Appendix C

Technical Memorandum re. Effectiveness of Dry Weather Non-Structural Best Management Practices

LARRY WALKER ASSOCIATES

Technical Memorandum

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DATE.	August 15, 2011
TO.	Randall Davis County of Los Angeles, Department of Public Works
CC.	Mitch Mysliwiec, LWA
SUBJECT	Effectiveness of Dry Weather Non-Structural Best Management Practices

INTRODUCTION

The United States Environmental Protection Agency adopted the Machado Lake Nutrient Total Maximum Daily Load (TMDL) on March 11, 2009. On September 2, 2010, the Los Angeles Regional Water Quality Control Board adopted the Machado Lake Toxics TMDL which addresses persistent chlorinated hydrocarbon pesticides (PCHP) and polychlorinated biphenyls (PCBs) together as "toxics" The County is currently developing multi-pollutant implementation plans to support both the TMDLs pursuant to California Water Code. The Implementation Plans identify a comprehensive, phased approach of best management practice (BMP) implementation to meet the nutrient and toxics waste load allocations (WLAs) of the TMDL. There are three islands of unincorporated County of Los Angeles (County) lands within the Machado Lake watershed which are subject to WLAs specified in the TMDLs.

The County has developed a regional modeling approach, the Watershed Management Modeling System(WMMS), to simulate the transport of sediment, nutrients, and other compounds; and to evaluate best management practice (BMP) scenarios for the control of the simulated constituents. While nutrients can be directly modeled, the toxics are simulated by modeling sediment loads and applying factors reflecting the concentration of the toxics on the soil particles. The WMMS is more suited to simulation of wet-weather loading and BMPs to control wet-weather loading. As the toxics are strongly associated with suspended solids in the storm water, control of these compounds is modeled through BMPs for the control of total suspended solids (TSS).

The purpose of this memo is to identify the efficiencies of potential dry weather, source control BMPs that the County can input into its model to determine what BMPs are needed to meet the WLA. The dry weather season is considered to extend from April 1 to September 30.

The following sections describe the:

- Dry Weather Loading Model
- Dry weather non-structural BMPs
- Watershed Treatment Model used to determine BMP effectiveness
- Estimation of BMP effectiveness
    - Best Management Practice Evaluation
    - Results from the Watershed Treatment Model

The County conducted a Special Study to determine the nutrient and TSS loads from the unincorporated County Islands in the Machado Lake watershed. The TSS loads are used to derive toxics loads from the County Islands. To reduce these dry weather loads, this memo investigates non-structural dry weather BMPs. The memo reviews several BMPs and their associated effectiveness. The effectiveness of BMPs, however, is measured in various ways, such as a reduction in load from a specific site (e.g., TSS on streets was reduced by 45%) or a reduction in runoff flow These do not directly translate into a reduction in loads to dry weather stormwater For example, in the literature the percent reduction of loads from streets was calculated by measuring loads *from streets* before and after sweeping. The study that produced these results did not measure loads *in stormwater* before and after sweeping. Therefore, because it is unknown what loads from the street actually enter stormwater and what percent of the total load in stormwater is from streets, the study results are not directly applicable to reduction of loads from County islands through implementation of enhanced street sweeping.

To address the issues of relating effectiveness of different dry weather BMPs to reductions in dry weather stormwater from County islands, the Watershed Treatment Model (WTM) was used to estimate the direct reduction of loads entering stormwater from various sources. The WTM is a simple spreadsheet model that estimates pollutant loading based on current land uses, secondary sources (such as illicit discharges), and pollutant removal based on existing and future management practices (such as implementing an illicit discharge detection and elimination program).

The WTM was modified to "mock-up" a dry weather scenario (April 1 – September 30) for the County islands found within the Lake Machado watershed to estimate the pollutant removal benefit of recommended (future) dry weather non-structural BMPs. A baseline of pollutant loading was established based on current land uses and associated impervious cover and pollutant loads. A small amount of illicit discharges (1% of residential population and 10% of businesses based on best professional judgment) were assumed to determine secondary loads (i.e., loads in addition to land use runoff). Existing management practices were utilized in the WTM to determine the amount of pollutant reductions that might be occurring as a result of the County's current stormwater program activities such as street sweeping. The last step applied future management practices that the County might implement as part of TMDL compliance. Future management practices included a more frequent catch basin clean outs, more effective street sweeping program (increased frequency, higher efficiency street sweepers), a program to detect and eliminate illicit discharges within the County islands, and a program to reduce irrigation runoff and foster effective fertilizer use through the use of residential outreach and structural controls.

WTM outputs included a rough estimate of existing dry weather loads (existing land use with existing management practices) and future dry weather loads (existing land use with future/enhanced management practices). These two outputs (existing and future) were used to determine a percent reduction for each dry weather non-structural BMP Additional information about the WTM and associated assumptions are provided in the sections below

DRY WEATHER LOADING MODEL

Through a Special Study[1], the County developed a dry weather loading model for nutrients and total suspended solids loads as part of an implementation plan for mass-based compliance with the TMDL. Monitoring for the study took place between May 2010 and March 2011 with six water quality sampling events and continuous measurements of flow rates at six sites. Results of the study successfully created an estimate of the dry weather flow rates for each individual site. Analysis of the data determined that each water quality constituent was part of one distribution for all County-owned lands in the Machado Lake watershed. Monte Carlo simulation modeling determined the mass-based dry weather loading estimates for total nitrogen and total phosphorous, while County modeling efforts with the WMMS model were used to estimate the annual mass-based loading estimates for total nitrogen and total phosphorous.

The estimated nutrient and suspended dry weather solid loading from County islands are listed in **Table 1**

Table 1: Current Nutrient Mass-Based Loading from County Islands.

Constituent	Dry Weather Mass-Based Loading Estimate (kg/yr)
Total Nitrogen	560
Total Phosphorous	56
Total Suspended Solids	2,000

DRY WEATHER NON-STRUCTURAL BEST MANAGEMENT PRACTICES

A literature review was conducted to determine the removal effectiveness and costs of several BMPs. Dry weather BMPs were evaluated based on County island land uses. These land uses are summarized in **Table 2**.

[1] Machado Lake Nutrients TMDL Special Study for Estimation of Loadings from the Unincorporated Areas of Los Angeles County within the Machado Lake Watershed Final Report – DRAFT, submitted to the Los Angeles County department of public works watershed management division, July 2011

Table 2: Summary of Land Uses within County Islands in the Machado Lake Watershed[1]

Island 1	Island 2	Island 3
SFR	MFR	SFR
Education	Open Space	MFR
Open Space		Industrial
		Mobile Homes
		Commercial
		Education
		Open Space

1. HDSF = High-Density Single Family Residential; MFR = Multi-Family Residential.

A summary of removal effectiveness is shown in **Table 3**. However, as discussed in the introduction, percent removals are not directly comparable. Illicit discharge removals and pet waste removals are direct reductions of the amount of nutrients and TSS in stormwater Catch basin/sump clean out and street sweeping removals are the percent reduction in the loads of nutrients and TSS on streets and in catch basins. They are not direct reductions in the amount of nutrients of TSS in stormwater Finally, impervious cover reduction reduces the amount of stormwater but is dependent on land use to determine the amount of nutrients and TSS that would be prevented from entering stormwater

Table 3: Removal Effectiveness and Cost of Select Dry Weather Non-Structural Best Management Practices[1]

Best Management Practice	Total Nitrogen Removal	Total Phosphorus Removal	TSS Removal	Flow Reduction	Costs
Illicit Connection Removal[2]	4%	4%	3%		• $2,500/illicit connection removal
Pet Waste Management[3]	1.4% (brochure) 2% (TV or radio PSA)		N/A		• $0.49/brochure • $2,560/39 spots on radio • $3,000/33 cable television spots • $15,000 for pet waste ordinance • $200/pet waste receptacle
Catch Basin/Sump Clean Out[4]	Semi-annual cleanout: 27%	 6%	 35%		• $150,000/vactor truck
	Annual cleanout: 14%	 3%	 18%		
Catch Basin Inserts[7]	15%	30%	30%		• $300 impervious acre (does not include annual O&M costs)
Street Sweeping (vacuum cleaner)[5]	Weekly sweeping: 45%	 30%	 31%		• $20,000 capital/ vacuum sweeper • $20 O&M /curb-mile
	Monthly sweeping: 20%	 15%	 22%		
Impervious Cover Reduction[6]	N/A	N/A	N/A	7%	• New development: $0 • Asphalt removal: $40,000/ac • Site restoration: $26,150/ac

1 N/A = Information not available
2. Removal estimates from Caraco, 2001 Cost estimate from Marcoux, 2004 and Brown et al., 2004.
3. Removal estimates from Orange Co., 2006 and Caraco, 2001 Cost estimates from HRPDC, 2006 and Butler et al.. 2000;
4. Removal estimates from Law et al., 2008. Cost estimate from CASQA, 2003.
5. Removal estimates from Law et al., 2008 and Zarriello et al., 2002. Cost estimate from RWMWD, 2005.
6. Flow reduction estimate from Zielinski, 2000a and Zielinski, 2000b. Cost estimates from RS Means, 2006
7. Cost estimates from Parametrix, 2010

Multiple types of street sweepers are available including mechanical, vacuum, and regenerative air sweepers. Effectiveness is based on street sweeper type as well as sweeping frequency **Table 4** shows the increase in removal efficiency from weekly to monthly sweeping determined in a study by the Center for Watershed Protection (Law, 2008).

Table 4: Comparison of Effectiveness in Removal of Nutrients Using Different Types of Street Sweepers at Varying Frequencies

Constituent	Monthly Sweeping Reduction	Weekly Sweeping Reduction	Increased Reduction from Switch from Monthly to Weekly Sweeping
Mechanical Cleaners			
Total Nitrogen	15%	35%	20%
Total Phosphorus	10%	20%	10%
Regular Air/Vacuum Cleaner			
Total Nitrogen	20%	45%	25%
Total Phosphorus	15%	30%	15%

For those BMPs for which removal efficiencies are unknown, but are expected to be high, a short description of the BMP and costs are given in **Table 5**.

