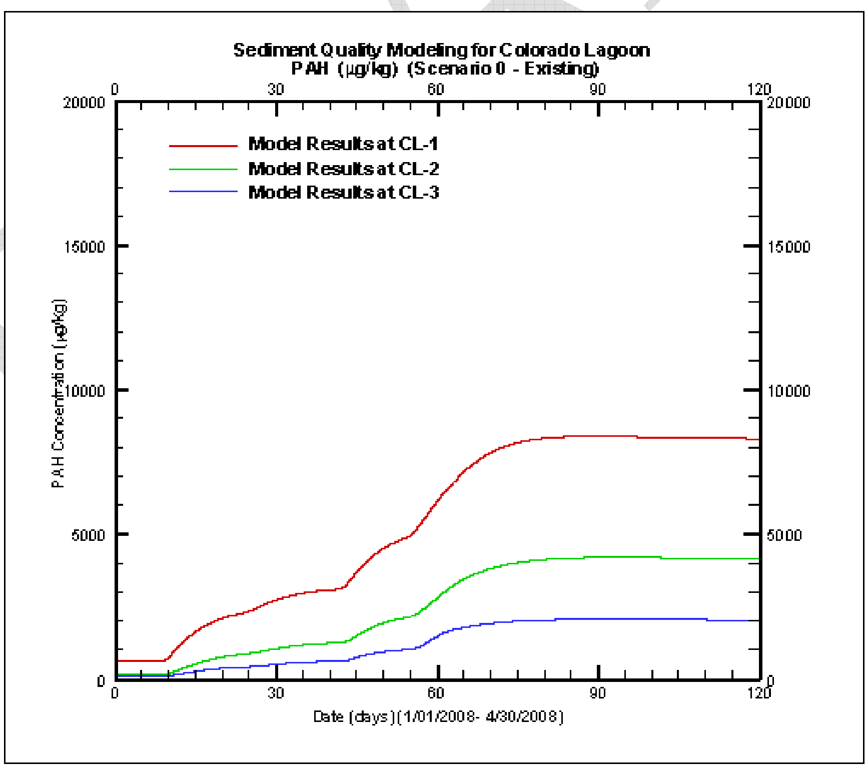


Figure 9.12 Predicted Concentrations of Total PAHs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Existing Conditions

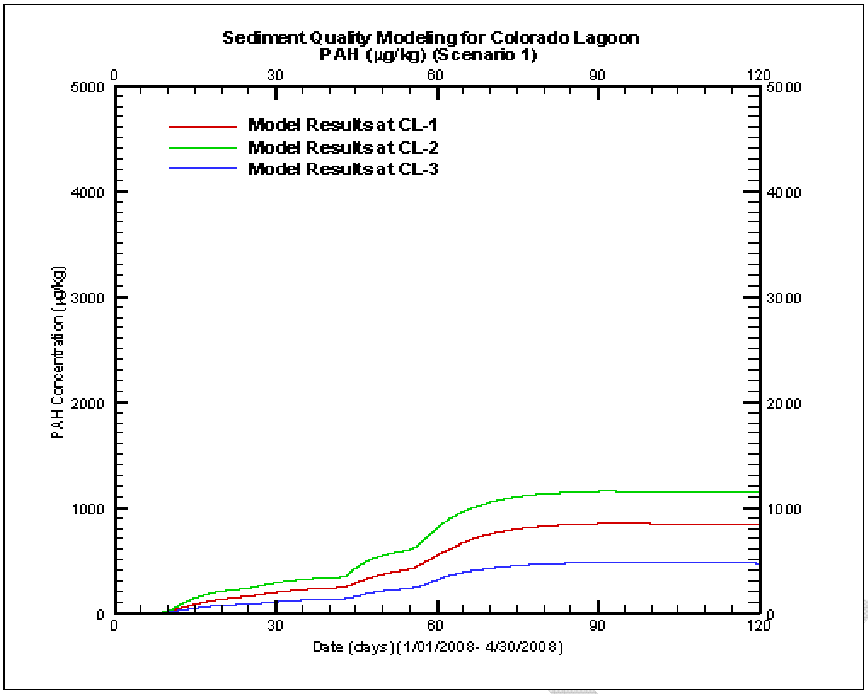


Figure 9.13 Predicted Concentrations of Total PAHs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 1

