Machado Lake Pesticides and PCBs TMDL

California Regional Water Quality Control Board
Los Angeles Region

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1. INTRODUCTION

Machado Lake, located in the Dominguez Channel Watershed Management Area in southern Los Angeles County, is identified on the 1998, 2002, 2006, and 2008 Clean Water Act 303(d) lists of impaired water bodies as impaired due to chlordane, DDT, dieldrin, Chem A, and PCBs in tissue. Approved 303(d) listings require the development of a total maximum daily load (TMDL) to establish the amount of pollutants a waterbody can assimilate, while still supporting beneficial uses. In addition to these approved 303(d) listings, there are sufficient data (see Section 2) to document the following impairments in sediment:

- Chlordane
- DDT
- PCBs

These impairments will also be addressed as part of this TMDL.

Chem A (abbreviation for chemical group A) is a suite of bio-accumulative pesticides that includes chlordane and dieldrin. The 1998 303(d) listing (and subsequent listings) for Chem A was predominately based on fish tissue concentrations of chlordane and dieldrin; there was only minimal detection of other Chem A pollutants in 1983 and 1984. Chlordane and dieldrin have been recently detected in tissue, while other Chem A pollutants have not been detected in 25 years. Therefore, this TMDL will only address the Chem A pollutants (chlordane and dieldrin) that are causing the current impairment.

1.1 REGULATORY BACKGROUND

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

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

States must include TMDLs in their water quality management plans or reference TMDLs as part of the water quality management plan if the TMDL is contained in a separate document (40 CFR 130.6 (c) (1)). The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If the U.S. EPA disapproves a TMDL submitted by a state, U.S. EPA is required to establish a TMDL for that waterbody. A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999. The consent decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. In accordance with the consent decree, this document summarizes the analyses performed and addresses the listings for chlordane, DDT, dieldrin, Chem A, and PCBs in Machado Lake (analytical unit 73).

1.2 Elements of a TMDL

There are seven elements of a TMDL. Sections 2 through 7 of this document describe the elements, with the analysis and findings of this TMDL for each element. The elements are:

- Section 2: Problem Identification. This section reviews the data used to add the waterbody to the 303(d) list, and summarizes existing conditions using that evidence along with any new information acquired since the listing. This element identifies those beneficial uses that are not supported by the waterbody; the water quality objectives (WQOs) designed to protect those beneficial uses; and summarizes the evidence supporting the decision to list each reach, such as the number and severity of exceedances observed.
- Section 3: Numeric Targets. The numeric targets for this TMDL are based upon the WQOs described in the Basin Plan.

- Section 4: Source Assessment. This section develops the quantitative estimate of loading from point sources and non-point sources into Machado Lake.
- Section 5: Linkage Analysis. This analysis shows how the sources of pollutants into the waterbody are linked to the observed conditions in the impaired waterbody.
- Section 6: Pollutant Allocation. Each pollutant source is allocated a quantitative load that it can discharge to meet the numeric targets. Allocations are designed such that the waterbody will not exceed numeric targets for any of the compounds or related effects. Allocations are based on critical conditions, so that the allocated pollutant loads may be expected to remove the impairments at all times.
- Section 7: Implementation and Monitoring. This section describes the plans, regulatory tools, or other mechanisms by which the waste load and load allocations are to be achieved. The TMDL provides cost estimates to implement best management practices (BMPs) required throughout the Machado Lake watershed to meet water quality objectives in the lake.

1.3 ENVIRONMENTAL SETTING

Machado Lake is located in the Ken Malloy Harbor Regional Park (KMHRP), which is a 231-acre Los Angeles City Park serving the Wilmington and Harbor City areas. (Figure 1) The Park is located west of the Harbor freeway (110) and east of Vermont Avenue between the Conoco Phillips Refinery on the south and the Pacific Coast Highway on the North. Machado Lake is one of the last lake and wetland systems in Los Angeles; the area is approximately 103.5 acres in total size. The upper portion, which includes the open water area, is approximately 40 acres and the lower wetland portion is about 63.5 acres. This TMDL will address the 40-acre open water lake. The lake was originally developed as part of Harbor Regional Park in 1971 and intended for boating and fishing. Over the years, water quality generally declined; boating was stopped and signs were posted warning of the risk of eating fish from the lake due to toxic chemical contamination.

Machado Lake is located within the Machado Lake subwatershed which is approximately 20 square miles and positioned within the larger 110-square mile Dominguez Channel Watershed Management Area. The watershed is located in southern Los Angeles County and includes all or a portion of the following communities: Los Angeles, Torrance, Carson, Lomita, Rolling Hills, Rolling Hills Estates, Ranch Palos Verdes, Redondo Beach, Palos Verdes Estates, and Los Angeles County (Figure 2). The dominant land use in the Machado Lake Watershed is high density single family residential, accounting for approximately 45 % of the land use. Industrial, vacant, retail/commercial, multi-family residential, transportation, and educational institutions each account for 5-7 % of the land use, while "all other" accounts for the remaining 23 %. Machado Lake is a receiving body of urban and stormwater runoff from a network of storm drains throughout the watershed. There are three discharge points into Machado Lake from the following storm drain channels (Figure 3):

- Wilmington Drain
- Project No. 77
- Project 510.

Approximately 88 % of the Machado Lake Watershed area flows through the Wilmington Drain into Machado Lake. Machado Lake is not the terminal point of the Machado Lake subwatershed. Machado Lake has the ability to overflow its dam into the lower wetlands, which discharge through a stormdrain to Los Angeles Harbor (Figure 3).