Table 5: BMPs with High Expected Nutrient and Total Suspended Solids Removal Effectiveness

Best Management Practice	Basis for Removal Effectiveness Assessment	Cost
Dry Weather Flow Diversion to Wastewater Treatment Plant	Dry weather diversions capture primarily runoff from irrigation and other urban activities such as washing vehicles or surfaces. The irrigation runoff is high in nutrients, so diversion would be expected to have high nutrient removal effectiveness. Since all flow is typically diverted, all pollutants in the flow, including total suspended solids would be directly prevented from entering receiving water	Capital cost of $1,341 per tributary acre[1]
Sanitary Sewer Overflow (SSO) Repair	SSOs contain between 1.3 to 15.7 mg/L of total phosphorus and 11.4 to 61 mg/L TKN.[2] Therefore they are a significant source of nutrients. Prevention of SSOs completely prevents any pollutants from the SSO from entering the storm drain or directly entering receiving waters	$1,700/mi to clean sewer pipe[3]
Landscaping/ Fertilizer Education for Homeowners	Irrigation runoff can be high in TSS and nutrients due to fertilizers used in landscaping. Often fertilizers are overused adding to the problem. Effective outreach can teach residents not to overwater and to test soil to determine the appropriate amount of fertilizer to apply. In addition, outreach can encourage residents to landscape in a way that minimizes the need for fertilizers and watering and install smart irrigation controllers. This approach targets the prevention of TSS and nutrients from entering the storm drain.	Highly dependent on approach

1 CDM, 2009.

2. US Environmental Protection Agency, 2004. Report to congress on impacts and control of combined sewer overflows and sanitary sewer overflows. Washington, D.C

3. WERF, 1997

The County currently has related non-structural BMPs in place. The County has a Smart Gardening Program which consists of learning centers and workshops that educate homeowners on reducing fertilizer, pesticide, and water use. The County also has an ordinance that specifically prohibits activities that generate dry weather runoff. These activities include those that generate runoff from irrigation, washing down sidewalks, and washing vehicles. Landscape/fertilizer education for homeowners would build on these BMPs. Such outreach would include the reduction of irrigation return flow through education and encouraging the installation of smart irrigation controllers. To affect greater levels of dry weather flow reductions, enforcement actions would be necessary against residents in the County Islands where overwatering and street runoff is observed

Based on this evaluation, illicit connection removal, catch basin clean out, and street sweeping were selected as final BMPs for analysis. Landscaping/fertilizer education for homeowners also appeared to be promising, and is included in the analysis as a high level of public outreach.

Five other non-structural BMPs are in place which could not be fully evaluated by the WTM. However, the Los Angeles Municipal Stormwater Permit (Permit) indicates their effectiveness as having "low", "medium", or "high" relative ability to address nutrients. They BMPs consist of the following programs:

- Public Information and Participation Program
- Industrial/Commercial Facilities Control Program
- Development Planning Program
- Development Construction Program
- Public Agency Activities Program

The Public Information and Participation Program is comprised of several programs. It includes the Smart Gardening Program, which most directly addresses nutrients. It also includes stormwater training for County Staff. The "be smart, do your part" message of this program is intended to ensure County employees understand the importance of BMPs. The effectiveness of this program is dependent on staff's current level of diligence in implementing BMPs and is difficult to evaluate. However the Permit indicates that the Public Information and Participation Program has a "medium" ability to address nutrients.

The Industrial/Commercial Facilities Control Program tracks, inspects, and ensures compliance with permits for industrial and commercial facilities. Washing down sidewalks and other paved areas may be one of the largest sources of runoff, and therefore TSS and nutrients, and this source is already addressed by County ordinance. It is ranked as having a "medium" ability to address nutrients. To further evaluate the impact of this program on nutrient loads, the program would need to be audited to determine the prevalence of nutrient generating activities at industrial and commercial facilities.

The Development Planning Program focuses on mitigating the long-term hydrologic and pollutant effects of the built environment and changes in land use. TSS and nutrient loads are likely to be reduced through proper education and planning of structural BMPs. These BMPs are likely very effective in reducing runoff in general, and therefore TSS loads. The Permit ranks it as having "medium" ability to address nutrients

The Development Construction Program addresses runoff from public and private construction projects through the use of stormwater pollution prevention plans (SWPPPs), training of staff engaged in construction activities, and compliance inspections. This program is likely very effective in reducing construction site runoff, and therefore TSS loads. The Permit ranks it as having "medium" ability to address nutrients

The Public Agency Activities Program addresses infrastructure and facility operations and maintenance activities of Public Agencies. BMPs should be applied to the following activities:

- Sewage systems maintenance, overflow, and spill prevention
- Vehicle maintenance/material storage facilities/corporation yards management
- Landscape and recreational facilities management
- Storm drain operation and management
- Street and roads maintenance
- Public transportation facility management

Sewer system maintenance in particular is very likely to reduce nutrient loads. The Permit ranks this program as having "high" ability to address nutrients. Implementation of BMPs with each of these activities is likely to reduce runoff and be effective in reducing TSS loads.

Additionally, the County has adopted an ordnance requiring low impact development (LID) components when greater than 50% of the impervious area is modified. Since the adoption of the ordnance in 2009, there has been a relatively low level of redevelopment. Due to the low level of LID applied to existing land uses in the County Islands, the gains from the ordnance is not included here, and is held in reserve for the adaptive management implementation. In the future, if the LID through redevelopment becomes significant, there would be less required structural BMPs to be built in the County Islands.

WATERSHED TREATMENT MODEL

The WTM[2] was developed by the Center for Watershed Protection with funding by the EPA in June 2010. The WTM is a spreadsheet-based model that calculates annual pollutant loads and runoff volumes and accounts for the benefits of a full suite of stormwater treatment practices to determine reductions in pollutant loads. It is currently a beta model. The WTM is used for the County islands in the Machado Lake watershed to determine the accumulated effectiveness of implementing dry weather BMPs for the control of nutrients and suspended solids.

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[2] www.cwp.org/Resource_Library/Center_Docs/Desktop/ELC_WTM.pdf

The WTM uses both environmental inputs (e.g., area of land use types, soil types, etc.) and inputs about BMPs. Environmental inputs are used to determine current loads and BMPs determine the percent reduction in loads.

EVALUATION OF BMP EFFECTIVENESS

This section first discusses the process of evaluating BMP effectiveness and WTM inputs. The second section discusses the results of the WTM.

Best Management Practice Evaluation

A previous memo to the County, entitled "Machado Lake Nutrients and Toxics TMDLs BMPs Review and Evaluation", evaluated both structural and non-structural BMPs to address nutrients and toxics in the Lake Machado watershed. These BMPs were drawn from the County's Los Angeles River and Ballona Creek TMDL Implementation Plans. This memo expands upon the previous memo by identifying nutrient removal efficiencies associated with dry weather non-structural BMPs.

The relative prevalence of the land uses on the County islands is shown in **Figure 1**.

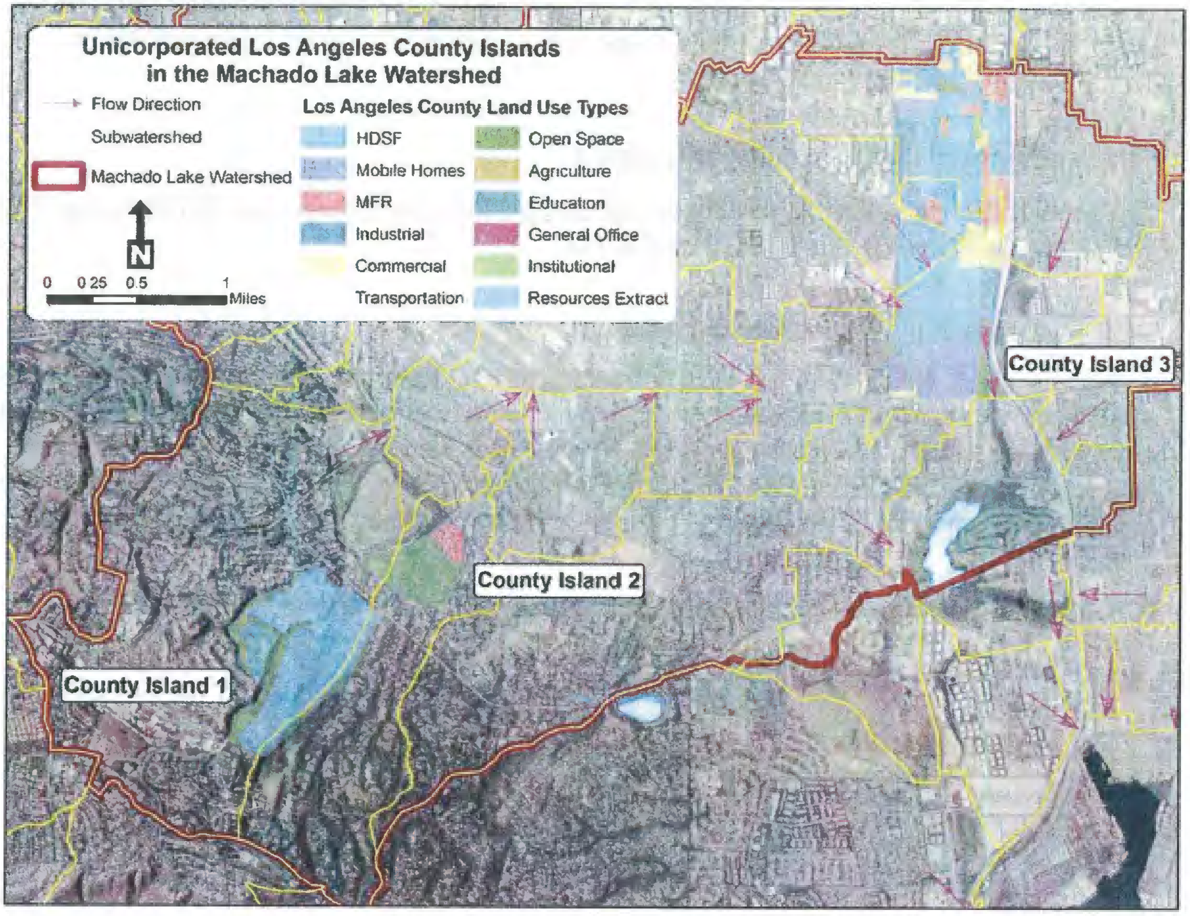

Figure 1. Land Uses within County Islands in the Machado Lake Watershed

A literature review and best professional judgment were used to determine both current and potential future conditions in order to model potential nutrient and TSS reductions using the WTM. Current conditions inputs included environmental simplifications (e.g., all land use is multi-family residential, commercial, industrial or open space) and estimates (e.g., prevalence of soil types). For the purposes of this memo, it was assumed that there were 182 days of dry weather (April 1 to September 30). Key assumptions about program modifications are discussed in the following sections.