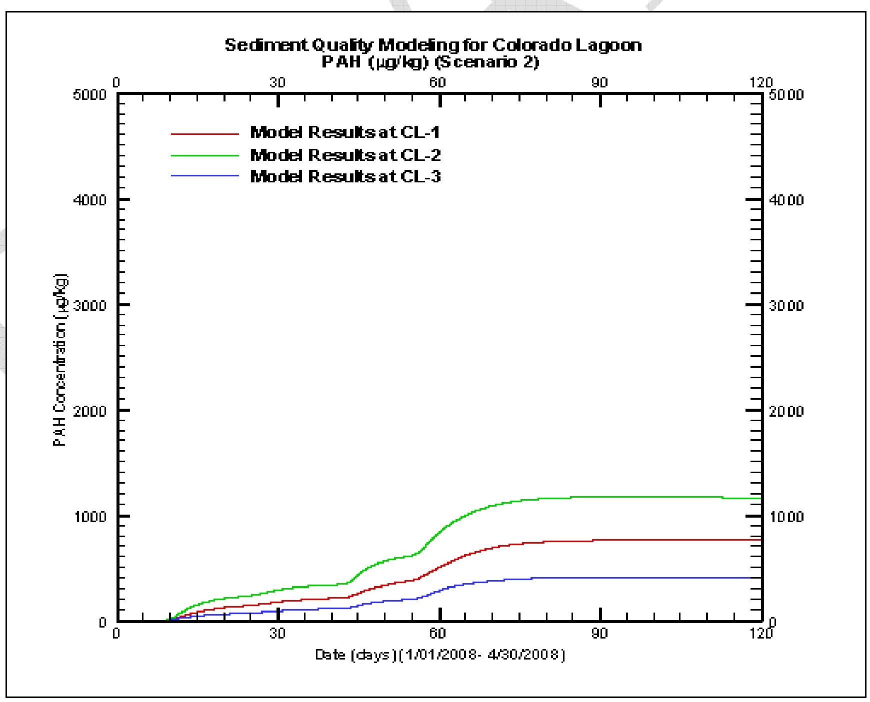


Figure 9.14 Predicted Concentrations of Total PAHs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 2

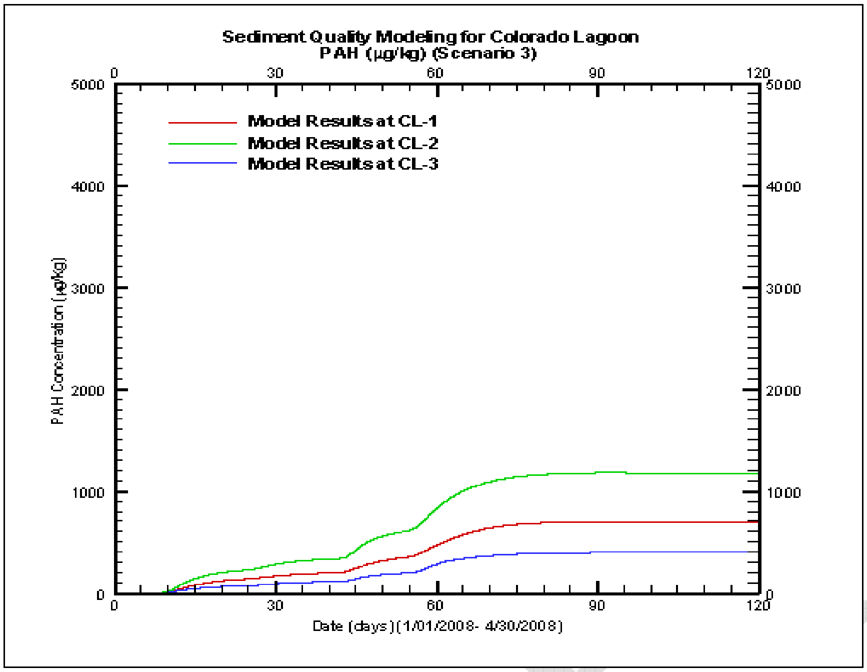


Figure 9.15 Predicted Concentrations of Total PAHs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 3