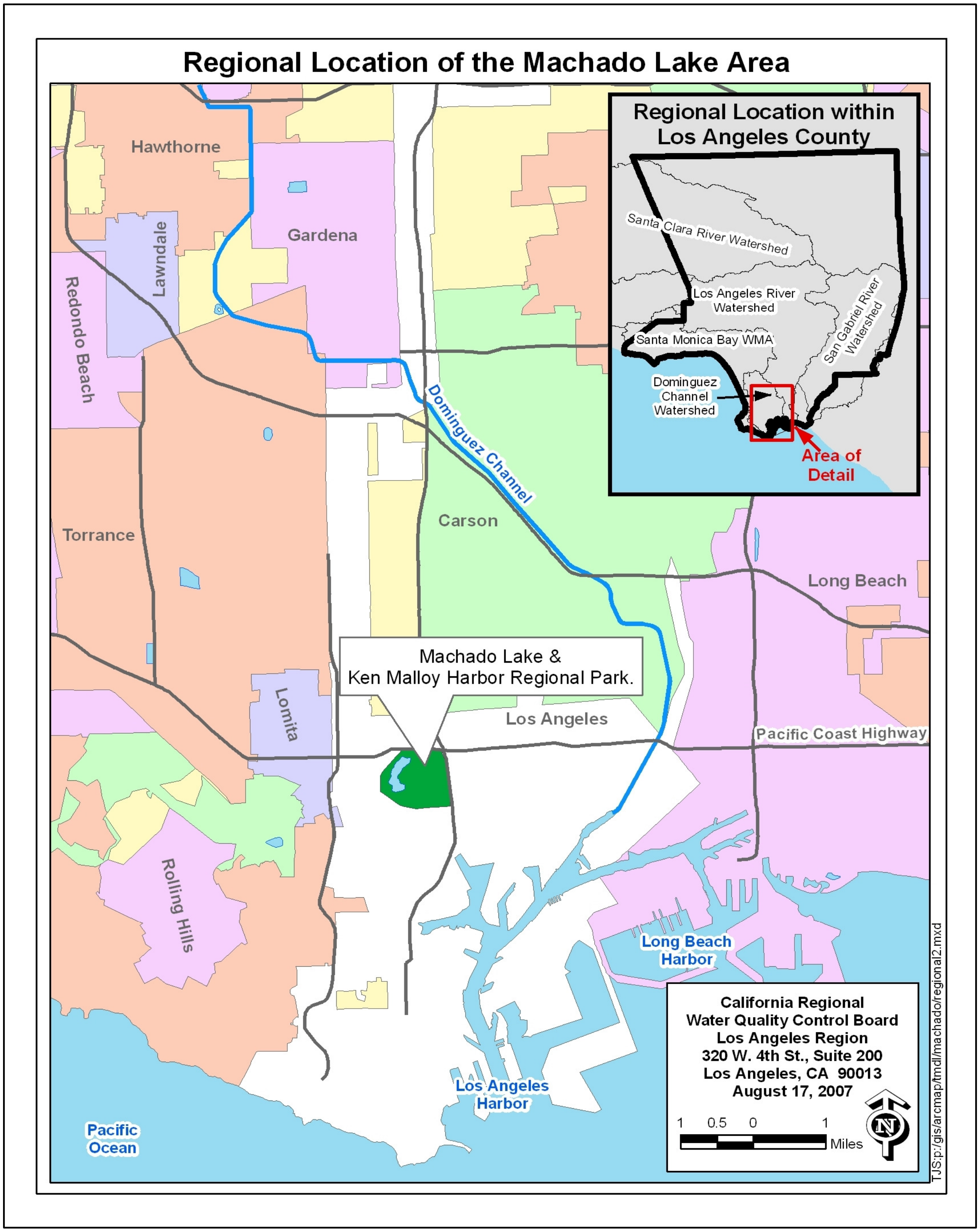


Figure 1. Machado Lake regional location map

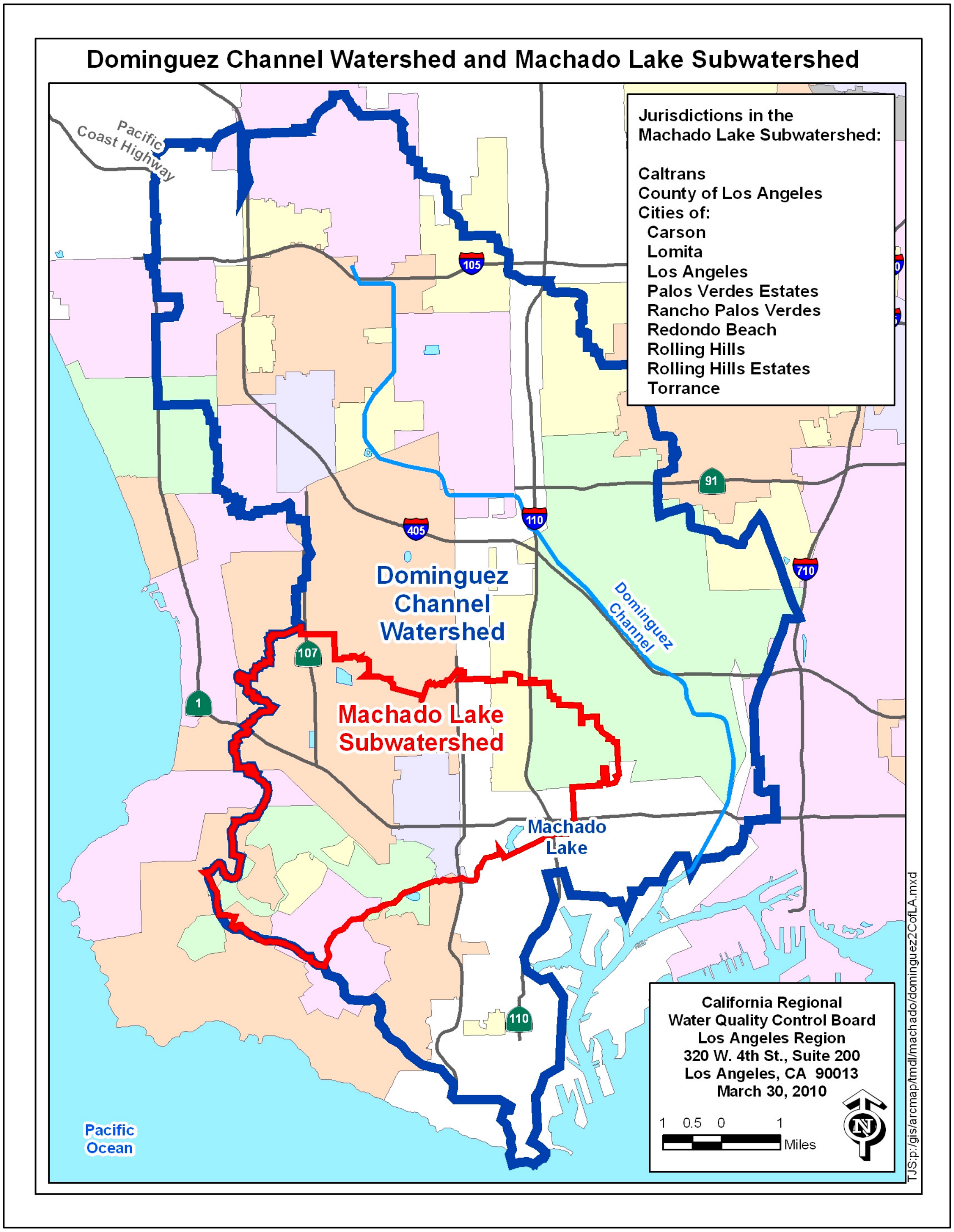


Figure 2. Dominguez Channel watershed and Machado Lake subwatershed map

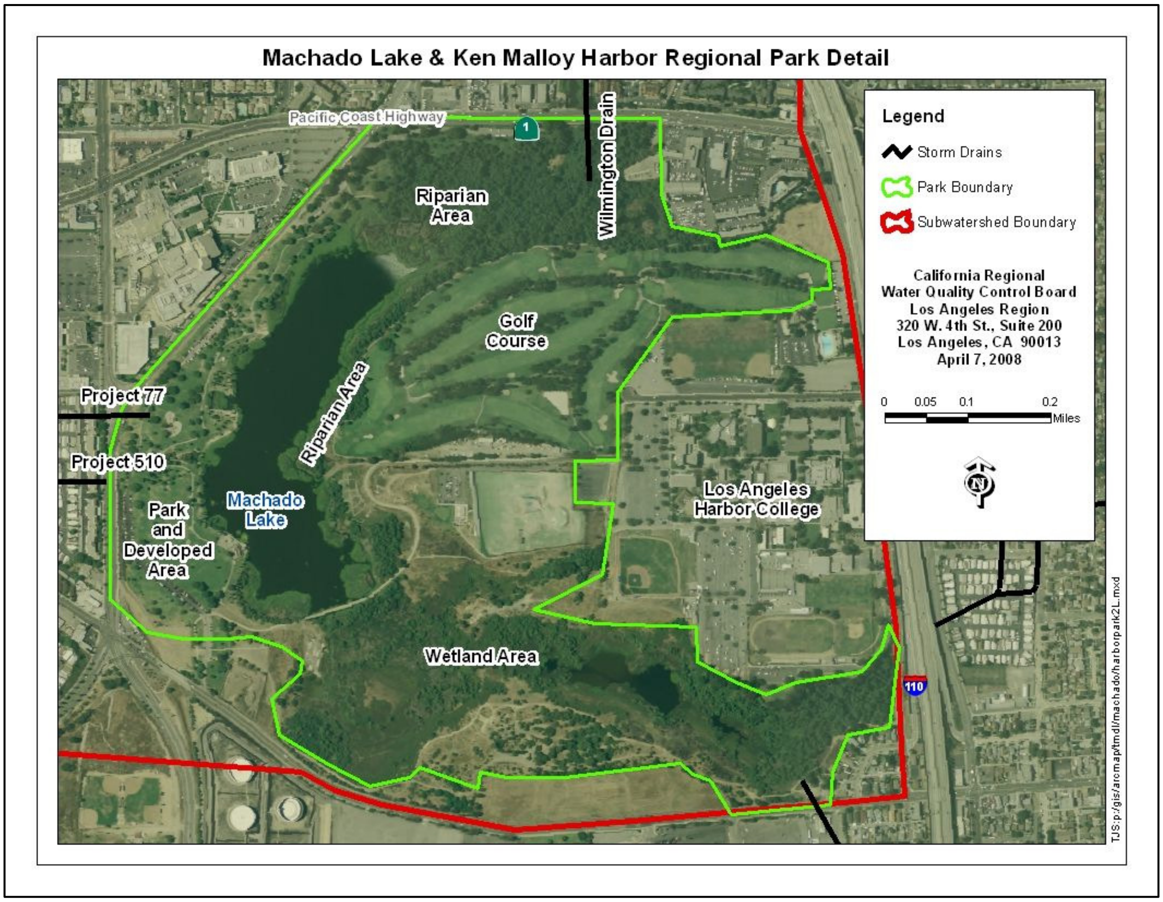


Figure 3. Machado Lake and Ken Malloy Harbor Regional Park overview

Machado Lake is part of one of the last freshwater lake/wetland habitats in the Los Angeles area. Although the lake is generally located in a highly urbanized area, it is surrounded by important habitat and designated a significant ecological area by Los Angeles County (Basin Plan, p 1-17). Immediately bordering the lake are emergent wetland vegetation types such as bulrushes, cattails, and water primrose. On the north end of the lake, near the Wilmington Drain inlet, there is a well established willow riparian forest and an area where cottonwoods and sycamore have been planted. The willow riparian habitat continues along the east side of the lake creating a buffer between the lake and the Harbor Regional Golf Course. South of the lake, below the dam, is a 63 acre seasonal wetland; this area contains several sensitive habitats and vegetation types. The west side of the lake is landscaped and considered the active recreation area for activities such as picnicking. There have been several sightings of sensitive, threatened and endangered bird species residing and foraging in the area; for example, Machado Lake is considered suitable breeding habitat for the least Bells vireo and the black-crowned night heron is known to regularly forge on the banks of Machado Lake.

Machado Lake is a shallow polymictic lake; the depth is generally 0.5 – 1.5 meters; the average depth is approximately 1.0 meter. The northwest portion of the lake is slightly shallower (approximately 0.6- 0.9 meter deep). There is a well established macrophyte community along the edge of the lake. The water normally has a brown – yellowish tint throughout the year, but the lake can be green and subject to algal blooms in the summer months. The fish population includes goldfish, carp, blue gill and largemouth bass. This lake description is based on Regional Board staff field notes and observations.

2 PROBLEM IDENTIFICATION

This section provides background information on the pollutants addressed in this TMDL, an overview of water quality standards for Machado Lake, and a review of water quality data used in the 1996 water quality assessment and the 1998, 2002, and 2006 303(d) listings. Additional pertinent data were used to assess the condition of the lake and subwatershed if available.

2.1 TOXIC POLLUTANTS BACKGROUND

The chemical properties of the pollutants in this TMDL result in strong binding to particulate matter, such as fine-grained sediment and organic matter. The chemical properties of each pollutant are presented in Table 1. This section also provides a general background and history of each pollutant.

Table 1. Chemical properties of Organochlorine Pesticides and PCBs

Constituent	Molecular Weight	Henry's Law Constant (atm - m^3/mole)	Log Kow	Log Koc	Log BCF	Half Life in Soil (low) (days)	Half Life in Soil (high) (days)	Water Solubility (mg/L)
Chlordane	409.8	4.86E - 05	NA	3.09	4.27	350	7300	0.56
DDD	321	4.00E - 06	6.02	NA	4.9	730	2190	0.09
DDE	319	2.10E - 05	5.69	4.7	4.91	1000	5475	0.12
DDT	354.5	8.10E - 06	6.36	5.18	4.97	1460	5330	0.025
Dieldrin	380.93	1.51E - 05	4.55	3.92	3.65	109	4560	0.195
PCBs	200.7 - 453	4.0E - 04	3.9 - 6.7	NA	NA	730	2190	0.004 - 0.91

Organochlorine Pesticides

Organochlorine (OC) pesticides are a large group of pesticides that historically have had widespread use throughout the United States. This group of pesticides is often referred to as legacy pesticides because even though they have been banned from use for many years, they continue to persist in the environment and cause water quality impairments. The pesticides identified on the 303(d) list for Machado Lake -- DDT, chlordane, and dieldrin -- are organochlorine pesticides.

DDT

DDT is a broad spectrum organochlorine pesticide with two primary break-down products: DDE and DDD. Two attributes of DDT, low water solubility and high lipophilicity (fat soluble), play a key role in its environmental fate. The low water solubility of DDT results in strong binding of the compound to soil particles (Walker, 2001). These soil particles can be easily mobilized by the force of water runoff and the soil-bound DDT is transported to surface waterbodies. The soil particles then settle out of the water column into the sediments of the waterbody. DDT is also highly lipophilic and will accumulate in the fatty tissues of exposed wildlife and bioaccumulate as it moves through the food chain to reach the primary predator (National Pesticide Telecommunications Network (NPTN) DDT Technical Fact Sheet, 1999). The ability of DDT to bioaccumulate is one of the primary environmental concerns of this pollutant because the exposure spreads and increases from one organism to another.

DDT first became widely used as a pesticide in 1939; the use was focused on controlling insects that transmit diseases, such as malaria and typhus during World War II (U.S. EPA, 1975). DDT for agricultural and commercial uses became widespread in the United States after 1945. 1959 was the peak of DDT use in the United States when approximately 80 million pounds were applied (U.S. EPA, 1975). In California, DDT was used for the control of both agricultural and urban pests like mosquitoes and cockroaches (Mischke, 1985). In 1963, the California Department of Food and Agriculture (CDFA) declared DDT a restricted material. The last year that substantial amounts of DDT were applied in California was 1970 when 1.2 million pounds of DDT were applied primarily to agricultural areas (Mischke, 1985).

The use of DDT began to decline in the early 1970s, as many of the pests previously sensitive to DDT had developed a resistance to the chemical (U.S. EPA, 1975). Furthermore, new more effective pesticides had been developed, and there was growing public concern over adverse human and environmental health effects from DDT exposure (U.S. EPA, 1975). On June 14, 1972, the U.S. EPA announced the cancellation of all crop uses of DDT in the United States effective on December 31, 1972 (U.S. EPA, 1975).

In the Dominguez Channel Watershed, approximately five miles north of Machado Lake, the Montrose Chemical Corporation of California (Montrose) manufactured the pesticide DDT. The Montrose plant was located at 20201 Normandie Avenue in Los Angeles and operated from 1947 – 1982. The plant operations included manufacturing, grinding, packaging, and distributing DDT pesticide (U.S. EPA, 2009). The Montrose plant stopped all operations in 1982 and the plant was disassembled and removed from the property; today the site is undeveloped and unoccupied and is an U.S. EPA Superfund site. As a final step to dismantle the plant, U.S. EPA required that Montrose build a temporary asphalt cover over the contaminated site. This cover is required to ensure that high concentrations of DDT at the site cannot be disturbed and conveyed by wind or stormwater runoff to other locations (U.S. EPA, 2009).

Historically, stormwater from the Montrose plant generally flowed off the property into an open ditch along Kenwood Avenue. This ditch emptied into a slough south of Torrance Boulevard and flowed eastward to the Dominguez Channel. However, given the long time of the plant operation (35 years) and the changes in stormwater drainage pathways over this time, it is likely that some stormwater runoff may have been discharged to Machado Lake. Today all stormwater from the site is conveyed to the Los Angeles Harbor via the Dominguez Channel. A separate TMDL is being developed to address DDT impairments in the Dominguez Channel. DDT may have also entered Machado Lake through atmospheric deposition.

Even though domestic usage of DDT has been banned and the Montrose plant has been closed for 30 years, due to its long soil half life (see table 1), there are still widespread environmental impairments from DDT. The data presented in Section 2.3 of this report documents the DDT impairment in Machado Lake.

Chlordane

Chlordane was first registered and approved for both agricultural and non-agricultural uses in the United States in 1948 (NPTN Chlordane Fact Sheet, 2001). Non-agricultural uses of chlordane included treating pests in residential lawns and gardens as well as structural pests such as termites. Chlordane was used on a variety of agricultural crops including corn, citrus, deciduous fruits and nuts, and vegetables (U.S. EPA, Consumer Fact Sheet on Chlordane). In 1978, the U.S. EPA cancelled the use of chlordane on all food crops and for applications to lawns and gardens, although it was still registered for use in termite control. In 1988, the U.S. EPA cancelled all uses for chlordane.

As an organochlorine compound, chlordane has similar properties to DDT; it has low water solubility, a strong binding affinity to soil particles, and is a persistent compound (EXTOXNET Chlordane, 1996). Thus, soils historically treated with chlordane can continue to be a present source of chlordane in the environment; these contaminated soils may be transported to waterbodies via runoff causing water quality impairments. Moreover, chlordane will bioaccumulate in the fat tissue of exposed organisms and is considered highly toxic to fish and freshwater invertebrates (NPTN Chlordane Fact Sheet, 2001, EXTOXNET Chlordane, 1996).

Dieldrin

Dieldrin is also an organochlorine pesticide and a break-down product of the pesticide aldrin. Dieldrin was widely used from 1950 - 1970 as a structural pesticide for the control of termites (ATSDR, 2002) and as an agricultural pesticide for cotton, corn, and citrus crops (U.S. EPA, 2008). The agricultural use of dieldrin was banned by the US Department of Agriculture in 1970 (ATSDR, 2002) and in 1987 all uses of dieldrin were cancelled (U.S. EPA, 2008). Dieldrin is a persistent compound in the environment that easily binds to soil and is often conveyed to surface waterbodies in runoff.