As discussed in the review of dry weather non-structural BMPs, illicit connection removal, additional catch basin clean outs, enhanced public outreach for reduced irrigation and effective fertilizer use, and street sweeping improvements are recommended. These BMPs are discussed in the following subsections.

Illicit Connection Removal

Illicit connections are sources of a variety of pollutants including nutrients. This source control is applicable to residential and commercial areas in the County islands. However, the success of this program would be dependent on the presence of illicit connections in the County islands.

The costs of field investigation, water sample analysis and cost to trace illicit connections or confirm reconnection to the sewer system (via dye, video, or smoke testing) can be highly variable and depend on the extent and nature of the problem. Literature review indicates that the cost of removal of one illicit connection and its reconnection to the sewer system is $2,500 per connection (Marcoux, 2004 and Brown et al., 2004). Therefore this is an expensive option. However, an increased effort to identify illicit connections would enhance the County's illicit connection program, which the County's NPDES Permit already requires to include inspection of the storm drain system for illicit connections and removal of the connections.[3]

For the purposes of this evaluation, it was assumed:

- 1% of residents have illicit connections
- 10% of businesses have illicit connections
- 40% of the sanitary sewer is surveyed for illicit connections
- 20% of illicit connections are corrected

Assumptions were based on best professional judgment because the number of illicit connections present varies dependent on local habits, municipal outreach, and enforcement. The number of illicit connections identified and corrected would be dependent on the resources the County can allocate to this program.

Catch Basin Cleanout

Regular catch basin clean out prevents pollutants from entering the storm drain system. Sediment, debris, and gross particulate matter are the targeted pollutants, but removal of other pollutants can be accomplished as well.

The County's Annual Report indicates that the County prioritizes catch basin clean outs as follows:

- Priority A: These catch basins are cleaned quarterly
- Priority B: These catch basins are cleaned semi-annually
- Priority C: These catch basins are cleaned annually

For the purposes of this evaluation it was assumed:

- The impervious area drains to the catch
- Catch basins are currently cleaned semi-annually
- In the future, 60% of catch basins will be cleaned monthly
- In the future, 40% of catch basins will be cleaned semi-annually

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[3] NPDES Permit Order # 01-182 Part 4 (G) http://63.199.216.6/larwqcb_new/permits/docs/6948_01-182_WDR.pdf

Review of the Annual Report showed that most catch basins were Priority C. However, the model only allows input of semi-annual or monthly clean outs. Therefore, semi-annual clean outs were selected. Other inputs were based on best professional judgment. The assumption of semi-annual clean outs may overestimate current load removal and therefore underestimate the percent reduction in loads due to increase clean out frequency

Catch Basin Inserts

Catch basin inserts are proprietary devices designed to remove pollutants as they enter storm drain catch basins and are often utilized to treat first flush storm events. Catch basin inserts remove pollutants through settling and filtration, usually through activated carbon and/or some type of membrane and are most effective at removing suspended sediments and associated pollutants.

The advantage of catch basins is their ease of implementation and wide spread applicability Limitations include a relatively high maintenance requirement to prevent clogging and ensure pollutant removal effectiveness.

The County is already implementing catch basin inserts as part of the implementation of the Machado Lake Trash TMDL. The products used as part of the trash TMDL should be evaluated for their ability to also remove nutrients and toxics.

For the purposes of this evaluation the following assumptions were made:

- County already has inserts on 10% of the catch basins in Island 3 as part of the trash TMDL
- Of the remaining catch basins, assumed that 75% of County-owned catch basins in Island 3 would be retrofitted with inserts
- Pollutant removals: 15% TN, 30% TP, 30% TSS

Street Sweeping

Street sweeping uses mechanical pavement cleaning practices to minimize pollutant transport to receiving water bodies. Sediment, debris, and gross particulate matter are the targeted pollutants, but removal of other pollutants can be accomplished as well.

The County's Permit requires that the County prioritize street sweeping as follows:

- Priority A: These streets and/or street segments shall be swept at least two times per month.
- Priority B: Each street and/or street segments is swept at least once per month.
- Priority C: These streets and/or street segments shall be swept as necessary but in no case less than once per year

In the County's document "Streets and Roads Maintenance Guidance" the County states that all curbed streets must be swept monthly and that priority A and B curbed streets must be swept more frequently. The County defines these and A and B priority streets as the following:

- High vehicle (ADT above 20,000) or pedestrian traffic areas

- Construction areas
- Industrial areas

For the purposes of this evaluation, it was assumed:

- Currently, roads and parking lots are swept weekly
- Currently all roads in County Islands 1 and 2 and roads in County Island 3 south of Sepulveda are swept with vacuum sweepers. The remaining roads are swept with mechanical (broom) sweepers.
- In the future, residential roads and parking lots will be swept twice weekly, other roads will be swept weekly
- Future programs will use vacuum sweepers.

It was assumed that most roads are being swept monthly because it is not known how many miles of A and B priority streets there are in the County islands. The County uses both mechanical and higher efficiency vacuum sweepers. The O&M costs of regenerative air street sweepers is $64/curb mile (in 2001 dollars) (Shilling, 2005).

Residential Irrigation Reduction

Irrigation runoff can be high in TSS and nutrients due to fertilizers used in landscaping. Often fertilizers are overused adding to the problem. Effective outreach can teach residents not to overwater and to test soil to determine the appropriate amount of fertilizer to apply In addition, the use of evapotranspiration (ET) controllers has been successfully used to reduce runoff. The cost of this outreach is highly dependent on approach.

For the purposes of this evaluation, it was assumed:

- Half of runoff from the islands is dry weather flow[4]
- An irrigation reduction program would reduce irrigation flows by 20%[5]
- Enhanced outreach of television and radio spots would be necessary to reach and convey the message of controlling irrigation and using the proper amounts of fertilizers.

Results of Watershed Treatment Model

The results of the above combined inputs to the WTM are listed in **Table 6**. The reductions are based on percent of drt-weather load and the percent of annual runoff loads (e.g. street sweeping will have benefits in both wet and dry weather). These reductions are considered rough estimates due to the assumptions made in environmental characterization for the model and the assumptions listed in the previous sections.

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[4]Nearly half the annual MS4 flow volume in Sacramento, California could not be attributed to precipitation. (Montoya, 1987) It is assumed that irrigation flows would be similar to if not higher than Sacramento's in the County, because of less precipitation in the County

[5]Runoff reduction ranged from 49% to 71% with the installation of ET controllers. (Diamond, 2003). Best professional judgment was used to lower this number as ET controllers use would not be installed on all turf.

Table 6: Reductions in Nutrient and Total Suspended Solids Loads in Stormwater Given by Watershed Treatment Model

Percent Reduction	Total Nitrogen	Total Phosphorus	Total Suspended Solids
Dry Weather Runoff	20%	14%	32%
Annual Runoff	22%	10%	26%

While many assumptions were made about the current conditions of the County island environment and the effectiveness of specific source controls in order to use the WTM, literature on reductions of loads in stormwater as opposed to the reduction of loads from a source (e.g., reduction in the load of nutrients on streets) was very limited. The WTM was considered the best source of total reduction estimates.

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APPENDIX A: WATERSHED TREATMENT MODEL INPUTS AND OUTPUTS

The Watershed Treatment Model (WTM) calculated load reductions by establishing current conditions and loadings with no best management practices (BMPs) in place, loads reduced by BMPs in place, and loads reduced by potential new BMPs. In the tables below, user inputs to the WTM are in italics, model assumptions are in plain text, and model outputs are in bold.

Current Conditions and Loads with No BMPs in Place

Land use inputs and outputs are summarized in **Table A-1**.

Table A-1. Model Output Loadings with No BMPs in Place Based on User Land Use Inputs

			Total Annual Concentrations			**Annual Loading**			
Land Use	*Acres*	Impervious % cover	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	**Total Nitrogen (lb/yr)**	**Total Phosphorus (lb/yr)**	**TSS (lb/yr)**	**Annual Runoff Volume (acre-ft)**
Open Space	*104*	15%	0.82	0.026	**19**	**179**	**24**	**282**	**5**
Residential	*783*	44%	0.82	0.026	**19**	**948**	**120**	**2,813**	**53**
Commercial	*133*	87%	0.82	0.026	**19**	**112**	**26**	**651**	**12**
Industrial	*129*	92%	0.82	0.026	**19**	**77**	**16**	**644**	**12**

Soil group inputs and associated model variables are summarized in **Table A-2**. These are used to determine runoff with and without BMPs from areas such as lawns.

Table A-2. Soil Group User Inputs and Model Associated Runoff Coefficients

		Runoff Coefficients				
Land Use	%	Impervious	Turf	Forest	Rural	Active Construction
C Soils	*22%*	0.95	0.22	0.04	0.04	0.5
D Soils	*78%*	0.95	0.25	0.05	0.05	0.5

Existing Management Practices

Table A-3 and **Table A-4** show inputs that are used to calculate the load of nutrients currently reduced by street sweeping and catch basin cleanouts, respectively

Table A-3. Current Street Sweeping User Inputs and Load Reduction Model Outputs

Sweeper Type	*Residential Streets Swept (acres)*	*Other Streets Swept (acres)*	*Parking Lots Swept (acres)*	Residential Efficiencies		Other Streets Efficiencies		**Load Reductions**		
				Nutrients	TSS	Nutrients	TSS	**Nitrogen (lb/yr)**	**Phosphorus (lb/yr)**	**TSS (lb/yr)**
Mechanical	*0*	*14.2*	*0*	24%	30%	4%	5%			
Vaccum	*91.26*	*0*	*8.81*	62%	78%	63%	79%			
Sweeping Frequency ->	*Weekly*	*Weekly*	*Weekly*					12	0	354

Table A-4. Current Catch Basin Cleanout User Inputs and Load Reduction Model Outputs

Catch Basin Cleanouts	*Impervious Area Captured (acres)*	Nutrient Efficiency	TSS Efficiency	**Load Reductions**		
				Nitrogen (lb/yr)	**Phosphorus (lb/yr)**	**TSS (lb/yr)**
Monthly Cleaning	*0*	15%	25%	0	0	0
Semi-Annual Cleaning	*100*	8%	13%	2	0	69