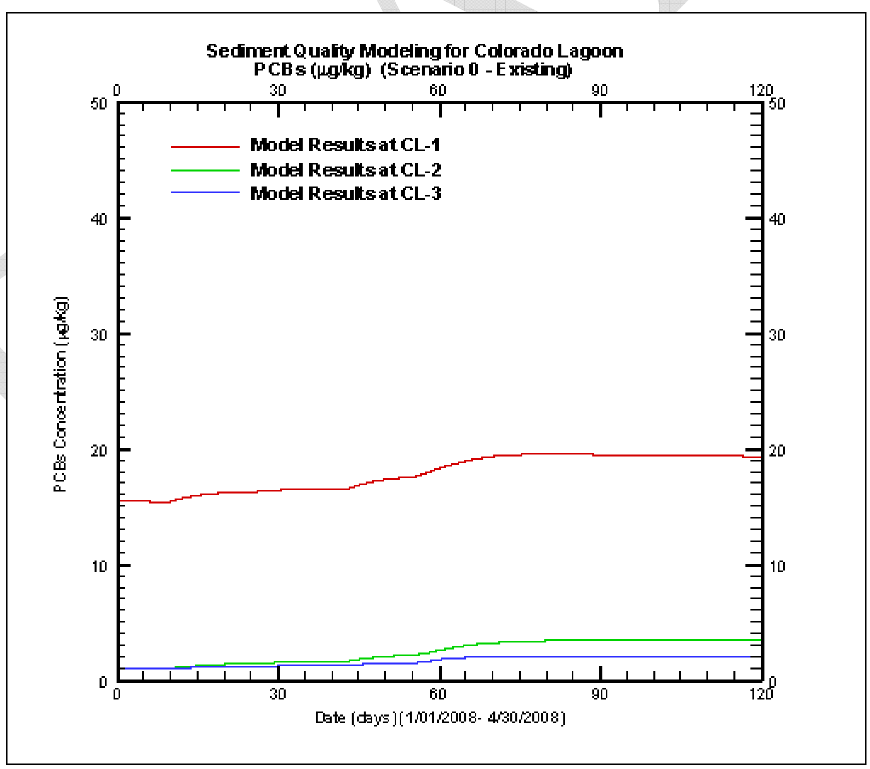


Figure 9.16 Predicted Concentrations of Total PCBs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Existing Conditions

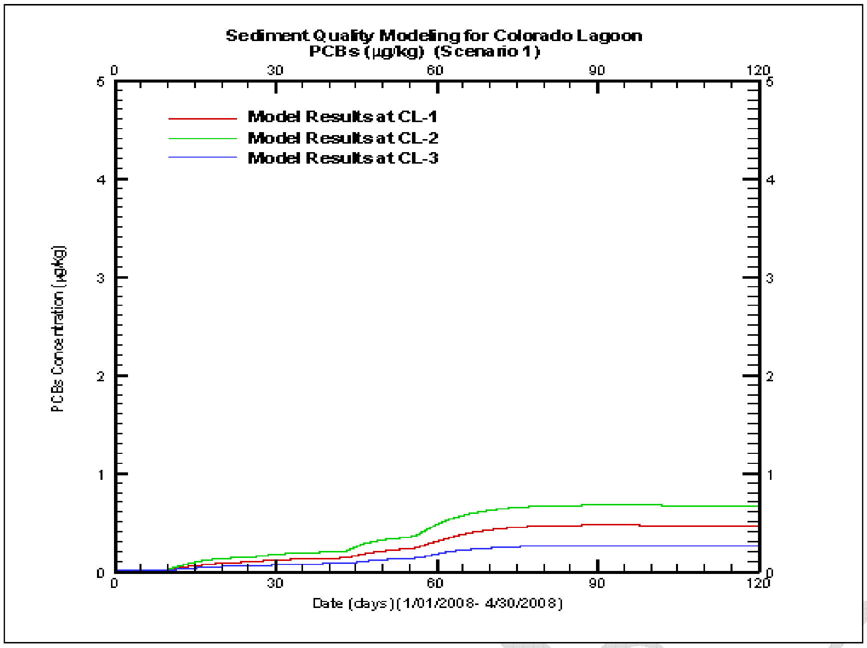


Figure 9.17 Predicted Concentrations of Total PCBs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 1