Polychlorinated biphenyls – PCBs

PCBs belong to a group of organic chemicals called chlorinated hydrocarbons; they are a mixture of up to 209 different chlorinated compounds which are called congeners (ATSDR, 2001). PCBs generally are in the form of oily liquids or waxy solids (ATSDR, 2001; U.S. EPA, 2008). They were produced in the United States from 1929 until they were banned in 1979; because of their useful characteristics, such as non-flammability, chemical stability, and insulating ability, they were used for industrial and commercial purposes (U.S. EPA, 2008). PCBs have been used in the following applications (ATSDR, 2001; U.S. EPA, 2008):

- Coolants and lubricants
- Transformers
- Capacitors
- Electrical equipment
- Hydraulic equipment
- Plasticizers in paints
- Plastics

Even though PCBs are no longer manufactured in the United States, they may still be present in materials that were manufactured prior to 1979. For example, the working life of electrical transformers containing PCBs is expected to be 30 years or more (U.S. EPA, 1999). In general, point sources of PCBs have been eliminated because there are no longer facilities that manufacture products containing PCBs. However, non-point sources may still exist from activities such as improper disposal of industrial waste, landfill sites not designed to accept hazardous waste, abandoned manufacturing areas, leaks and/or improper dumping of materials containing PCBs (ATSDR, 2001; U.S. EPA, 2008). Moreover, the global cycling of PCBs occurs when they are evaporated from soils and/or surface waters, transported in the atmosphere, and then redeposited to the land and water (U.S. EPA, 1999, ATSDR, 2005). This process plays an important role in the deposition of PCBs to surface waters and is considered a non-point source (U.S. EPA, 1999).

PCBs are persistent chemicals that remain in the environment for long periods of time. They have low water solubility, so they are typically attached to soil and/or sediment particles, which can be transported by water runoff leading to pollution in waterbodies (U.S. EPA, 1999). PCBs are also lipophilic and will be stored in the fat tissue of exposed organisms and bioaccumulate through the food chain (Walker, 2001). For example, concentrations of PCBs found in aquatic organisms may be 2,000 to more than one million times greater than concentrations measured in the surrounding water (U.S. EPA, 1999). Because PCBs rapidly concentrate in the food chain, a small concentration measured in water or sediment can have a significant environmental impact.

The U.S. EPA maintains databases for the tracking and evaluation of PCB activity in the in the United States. The Notification of PCB Activity Report database was reviewed for PCB Activity Reports in the Machado Lake subwatershed. There are 14 facilities conducting PCB activities in the area of the Machado Lake subwatershed. PCB activities, as typified by U.S. EPA, include generators, storers, and transporters. There is no evidence in the reports that the facilities have contributed to PCB impairments at Machado Lake because they are operating properly and/or do not drain within the Machado Lake subwatershed. In addition, the U.S. EPA PCB Transformer Registration Database was reviewed; there are no registered PCB transformers in the Machado Lake subwatershed.

2.2 WATER QUALITY STANDARDS

California state water quality standards consist of the following three elements: 1) beneficial uses of the waterbody; 2) narrative and/or numeric water quality objectives; and 3) an antidegradation policy. Beneficial uses are defined by the Regional Board in the Basin Plan. Numeric and narrative objectives are also specified in the Basin Plan and other state plans and policies. These objectives are set to be protective of the beneficial uses in each waterbody in the region.

2.2.1 BENEFICIAL USES

The Basin Plan (1994) defines seven beneficial uses for Machado Lake (Table 2). These uses are recognized as existing (E), potential (P) or intermittent (I) uses. Machado Lake has existing aquatic life beneficial uses (WARM, WILD, RARE, and WET) and existing recreation beneficial uses (REC 1 and REC 2). The municipal supply (MUN) use designation applies to Machado Lake as a potential beneficial use. This beneficial use, for Machado Lake, is indicted with an asterisk in the Basin Plan as a conditional use. Conditional designations are not recognized under federal law and are not water quality standards requiring TMDL development at this time. (See letter from Alexis Strauss [US EPA] to Celeste Cantú [State Board], Feb. 15, 2002.)

Table 2. Beneficial uses of Machado Lake

Reach	MUN	REC 1	REC 2	WARM	WILD	RARE	WET
Machado Lake	P*	E	E	E	E	E	E

2.2.2 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 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, U.S. EPA promulgated numeric water quality objectives for several pollutants addressed in this TMDL in the California Toxics Rule (CTR; U.S. EPA 2000b). The CTR establishes numeric aquatic life criteria for 23 priority 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.

To protect 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. Salt water crieteria apply to waters in which salinity is equal to or greater than 10 ppt 95 percent or more of the time. For waterbodies in which the salinity is between 1 and 10 ppt, the more stringent of the two criteria applies.

The CTR human health criteria are established to protect the general population from priority toxic pollutants regulated as carcinogens 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 3 summarizes the CTR aquatic life criteria and human health criteria for organic chemicals that are relevant to this TMDL (Chlordane, Dieldrin, DDT, and PCBs).

Table 3. Water quality criteria established in CTR for OC Pesticides and PCBs

	Criteria for the Protection of Aquatic Life		Criteria for the Protection of Human Health
	Freshwater		
Pollutant	Acute (ug/L)	Chronic (ug/L)	Organisms only (ug/L)
4,4' DDT [1]	1.1	0.001	0.00059
4,4' DDE [2]			0.00059
4,4' DDD [3]			0.00084
Total PCBs [4]		0.014	0.00017
Chlordane	2.4	0.0043	0.00059
Dieldrin	0.24	0.056	0.00014

1. Based on single isomer (4,4' DDT)
2. Based on single isomer (4,4' DDE)
3. Based on single isomer (4,4' DDD)
4. Based on total PCBs, the sum of all congener or isomer or homolog or aroclor analysis

Sediment Quality Guidelines

Sediment quality is protected by applying the narrative objectives stated above. These narrative objectives require that surface waters do not contain chemicals and/or pesticides that will bioaccumulate, cause toxicity, or adversely affect any beneficial use. It is necessary to translate the narrative objectives into numeric targets that will attain all applicable water quality objectives and protect beneficial uses. Regional Board staff will evaluate sediment contaminates relative to sediment quality guidelines (SQG), specifically the *Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* developed by MacDonald, Ingersoll, and Berger (2000a). The consensus-based Threshold Effect Concentration (TEC) will be used as the evaluation guideline.

The *Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* have been used by the Surface Water Ambient Monitoring Program (SWAMP) in assessments of freshwater sediment and are recommended for use by the State Water Resources Control Board (SWRCB) to interpret narrative objectives under the 303 (d) listing policy.

The consensus-based TEC SQGs were developed for freshwater sediment; these guidelines combine and integrate the effect levels from several sets of guidelines to result in a "consensus-based" sediment quality guideline. Moreover, MacDonald et al. (2000a) evaluated the consensus-based TEC for reliability in predicting toxicity in freshwater sediment. This evaluation showed that most of the consensus-based TECs (21 of 28) accurately predicted the absence of sediment toxicity. The consensus-based TECs were considered to accurately predict sediment quality if more than 75 % of the sediment samples were correctly predicted to be not toxic.

The consensus-based TEC is the level below which adverse effects are not expected to occur and pose a high degree of confidence that the narrative objectives will be attained and aquatic life protected. The consensus-based TEC guidelines have also been incorporated into the most recent set of NOAA Screening Quick Reference Tables (SquiRT). The table below presents the consensus-based TECs that are available for pollutants being addressed by this TMDL (Table 4).

Table 4. Sediment quality guidelines for OC Pesticides and PCBs

Pollutant	**Consensus Based TEC (ug/kg DW)**
DDT (all congeners)	4.16
DDE (all congeners)	3.16
DDD (all congeners)	4.88
Total DDT	5.28
Chlordane	3.24
Dieldrin	1.9
Total PCBs	59.8

Fish Tissue Guidelines

In California, the Office of Environmental Health Hazard Assessment (OEHHA) is the agency responsible for evaluating the potential public health risks of chemical contaminants in sport fish and issues advisories, when appropriate. In June 2008, OEHHA issued Fish Contaminant Goals (FCGs) for common contaminants in sport fish (OEHHA, 2008). FCGs are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, over a lifetime. The FCGs relevant to this TMDL are listed below (Table 5).

Table 5. OEHHA 2008 Fish Contaminant Goals

Contaminant	FCG (ng/g wet weight)
Chlordane	5.6
DDTs	21
Dieldrin	0.46
PCBs	3.6

2.2.3 ANTIDEGRADATION

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

2.3 WATER QUALITY DATA SUMMARY

This section summarizes available sediment and tissue data for Machado Lake. This summary includes data considered by the Regional Board and U.S. EPA in developing the 1998, 2002, 2006, and 2008 303(d) lists as well as additional data collected by the Regional Board as part of TMDL development.

2.3.1 FISH TISSUE DATA SUMMARY

Machado Lake was included on the 1998, 2002, 2006, and 2008 303(d) lists for OC pesticides and PCBs in fish tissue based on data collected by the Toxic Substances Monitoring Program (TSMP) and the Surface Water Ambient Monitoring Program (SWAMP). The TSMP was started in 1976 by the SWRCB in order to provide a statewide approach to the detection and evaluation of toxic substances in fish and other aquatic life. In 2003, the responsibilities and objectives of the TSMP were incorporated into SWAMP; the data presented below was collected by the TSMP or SWAMP.

The fish most consistently collected for tissue analysis were common carp and largemouth bass. Goldfish and catfish were also collected through the 1980s. At the time Machado Lake was placed on the 1998 303(d) list for tissue impairments, the TSMP Maximum Tissue Residue Levels (MTRLs) were the accepted guideline for the assessment of tissue data. Currently, the results of the tissue analysis are compared against the OEHAA Fish Contaminate Goals as described above. However, it is notable that both the MTRLs and the FCGs are within the same order of magnitude.

Goldfish and catfish collected from approximately 1983-90 exceeded both the MTRLs and the FCGs for OC pesticides and PCBs (Figures 4, 5, 6, and 7); the contaminant tissue concentrations in goldfish were often several orders of magnitude greater than the guidelines. Similarly, carp collected from the mid 1980s through 1997 significantly exceeded the MTRLs and FCGs for OC pesticides and PCBs (Figures 4, 5, 6, and 7). Largemouth bass collected between 1984 and 1997 exceeded the tissue guidelines (MTRLs and FCGs) for chlordane. In response to several fish species exceeding the MTRLs for multiple years, Machado Lake was placed on the 1998 303 (d) list for Chlordane, DDT, Dieldrin, and PCBs in tissue.

Since 1998, fish were collected at Machado Lake for tissue analysis in 2002 and 2007. Carp collected in 2002 showed similar concentrations to those collected in 1997 and were well above FCGs for OC pesticides and PCBs. Largemouth bass collected in 2002 showed decreases in pesticide tissue concentrations compared to 1997. However, there was a detection of PCBs in the tissue of largemouth bass; PCBs were not previously detected in bass. In 2007, there was a dramatic decrease in pesticide concentrations in carp; tissue concentrations measured in 2007 were below the FCG guidelines (Figure 4 and 6). There were no largemouth bass collected from Machado Lake in 2007. The 2007 tissue samples for PCBs were not reported by SWAMP due to poor quality assurance quality control results. Thus, Figure 7 only reports data through 2002 and changes in PCB tissue concentration since 2002 are unknown. It is assumed, based on the 2002 results that PCB tissue concentrations continue to exceed the FCG guidelines.