Potential Future Practices

Table A-4, Table A-5, and **Table A-6** show inputs that are used to calculate the load of nutrients that would be reduced by future street sweeping, catch basin cleanouts, and illicit connection removal respectively

Table A-4. Future Street Sweeping User Inputs and Load Reduction Model Outputs

Sweeper Type	*Residential Streets Swept (acres)*	*Other Streets Swept (acres)*	*Parking Lots Swept (acres)*	Residential Efficiencies		Other Streets Efficiencies		**Load Reductions**		
				Nutrients	TSS	Nutrients	TSS	**Nitrogen (lb/yr)**	**Phosphorus (lb/yr)**	**TSS (lb/yr)**
Vacuum	*91.26*	*14.2*	*8.81*	62%	78%	63%	79%	**31**	**1**	**1,102**
Sweeping Frequency ->	*Twice Weekly*	*Twice Weekly*	*Twice Weekly*							

Table A-5. Future Catch Basin Cleanout User Inputs and Load Reduction Model Outputs

Catch Basin Cleanouts	*Impervious Area Captured (acres)*	Nutrient Efficiency	TSS Efficiency	**Load Reductions**		
				Nitrogen (lb/yr)	**Phosphorus (lb/yr)**	**TSS (lb/yr)**
Monthly Cleaning	*60*	15%	25%	**17**	**1**	**683**
Semi-Annual Cleaning	*40*	8%	13%			

Table A-6. Future Illicit Discharge Removal User Inputs and Load Reduction Model Outputs

% of System Surveyed	*% of Repairs Made*	**Nitrogen Load Reduction (lb/yr)**	**Phosphorus Load Reduction (lb/yr)**	**TSS Load Reduction (lb/yr)**
40%	*20%*	**9**	**2**	**61**

Appendix D

Technical Memorandum re. Quantification of Organochlorine Pesticide and PCB Fractions in Sediment in Machado Lake

Memorandum

LARRY WALKER ASSOCIATES

DATE: August 1, 2011

TO: Randall Davis, Youn Sim

County of Los Angeles, Department of Public Works

COPY TO: Mitch Mysliwiec - LWA

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SUBJECT: **Quantification of Organochlorine Pesticide and PCB Fractions in Sediments Loaded to Machado Lake**

1.1 INTRODUCTION

The Los Angeles Regional Water Quality Control Board adopted the Machado Lake Toxics Total Maximum Daily Load (TMDL) on September 2, 2010 and is currently awaiting approval by the State Water Quality Control Board and the US Environmental Protection Agency (USEPA). With respect to the TMDL, toxics include organochlorine (OC) pesticides and polychlorinated biphenyls (PCBs). The County of Los Angeles (County) is an MS4 permittee named in the TMDL, as there are three islands of unincorporated land areas within the Machado Lake watershed. Allocations are determined as a fraction of suspended solids loading by stormwater dischargers and are assigned in both dry and wet weather. The compliance points are measured either at the storm drain outfall of the permittee's drainage area, at representative storm drain outfalls representing the combined discharge of cooperating parties if a coordinated compliance option is chosen by multiple permittees, or an alternative compliance point approved by the Regional Board Executive Officer. Toxics TMDL numeric targets and Waste Load Allocations (WLAs) for MS4 permittees are presented in **Table 1**. Note that the WLAs for toxics are set to the numeric targets.

Table 1: Machado Lake Toxics TMDL Targets and Associated MS4 Allocations.

	Numeric Target for Sediment	Waste Load Allocation for Suspended Sediment-Associated Contaminants[1]	
Parameter of Concern	Concentration (µg/kg dry weight)	Concentration (µg/kg dry weight)	Compliance Averaging Period
Total PCBs	59.8	59.8	3-year average
DDT (all congeners)	4.16	4.16	3-year average
DDE (all congeners)	3.16	3.16	3-year average
DDD (all congeners)	4.88	4.88	3-year average
Total DDT	5.28	5.28	3-year average
Chlordane	3.24	3.24	3-year average
Dieldrin	1.9	1.9	3-year average

1 The WLA applies to all MS4 Permittees including the County, Caltrans, General Construction and, Industrial Stormwater Permittees, and other non-stormwater NPDES Permittees.

The Special Study evaluated the constituents of concern in the Toxics TMDL, including organochlorine (OC) pesticides, polychlorinated biphenyls (PCBs), and total suspended solids (TSS). The study produced a loading estimation of total suspended solids from unincorporated areas of Los Angeles County to Machado Lake during dry weather conditions. In addition, the County has developed a Best Management Practice Decision Support System (BMPDSS) model that calculates the annual loading from County-owned lands to Machado Lake. The County's watershed management modeling system (WMMS) uses the LACDPW sub-watershed GIS layer to divide the Machado Lake watershed into hydrologically connected sub-watersheds. The sub-watersheds are based on flow patterns, not jurisdictional areas. As such, loading information generated from each sub-watershed is then refined to isolate the loads contributed from unincorporated County areas. Annual loading rates for metals, total suspended solids, and nutrients have been generated using the BMPDSS model. Wet weather loading can effectively be calculated as the difference between the annual loading rates and the dry weather loading rates. The calculated dry, wet, and annual loading rates for Total Suspended Solids are presented in **Table 2.** The WLAs for OC Pesticides and PCBs established by the Toxics TMDL[1] calculated from the modeled sediment loading rate are listed in **Table 3**.

[1] Adopted September 2, 2010 by the Los Angeles Regional Water Quality Control Board (LARWQCB), still requires State Water Resources Control Board (SWRCB), Office of Administrative Law (OAL), and USEPA approvals before becoming effective. (http://www.swrcb.ca.gov/losangeles/water_issues/programs/tmdl/tmdl_list.shtml)

Table 2: Calculated Total Suspended Solids Loading to Machado Lake from Unincorporated Areas of Los Angeles County.

Constituent	Annual Loading[1] (kg/yr)	Dry Weather Loading[2] (kg/yr)	Wet Weather Loading (kg/yr)	Loading from Dry Weather (%)
Total Suspended Solids	38,000	2,000	36,000	5.2%

1 WMMS simulated value

2 Special Study calculated value

Table 3: Calculated Toxic Constituent WLAs for Unincorporated Areas of Los Angeles County.

Constituent	Waste Load Allocation for Suspended Sediment-Associated Contaminants (µg/kg dry weight)	Annual Waste Load Allocation[1] (g/yr)
Total PCBs	59.8	2.3
DDT (all congeners)	4.16	0.16
DDE (all congeners)	3.16	0.12
DDD (all congeners)	4.88	0.19
Total DDT	5.28	0.20
Chlordane	3.24	0.12
Dieldrin	1.9	0.073

1 Based on modeled annual loading of total suspended solids of 38,000 kg/yr.

With the establishment of an annual WLA for OC pesticides and PCBs, it is then necessary to estimate the actual loading of OC pesticides and PCBs from the County areas and establish an implementation plan to reduce loading if necessary. As the WLA for these toxic constituents is suspended sediment-based, so too are the loading estimates from the County derived as a fraction of its TSS loadings. It is critical that the County establish a reasonable and appropriate relationship between toxic constituents and sediments loaded to Machado Lake to leverage the use of WMMS and Special Study results to estimate loading of toxics from County islands. Establishing an appropriate fractional relationship between OC pesticides and solids as well as between PCBs and solids from the unincorporated areas of the County within the Machado Lake watershed is performed by evaluating data available from similarly situated watersheds.

1.2 DATA REVIEW

Data sets and studies reviewed to develop the relationships between toxic compounds and sediment include:

- Machado Lake Dry Weather Special Study, 2010-2011
- Ballona Creek Sediment Study, 2007
- Ballona Creek Sediment Study, 2011

- East Bay Municipal Utilities District Supplemental Environmental Project, 2010
- Machado Lake Ecosystem Rehabilitation Project, Sediment Removal Plan, 2009
- Machado Lake Sediment Characterization Report, 2010
- Calleguas Creek Watershed Annual Report Sampling, 2008-2010

Consideration was given for studies based upon relevance, propensity of data, and proximity or similarity to the County islands within the Machado Lake watershed.

1.2.1 Machado Lake Dry Weather Special Study, 2010-2011

The Dry Weather Special Study commissioned by the County included toxic constituent sampling as well as TSS sampling. Over the course of one year, a total of 31 water column samples were collected over six sites within the County island boundaries and analyzed for TSS, OC pesticide, and PCB concentrations. The data set was reviewed for the evaluation as it was recent, contained all relevant parameters, and occurred within county owned lands.

The fractional relationship between toxic and TSS was derived by dividing the concentration of an individual constituent by the measured TSS concentration for the corresponding site and event.

The majority of the observations resulted in non-detect for OC pesticides and PCBs. For the analysis, non-detect concentrations were assigned the value of the minimum detection limit (MDL) determined by the laboratory. Calculated sums of toxic constituents (e.g. DDT congeners, Total PCBs) were calculated as either the sum of all detected values or, in the event of no detected concentration, the greatest detection limit of the individual constituents. Because of the prevalence of non-detected values, the estimated fractional relationships between toxic constituents and sediment are significantly influenced by the detection limits and the TSS concentrations.

Analysis of variance performed on other water quality constituents in the Special Study determined that the site or date was not a significant factor in determining the water quality concentration within the County islands. In performing the analysis, it was assumed there was no statistical difference between the sites for the toxic parameters as well. Therefore, all 31 data points of were considered in the derivation of values for each constituent listed in the Toxics TMDL. The calculated fractional relationships between constituents listed in the Toxics TMDL and TSS expressed as micrograms per kilogram (µg/kg) are presented in **Table 4**. The values in **Table 4** serve to represent an upper bound on the toxic associated with TSS as the values are based on TSS concentrations which predominantly were associated with non-detect toxic concentrations.

Table 4: Toxic Constituent Fractions Calculated from Dry Weather Water Samples during Special Study in Unincorporated Areas of Los Angeles County.