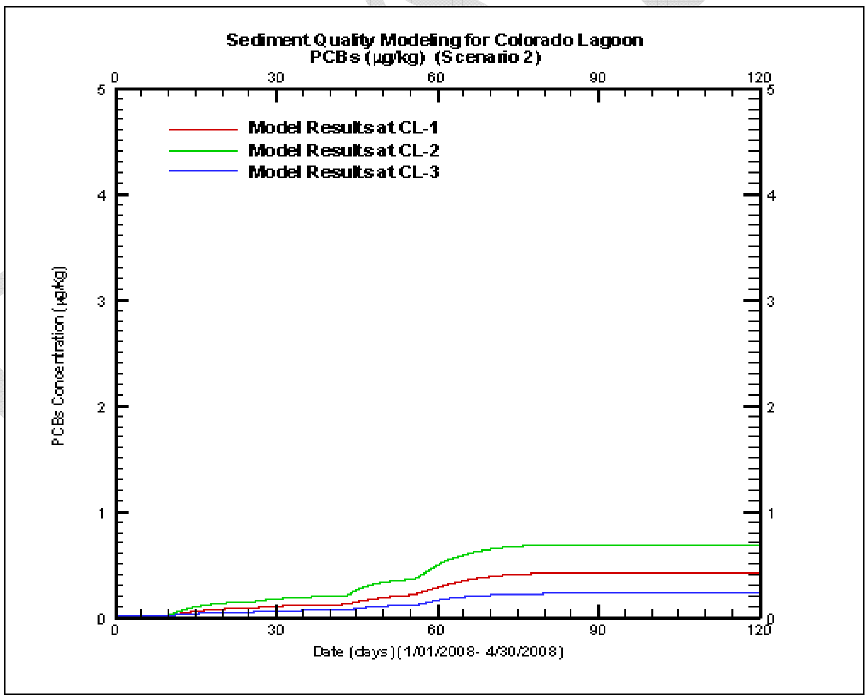


Figure 9.18 Predicted Concentrations of Total PCBs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 2

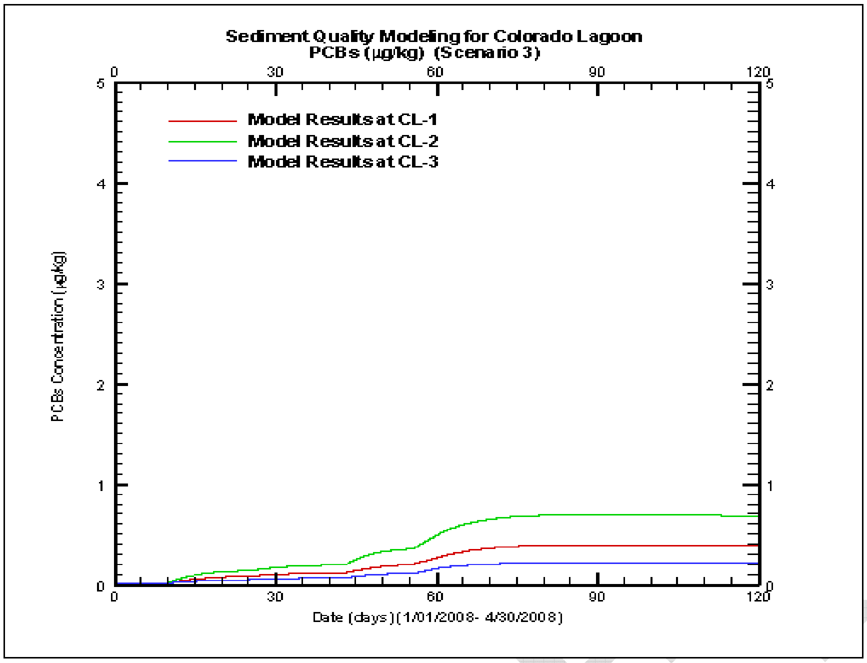


Figure 9.19 Predicted Concentrations of Total PCBs in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 3