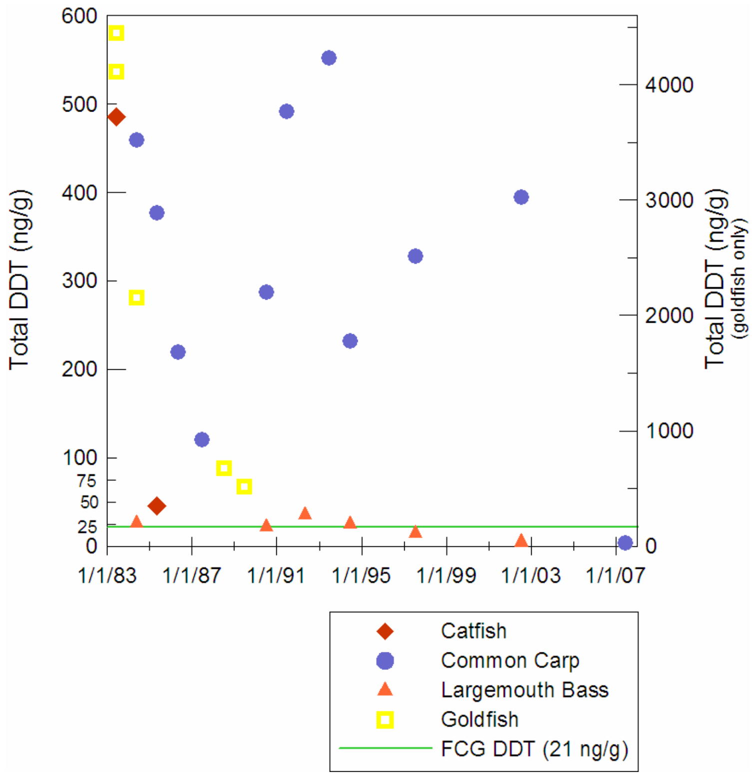


Figure 4. DDT concentration in fish tissue over time (1983-2007)

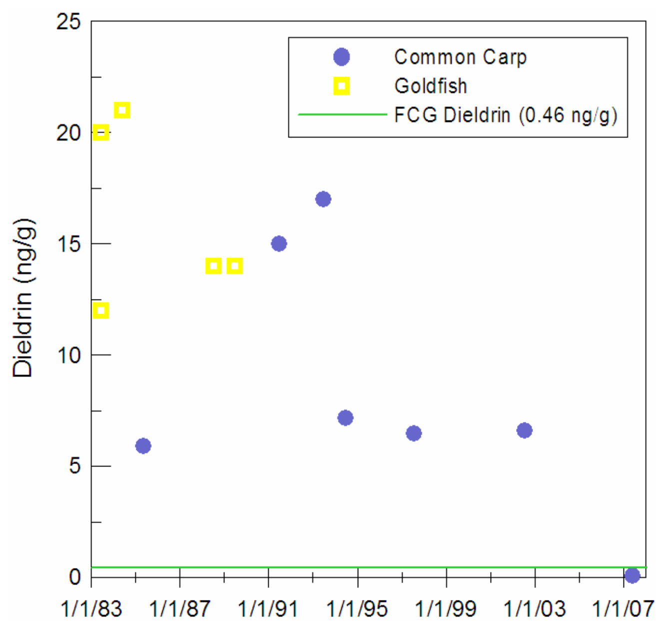


Figure 5. Dieldrin concentration in fish tissue over time (1983-2007)

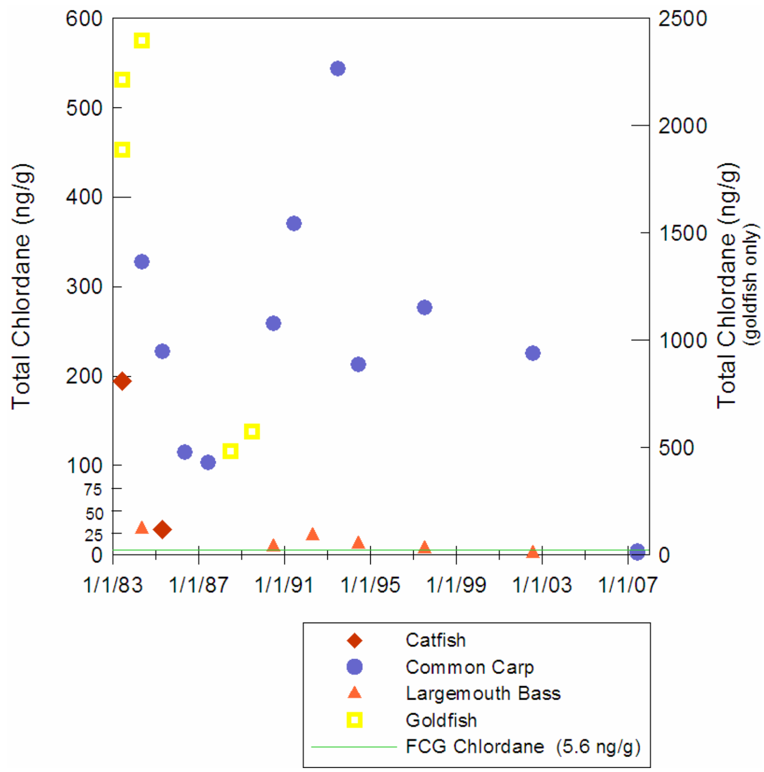


Figure 6. Chlordane concentration in fish tissue over time (1983-2007)

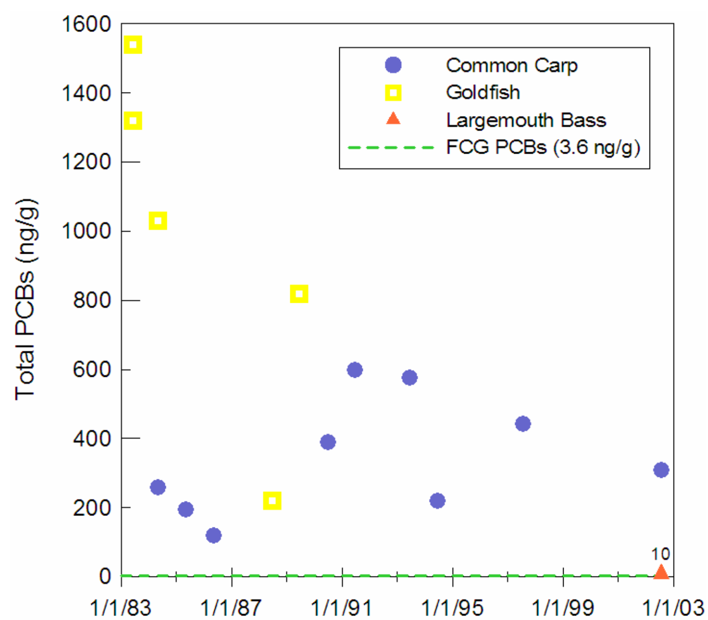


Figure 7. PCBs concentration in fish tissue over time (1983-2002)

2.3.2 SEDIMENT QUALITY DATA SUMMARY

The sediment quality data assessment reviews the chemicals for which there are fish tissue impairments and is based on sample sets collected over the last nine years. The data presented include both surface sediment samples and sediment cores collected at various depths. These data are presented to provide a comprehensive picture of sediment quality in Machado Lake; however, only surface sediment data were assessed when evaluating impairment. The table below lists the source of the data and sample date (Table 6).

Table 6. Summary of Machado Lake sediment data sets

Source	Sample Date
City of Los Angeles, Machado Lake Watershed Management Plan	May 14 & 15, 2001
SWAMP	August 4, 2003
City of Los Angeles	October 22, 2008
Regional Board	January 14, 2009

Sediment sampling at Machado Lake has documented exeedances of TEC values for chlordane, DDT and PCBs (Table 7). TEC values were exceeded for chlordane in 11 samples, DDT in 12 samples, and PCBs in six samples (Table 8). Also, in 2003 the chemical group A pollutant heptachlor expoxide exceeded the TEC value in four samples.

These data document the impairment of Machado Lake sediments for Chlordane, DDT and PCBs. The concentrations observed are above the TEC values and therefore likely causing impairment to the benthic community of the lake. In fact, sediment toxicity has been reported at Machado Lake. Acute sediment toxicity was observed in 2 out of 5 samples collected by SWAMP as part of the Water Quality Dominguez Channel Watershed Report (2003). Therefore, these impairments will also be addressed in this TMDL.

Table 7. Summary of Machado Lake sediment data

Lake Region	Sample Date	Sample Depth (cm)	Constituents of Concern (µg/kg)			
			Total Chlordane	Total DDT	Dieldrin	PCBs
North lake	May 14-15 2001	20 - composite	5.8	5.8	ND	no data
mid North Lake	May 14-15 2001	20 - composite	1.4	4.4	ND	no data
Mid Lake	May 14-15 2001	20 - composite	2	2	ND	no data
mid South lake	May 14-15 2001	20 - composite	7	ND	ND	no data
South lake	May 14-15 2001	20 - composite	3	2	ND	no data
North lake	August 4, 2003	2	39.75	64.22	ND	94.1
mid North Lake	August 4, 2003	2	60.73	76.13	ND	115.8
Mid Lake	August 4, 2003	2	40.93	57.13	ND	119.3
mid South lake	August 4, 2003	2	82.29	80.14	1.54	87.5
South lake	August 4, 2003	2	64.01	57.35	1.1	75.2
North lake	October 22, 2008	15	no data	4.69	no data	no data
North lake	October 22, 2008	76	no data	8.38	no data	no data
Mid lake (west side)	October 22, 2008	15	no data	10.04	no data	no data
Mid lake (west side)	October 22, 2008	76	no data	8.7	no data	no data
North Lake	January 14, 2009	2	98.5	ND	ND	16.6
Mid Lake	January 14, 2009	2	56.4	34.8	ND	35.2
South Lake	January 14, 2009	2	60.7	19.8	ND	22.7
South Lake	January 14, 2009	2	67.1	51.9	ND	68.6
Non Detect (ND) Detection Limit 1 µg/dry kg						

Table 8. Sediment guideline exceedance summary, Machado Lake sediment data

Sample Date	Number Sediment Samples	No. Samples > Chlordane Guideline	No. Samples > DDT Guideline	No. Samples > Dieldrin Guideline	No. Samples > PCBs Guideline
May 14-15, 01	5	2	1	0	no data
Aug. 4, 03	5	5	5	0	5
Oct. 22, 08	4	no data	3	no data	no data
Jan. 14, 09	4	4	3	0	1
total	18	11	12	0	6

2.4 SUMMARY OF PROBLEM STATEMENT

Machado Lake is impaired for chlordane, DDT, dieldrin, and PCBs in tissue and chlordane, DDT, and PCBs in sediment. Because of potential harm to human health and the environment, the use of these pollutants has been banned for many years; however, the physio-chemical properties of the pollutants make them very persistent in the environment. These pollutants, bound to soil particles, are easily transported with runoff to surface waterbodies. Contaminated sediments accumulate in the waterbodies and aquatic organisms are exposed to the toxic pollutants. Moreover, all of these pollutants bioaccumulate as they move through the food chain, thereby not only spreading throughout the food chain, but increasing exposure as well. Finally, sediment toxicity has been reported at Machado Lake, and it is likely that OC pesticides and PCBs contribute to the toxic condition of the sediments.

The exposure of the Machado Lake ecosystem to chlordane, DDT, dieldrin, and PCBs has impaired the aquatic life (WARM, WILD, RARE, WET) and recreation (REC 1, REC2) beneficial uses of the lake. As a result, Machado Lake was placed on the Clean Water Act 303(d) list of impaired waterbodies in 1998, 2002, 2006 and 2008. TMDLs are developed to reduce sediment contamination in Machado Lake for chlordane, DDT, dieldrin, and PCBs. Reducing these contaminants in sediment will address the impairment of fish tissue.

3 NUMERIC TARGETS

Numeric targets are developed for organochlorine pesticides and PCBs in water, sediment, and fish tissue. Numeric targets identify the specific water, sediment, and tissue goals for the TMDL, which equate to attainment of the water quality standard. In some cases, multiple numeric targets may be used; a single target may not be sufficient to ensure attainment of the water quality standard and protect the beneficial use. For the pollutants addressed by this TMDL the numeric targets are expressed as water, sediment, and fish tissue levels (Table 9 and 10).

Table 9. Numeric Targets for water column

Pollutant	Water Column Target (µg/L)
Total PCBs	0.00017
4,4' DDT	0.00059
4,4' DDE	0.00059
4,4' DDD	0.00084
Chlordane	0.00059
Dieldrin	0.00014

Table 10. Numeric Targets for sediment and fish tissue

Pollutant	Sediment Target (µg/kg dry weight)	Fish Tissue (ng/g wet weight)
Total PCBs	59.8	3.6
DDT (all congeners)	4.16	no target
DDE (all congeners)	3.16	no target
DDD (all congeners)	4.88	no target
Total DDT	5.28	21.0
Chlordane	3.24	5.6
Dieldrin	1.9	0.46

The CTR criteria for human health (consumption of organisms only) are selected as numeric targets for the water column. These targets will protect both aquatic life and human health because the CTR human health criteria are more stringent than the aquatic life criteria. The sediment numeric targets are selected from the TEC guidelines discussed in Section 2.2. The fish tissue targets for OC pesticides and PCBs are selected from the OEHHA guidelines discussed in Section 2.2. It is appropriate to use water, sediment, and tissue targets in this TMDL in order to account for uncertainties in the relationship between pollutant loading and beneficial use effects, especially as related to fish tissue impairments. This approach will also ensure that narrative water quality objectives are attained and protect beneficial uses. Moreover, the use of sediment quality and fish tissue values as numeric targets for the pollutants in this TMDL is effective because these pollutants are much more likely to be associated with particulate matter than dissolved in water. The pollutants will typically sorb to bottom sediments or fine suspended sediments; therefore, it is technically reasonable to assign sediment and tissue numeric targets. The water column numeric targets ensure protection of all beneficial uses.

4 SOURCE ASSESSMENT

This section identifies the potential sources of pollutants in the Machado Lake subwatershed. In the context of TMDLs pollutant sources are either point sources or nonpoint sources. Point sources include discharges for which there are defined outfalls such as wastewater treatment plants and storm drain outfalls. The point source discharges are regulated through the National Pollutant Discharge Elimination System (NPDES) permits. Nonpoint sources, by definition, include pollutants that reach waters from a number of diffuse landuses and source activities that generate runoff to the lake and are not regulated through NPDES permits.