Constituent	Range of values[1] (µg/kg)	Median Concentration[1] (µg/kg)	Average Concentration[1] (µg/kg)
Chlordane-alpha	14 – 2,800	170	330
Chlordane-gamma	14 – 2,800	170	310
Total Chlordanes	14 – 2,800	170	340
2,4'-DDD	9.1 – 2,800	170	310
2,4'-DDE	9.1 – 2,800	170	310
2,4'-DDT	9.1 – 2,800	170	320
4,4'-DDD	9.1 – 2,800	170	320
4,4'-DDE	9.1 – 2,800	170	330
4,4'-DDT	9.1 – 2,800	170	310
DDD (all congeners)	9.1 – 2,800	170	320
DDE (all congeners)	9.1 – 2,800	170	330
DDT (all congeners)	9.1 – 2,800	170	320
Total DDTs	9.1 – 2,800	170	370
Dieldrin	9.1 – 2,800	170	310
Total PCBs	91 – 28,000	1,700	3,100

1 Values largely based on minimum detection levels for measured parameters. The calculated values represent an upper bounds of the toxics associated with total suspended solids.

1.2.2 Ballona Creek Watershed Sediment Study, 2007

The Santa Monica Bay Restoration Foundation study investigating OC Pesticide sources leading to the Ballona Creek Estuary[2] currently serves to inform the County WMMS for the solids associated fraction of toxic compounds. The study investigated and identified average values of several parameters relevant to the Machado Lake watershed, which are presented below in **Table 5**. It is unclear as to whether the study collected water column or benthic sediments. The study was chosen because of the proximity of the Ballona Creek Estuary to the Machado Lake watershed, its thoroughness, and its similar percentage of urban areas within each catchment.

[2] "Determining the Primary Source of Chlorinated Pesticides that enter Ballona Creek" Strenstrom and Suffet, 2007.

Table 5: Toxic Constituent Fractions Measured in Sediments from 2007 Ballona Creek Study.

Constituent	Average Concentration (µg/kg)
Total Chlordanes	27
Total DDTs	34
Dieldrin	11

As the study also does not provide individual congener or PCB data, the study is not likely to provide a full and accurate depiction of toxic constituents loaded to the Machado Lake watershed.

1.2.3 Ballona Creek Watershed Sediment Study, 2011

Similar to the 2007 Study, an investigation of pesticide and PCB sources to the Ballona Creek Watershed was conducted through the measurement of toxic concentrations associated with total suspended solids across the watershed during wet weather events.[3] Fifteen storm drains from these sub-watersheds were sampled during three storms during the 2005–2006 winter rainy season and published in 2011. A series of grab samples were taken over the duration of the storms. The suspended solids were analyzed for polychlorinated biphenyls (PCBs) and OC pesticides. As with the 2007 Ballona Creek study, the 2011 study was chosen because of the proximity of the Ballona Creek Estuary to the Machado Lake Sub-watershed, its thoroughness, and its similar percentage of urban areas within each catchment. Additionally, the samples collected during the Ballona Creek 2011 study mimic the conditions the County will collect samples for the future Toxic TMDL monitoring.

Individual values per site were not provided as part the study. The study substituted non-detect values as concentrations of zero. No detection limit was provided with the study information. The range of the toxic concentrations in the sediment measured during the study is presented in **Table 6**.

[3] "Identification of sub-watershed sources for chlorinated pesticides and polychlorinated biphenyls in the Ballona Creek watershed" J. Curren et al, 2011, *Science of the Total Environment*, V. 409, pp. 2525-2333

Table 6: Toxic Constituent Fractions Measured in Suspended Solids during 2011 Ballona Creek Study for all sites.

Constituent	Range of Concentrations (μg/kg)
Total Chlordanes	0 - 191
Total DDTs	0 - 70
Total PCBs	0 - 119

The study used a geographic information system to calculate the runoff volume from each of the 14 sampled sub-watersheds to estimate pollution mass loading in terms of μg of pesticide and kg of TSS. The study used a concentration of zero when a constituent was not detected. Using the modeled values presented in the report, the toxic constituent fractions could be calculated by dividing a site's pollutant mass loading by corresponding TSS loading. The calculated values of toxic constituent fractions across each site are presented in **Table 7**.

Table 7: Toxic Constituent Fractions Calculated from Pollutant Loading Estimates during 2011 Ballona Creek Study.

Constituent	Range of Average Concentrations per Site[1] (μg/kg)	Median Concentration for all Sites[1] (μg/kg)	Average Concentration for all Sites[1] (μg/kg)
Total Chlordanes	0 - 38	13	12
Total DDTs	0 - 23	3.9	6.1
Total PCBs	4.2 - 86	20	27

1 Non-Detects set to 0.0, study did not provide percent detected information.

One of the objectives of the 2011 Ballona Creek study was to compare the measured values to other local, national, and international studies investigating pesticide and PCB concentrations within sediments, finding that the 2011 Ballona Creek measurements fell within the ranges sited in the majority of studies. The 2011 Ballona Creek Study presents concentrations for toxic constituents that are more in line with historical concentrations, as evidenced by the previous studies it cites as well as the majority of studies reviewed here. The study does not provide information regarding specific DDT congeners or Dieldrin, and therefore is not as useful for application to the WLA as other studies.

1.2.4 East Bay Municipal Utilities District Supplemental Environmental Project, 2010

The East Bay Municipal Utilities District (EBMUD) completed a supplemental environmental project[4] (SEP) to characterize the toxics present in flows at the Ettie Street pump station as part of an agreement with the San Francisco Bay Regional Water Quality Control Board. Between April 2008 and February 2010, a total of 70 water quality samples were collected during dry weather, wet weather, and first flush events. One of these sites was the Ettie Street pump station influent, to assess pollutant concentrations from the Ettie Street watershed and to allow calculation of pollutant removal through solids settling in the pump station's wet wells. The data were reviewed and analyzed to effectively identify TSS and PCB loading rates during dry weather, wet weather, and first flush conditions, and proceeded to use the climatology of the EBMUD service area to estimate an annualized loading rate to the Ettie Street pump station. The study was considered here because the data was thoroughly reviewed and analyzed, described PCB and TSS loadings from an urban area in California, was sampled across all types of weather events, and provided flexibility in its estimations to apply the data to the climatology of the Machado Lake sub-watershed.

The calculated average loadings for PCB and TSS during the three weather classes are presented in **Table 8**. One can then calculate PCB-sediment fractions from the three classes of weather. It is not expected that the fractions should vary significantly between dry and wet weather; the sediment and attached constituents discharging to the pump station are coming from the same sources regardless of the volume of sediment discharged. However, the conclusion from the study results would be that wet weather events tend to collect significantly more PCBs in sediments than dry weather events.

Table 8: Average Loading to Ettie Street Pump Station Calculated during 2010 EBMUD Study.

Weather Condition	Average TSS loading to Ettie Street Pump Station (kg/day)	Average PCB Loading to Ettie Street Pump Station (kg/day)	Average PCB concentration within Sediment (µg/kg)
Dry Weather	36	0.000010	280
Wet Weather	1400	0.0027	1900
First Flush	5300	0.0013	250

To apply the values from **Table 8** to estimate the annual loading for the East Bay watershed, the average climatology of the San Francisco area was considered in the study. Similarly, identifying an average fraction of sediment loading would, according to the study's conclusions, require consideration of the climatology as well. The Los Angeles area climate is used to translate the study results from the East Bay to the Machado Lake watershed. The annualized averages of PCB-sediment fractions in sediment considering San Francisco Bay weather, Los Angeles County weather, and a non-weighted average that does not consider weather are listed in

[4] "Characterization of Stormwater Flows, Diversion of Dry Weather and First Flush Flows to a Publicly-Operated Treatment Works: Final Report" East Bay Municipal Utility District, July 2010

Table 9. The number of dry and wet weather days for Los Angeles County used in the calculations reflected in **Table 9** was based upon long-term averages for the area[5].

Table 9: PCB Fractions Calculated from Loading Estimates during 2010 EBMUD Study and Average Weather Conditions.

		San Francisco Bay		Los Angeles County		Non-weighted Average	
Weather Type	Average Fraction (µg/kg)	Days per year	Annualized Average (µg/kg)	Days per year	Annualized Average (µg/kg)	Weight	Average (µg/kg)
Dry Weather Average	280	300	1,400	330	1,200	1/3	810
Wet Weather	1,900	60		30		1/3	
First Flush	250	5		5		1/3	

The differences in PCB fractions across weather events run counter to the conclusions of most sediment studies. In this instance, it is very likely that PCB fractional estimates for both the San Francisco Bay area and Los Angeles County area significantly overestimate the concentration of PCB within sediments. Both estimates are significantly greater than the non-weighted average estimate. All three averaged PCB fractions are significantly higher than the values presented in most studies reviewed in this effort. It is possible that using a PCB fractional estimate from this study will result in overestimation of PCB loadings to Machado Lake.

1.2.5 Machado Lake Ecosystem Rehabilitation Project, Sediment Removal Plan, 2009

The City of Los Angeles initiated a Sediment Removal Plan (SRP) for consideration of the sediment removal option to meet the water quality objectives for Machado Lake[6]. Sediment core samples were collected on October 22 and 23 in 2008 at seven sites in the lake bottom at 0.5 feet and 2.5 feet, respectively. An additional four samples were collected in the riparian woodland and the freshwater marsh at depths of 0.5 and 2.5 feet, respectively. The study results are currently in draft form and under review. The study was chosen for review because it was recent and conducted on the water body in question.

Though PCBs were sampled at three of the seven in-lake sites, the data was not presented in the report because all values were reported as non-detect and it was concluded that additional sampling would be needed for characterization. Results of the OC pesticide measurements from the study are presented in **Table 10**. Concentration of pesticides tended to increase as the depth increased. A majority of samples were non-detect across the study, with the greatest concentrations detected for chlordane congeners.

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[5] Available: http://www.weatherbase.com/weather/weather.php3?s=159227&refer=

[6] "DRAFT Machado Lake Ecosystem Rehabilitation Project and Wilmington Drain Multi-Use Project - Sediment Removal Plan", CDM in association with Parsons Corporation, June 17, 2009

Table 10: Toxic Constituent Fractions Measured in Machado Lake Ecosystem Rehabilitation Project SRP 2009 data.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	0.5 - 9	0.5	1
Chlordane-gamma	0.5 - 10	0.5	1
Total Chlordanes	5 - 70	5	9
Dieldrin	0.5 - 10	5	3
4,4-DDD	0.5 - 7	0.5	1
4,4-DDE	0.5 - 9	0.5	2
4,4-DDT	0.05 - 10	0.5	1

The typically low concentrations of pesticides detected in the sediments complement the results of the Dry Weather Special Study. The values also fall within the typical ranges of values observed for the 2011 Ballona Creek study. It is likely that the sediment samples are more representative of the sediments from catchments within the Machado Lake watershed, though no direct data is available to support that hypothesis. The study does not provide data for all the constituents described in the WLA, but does appear to provide reasonable representations of pesticide concentrations as fractions of sediment for the unincorporated areas of the County of Los Angeles discharging to Machado Lake.