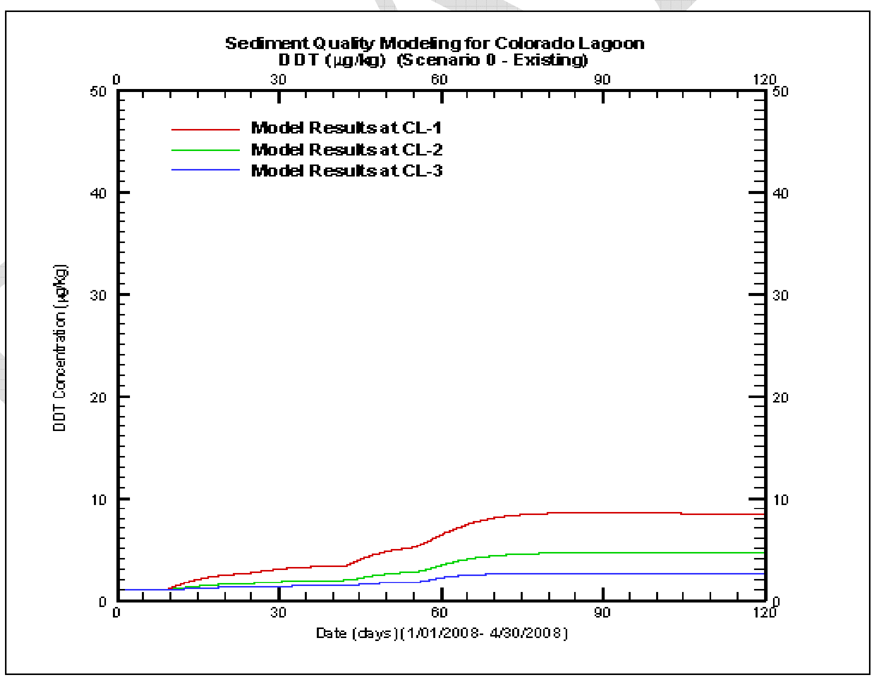


Figure 9.20 Predicted Concentrations of DDT in Sediment Bed at Stations CL-1, CL-2, CL-3 for Existing Conditions

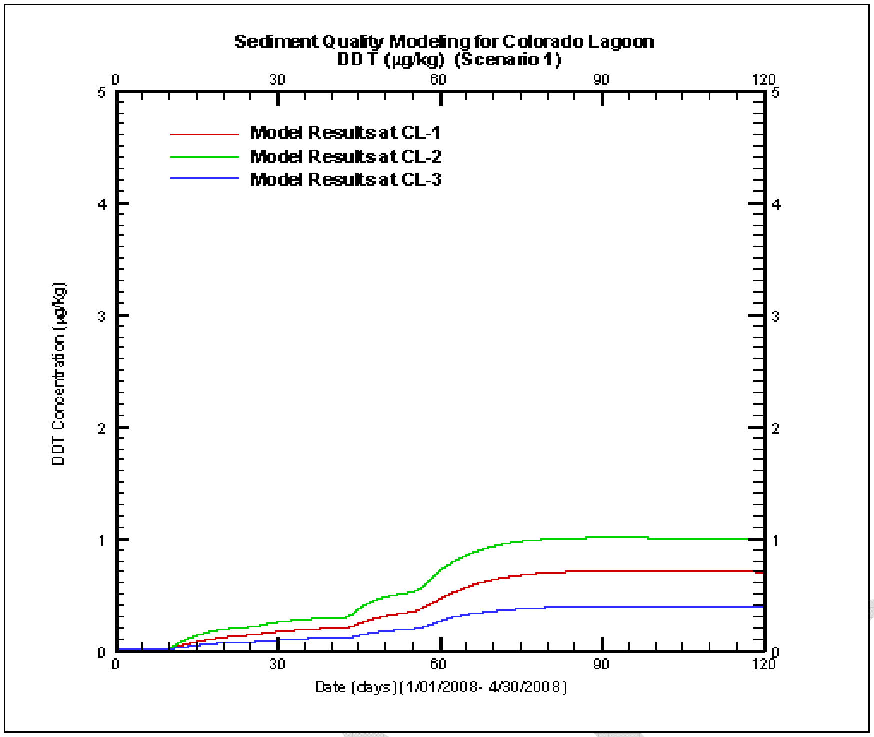


Figure 9.21 Predicted Concentrations of DDT in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 1