4.1 POINT SOURCES

The NPDES permits in the Machado Lake subwatershed include the Los Angeles County municipal separate storm sewer system (MS4) permit, the Caltrans stormwater permit, and general industrial and construction stormwater permits. A summary of the NPDES permits with discharges to Machado Lake are presented in Table 11.

Table 11. Summary of NPDES permits in the Machado Lake subwatershed

Type of Discharge	Total Permits
Municipal Stormwater	1
Caltrans Stormwater	1
Industrial Stormwater	47
Construction Stormwater	31

4.1.1 STORMWATER PERMITS

MS4 Stormwater Permits

In 1990, U.S. EPA developed rules establishing Phase 1 of the NPDES stormwater program designed to prohibit non-stormwater discharges to the MS4, and to reduce the discharge of pollutants into the MS4 and then 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 Los Angeles County MS4 permit (NPDES Permit No. CAS004001) was renewed in December 2001 as Order No. R4-01-182 and is on a five-year renewal cycle. The Los Angeles County Flood Control District is the principal permittee and there are 85 co-permittees covered by the permit, including 84 incorporated cities and the County of Los Angeles. The permittees in the Machado Lake subwatershed include the following:

- City of Carson
- City of Lomita
- City of Los Angeles
- City of Palos Verdes Estates
- City of Rancho Palos Verdes
- City of Redondo Beach
- City of Rolling Hills
- City of Rolling Hills Estates
- City of Torrance
- County of Los Angeles
- County of Los Angeles, Flood Control District

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, NPDES Permit No. CAS000003). 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 or county storm drain, which then discharges to Machado Lake.

General Stormwater Permits

In 1990, U.S. EPA issued regulations for controlling pollutants in stormwater discharges from industrial sites (40 CFR Parts 122, 123, and 124) equal to or greater than five acres. The regulations require discharges of stormwater associated with industrial activity to obtain an NPDES permit and to implement Best Available Technology Economically Achievable (BAT) to reduce or prevent pollutants associated with industrial activity. On April 17, 1997, the State Water Resources Control Board issued a statewide general NPDES permit for Discharges of Stormwater Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ, NPDES Permit Nos. CA S000001). As of the writing of the TMDL, there are approximately 47 dischargers enrolled under the general industrial stormwater permit in the Machado Lake subwatershed.

The State Water Resources Control Board issued a statewide general NPDES permit for Discharges of Stormwater Runoff Associated with Construction Activities (Order No. 99-08-DWQ, NPDES Permit Nos. CAS000002) on August 19, 1999. As of the writing of this TMDL, there are 31 dischargers enrolled under the general construction stormwater permit in the Machado Lake subwatershed.

4.1.2 OTHER NPDES PERMITS

There are no Major Individual, Minor Individual, or General NPDES Permits adopted by the Regional Board for the Machado Lake subwatershed.

4.1.3 SUMMARY OF LOS ANGELES COUNTY MS4 STORMWATER MONITORING

As part of the Los Angeles County MS4 Permit Core Monitoring Program, tributary monitoring is conducted in specific subwatersheds each year. Tributary monitoring was conducted at six locations in the Dominguez Channel watershed in 2008-2009. Automatic flow weighted composite samples and grab samples were taken from each tributary location; five wet-weather and three dry-weather events were monitored for each location. The samples were analyzed for OC pesticides and PCBs. These pollutants were not detected in any of the samples (Los Angeles County Stormwater Monitoring Report, 2008-09). While these data were not collected from the Machado Lake subwatershed specifically, they are representative of contaminant loadings from the Dominguez Channel Watershed Management Area, which contains similar land uses and topography as the Machado Lake subwatershed. Based on these data, current stormwater discharge from the Machado Lake subwatershed appears to be a minimal source of contamination to the lake. However, it is possible for small amounts of contaminated sediment to accumulate to levels that cause impairment.

4.1.4 SUMMARY OF WILMINGTON DRAIN SEDIMENT QUALITY DATA

Wilmington Drain is a Los Angeles County Flood Control District facility. The southern most portion of the drain (between Lomita Boulevard and Pacific Coast Highway) is a 150-foot wide soft bottom channel. Wilmington Drain directly discharges into the riparian area north of Machado Lake; sediment in Wilmington Drain will be transported to and deposited in Machado Lake. A sediment characterization study was conducted in Wilmington Drain as part of the pre-design work for the Machado Lake Ecosystem Rehabilitation Project and Wilmington Drain Multi-Use Project.

The sediment characterization study included four primary sites in Wilmington Drain. The first site (WD-01) was slightly north of Lomita Boulevard and the last site (WD-06) was adjacent to Pacific Coast Highway; sites WD-02 and WD-05 were along the channel between WD-01 and WD-06. Composite profile samples were collected at each site; two depth profiles were collected 0 - 4.5 feet and 4.5 – 5.5 feet. All four upper profile samples (0 - 4.5 ft) exceeded TEC guidelines for Total DDT and chlordane (Table 12). At site WD-06 the concentrations of PCB also exceeded the TEC guideline. Pollutant concentrations observed in the lower profile samples (4.5 - 5.5 ft) generally decreased as compared to the upper profile sample results and were often below TEC guidelines (Table 12).

Table 12 Summary of Wilmington Drain sediment data

Wilmington Drain Sites								
Pollutant (ug/kg)	**WD-01**		**WD-02**		**WD-05**		**WD-06**	
	0-4.5 ft	4.5-5.5 ft	0-4.5 ft	4.5-5.5 ft	0-4.5 ft	4.5-5.5 ft	0-4.5 ft	4.5-5.5 ft
Total DDT	120	4.2	36	ND	177	ND	163	39
Chlordane	29	ND	25	ND	249	ND	450	148
PCBs	38*	44*	7.5*	ND	20*	ND	72*	31*
Non Detect (ND)								
* Value is an estimate								

These data document the presence of contaminated sediment residing in Wilmington Drain. If this sediment is transported downstream to Machado Lake it would be a significant source of contaminated sediment.

4.1.5 Quantification of External Sources from Stormdrains

The annual mass of contaminants entering Machado Lake from the surrounding subwatershed was estimated based on concentrations of sediments measured at lake inlets and the sediment deposits to the lake, using the following equation. This approach was adopted from the TMDL for Toxic Pollutants in San Diego Creek and Newport Bay (U.S. EPA Region 9, June 2002).

$$\text{Load (g/yr)} = Cs \times Ds \times \rho s \times (1-Ps) \times CF$$

where:

Cs = sediment concentration (µg/kg dry)

Ds = sediment deposition (m^3/yr)

ρs = sediment density (kg/m^3)

Ps = sediment porosity

CF = conversion factor (µg to g)

The values for all parameters used in this analysis are presented in the following table (Table 13).

Table 13. Parameter values used in the TMDL external sources analysis

Pollutant	Observed Concentrations (µg/Kg)			*Ps** (kg/m3)	Ps*	Ds (m3/yr)	CF
	Wilmington	Project 77	Project 510				
Chlordane	25.4	6.7	ND	2650	0.65	1110.2	0.000001
Total DDT	18.5	1.5	ND				
Dieldrin	ND	ND	ND				
PCBs	19.2	ND	ND				
ND (non detect)							
* Standard values for sediment properties (Leo C. van Rijn, 1993)							

The observed concentrations were obtained from field samples collected by Regional Board staff on December 10, 2008. The value for sediment deposition was taken from the Machado Lake Ecosystem Rehabilitation Project, Pre-Design Report (July 2009, Appendix N). The sediment deposition rate was estimated based on the comparison of bathymetric maps from 2000 and 2008. The values used for sediment density and porosity are typical values for lake sediment obtained from literature sources.

The annual load was calculated for pollutants with observed concentrations. There were no pollutants detected in the Project 510 drain, so loading is not calculated from this drain. Moreover, dieldrin was undetected in all drains and PCBs were undetected at the Project 77 drain. The results for pollutants with observed concentrations are presented in Table 14.

Table 14. Mass of contaminant loaded from sub-drainage areas

Pollutant	Annual Load (g/year)	
	Wilmington Drain	Project 77
Chlordane	26.2	6.9
Total DDT	19.0	1.5
PCBs	19.8	-

4.2 NONPOINT SOURCES

4.2.1 LAKE SEDIMENTS

As presented in Section 2.3, the sediments in Machado Lake are contaminated with OC pesticides and PCBs. This section estimates the mass of pollutants residing in the sediments at Machado Lake.

Subsurface sediment properties are important to assessing how sediments contribute pollutants to the lake. It is theorized that the sediments of Machado Lake form two layers. The top layer is composed of loose silty organic material that is easily resuspended; the top layer can be considered the active layer of sediment. The lower layer is firm sediment that is deeply buried below the active layer and not likely to contribute pollutants to the lake. The source assessment is based on an estimate of the volume of the active layer of sediment since it is considered the source of contaminants. As part of the Pre-Design Report for the Machado Lake Ecosystem Rehabilitation Project a field team evaluated subsurface sediment properties. The team approximated depth to firm sediment by inserting a metal probe through the sediment surface to refusal. The depths to firm sediment ranged from 3.5 to >7.5 feet (Machado Lake Ecosystem Rehabilitation Project, Pre-Design Report Appendix N, page 2-11). This is a crude method and the team had some difficultly determining the firm sediment layer due to the softness of the active sediment layer; however, this evaluation represents the best information available on the depth of active sediments at Machado Lake.

Regional Board staff multiplied the greatest active sediment depth reported (7.5 feet) by the surface area of the lake (40 acres) to estimate the volume of contaminated sediments.

Volume Sediment = Depth Active Sediment x Lake Surface Area

This volume of sediment was then multiplied by the observed pollutant concentration to estimate the mass of pollutants residing in the active lake sediments.

Existing Sediment Pollutant Load = Volume Sediment x Observed Pollutant Conc.

The following table presents values for parameters used in this analysis and the existing pollutant load (Table 15). Conversion factors are not included in the table.

Table 15. Parameter values used in the TMDL lake sediment source analysis

Pollutant	Observed Concentration* (µg/kg)	Sediment Volume (m^3)	Sediment Bulk Density** (g/ml)	Existing Load (g)
Chlordane	70.7	372,310	1.057	**27,822**
Total DDT	35.5			**13,970**
Dieldrin	1.32			**519**
PCBs	35.7			**14,049**
* Average Concentration from data collected on January 14, 2009				
** Standard value from lakes with similar sediment types (Rowan, Kalff, and Rasmussen, 1992)				

4.2.2 ATMOSPHERIC DEPOSITION

Residue from past use of OC pesticides and PCBs can be volatilized and/or resuspended as particulates, transported and redeposited from both local and distant sources. The atmospheric deposition of OC pesticides and PCBs can be in the form of wet deposition or dry deposition of particulate-bound contaminants (gravity settling of particles). There are two major pathways for pollutants from atmospheric deposition to enter waterbodies. One is direct deposition (pollutants fall directly on the water surface) and the other is indirect deposition, in which pollutants are deposited in the surrounding watershed and washed into the waterbody during a storm event. The load of OC pesticides and PCBs from indirect atmospheric deposition is accounted for in the estimates of stormwater loading from the watershed. The direct deposition is small, since the portion of the TMDL area covered by water is less than 1% of the total subwatershed area.

5 LINKAGE ANALYSIS

The linkage analysis is used to identify the loading capacity of the receiving water for the pollutant of concern by linking the source loading information to the water quality impairment. This section discusses the linkage analysis used for Machado Lake (Figure 8). For Machado Lake, the impairment is for OC pesticides and PCBs in fish tissue and sediment. The sources of these pollutants are stormwater discharged from the watershed to the lake and the lake sediments.