1.2.6 Machado Lake Sediment Characterization Report, 2010

Camp Dresser & McKee Inc. (CDM), in association with Parsons Corporation, prepared a Sediment Characterization Report (SCR) in support of proposed dredging and excavation activities within Ken Malloy Harbor Regional Park, Machado Lake, and Wilmington Drain Channel in 2010 on behalf of project proponent the City of Los Angeles[8]. The report consisted of a total of 124 sediment core samples taken across 53 sampling sites across the areas surrounding Machado Lake. Of the sites sampled, 24 were within Machado Lake, seven were in the Wilmington Drain delta, 17 were within the freshwater marsh, and five were within the riparian woodland. Site locations and identifiers were separate from those used in the previous sediment studies performed in the Wilmington Drain and Machado Lake areas and reviewed here. Sediment sampling was completed over a seven-week period ending October 9, 2009, then twelve additional samples were collected from the freshwater marsh and riparian woodland on March 5 and 8, 2010. Samples were taken across several depths dependent upon the site area and analyzed for OC pesticides and PCBs among other constituents. The study was reviewed because it was recent and conducted on the impacted water body in question and its tributaries.

[8] "Sediment Characterization Report: Machado Lake Ecosystem Rehabilitation Project and Wilmington Drain Multi-Use Project" CDM in association with Parsons Corporation, April 22, 2010

The study opted to quantify the summation of total DDT and total Chlordanes with its own methodology. Similarly, the study described PCBs as Aroclors and congeners, although only about 5 percent of the samples were analyzed for PCB congeners. The study calculated a value of Total PCBs as the summation of the detected Aroclors or the largest MDL of Aroclor samples. To calculate the particle associated toxics, the Total PCB value calculated by the SCR is used in the calculation of the fraction metrics. DDD, DDE, and DDT congeners were calculated where sufficient data were available. Total DDT congeners were calculated as either the sum of detected values or the largest detection limit if all individual concentrations were non-detect. All samples were considered during calculations regardless of location or depth.

The calculated results of the sediment data sampled during the Sediment Characterization Report study are summarized in **Table 11**. The majority of samples were found to be non-detect for PCBs, though PCBs were sporatically detected across all four sampling areas.

Table 11: Toxic Constituent Fractions Measured from Sediments in 2010 Machado Lake Sediment Characterization Report.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	1.2- 130	2.3	6.8
Chlordane-gamma	1.1 - 160	3.2	16
Total Chlordanes	2 - 1100	20	35
Dieldrin	1.3 - 30	4.9	4.8
2,4-DDD	1.2 - 18	2.0	4.6
2,4-DDE	1.2 - 39	4.4	8.2
2,4-DDT	1.0 - 2.4	2.0	1.9
4,4-DDD	1.0 - 150	4.1	15
4,4-DDE	0.99 - 200	4.2	19
4,4-DDT	0.88 - 870	3.9	15
DDD (all congeners)	1.0 - 170	4.2	16
DDE (all congeners)	0.99 - 240	5.1	20
DDT (all congeners)	0.88 - 870	4.0	16
Total DDTs	0.88 - 910	5.8	43
Total PCBs	4.8 - 240	58	61

Elutriate water samples were also conducted as part of the Sediment Characterization Report. Elutriate samples represent concentrations of resuspended contaminated material and gauges the potential of contaminants to transfer to the aqueous phase. Samples were spun in a centrifuge and the resulting supernatant water samples were tested for OC pesticides and PCBs. Results are presented in **Table 12**. The concentrations were frequently not detected or estimated below the associated detection limit. Only 4,4'-DDD and 4,4'-DDE were detected at concentrations above the detection limit, and at concentrations significantly lower than those observed in the sediment samples of the study. It is likely that toxic constituents entrapped in sediments that load to Machado Lake do not transfer to the aqueous phase at a significant rate. As the elutriate water samples provided a unique data set provided more for reference than for the establishment of a toxic sediment fraction, no calculation of congeners was performed for the data set.

Table 12: Toxic Water Column Concentrations Measured from Elutriate Water Samples in 2010 Sediment Characterization Study

Constituent	Range of Values (µg/L)	Median Concentration (µg/L)	Average Concentration (µg/L)
Chlordane-alpha	0.0018 - 0.0050	0.0050	0.0046
Chlordane-gamma	0.0017 - 0.0050	0.0050	0.0040
Dieldrin	0.0050 - 0.0050	0.0050	0.0050
2,4-DDE	0.0024 - 0.0050	0.0050	0.0047
4,4-DDD	0.0026 - 0.020	0.0050	0.0073
4,4-DDE	0.0024 - 0.027	0.0052	0.0092
Total PCBs	0.020 - 0.020	0.020	0.020

While the elutriate water samples did not appear to provide representative toxic constituent fractions, the sediment samples did. Though the range of concentrations are occasionally higher than other studies sampled within the region, the median and average concentrations are in league with other studies performed in the Los Angeles area. It is possible that the sediment samples are more representative of other catchments within the Machado Lake watershed, though no data is available to support that hypothesis. The large sample size of the study provides the most useful representation of toxic constituents within sediments loaded to Machado Lake of the studies reviewed, and may likely be the most representative of the sediments loaded from the unincorporated areas of Los Angeles County.

1.2.7 Calleguas Creek Watershed Annual Report Sampling, 2008 - 2010

Sampling for TSS, Pesticide and PCB occurs within the Calleguas Creek Watershed as part of the Basin Plan Amendments that implement the associated TMDLs. Both water column and benthic sediments are evaluated as part of the Calleguas Creek monitoring program. Results from water column sampling conducted from June 2008 to June 2010 are reviewed here. Samples were collected across several reaches of the watershed and during both dry and wet weather events. Sediment samples were collected annually from 2008 to 2010 and reflect sediments from the surface of the stream bed in conjunction with dry weather event water quality sampling. The Calleguas Creek data are reviewed here because it is a large and thorough data set from a Southern California watershed that is predominantly influenced by urban activities.

Water quality and sediment data were pulled from the LWA's Calleguas Creek Watershed database for the events and parsed by event and site. Water quality data from Event 14 was not considered as the storm event filtered samples before analysis. Field duplicates were considered in averaging if present. No calculated summations of congeners (e.g. Total PCBs, DDE Congeners) were present within the database. This effort created summations of congeners only if values were above the detection limit. For water quality data reflecting water column conditions, toxic constituent values were divided by the corresponding TSS concentration for that site and event to produce a sediment fraction value. The calculated fractions derived from the water quality data set across all sites and events are listed in **Table 13**.

Table 13: Toxic Constituent Fractions Measured from 2008 to 2010 Water Column Samples in the Calleguas Creek Watershed.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	0.62 – 2,000	54	150
Chlordane-gamma	0.62 – 2,000	50	140
Total Chlordanes	3.3 - 505	32	54
Dieldrin	0.15 – 17,000	54	380
2,4-DDD	0.26 – 56,000	69	430
2,4-DDE	0.26 – 56,000	62	420
2,4-DDT	0.24 – 11,000	71	240
4,4-DDD	0.56 – 83,000	110	1,300
4,4-DDE	3.8 – 83,000	260	1,500
4,4-DDT	0.26 – 17,000	110	620
DDD (all congeners)	13 – 17,000	180	570
DDE (all congeners)	23 – 9,500	530	1,100
DDT (all congeners)	15 – 17,000	310	1,300
Total DDTs	24 – 38,000	780	2,000
Total PCBs	7.4 – 260,000	340	88,000

Sediment sample matrices were either recorded as general (no filtering), sands (particles between 63 µm and 2 mm in diameter), or fines (particles less than 63 µm in diameter). The summarized results of non-filtered samples, sands samples, and fines samples, are presented in **Table 14**, **Table 15**, and **Table 16**, respectively. The results presented in the tables reflect sediment samples across all sites and events.

Table 14: Toxic Constituent Fractions Measured from 2008 to 2010 at Calleguas Creek Watershed - Non-filtered Sediment Samples.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	1.0 - 2.2	1.0	1.2
Chlordane-gamma	1.0 - 2.1	1.0	1.2
Total Chlordanes	1.4 - 12	3.1	5.2
Dieldrin	1.0 - 1.4	1.0	1.1
2,4-DDD	1.0 - 13	1.3	2.7
2,4-DDE	1.0 - 4.0	1.2	1.4
2,4-DDT	1.0 - 5.3	1.0	1.2
4,4-DDD	1.0 - 29	1.3	5.8
4,4-DDE	1.0 - 190	5.4	39
4,4-DDT	1.0 - 10	1.2	2.3
DDD (all congeners)	1.1 - 120	10	25
DDE (all congeners)	1.1 - 530	7.7	65
DDT (all congeners)	1.6 - 24	6.1	8.9
Total DDTs	1.1 - 670	11	80
Total PCBs	260 - 800	280	390

Table 15: Toxic Constituent Fractions Measured from 2008 to 2010 at Calleguas Creek Watershed - Sands Sediment Samples.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	1.0 - 2.0	1.0	1.1
Chlordane-gamma	1.0 - 1.7	1.0	1.1
Total Chlordanes	7.1	7.1	7.1
Dieldrin	1.0 - 1.4	1.0	1.1
2,4-DDD	1.0 - 10	1.0	2.2
2,4-DDE	1.0 - 2.3	1.0	1.1
2,4-DDT	1.0 - 4.8	1.0	1.2
4,4-DDD	1.0 - 24	1.2	3.9
4,4-DDE	1.0 - 130	2.4	22
4,4-DDT	1.0 - 14	1.0	1.9
DDD (all congeners)	1.0 - 66	5.1	17
DDE (all congeners)	1.0 - 270	3.2	33
DDT (all congeners)	1.6 - 26	3.7	7.6
Total DDTs	1.0 - 360	3.7	38
Total PCBs	260 - 550	280	320

Table 16: Toxic Constituent Fractions Measured from 2008 to 2010 at Calleguas Creek Watershed - Fines Sediment Samples.