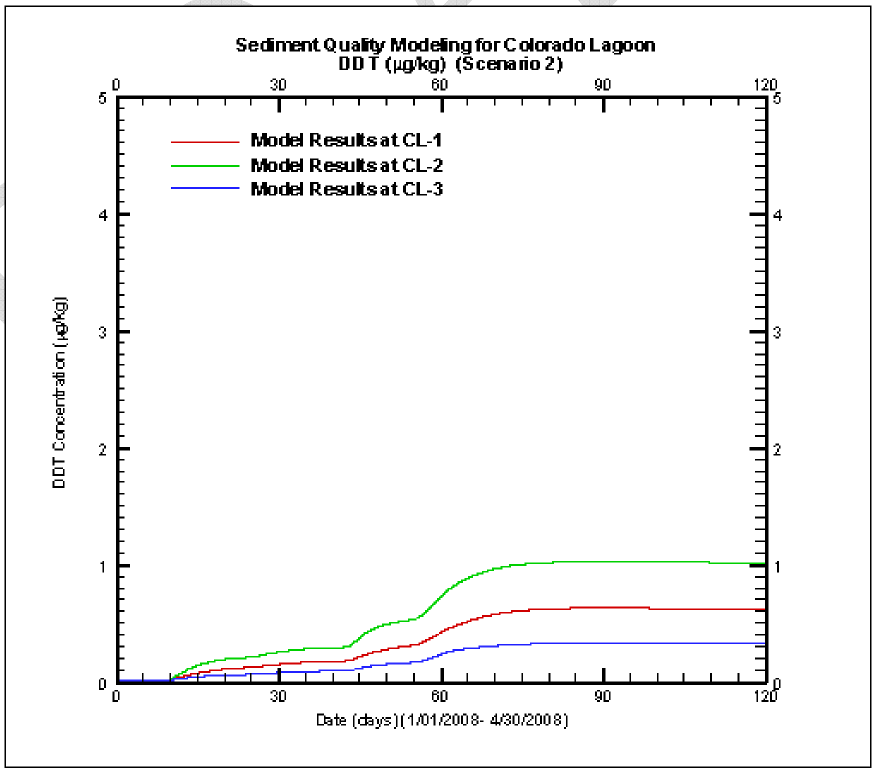


Figure 9.22 Predicted Concentrations of DDT in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 2

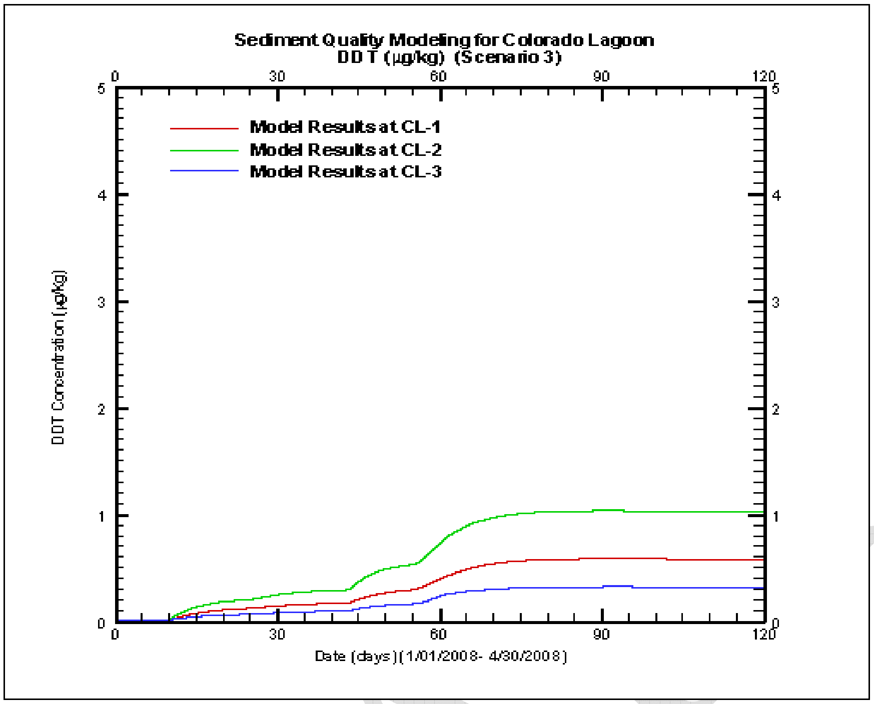


Figure 9.23 Predicted Concentrations of DDT in Sediment Bed at Stations CL-1, CL-2, CL-3 for Scenario 3