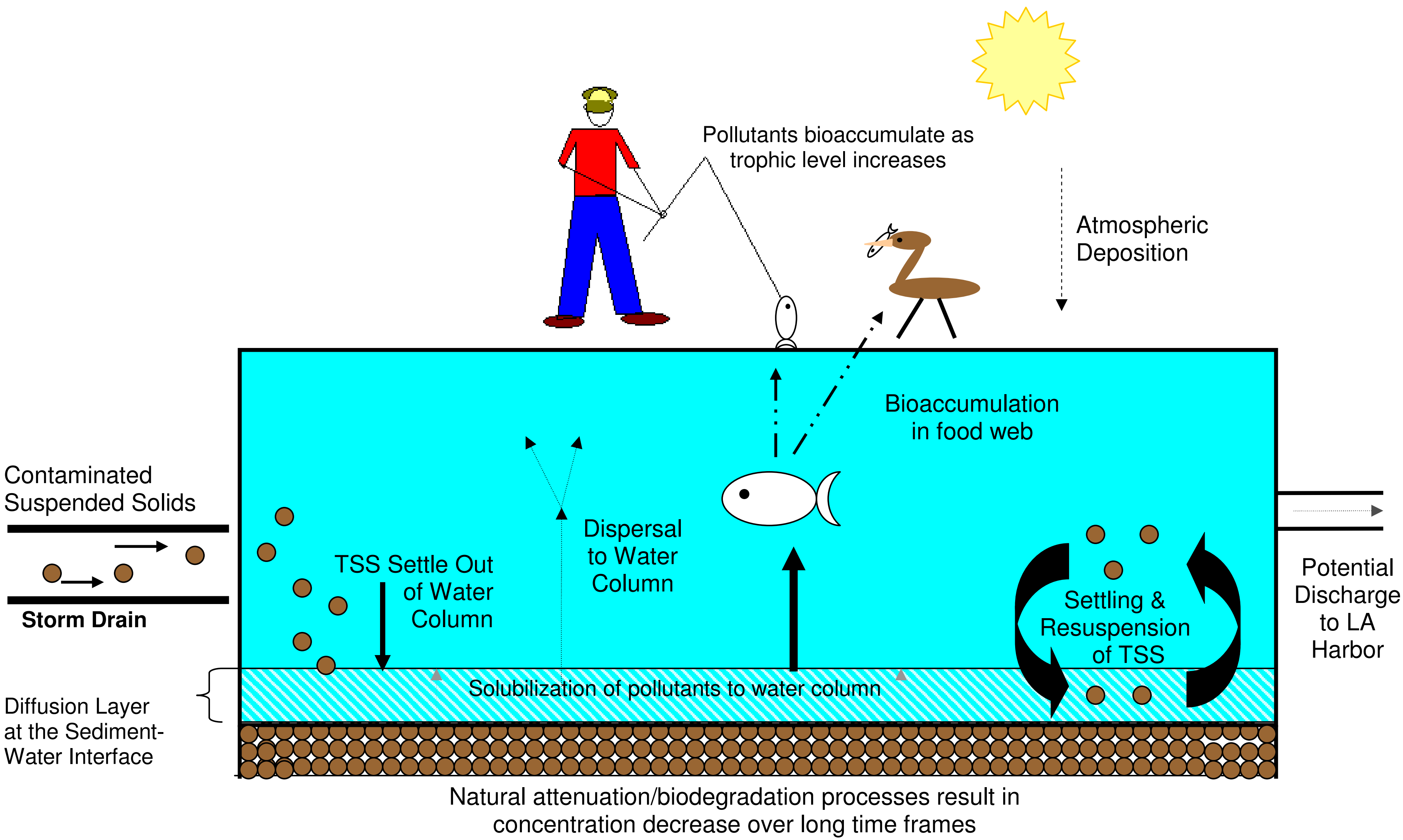
5.1 CONCEPTUAL MODEL

All the contaminants included in this TMDL are legacy pollutants. While PCBs and the OC pesticides DDT, dieldrin, and chlordane are no longer legally sold or used, they remain ubiquitous in the environment, bound to fine-grained particles. As such, there are no new sources in the watershed. When these particles become waterborne, the chemicals are ferried to new locations. The more recent small additions of OC pesticides and PCBs to Machado Lake most likely come from the erosion of pollutant-laden sediment further up in the watershed. Urban runoff and rainfall higher in the watershed mobilize the particles, which are then washed into storm drains and channels that discharge to the lake. Additionally, the contaminated lake sediments are a reservoir of historically deposited pollutants. The resuspension of these sediments contributes to the lake impairment.

While a portion of the sediment-bound contaminants may be carried out of the lake through the discharge to the lower wetland and/or the Los Angels Harbor, most of the contaminants are likely to remain within the lake system. As the pollutants settle into the sediments, some loss may occur through the slow decay and breakdown of these organic compounds. Concentrations in surface sediments may also be reduced through the mixing with cleaner sediments. However these processes occur slowly and it will take several years for the chemicals to breakdown naturally.

With PCBs and OC pesticides accumulating in the sediments, the constituents are available to migrate to the water column and ultimately to the food web. Through bioturbation and feeding processes, the contaminants may be taken up by benthic organisms. Once the sediment-bound PCBs and OC pesticides contaminate benthic organisms, the contaminants may move out of the lake sediments through each trophic layer. Thus, the contaminated lake sediments are an important source. It is expected that if sediments within the lake and those loaded to the lake meet sediment numeric targets, then the fish tissue targets will be met as well. The monitoring program will consist of water, sediment, and fish tissue monitoring to assess this assumption.

Figure 8. Conceptual model for contaminant mobilization in the Machado Lake ecosystem



5.2 Loading Capacity

The loading capacity for each pollutant was calculated for Machado Lake. The loading capacity is the maximum amount of loading which can occur and still result in attainment of the sediment and fish tissue numeric targets and water quality objectives. In the case that the existing load is less than the loading capacity, the existing load is established as the loading capacity to ensure that sediment quality does not degrade below the existing levels.

The loading capacity was calculated in the same manner as the existing sediment load discussed in section 4.2. The volume of contaminated sediments was estimated by multiplying the greatest active sediment depth reported (7.5 feet) by the surface area of the lake (40 acres).

Volume Sediment = Depth Active Sediment x Lake Surface Area

The loading capacity for each pollutant is equal to the volume of the active layer of sediment multiplied by the numeric target.

Pollutant Loading Capacity = Volume Sediment x Target Concentration

The loading capacity for each pollutant is presented in Table 16; the conversion factors are not included in the table. The loading capacities presented in Table 16 are based on the best information currently available. The existing load for dieldrin and PCBs (Table 15) is less than the calculated loading capacity (Table 16). Therefore, the existing load of dieldrin and PCBs is the TMDL loading capacity (Table 17).

Table 16. Parameters used in the loading capacity analysis

Pollutant	Target Concentration (µg/kg)	Sediment Volume (m^3)	Sediment Bulk Density* (g/ml)	Loading Capacity (g)
Chlordane	3.24	372,310	1.057	**1,275**
Total DDT	5.28			**2,078**
Dieldrin	1.9			**747****
PCBs	59.8			**23,533****

* Standard value from lakes with similar sediment types (Rowan, Kalff, and Rasmussen, 1992)

** Calculated loading capacity is greater than existing load, so loading capacity is set as the existing load (Table 17)

Table 17 presents the percent reduction required to meet the loading capacity for each pollutant and accounts for a margin of safety (see section 6.3).

Table 17. Percent reduction to achieve loading capacity

Pollutant	Loading Capacity[1] (g)	Loading Capacity with 10 % Margin of Safety	Existing Load (g)	Percent Reduction Required
Chlordane	1,275	1,147	27,822	96
Total DDT	2,078	1,870	13,970	87
Dieldrin	519	467	519	10
PCBs	14,049	12,644	14,049	10

[1]If the existing load is less than the loading capacity the existing load is set as the TMDL loading capacity.

6 POLLUTANT ALLOCATION

This section summarizes the pollutant allocations and identifies responsible parties to which allocations are assigned. TMDLs are comprised of waste load allocations (WLAs), load allocations (LAs) and a margin of safety (MOS) according to the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

WLAs are assigned to point source discharges and LAs are assigned to nonpoint source discharges. The constituents of concern for this TMDL, OC pesticides and PCBs, are not naturally occurring, thus, the background allocation is equal to zero. Additionally, OC pesticides and PCBs cause impairments due to long term loading and food chain bioaccumulation effects. There is no evidence of short term effects. This TMDL is established in a manner that accounts for longer time periods in which ecological effects may occur.

6.1 WASTE LOAD ALLOCATIONS

Waste Load Allocations are assigned to stormwater dischargers (MS4, Caltrans, general construction and general industrial). Even though stormwater contributions of the TMDL pollutants appear to be small, these small amounts of contaminated sediments accumulate over time and cause impairment. Therefore, WLAs are necessary in this TMDL to ensure that Machado Lake is not re-contaminated after lake remediation actions are completed. The WLAs are assigned as concentration-based allocations (equal to the sediment numeric targets) for suspended sediment-associated contaminants (Table 18). This approach ensures that targets in the lake will not be exceeded and applies the same standard throughout the watershed, instilling equal protection. Furthermore, because OC pesticides and PCBs bioaccumulate, the risk to human health and the environment does not occur as the result of a single discharge event. Therefore, the WLAs are applied with a 3-year averaging period. The impacts of OC pesticides and PCBs are manifested over long time periods. Short-term variations in pollutant concentrations are not likely to significantly impact the impairment and/or protection of beneficial uses. Thus, it is reasonable to evaluate discharges and improvements in water quality over a longer time period. The 3-year averaging period protects the beneficial uses of the lake over long time periods.

Table 18. Waste Load Allocations for OC Pesticides and PCBs

Responsible Party	Pollutant	WLA for Suspended Sediment-Associated Contaminants[1] (µg/kg dry weight)
MS4 Permittees[1], Caltrans, General Construction and Industrial Stormwater Permits, and other Non-stormwater NPDES Permits	Total PCBs	59.8
	DDT (all congeners)	4.16
	DDE (all congeners)	3.16
	DDD (all congeners)	4.88
	Total DDT	5.28
	Chlordane	3.24
	Dieldrin	1.9

[1] WLA are applied with a 3-year averaging period

6.2 LOAD ALLOCATIONS

Load allocations addressing non-point sources of OC pesticides and PCBs are assigned to internal sources from the lake sediments. The LAs are set to attain the loading

[1] Municipal Separate Storm Sewer System (MS4) Permittees including: Los Angeles County, Los Angeles County Flood Control District, and the Cities of Carson, Lomita, Los Angeles, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, and Torrance.

capacity, including the margin of safety, for the lake (Table 19). The LAs for chlordane total DDT, dieldrin, and PCBs are set to attain the lake loading capacity with a 10% margin of safety (Table 17).

Table 19. Load Allocations for OC Pesticides and PCBs

Responsible Party	Pollutant	LA (grams)
City of Los Angeles, Department of Recreation and Parks	Total DDT	1,870
	PCBs	12,644
	Chlordane	1,147
	Dieldrin	467

6.3 MARGIN OF SAFETY

TMDLs must include an explicit and/or implicit MOS to account for uncertainty in determining the relationship between pollutant loads and impacts on water quality. An explicit MOS can be provided by reserving (i.e. not allocating) part of the TMDL. An implicit MOS can be provided by conservative assumptions in the TMDL analysis.

An explicit 10% margin of safety was applied to the loading capacity for this TMDL. This margin of safety will provide additional protection for aquatic life, wildlife, and human health. The explicit margin of safety addresses uncertainties in the relationship between OC pesticides and PCBs and environmental responses in different media and organisms.

In addition, the TMDL includes an implicit margin of safety. The parameters used in the analysis were based on best available information and were selected to be conservative where possible. For example, the numeric targets selected are the most protective of the potentially applicable sediment guidelines available. The use of an explicit and implicit margin of safety and required compliance monitoring will ensure that numeric targets and allocations are successfully achieved.

Areas of uncertainty recognized in the margin of safety include the following.

- Limited data on the amount of pesticides and PCBs residing within the lake sediments
- Limited data on the amount of pesticides and PCBs entering the lake
- Estimated information on the depth to firm sediment in Machado Lake

- Estimated information on the watershed sediment deposition rate
- Constant bulk density, sediment density, and sediment porosity values were used to calculate the load associated with deposited sediment

6.4 CRITICAL CONDITION

TMDLs must include consideration of critical conditions and seasonal factors. OC pesticides and PCBs are a concern in Machado Lake due to long-term loading and food chain bioaccumulation effects. Clearly, wet weather events may produce extensive sediment redistribution and transport sediments to the lake and the CTR-based water column targets are protective of this condition. This would be considered the critical condition for loading. However, the effects of OC pesticides and PCBs are manifested over long time periods. Therefore, short term variations (e.g., annual wet and dry seasons) are not likely to cause significant variations in impairment in fish tissue or sediments. The TMDL is established in a manner that accounts for the longer time periods in which ecological effects may occur.

7 IMPLEMENTATION

This section describes the implementation procedures that could be used to provide reasonable assurances that water quality standards will be met. Compliance with the TMDL is based on achieving the load and waste load allocations and demonstrating attainment of the numeric targets. Compliance will require the elimination of toxic pollutants being loaded into the lake from the subwatershed and clean up of contaminated sediments lying at the bottom of the lake. Dischargers and responsible parties may implement structural and or non-structural BMPs and work collaboratively to achieve the numeric targets and allocations in Machado Lake.