Constituent	Range of Values (µg/kg)	Median Concentration (µg/kg)	Average Concentration (µg/kg)
Chlordane-alpha	1.0 - 16	1.0	2.9
Chlordane-gamma	1.0 - 16	1.0	2.9
Total Chlordanes	1.1 - 9.0	4.6	4.2
Dieldrin	1.0 - 32	1.0	3.7
2,4-DDD	1.0 - 17	4.2	5.7
2,4-DDE	1.0 - 16	1.3	3.4
2,4-DDT	1.0 - 29	1.0	3.9
4,4-DDD	1.0 - 41	12	14
4,4-DDE	1.0 - 360	75	95
4,4-DDT	1.0 - 53	1.0	6.1
DDD (all congeners)	4.0 - 110	26	30
DDE (all congeners)	12 - 430	78	120
DDT (all congeners)	7.5 - 82	15	25
Total DDTs	12 - 530	80	150
Total PCBs	220 - 590	280	310

As with most water sample calculations, the resulting fractions derived from toxics and suspended solids concentrations are higher than most toxic concentrations measured in sediment samples. The sediment samples produce toxic constituent fractions that are more in line with the observations of other studies. A majority of DDT concentrations were observed to come from the fines samples, which may or may not hold true for the Machado Lake watershed. The concentration of PCBs reported in the Calleguas Creek Watershed appears to be higher than those observed in other studies around the Machado Lake watershed. The total or non-filtered sediment sample medians may provide the accurate representations of toxic constituent loadings from the unincorporated areas of Los Angeles County.

1.3 RESULTS

Using the toxic constituent fraction values derived from the studies and applying them to the modeled TSS loadings to Machado Lake, toxic constituent loadings from the unincorporated areas of Los Angeles County can be effectively estimated. The resulting dry weather loading estimates of toxic constituents (considering a modeled dry weather TSS loading of 2,000 kg per year) are presented below both as mass and as percentage of the associated waste load allocation (considering a modeled annual TSS loading of 38,000 kg per year).

A majority of the studies investigating PCB sediment fractions estimate the dry weather PCB loading to Machado Lake as compliant with the Machado Lake Toxic TMDL WLA. Most studies indicating compliance find that PCB dry weather loading to be less than 10 percent of the WLA, while all metrics derived from the Calleguas Creek Watershed data sets find PCB loadings to be less than 51 percent of the WLA. It is expected that dry weather loadings should not significantly contribute towards the WLA, as all dry weather PCB samples from the Machado Lake Special Study were non-detect. The associated PCB loading calculations to Machado Lake based on the calculated toxics fractions are presented in **Table 17**.

Some studies investigating DDT congener sediment fractions would estimate the dry weather DDT loading to Machado Lake as compliant with the Machado Lake Toxic TMDL WLA. Compliance would be achieved with the median fractions associated with the Machado Lake Sediment Characterization Report and the Calleguas Creek Watershed sediment data sets, which are less than 19 percent of the WLA. It is expected that dry weather loadings should comply with the WLA, as one dry weather sample of 31 total samples from the Machado Lake Special Study detected concentrations of DDT congeners. The DDT congener loading estimates to Machado Lake based on the calculated toxics fractions are presented in **Table 18**.

A majority of studies investigating DDE congener sediment fractions estimate the dry weather DDE loading to Machado Lake as out of compliance with the Machado Lake Toxic TMDL WLA. Compliance would be achieved with the median fractions associated with the Machado Lake Sediment Characterization Report and the Calleguas Creek Watershed sediment data sets (excluding fines), which are less than 23 percent of the WLA. It is expected that dry weather loadings should comply with the WLA, as three dry weather samples of 31 from the Machado Lake Special Study detected concentrations of DDE congeners. The estimated loadings of DDE Congeners to Machado Lake from the County-owned lands based on the calculated toxics fractions are listed in **Table 19**.

Some studies investigating the DDD congener sediment fractions estimate the dry weather DDD congener loading to Machado Lake as compliant with the Machado Lake Toxic TMDL WLA.

No water sample median values produced median or average results that were in compliance with the WLA. Compliance is achieved with the median fractions associated with the Machado Lake Sediment Characterization Report and the Calleguas Creek Watershed sediment data sets, which are less than 27 percent of the WLA. It is expected that the dry weather loadings should comply with the WLA, as one dry weather sample of 31 from the Machado Lake Special Study detected concentrations of DDD congeners. The estimated loadings of DDD congeners to Machado Lake from the County-owned lands based on the calculated toxics fractions are listed in **Table 20**.

A majority of the calculated chlordane sediment fractions investigated estimate the dry weather loading of total chlordane to Machado Lake that would be less than the Machado Lake Toxic TMDL WLA. Only certain maximum values and the 2007 Ballona Creek study find total chlordane dry weather loadings to be out of compliance with the waste load allocation. All but one study estimated the dry weather loadings would be less than 30 percent of the overall WLA. It is expected that the dry weather loadings should comply with the WLA, as two dry weather samples of 31 from the Machado Lake Special Study detected concentrations of chlordanes. The estimated loadings of Total Chlordanes to Machado Lake from the County-owned lands based on the calculated toxics fractions are presented in **Table 21**.

A majority of studies investigating Dieldrin sediment fractions estimated Dieldrin dry weather loadings for Dieldrin that would be in compliance with the Machado Lake Toxic TMDL WLA. A majority of the estimates found the dry weather Dieldrin mass loading to be less than 20 percent of the annual WLA. Most estimates derived from water quality samples found the Dieldrin dry weather loadings to be out of compliance, while most estimates from sediment samples found the loadings to be in compliance. It is expected that dry weather loadings of Dieldrin should not significantly contribute towards the WLA, as none of the dry weather samples from the Machado Lake Special Study detected concentrations of Dieldrin. The estimated loadings of Dieldrin to Machado Lake from the County-owned lands based on the calculated toxics fractions are presented in **Table 22**.

Table 17: Estimated PCB Dry Weather Loadings to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	91	0.18	7.9%
	Max	28,000	56	2,400%
	Median	1,700	3.4	150%
	Average	3,100	6.2	270%
Ballona Creek Study Sediment Samples, 2011	Min	0	0	0.0%
	Max	120	0.24	10%
Ballona Creek Study Pollutant Loading Calculations, 2011	Min	4.2	0.0084	0.37%
	Max	86	0.17	7.5%
	Median	20	0.04	1.7%
	Average	27	0.054	2.4%
East Bay Study Pollutant Loading Calculations, 2010	San Francisco Bay Annual Average	1,400	2.8	120%
	Los Angeles County Annual Average	1,200	2.4	100%
	Non-weighted Average	810	1.6	70%
Machado Lake Sediment Characterization Report Sediment samples, 2010	Min	4.8	0.0096	0.42%
	Max	240	0.48	21%
	Median	58	0.12	5.0%
	Average	61	0.12	5.3%
Machado Lake Sediment Characterization Report Water Sample Calculations, 2010	Min	12,000	24	1,000%
	Max	28,000	56	2,400%
	Median	25,000	50	2,200%
	Average	21,000	42	1,800%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Min	7.4	0.015	0.64%
	Max	260,000	520	23,000%
	Median	340	0.68	30%
	Average	88,000	180	7,700%

Continued

Table 17: Continued.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Calleguas Creek Watershed Sediment Samples (2008 - 2010)	All Values - Min	220	0.44	19%
	All Values - Max	800	1.6	70%
	All Values - Median	280	0.56	24%
	All Values - Average	340	0.68	30%
	Non-filtered Sediment - Min	260	0.52	23%
	Non-filtered Sediment - Max	800	1.6	70%
	Non-filtered Sediment - Median	280	0.56	24%
	Non-filtered Sediment - Average	390	0.78	34%
	Sands - Min	260	0.52	23%
	Sands - Max	550	1.1	48%
	Sands - Median	280	0.56	24%
	Sands - Average	320	0.64	28%
	Fines - Min	220	0.44	19%
	Fines - Max	590	1.2	51%
	Fines - Median	270	0.54	23%
	Fines - Average	310	0.62	27%

Table 18: Estimated DDT Congener Dry Weather Loading to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	9.1	0.018	11%
	Max	2,800	5.6	3,500%
	Median	170	0.34	210%
	Average	320	0.64	400%
Machado Lake Sediment Characterization Report Sediment samples, 2010	Median	4	0.0080	5.0%
	Average	16	0.031	19%
	Min	0.88	0.0018	1.1%
	Max	870	1.7	1,100%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Median	310	0.62	390%
	Average	1,300	2.5	1,600%
	Min	15	0.029	18%
	Max	17,000	35	22,000%
Calleguas Creek Watershed Sediment Samples (2008 - 2010)	All Values - Median	7.5	0.015	9.4%
	All Values - Average	14	0.027	17%
	All Values - Min	1.6	0.0032	2.0%
	All Values - Max	82	0.16	100%
	Non-filtered Sediment - Median	6.1	0.012	7.6%
	Non-filtered Sediment - Average	8.9	0.018	11%
	Non-filtered Sediment - Min	1.6	0.0032	2.0%
	Non-filtered Sediment - Max	24	0.047	30%
	Sands - Median	3.7	0.0074	4.7%
	Sands - Average	7.6	0.015	9.5%
	Sands - Min	1.6	0.0032	2.0%
	Sands - Max	26	0.052	33%
	Fines - Median	15	0.031	19%
	Fines - Average	25	0.050	31%
	Fines - Min	7.5	0.015	9.4%
	Fines - Max	82	0.16	100%

Table 19: Estimated DDE Congener Dry Weather Loadings to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	9.1	0.018	15 %
	Max	2,800	5.6	4,700%
	Median	170	0.34	280%
	Average	330	0.66	550%
Machado Lake Sediment Characterization Report Sediment samples, 2010	Min	0.99	0.0020	1.7%
	Max	240	0.47	390%
	Median	5.1	0.010	8.5%
	Average	20	0.041	34%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Min	23	0.047	39%
	Max	9,500	19	16,000%
	Median	530	1.1	880%
	Average	1,100	2.1	1,800%
Calleguas Creek Watershed Sediment Samples (2008 - 2010)	All Values - Min	1	0.002	1.7%
	All Values - Max	530	1.1	880%
	All Values - Median	14	0.027	23%
	All Values - Average	75	0.15	130%
	Non-filtered Sediment - Min	1.1	0.0022	1.8%
	Non-filtered Sediment - Max	530	1.1	880%
	Non-filtered Sediment - Median	7.7	0.015	13%
	Non-filtered Sediment - Average	65	0.13	110%
	Sands - Min	1.0	0.0020	1.7%
	Sands - Max	270	0.54	450%
	Sands - Median	3.2	0.0064	5.3%
	Sands - Average	33	0.066	55%
	Fines - Min	12	0.024	20%
	Fines - Max	430	0.86	720%
	Fines - Median	78	0.16	130%
	Fines - Average	120	0.24	200%