Table 9.5 Concentration Increased in Sediment Bed Due to Annual Loading for Different Scenarios

	Unit	Numeric Target	Existing			Scenario 1			Scenario 2			Scenario 3		
			CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3
Zinc	(mg/Kg dry)	150	245	140	60	45	58	28	42	59	25	40	59	24
Lead	(mg/Kg dry)	46.7	20	13	5	5.7	7.0	3.8	5.3	7.2	3.4	5.0	7.2	3.3
PAHs	(µg/Kg dry)	4,022	7,791	3,947	1,893	850	1,140	490	790	1,190	400	700	1,190	400
PCBs	(µg/Kg dry)	22.7	4.0	2.5	1.0	0.48	0.67	0.27	0.40	0.69	0.22	0.39	0.69	0.20
DDT	(µg/Kg dry)	1.0	7.5	3.7	1.7	0.7	1.0	0.4	0.6	1.0	0.32	0.59	1.0	0.30

Note: the values are obtained from the model with zero background concentration

Table 9.6 Background Concentration in Sediment Bed for Different Scenarios

Constituent	Unit	Numeric Target	Existing			Scenario 1			Scenario 2			Scenario 3		
			CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3
Zinc	(mg/Kg dry)	150	515	340	250	52	340	25	52	340	25	52	340	250
Lead	(mg/Kg dry)	46.7	235	185	120	24	185	12	24	185	12	24	185	120
PAHs	(µg/Kg dry)	4,022	609	153	107	61	1,153	11	61	153	11	61	153	107
PCBs	(µg/Kg dry)	22.7	15.5	1.0	1.0	1.6	1.0	0.1	1.6	01.0	0.1	1.6	1.0	1.0
DDT	(µg/Kg dry)	1.0	1.0	1.0	1.0	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	1.0

Note: Assume 10% remained in the sediment bed after each lagoon restoration scenario

Table 9.7 Final Concentration in Sediment Bed for Different Scenarios

	Unit	Numeric Target	Existing			Scenario 1			Scenario 2			Scenario 3		
			CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3	CL-1	CL-2	CL-3
Zinc	(mg/Kg dry)	150	760	480	310	97	398	53	94	399	50	92	399	274
Lead	(mg/Kg dry)	46.7	255	198	125	29.7	192	15.8	29.3	192	15.4	29	192	123
PAHs	(µg/Kg dry)	4,022	8,400	4,100	2,000	911	11,293	501	851	1,343	411	761	1,343	507
PCBs	(µg/Kg dry)	22.7	19.5	3.5	2.0	2.08	1.67	0.37	2.0	1.69	0.32	1.99	1.69	1.20
DDT	(µg/Kg dry)	1.0	8.5	4.7	2.7	0.8	2.0	0.5	0.7	2.0	0.42	0.69	2.0	1.30

Note: The values of final concentration are obtained by adding the increased concentration due to annual loading as indicated in Table 10.5 into the background concentration indicated in Table 10.6

10. Final TMDL Milestones and Implementation Schedule

The TMDL milestones and implementation schedule are summarized in Table 10-1. The schedule allows time for dischargers to perform special studies and to develop implementation plans before any waste load reductions are required.

Interim allocations presented in the TMDL Allocations section and the implementation schedule will provide sufficient time to:

- Allow for the implementation of the Termino Avenue Drain Project and the Colorado Lagoon Restoration Project by the Los Angeles County Flood Control District and the City of Long Beach;
- Determine the most appropriate BMPs, implement appropriate BMPs and monitor to evaluate effect on water and sediment quality;
- Allow for coordination of implementation actions resulting from other TMDL Implementation Plans;
- Allow for the completion of monitoring to verify the appropriateness of allocations; and
- Implement adaptive management strategies to employ additional BMPs or revise existing BMPs to meet allocations, if necessary.