7.1 WASTE LOAD ALLOCATION IMPLEMENTATION

The TMDL WLAs shall be incorporated into the MS4, Caltrans, and general construction and industrial stormwater NPDES permits and other non-stormwater NPDES permits. Because the pollutants in this TMDL are attached to sediment particles, the control of sediment loading to Machado Lake is an effective method to attain the WLAs. Permitted stormwater dischargers can implement a variety of implementation strategies to meet the required WLAs, such as non-structural and structural BMPs, and/or diversion and treatment to reduce sediment transport from the watershed to the lake. Additionally, as presented in the Source Assessment, a relatively small of load of pollutants is currently transported to the lake from the surrounding watershed. Therefore, it is likely that areas of the watershed are already attaining the WLAs and only compliance monitoring would be required.

- Non-Structural BMPs

Non-structural BMPs addressing sediment would help attain the TMDL WLAs. Non-structural BMPs include more frequent and appropriately timed storm drain catch basin cleanings, improved street cleaning by upgrading to vacuum type sweepers, and educating residents and industries of good housekeeping practices. These BMPs would reduce the amount of sediment transported to Machado Lake during storm events.

- Diversion and Treatment and/or Structural BMPs

Diversion and treatment facilities divert runoff directly, or provide capture and storage of runoff and then divert, to a location for treatment. Once the water is treated, a portion or all of it could be routed back to the lake. Treatment options to reduce sediment could include sand or media filters. A typical sand/media filter system contains two or more chambers. The first is the sedimentation chamber for removing floatables and heavy sediments. The second is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed or filtering media. This type of treatment system provides high removal efficiency for sediment (CASQA, 2003).

Structural BMPs may include the placement of stormwater treatment devices designed to reduce sediment loading, such as infiltration trenches, vegetated swales, and/or filter strips at critical points in the watershed. These types of BMPs generally reduce stormwater velocity, which allows sediment to settle out and to infiltrate runoff. These types of BMPs are reported to have medium to high sediment removal efficiencies (CASQA, 2003).

7.2 Load Allocation Implementation for Contaminated Lake Sediments

Load allocations addressing nonpoint sources (NPS) of OC pesticides and PCBs are assigned to the lake sediments. Two primary federal statutes establish a framework in California for addressing NPS water pollution: Section 319 of the Clean Water Act of 1987 and Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990.

Non-point source load allocations can also be addressed through provisions in the California Water Code, such as Conditional Waivers, Waste Discharge Requirements (WDRs), or Discharge Prohibitions. In accordance with these statutes, the state assesses water quality associated with NPS pollution and develops programs to address NPS. In 2004, the SWRCB, in its continuing efforts to control NPS pollution in California, adopted the Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program, which prescribes implementation and monitoring of management practices to address non-point source pollution.

The responsible parties identified in the Pollutant Allocation section of this document are assigned a lake sediment load allocation and the responsibility for clean up of the contaminated lake sediments to attain the load allocation. This section reviews the regulatory tools that may be used to ensure clean up of the lake sediment and presents possible implementation measures.

One of the options available to implement the LAs assigned to internal lake sources includes the Regional Board Executive Officer, if delegated authority by the Regional Board, entering into a Memorandum of Agreement (MOA) with responsible parties. Alternatively, the Regional Board Executive Officer shall issue a Clean-up and Abatement Order (CAO) or use another appropriate regulatory mechanism.

An MOA may be entered into by the Regional Board and responsible parties to implement the LAs of the Machado Lake OC Pesticides and PCBs TMDL. The MOA shall meet requirements pursuant to the development of a non-regulatory implementation program as presented in the Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (State Board Resolution 2005-0050) section 2 C ii and requirements of this TMDL.

To be a valid non-regulatory implementation program adopted by the Regional Board, the MOA shall include the following requirements and conditions:

- The MOA shall direct development of a monitoring and reporting program plan that addresses the impaired waterbody as approved by the Regional Board's Executive Officer.

- The MOA shall contain conditions that require trackable progress on attaining load allocations and numeric targets. A timeline shall be included that identifies the point or points at which Regional Board regulatory intervention and oversight will be triggered if the pace of work lags or fails.

- The MOA shall contain a provision that it shall be revoked based upon findings by the Executive Officer that the program has not been adequately implemented, is not achieving its goals, or is no longer adequate to restore water quality.

- The MOA shall be consistent with the California Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program, including but not limited to the "Key Elements of a Non-point Source Pollution Control Implementation Program".

Responsible parties entering into an MOA with the Regional Board shall submit and implement a Lake Water Quality Management Plan (LWQMP). The LWQMP must be approved by the Executive Officer and may be amended by Executive Officer approval, as necessary. The LWQMP shall include a Monitoring and Reporting Program (MRP) plan to address appropriate monitoring and a clear timeline for the implementation of measures that will achieve the lake sediment LAs. The LWQMP shall include annual reporting requirements. In addition to the LWQMP and MRP plan, a Quality Assurance Project Plan (QAPP) shall also be submitted to the Regional Board for approval by the Executive Officer to ensure data quality.

One and one-half years from the effective date of the TMDL, the responsible parties entering into the MOA shall submit a letter of intent, LWQMP, MRP Plan, and QAPP for approval by the Executive Officer in order to be in compliance with the MOA adopted as part of this TMDL. If there is already an MOA, LWQMP, MRP Plan, and QAPP in place to implement the Machado Lake Nutrient TMDL, these documents may be amended to implement and attain the load allocations of this TMDL.

The implementation of the LWQMP must result in attainment of the TMDL load allocations. Implementation of the MOA, LWQMP, and progress toward the attainment of the TMDL load allocations shall be reviewed annually by the Executive Officer as part of the annual monitoring report submitted by responsible parties. If the MOA and LWQMP are not implemented such that the TMDL load allocations are achieved, the

Regional Board shall revoke the MOA and the TMDL load allocations may be implemented through a CAO or other appropriate regulatory mechanism.

Regional Board staff will work cooperatively and actively with the responsible parties to develop the MOA or other regulatory mechanism that will completely clean up the lake sediments and restore beneficial uses. Described below are four potential measures to clean up the contaminated sediments in Machado Lake.

- Sediment Capping

The objective of sediment capping is to cover contaminated sediment by a layer of clean sediment, clay, gravel, or other material. The cap reduces the mobility of the pollutants and places a physical barrier between the water column and the contaminated sediment. Capping can be an effective remediation action; however, it is most effective in large deep waterbodies under certain conditions. For example, the bottom sediments of the waterbody must be able to support the cap and the hydrologic conditions of the waterbody must not disturb the cap site. This option would require long term monitoring and maintenance to ensure that the contaminated sediments are not moving and that the cap is still in place. A feasibility study considering the conditions of Machado Lake would be necessary before this option could be implemented.

- Dredging/Hydraulic Dredging

Dredging is the removal of accumulated sediments from the lake bottom. In the case of Machado Lake, the objective would be to remove the sediments that are contaminated with OC pesticides and PCBs. Therefore, it would be necessary to dredge to a depth that would ensure the removal of all contaminated sediments. A method of sediment removal from lakes is hydraulic dredging. A hydraulic dredge floats on the water and is approximately the size of a boat. It has a flexible pipe that siphons a mix of water and sediment from the bottom of the lake. The flexible pipe is attached to a stationary pipe that extends to an-off site location. The sediment that is removed from the lake bottom is pumped to a settling pond to dry prior to disposal. Hydraulic dredging does not require draining the lake or damage to the shoreline of the lake; however, it can cause damage to aquatic life, liberation of toxic pollutants, short term turbid conditions, and low dissolved oxygen. Hydraulic dredging does require careful planning and mitigation for non-target disturbances.

- Combination of Dredging and Capping

Responsible parties may consider combining the remediation measures of dredging and capping. For example, it may be possible to partially dredge and then cap either all of the lake or particular areas of the lake. Disposing of dredged contaminated sediment can be very expensive. The approach of combining dredging and capping may minimize the amount of dredge sediment for disposal and effectively remediate the lake sediments. A feasibility study would be required to determine if this approach is suitable for Machado Lake.

- Monitored Natural Attenuation of Contaminants

Natural attenuation encompasses the physical, chemical, and biological processes that the sediment may undergo, which over time will attenuate (i.e., reduce concentration and bioavailability) the impacts of contamination. These are natural processes that will occur without other remediation actions. Monitoring would be required as part of this remediation strategy to demonstrate that contaminants are in fact attenuating and that human health and the environment are protected. A disadvantage of choosing natural attenuation as a remediation strategy is that it generally requires long periods of time to be effective given the long half lives of the pollutants of concern.

7.3 Determining Compliance with the TMDL Allocations

The goal of the TMDL is to restore all of the beneficial uses of Machado Lake through attainment of water quality objectives. TMDL effectiveness will be determined through water, sediment, and fish tissue monitoring and comparison with the TMDL waste load and load allocations and numeric targets. The compliance point for the stormwater WLA is at the storm drain outfall of the permittee’s drainage area. Alternatively, if stormwater dischargers select a coordinated compliance option, the compliance point for the stormwater WLA may be at storm drain outfalls which suitably represent the combined discharge of cooperating parties. Depending on potential BMPs implemented, alternative stormwater compliance points may be proposed by responsible parties subject to approval by the Regional Board Executive Officer. The compliance point for responsible parties receiving a load allocation is in Machado Lake.

Stormwater dischargers may coordinate compliance with the TMDL. Compliance with the TMDL may be based on a coordinated MRP. Dischargers interested in coordinated compliance shall submit a coordinated MRP that identifies stormwater BMPs and monitoring to be implemented by the responsible parties. Under the coordinated compliance option, the compliance point for the stormwater WLAs shall be storm drain outfalls which suitably represent the combined discharge of cooperating parties.

After lake remediation activities are complete and LAs are attained, if Machado Lake is recontaminated as a result of continued polluted discharge from the surrounding watershed, the WLA compliance monitoring data will be used, along with other available information, to assess the relative contribution of watershed dischargers and determine their responsibility for secondary lake remediation activities. If a significant amount of contaminated sediment is transported to Machado Lake from the surrounding watershed after lake remediation actives are completed, but before monitoring is conducted to confirm attainment of LAs, Regional Board staff shall consider all confounding information related to watershed discharges and lake conditions when assessing responsibility for secondary lake remediation activities.

7.4 Monitoring

Monitoring for the Machado Lake OC Pesticides and PCBs TMDL will be designed to implement and assess the effectiveness of this TMDL. The monitoring program is required to measure the progress of pollutant load reductions and improvements in water and sediment quality and fish tissue. The monitoring program has several goals:

- Determine attainment of OC pesticides and PCBs numeric targets;
- Determine compliance with waste load and load allocations; and
- Monitor the effect of implementation actions on the lake.

Responsible parties assigned both WLAs and LAs may submit one document that addresses the monitoring requirements (as described below) and implementation activities for both WLAs and LAs.

7.4.1 Compliance Monitoring – Waste Load Allocations

Responsible parties assigned WLAs shall conduct monitoring to determine compliance with the WLAs. The monitoring shall be conducted in two phases at appropriate locations in the subwatershed.

Phase 1

Phase 1 monitoring will be conducted for a two year period. Samples will be collected during three wet weather events each year. The first large storm event of the season shall be included as one of the monitoring events. Samples will be analyzed for total suspended solids. Sampling shall be designed to collected sufficient volumes of suspended solids to allow for analysis of the following pollutants in the bulk sediment:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

In addition to TMDL constituents, general water chemistry (temperature, dissolved oxygen, pH, and electrical conductivity) and a flow measurement will be required at each sampling event. General chemistry measurements may be taken in the laboratory immediately following sample collection, if auto samplers are used for sample collection or if weather conditions are unsuitable for field measurements.

Phase 2

Phase 2 monitoring will commence once Phase 1 monitoring has been completed. Samples will be collected during one wet weather event every other year. Samples will be analyzed for total suspended solids. Sampling shall be designed to collected sufficient volumes of suspended solids to allow for analysis of the following pollutants in the bulk sediment:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

In addition to TMDL constituents, general water chemistry (temperature, dissolved oxygen, pH, and electrical conductivity) and a flow measurement will be required at each sampling event.

Monitoring shall be conducted under a technically appropriate MRP and QAPP. The MRP shall include a requirement that the responsible parties report compliance and non-compliance with waste load allocations as part of annual (or biennial during Phase 2 monitoring) reports submitted to the Regional Board. The QAPP shall include protocols for sample collection, standard analytical procedures, and laboratory certification. All samples shall be collected in accordance with SWAMP protocols. Phase 1 sampling shall begin within 60 days of Executive Officer approval of the MRP and QAPP.

The Regional Board Executive Officer may reduce, increase, or modify Phase 2 monitoring and reporting requirements, as necessary, based on the results of Phase 1 monitoring. Currently, several of the constituents of concern have numeric targets that are lower than the readily available detection limits. As analytical methods and detection limits continue to improve (i.e., development of lower detection limits) and become more environmentally relevant, responsible parties shall incorporate new method detection limits in the MRP and QAPP.