Table 20: Estimated DDD Congener Dry Weather Loadings to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	9.1	0.018	9.6%
	Max	2,800	5.6	2,900%
	Median	170	0.34	180%
	Average	320	0.64	340%
Machado Lake Sediment Characterization Report Sediment Samples, 2010	Min	1	0.0020	1.1%
	Max	170	0.34	177%
	Median	4.2	0.0084	4.4%
	Average	16	0.032	17%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Min	13	0.027	14%
	Max	17,000	34	18,000%
	Median	180	0.35	190%
	Average	570	1.1	600%
Calleguas Creek Watershed Sediment Samples (2008 - 2010)	All Values - Min	1.0	0.0020	1.1%
	All Values - Max	120	0.24	130%
	All Values - Median	14	0.027	14%
	All Values - Average	25	0.051	27%
	Non-filtered Sediment - Min	1.1	0.0022	1.2%
	Non-filtered Sediment - Max	120	0.24	130%
	Non-filtered Sediment - Median	10	0.020	11%
	Non-filtered Sediment - Average	25	0.050	26%
	Sands - Min	1.0	0.0020	1.1%
	Sands - Max	66	0.13	69%
	Sands - Median	5.1	0.010	5.4%
	Sands - Average	17	0.033	17%
	Fines - Min	4.0	0.0080	4.2%
	Fines - Max	110	0.21	110%
	Fines - Median	26	0.052	27%
	Fines - Average	30	0.060	32%

Table 21: Estimated Total Chlordane Dry Weather Loadings to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	14	0.028	23%
	Max	2,800	5.6	4,700%
	Median	170	0.34	280%
	Average	340	0.68	570%
Ballona Creek Study Sediment Samples, 2007	Average	27,000,000	54000	45,000,000%
Ballona Creek Study Sediment Samples, 2011	Min	0	0	0.0%
	Max	190	0.38	320%
Ballona Creek Study Pollutant Loading Calculations, 2011	Min	0	0.0	0.0%
	Max	38	0.076	63%
	Median	13	0.026	22%
	Average	12	0.024	20%
Machado Lake Ecosystem Rehabilitation Project Sediment Removal Plan Sediment Samples, 2009	Min	5	0.010	8.3%
	Max	70	0.14	120%
	Median	5	0.01	8.3%
	Average	9	0.018	15%
Machado Lake Sediment Characterization Report, 2010	Min	2	0.0040	3.3%
	Max	1,100	2.2	1,800%
	Median	20	0.040	33%
	Average	35	0.070	58%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Min	3.2	0.0064	5.3%
	Max	510	1.0	850%
	Median	32	0.064	53%
	Average	54	0.11	90%

Continued

Table 21: Continued.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Calleguas Creek Watershed Sediment Samples (2008 – 2010)	All Values – Min	1.1	0.0022	1.8%
	All Values – Max	12	0.024	20%
	All Values – Median	4.6	0.0092	7.7%
	All Values – Average	4.8	0.0096	8.0%
	Non-filtered Sediment – Min	1.4	0.0028	2.3%
	Non-filtered Sediment – Max	12	0.024	20%
	Non-filtered Sediment – Median	3.1	0.0062	5.2%
	Non-filtered Sediment – Average	5.2	0.010	8.7%
	Sands – Min	7.1	0.014	12%
	Sands – Max	7.1	0.014	12%
	Sands – Median	7.1	0.014	12%
	Sands – Average	7.1	0.014	12%
	Fines – Min	1.1	0.0022	1.8%
	Fines – Max	9.4	0.019	16%
	Fines – Median	4.6	0.0092	7.7%
	Fines – Average	4.2	0.0084	7.0%

Table 22: Estimated Dieldrin Dry Weather Loadings to Machado Lake.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Machado Lake Special Study Water Sample Calculations, 2010-2011	Min	9.1	0.018	25%
	Max	2,800	5.6	7,700%
	Median	170	0.34	470%
	Average	310	0.62	850%
Ballona Creek Study Sediment Samples, 2007	Average	11,000,000	22,000	3,000,000%
Machado Lake Ecosystem Project Sediment Removal Plan Sediment Samples, 2009	Minimum	0.50	0.0010	1.4%
	Maximum	10	0.020	27%
	Median	5	0.010	14%
	Average	3	0.0060	8.2%
Machado Lake Sediment Characterization Report Sediment Samples, 2010	Minimum	1.3	0.0026	3.6%
	Maximum	30	0.060	82%
	Median	4.9	0.0098	13%
	Average	4.8	0.0096	13%
Machado Lake Sediment Characterization Report Water Quality Samples, 2010	Minimum	3,100	6.2	8,500%
	Maximum	7,000	14	19,000%
	Median	6,100	12.2	17,000%
	Average	5,400	11	15,000%
Calleguas Creek Watershed Water Sample Calculations (2008-2010)	Min	0.15	0.00030	0.41%
	Max	17,000	34	47,000%
	Median	54	0.11	150%
	Average	380	0.76	1,000%

Continued

Table 22: Continued.

Data Source	Derived Toxic Constituent Fraction Metric	Value (µg/kg)	Estimated Dry Weather Loading to Machado Lake (g/year)	Percent of Annual WLA
Calleguas Creek Watershed Sediment Samples (2008 - 2010)	All Values - Min	1.0	0.0020	2.7%
	All Values - Max	32	0.064	88%
	All Values - Median	1.0	0.0020	2.7%
	All Values - Average	1.9	0.0038	5.2%
	Non-filtered Sediment - Min	1.0	0.0020	2.7%
	Non-filtered Sediment - Max	1.4	0.0028	3.8%
	Non-filtered Sediment - Median	1.0	0.0020	2.7%
	Non-filtered Sediment - Average	1.1	0.0022	3.0%
	Sands - Min	1.0	0.0020	2.7%
	Sands - Max	1.4	0.0028	3.8%
	Sands - Median	1.0	0.0020	2.7%
	Sands - Average	1.1	0.0022	3.0%
	Fines - Min	1.0	0.0020	2.7%
	Fines - Max	32	0.064	88%
	Fines - Median	1.0	0.0020	2.7%
	Fines - Average	3.7	0.0074	10%

1.4 CONCLUSIONS

Toxic constituent fractions vary significantly between studies, with a range spanning from 0.1 µg/kg to 10,000,000 µg/kg. It is therefore not straightforward to establish an appropriate single value for toxic constituent fractions on sediment. Fractions derived from toxics and TSS water quality samples consistently produce significantly higher fractions than sediment samples, however, these fractions reflect the measurements in future Toxics TMDL monitoring. Conversely, analysis of the majority of the sediment samples result in most toxic constituents fractions less than 10 µg/kg. Applying these fractions to calculations for dry weather loadings to Machado Lake would indicate that the dry weather toxics loadings from the County-owned lands would be compliant with the annual WLAs.

Of the studies reviewed, it is recommended that the median values for the 2010 Machado Lake Ecosystem Sediment Characterization Report sediment samples be used as values for the toxic constituent fractions for sediments in the County-owned lands. The values from the study are optimal because the study is one of the most complete and analyzed data sets reviewed by this effort, with a large sample size across a broad and representative range of sample sites. The sediments analyzed in the study originated from the Machado Lake watershed. The values contain no significant outliers and are typical of values observed in the other reviewed studies.

Because the data come from the Machado Lake watershed and are likely to represent the sediment concentrations seen in County-owned lands that drain to Machado Lake, the toxics fractions calculated are thought to best represent the runoff from the County islands. The toxic fractions and resulting estimated loading to Machado Lake are summarized in **Table 23**.

Table 23: Estimated Annual Toxic Loadings to Machado Lake.

Constituent	Estimated Sediment Fraction for County-owned Lands (µg/kg)	Annual loading to Machado Lake[1] (g/year)	Percentage of Annual WLA[2]
Chlordane-alpha	2.3	0.087	--[3]
Chlordane-gamma	3.2	0.12	--[3]
Total Chlordanes	20	0.76	630%
2,4'-DDD	2	0.076	--[3]
4,4'-DDD	4.1	0.16	--[3]
2,4'-DDE	4.4	0.17	--[3]
4,4'-DDE	4.2	0.16	--[3]
2,4'-DDT	2	0.076	--[3]
4,4'-DDT	3.9	0.15	--[3]
DDD Congeners	4.2	0.16	84%
DDE Congeners	5.1	0.19	160%
DDT Congeners	4	0.15	95%
Total DDTs	5.8	0.22	110%
Dieldrin	4.9	0.19	260%
Total PCBs	58	2.2	96%

1 Values based on modeled TSS loading of 38,000 kg per year.

2 Waste Load Allocation is based on a three-year average.

3 No value provided as Regional Board has not assigned a WLA for the constituent.

The applied fractions from the Sediment Characterization Report produce an estimate of annual loadings from County-owned lands that would be currently in compliance with the WLAs for DDD Congeners, DDT, Congeners, and Total PCBs. Using the recommended toxics fractions, the estimates for Total Chlordanes, DDE Congeners, Total DDTs, and Dieldrin would not be in compliance with the TMDL and would require a reduction of TSS loading to 16 percent of the current loading, from 38,400 kg solids/yr to 6,000 kg solids/yr, to comply with the greatest observed calculation of the Total Chlordane levels. Further investigation might refine whether data points from the riparian woodlands, freshwater marsh, and Wilmington Drain should be discounted from the data set, but currently there is no evidence to argue for exclusion.

The Calleguas Creek Watershed sediment samples can also be considered as supplemental values for the toxic constituent fractions. While not from the watershed under investigation, the sample size is large and taken across a broad range of sample sites. Further investigation might consider the addition of non-detect values to the calculated constituents (e.g. DDT Congeners, Total PCBs) for the data set to mimic the methodology of the 2010 Machado Lake Ecosystem Sediment Characterization Report data set.