The implementation schedule is designed to consider the potential development of the Bacteria TMDL Implementation Plan. The implementation schedule for this TMDL may be revised, if necessary, when the Bacteria TMDL is completed.

The Los Angeles County, the City of Long Beach, and Caltrans are encouraged to work together to meet the waste load allocations. This schedule is based on a combination of structural and non-structural strategies designed specifically to remove contaminated sediment and reduce pollutant loading to Colorado Lagoon.

Table 10.1 presents the overall implementation schedule for the Colorado Lagoon OC Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals TMDL.

Table 10.1. Overall Implementation Schedule for Colorado Lagoon OC Pesticides, PCBs, Sediment Toxicity, PAHs, and Metals TMDL

Item	Implementation Action	Responsible Party	Date
1	Effective date of interim waste load allocations (WLAs).	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	Effective date of the TMDL
2	Responsible jurisdictions shall submit a monitoring plan to the Los Angeles Regional Board for Executive Officer approval.	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	6 months after effective date of the TMDL
3	Responsible jurisdictions shall begin monitoring as outlined in the approved monitoring plan.	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	6 months after monitoring plan approved by EO
4	Responsible jurisdictions shall submit annual reports to the Los Angeles Regional Board for review.	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	15 months after monitoring starts and annually thereafter
5	Responsible jurisdictions shall submit bi-annual progress reports to provide updates on the status of implementation actions performed under the TMDL. The plan shall contain mechanisms for demonstrating progress toward meeting the assigned WLAs.	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	Every 2 years after effective date of the TMDL
6	Responsible jurisdictions shall achieve WLAs.	The City of Long Beach, the Los Angeles County Flood Control District, and Caltrans	7 years after effective date of the TMDL

11. ECONOMIC CONSIDERATION

The economic consideration for the TMDL identifies the estimated costs of the proposed implementation actions. Some specific cost estimates have been developed for planning and implementing this TMDL. Some aspects of the implementation plan have not yet reached the planning stage and/or are dependent on the impacts of earlier phases of the implementation plan. As a result, the cost estimates provided are a combination of these types of estimates. The final costs of implementation will likely vary from the estimates presented here. However, the estimates represent the best available information on the potential implementation costs of the TMDL.

Table 11.1 Estimated Costs of Implementing the TMDL

Description	Maintenance Needs	Construction Costs	Maintenance Costs
Relocate major storm drain system outfalls	Service storm drain system and remove debris	26,400,000	16,000
Clean Existing Culvert	Maintain and repair tide gates, remove debris and bio-fouling; clear track rack	170,000	15,000
Open Channel	Repair revetment; maintain bridge, fence, signs; remove trash	3,500,000	20,000
Remove Sediment – Western Arm	None	630,000	0
Remove Sediment – Central Lagoon	None	12,000,000	0
Increase/Improve City street sweeping	None	50,000	50,000
Enforce prohibition of no dry weather run-off from home owner	None	100,000	100,000
Trash Management	None	34,000	7,000
Watershed education display	None	63,000	3,000
Sediment trap at Western Arm	Periodic sediment removal	190,000	5,000
Storm drain bio-swales	Remove weeds	100,000	200
Storm drain low flow diversion	Service diversion structure and remove debris	1,300,000	12,000
Total Cost		44,537,000	228,200

Colorado Lagoon is not unique in that it possesses an active local stakeholder group, but it may be somewhat unique from other sites in that the local stakeholders are extremely active in enacting change to, and maintenance of the site. Restoration actions at the lagoon will cost a certain amount of money, with greater costs for more extensive actions and vice versa. Site maintenance will also require funds. Using volunteers to implement certain restoration actions and maintenance and monitoring may reduce costs. This study assumed no use of volunteer labor to construct and maintain alternatives so the most conservative costs are estimated. Conservative cost estimates are more reliable for purposes of budgeting and applying for grants, both of which the City may eventually have to perform. So the real costs of construction and maintenance of alternatives may actually be lower than estimated to the benefit of the City, but responsible planning dictates use of the assumption that volunteer labor is not available (Colorado Lagoon Restoration Feasibility Final Report, February 4, 2005).