7.4.2 Compliance Monitoring – Load Allocations

Monitoring to determine compliance with the TMDL load allocations and the fish tissue target will be conducted as part of the LWQMP. This monitoring will commence following the remediation of lake sediments as presented in the LWQMP.

Lake sediment samples will be collected every three years from three locations in the lake (northern end, mid point, southern end). All samples will be collected in accordance with SWAMP protocols. Sediment samples will be analyzed for:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Total Chlordane

Fish shall be collected for tissue analysis every 3 years. Fish tissue samples will be analyzed for:

- Total PCBs
- DDT and Derivatives
- Total Chlordane
- Dieldrin

The fish collection and analysis shall be conducted in accordance with the U.S. EPA *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1 Fish Sampling and Analysis* (EPA 823-B-00-0007).
In addition to TMDL constituents, general water chemistry (temperature, dissolved oxygen, pH, and electrical conductivity) will be required at each sampling event. Additional monitoring may be required depending on which implementation alternatives are pursued by the responsible parties.

Currently, several of the constituents of concern have numeric targets that are lower than the readily available detection limits. As analytical methods and detection limits continue to improve (i.e., development of lower detection limits) and become more environmentally relevant, responsible parties shall incorporate new method detection limits in the MRP and QAPP.

7.4.3 WILMINGTON DRAIN MONITORING

The Los Angeles County Flood Control District shall monitor Wilmington Drain to demonstrate that Wilmington Drain is not re-contaminating Machado Lake. Monitoring shall include bed sediment sampling and visual inspection of channel maintenance and BMP operation. Monitoring shall be required by Executive Officer order or a conditional Water Quality Certification under section 401 of the Clean Water Act. This monitoring shall be initiated at the same time as all other required WLA monitoring.

7.5 IMPLEMENTATION SCHEDULE

The TMDL Implementation Schedule (Table 20) is designed to provide responsible parties flexibility to implement BMPs and lake management strategies to address the OC pesticide and PCBs impairments at Machado Lake. Implementation consists of development of monitoring/management plans by responsible parties, implementation of BMPs to address external contaminant loading to the lake, and lake management activities to remediate the sediment contamination and protect aquatic life.

Table 20. Implementation Schedule for Machado Lake Pesticides and PCBs TMDL

Task Number	Task	Responsible Party	Deadline
Load Allocation Requirements			
1	Enter into a Memorandum of Agreement (MOA) with the Regional Board to implement the load allocations. If there is already an MOA in place to implement the Machado Lake Nutrient TMDL, the current MOA may be amended to address the requirements of this TMDL.	City of Los Angeles, Department of Recreation and Parks	1 year from effective date of TMDL
2	Begin development of a Clean-Up and Abatement Order or other regulatory order to implement the load allocations if an MOA is not established with responsible parties.	Regional Board	1 year from effective date of TMDL
3	Issue a Clean-Up and Abatement Order or other regulatory order if an MOA is not established with responsible parties. The Clean-Up and Abatement Order or other regulatory order shall reflect the TMDL Implementation Schedule.	Regional Board	1.5 years from effective date of TMDL
4	Submit a LWQMP, MRP Plan, and QAPP for approval by the Executive Officer to comply with the MOA. If there is already a LWQMP, MRP Plan, and QAPP in place to implement the Machado Lake Nutrient TMDL, these documents may be amended to address the requirements of this TMDL.	City of Los Angeles, Department of Recreation and Parks	1.5 years from the effective date of the TMDL
5	Begin implementation of the LWQMP.	City of Los Angeles, Department of Recreation and Parks	60 days from date of approval
6	Achieve LAs for OC Pesticides and PCBs and demonstrate attainment of numeric targets.	City of Los Angeles,	September 30, 2019

Task Number	Task	Responsible Party	Deadline
		Department of Recreation and Parks	
Waste Load Allocation Requirements			
7	Submit a MRP and QAPP for Executive Officer approval[3].	Caltrans, MS4 Permittees[2], General Construction and Industrial Stormwater Permittees	6 months from effective date of TMDL or September 11, 2011 whichever date is later
8	Begin monitoring as outlined in the approved MRP and QAPP.	Caltrans, MS4 Permittees, General Construction and Industrial Stormwater Permittees	60 days from date of approval
9	Conduct Phase 1 Monitoring	Caltrans, MS4 Permittees, General Construction and Industrial Stormwater Permittees	2 year monitoring period
10	Based on the results of Phase 1 Monitoring, submit an implementation plan to attain WLAs or document that WLAs are attained.	Caltrans, MS4 Permittees, General Construction and Industrial Stormwater Permittees	6 months from completion of Phase 1 Monitoring (Draft Plan) 1 year from completion of Phase 1 Monitoring (Final Plan)
11	Begin implementation actions to attain WLAs, as necessary	Caltrans, MS4 Permittees, General Construction and Industrial Stormwater Permittees	60 days from date of plan approval
12	Achieve WLAs for OC Pesticides and PCBs and demonstrate attainment of numeric targets.	Caltrans, MS4 Permittees, General Construction and Industrial Stormwater Permittees	September 30, 2019
[3]The deadline for Responsible Parties assigned both WLAs and LAs to submit one document to address both WLA and LA monitoring requirements and implementation activities shall be 1.5 years from the effective date.			

[2] Municipal Separate Storm Sewer System (MS4) Permittees including: Los Angeles County, Los Angeles County Flood Control District, and the Cities of Carson, Lomita, Los Angeles, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, and Torrance.

7.6 COST CONSIDERATIONS

The purpose of this cost analysis is to provide the Regional Board with a reasonable range of potential costs of implementing this TMDL and to address concerns about costs that have been raised by responsible parties. An evaluation of the potential costs of implementing this TMDL amounts to evaluating the costs of preventing loading of OC Pesticides and PCBs from the subwatershed to the lake and remediating the contaminant-laden sediments at the bottom of the lake. This section provides an overview of the potential costs associated with generalized discharge reduction and sediment remediation implementation methods. The implementation methods for the Machado Lake Nutrient TMDL may also apply for this TMDL, especially with respect to lake sediment remediation. Thus, the estimates in this section may over-estimate the actual costs of coordinated implementation of the Nutrient and OC Pesticides and PCBs TMDLs.

The cost of implementing this TMDL will range widely, depending on the methods that the responsible parties select to meet the waste load and load allocations. Based on the implementation measures discussed previously, approaches can be categorized as stormwater management/treatment and remediation of in-situ Machado Lake sediments.

7.6.1 STORMWATER MANAGEMENT AND/OR TREATMENT

Sand/Organic Filters

A typical sand/organic filter system contains two or more chambers. The first is the sedimentation chamber for removing floatables and heavy sediments. The second is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed. Properly designed sand/organic filters are effective methods to remove sediment from stormwater. The effectiveness of a sand/organic filter system is greatly influenced by the pollutant loadings, and the characteristics of drainage areas.

The construction cost of a sand/organic filter system depends on the drainage areas, expected efficiency, and other design parameters. Case studies conducted in 1997 indicate cost ranges from $6,600 to $11,000 to treat a drainage area of 5 acres or less. Systems designed to treat larger drainage areas (~ 50 acres) can cost $18,500 (U.S. EPA, 1999). Assuming that 30% of the subwatershed will be treated with sand filters designed for a 5-acre drainage area and a unit construction price of $12,000 dollars (adjusted for inflation), the estimated construction cost of sand/organic filters for 30% of the subwatershed would be $9.2 million dollars (Table 21). Annual maintenance costs average approximately 5% of construction costs.

Table 21. Summary of estimated costs for sand/organic filter systems

Item	Unit Price	Total Cost
Construction	$12,000[1]	$9.2 million
Maintenance	5% of construction cost	$ 460,800 annually
Amortized cost over 7 years (6% interest)		2.5 million annually
[1]Median cost of a 5-acre treatment system adjusted to 2010 dollars		

<u>Vegetated Swales and Filter Strips</u>

Vegetated swales are constructed drainage ways used to convey stormwater runoff. Vegetation in swales allows for the filtering of pollutants and infiltration of runoff into groundwater. Densely vegetated swales can be designed to add visual interest to a site or screen unsightly views. Broad swales on flat slopes with dense vegetation are the most effective at reducing the volume of runoff and pollutant removal. Vegetated swales generally have a trapezoidal or parabolic shape with relatively flat side slopes. Individual vegetated swales generally treat small drainage areas of five acres or less.

Filter strips are densely vegetated, uniformly graded areas that treat sheet flow from adjacent impervious surfaces. They reduce runoff velocities, which allow sediment and other pollutants to settle out. The reduced velocities also result in some infiltration. Filter strips are commonly planted with turf grass, but they may also employ native vegetation, trees, and shrubs to create visual screening and physical barriers. Filter strips are frequently used as pretreatment systems for stormwater that will be treated with other BMPs such as sand filters.

The effectiveness of vegetates swales or filter strips depends on slopes of swales, soil permeability, grass cover density, contact time of stormwater runoff and intensity of storm events. The performance of vegetated swales/filter strips, for sediment removal is considered medium to high (CASQA, 2003). Based on case studies, the ratio of swale surface area to drainage area is 1,000 square feet per acre (CASQA, 2003). The mid range cost to construct a swale for treatment of a 10-acre drainage area is approximately $19,000 (adjusted to 2010 dollars) (CASQA, 2003). If swales are used to treat 30% of the subwatershed, the construction cost would be approximately $7.3 million dollars (Table 22). The annual maintenance cost is estimated at 5% of the construction cost; annual maintenance costs are estimated at $365,000 (Table 22).

Table 22. Summary of estimated costs for vegetated swales

Item	Unit Price	Total Cost
Construction	$19,000[1]	$7.3 million
Maintenance	5% of construction cost	$ 365,000 annually
Amortized cost over 7 years (6% interest)		$2.0 million annually
[1]Mid-range cost of 10-acre treatment system adjusted to 2010 dollars		

7.6.2 Lake Management

As a remediation option, Monitored Natural Attenuation (MNA) is the most passive and therefore the least expensive of the possible in-lake implementation approaches. MNA requires monitoring to document that contaminant concentrations are decreasing. Sediment samples would need to be collected and analyzed for the following constituents.

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Total Chlordane

Regional Board staff reasonably assumes that a grid pattern of 15 sampling locations would adequately evaluate natural attenuation at Machado Lake. Annual monitoring costs would run approximately $9,680 including sample collection and analyses (Table 23).

Table 23. Summary of annual monitoring costs for MNA

Item	Cost	Total Cost
15 samples	Analysis at $400 per sample	6,000
3 QAQC samples	Analysis at $400 per sample	1,200
Sample collection (16 hours)	100 per hour	1,600
Sub total		**8,800**
10 % Contingency		880
Total		**9,680**

In-situ Capping

In-situ capping results in the containment of contaminated sediment rather than treatment. Due to the fact that the contaminants remain on-site and potentially could be exposed after the capping layer is installed, monitoring is required to verify that contaminants are not mobilizing to the water column and food web. To calculate the cost of in-situ capping, it is assumed that the entire area of the lake (approximately 40 acres) would be covered with a sand cap approximately 1 foot thick. In-situ capping would cost about $4,046,160 for installation activities (Table 24).

Table 24. Installation costs for in-situ capping at Machado Lake

Item	Unit Cost	Area (ft^2)	Total Cost
Mobilization/Demobilization [a]	$300,000		$300,000
Capping Activities [b]	$2.15/ft	1,742,400	3,746,160
			4,046,160
[a] U.S. Army Corps of Engineers, 2005 [b] U. S. EPA, 2002			

Provided the cap is not disturbed by high flow and/or storm events, annual maintenance should not be required. However, as with the MNA alternative, more extensive monitoring may be required. If monitoring reveals that the sediment contaminants are being transported across the sand cap, additional costs may be accrued to strengthen the cap. Sediment porewater samples would need to be collected twice a year and analyzed for the following constituents.

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Total Chlordane

Annual monitoring costs would run approximately $5,000 including sample collection and analyses.

Dredging

The cost to dredge Machado Lake depends on the vertical extent of contamination. In the Source Assessment section of this document, the potential contamination depth was estimated at 7.5 feet. The surface area of the lake is 40 acres. Accordingly, the estimated volume of contaminated sediment to be dredged is 486,963 cubic yards.

Sediment removal and disposal costs were obtained from the final Pre-Design Report for the Machado Lake Ecosystem Rehabilitation Project. The High-Level Scenario for sediment removal and disposal at Machado Lake includes dredging, dewatering, rehandling, transporting, and disposing; the High Level Scenario assumes that the majority of sediment in Machado Lake is contaminated. The cost estimate is $146 per cubic yard of dredged sediment. This estimate does not include contractor overhead or contingency costs (Pre-Design Report for the Machado Lake Ecosystem Rehabilitation Project Appendix N, July 2009). Based on the value of $146 per cubic yard, the estimated total costs for dredging Machado Lake is $71 million.

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