Machado Lake Nutrient TMDL
Special Study:
Characterization of Water Quality Conditions in the Unincorporated Areas of Los Angeles County within the Machado Lake Watershed
Final Report

Submitted to:

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Executive Summary

On May 1, 2008, the Los Angeles Regional Water Quality Control Board (Regional Board) adopted the Machado Lake Nutrients Total Maximum Daily Load (Nutrients TMDL) which was subsequently promulgated by the United States Environmental Protection Agency (USEPA) and became effective on March 11, 2009. The County of Los Angeles (County) is identified as a responsible agency under the Nutrient TMDL, as there are three islands of unincorporated land areas within the Machado Lake watershed for which the County operates the municipal separate storm sewer system (MS4). The default allocation for the Nutrients TMDL is concentration-based, with the option of developing mass-based allocations through a special study. The County opted for the mass-based compliance approach and, thus, conducted this special study, as required under the Nutrients TMDL, to characterize the nutrient loading from County islands.

On September 2, 2010, the Regional Board approved the Machado Lake Toxic Pollutants TMDL (Toxics TMDL) to address impairments in the lake associated with Organochlorine (OC) Pesticides and Polychlorinated Biphenyls (PCBs). The Toxics TMDL is currently awaiting approval by the State Water Resources Control Board (State Water Board) and the USEPA. The Toxics TMDL assigns waste load allocations as a fraction of the suspended sediment loading to Machado Lake. Further, Wilmington Drain, to which the County islands drain, is listed for metals and bacteria impairment. Though not required at this time, the County proactively incorporated the assessment of toxic pollutants, metals, and bacteria from County islands into the special study.

This special study was performed to fulfill the requirements of the Nutrients TMDL by assessing mass-based loading estimates for constituents of concern associated with the Nutrients TMDL, as well as additional efforts to determine loading estimates of other constituents within the Machado Lake Watershed, including toxics, metals, and bacteria.

The dry weather component of the study involves flow and water quality monitoring and the use statistical analysis tools to determine dry weather load estimates. The monitoring was conducted for about one year, between May 2010 and March 2011, with six water quality sampling events and continuous flow measurements at six sites within County islands. The annual average component of the Special Study relied on the County's Watershed Management Modeling System (WMMS), which was used to estimate the annual mass-based loading for constituents of concern. The regionally calibrated WMMS simulation results are based on a ten-year (1997-2006) hydrological and meteorological data. The estimated loading of total nitrogen and total phosphorus is provided in **Table ES-1** along with the waste load allocations (WLAs) assigned to each parameter by the Nutrients TMDL.

Table ES-1: Nutrient Mass-Based Loading from County Islands and associated Waste Load Allocations.

Constituent	Current Dry Weather Mass-Based Loading Estimate[1] (kg/yr)	Annual Mass-Based Loading Estimate[2] (kg/yr)	Interim Waste Load Allocation[3] (kg/yr)	Final Waste Load Allocation[3] (kg/yr)
Total Nitrogen	558	1,370	1,739	710
Total Phosphorous	55	1,110	887	71

1. Obtained via monitoring and Monte Carlo Simulation.
2. Calculation via the Watershed Management Modeling System.
3. Established by Regional Board from Machado Lake Nutrients TMDL.

The Total Nitrogen dry weather loading accounts for a significant portion of the annual loading from County Islands; however, wet weather loads constitute the majority of the annual loading. Total Phosphorous dry weather loading is relatively insignificant (i.e. <5%) to the current overall annual loading. Current Total Nitrogen loading needs a reduction of approximately 50% to attain final allocations, while current Total Phosphorous loads needs to be reduced by approximately 94% to meet the final allocations. These estimates may be revised in the future based on the data collected through the Nutrient TMDL Monitoring Program. Per the TMDL, the timeline for achieving the final WLAs is set to September 2018.

The high percentage of non detects in the samples from the monitoring precluded calculation of direct calculation of dry weather toxics loading. Instead, loading of OC pesticides and PCBs was calculated as a product of total suspended solids loading (38,400 kg/year) and a toxics-sediment fractional concentration derived from the 2010 Machado Lake Sediment Characterization Report (CDM 2010). It should be noted that as legacy pollutants, OC pesticide and PCB concentrations detected as part of the sediment characterization study for Machado Lake do not necessarily reflect actual concentrations in MS4 discharges today. The fractional concentration values from the Machado Lake study were used only as worst-case estimates of OC pesticides and PCBs loadings from County Islands. These estimates may be revised in the future based on data collected through the Toxics TMDL Monitoring Program.

Load estimates for toxics, metals, and bacteria are provided in **Table ES-2**.

Table ES-2: Mass-based Loading Estimates for Other Constituents of Concern.

Parameter of Concern	Current Dry Weather Mass-Based Loading Estimate[1] (kg/yr)	Annual Mass-Based Loading Estimate[2] (kg/yr)
Total Suspended Solids	2,000	38,400
Chlordane	—[3]	0.000768[4]
Total DDT	—[3]	0.000223[4]
Dieldrin	—[3]	0.000188[4]
Total PCBs	—[3]	0.00223[4]
Total Copper	1.35	16.3
Total Lead	0.147	14.8
E. Coli (MPN/yr)	$1.02 \cdot 10^{13}$	—[5]

1. Obtained via monitoring and Monte Carlo Simulation.
2. Calculated via the Watershed Management Modeling System (WMMS).
3. Insufficient detected data to make loading estimate from measured dry weather samples.
4. Toxic loads estimated based on TSS load of 38,400 kg/yr and fraction of toxic associated with solids from CDM 2010.
5. Bacteria not modeled with the WMMS.

1. Introduction

1.1 BACKGROUND

The Machado Lake Nutrients Total Maximum Daily Load (TMDL) was developed by the Los Angeles Regional Water Quality Control Board (Regional Board). The TMDL became effective upon its approval by the USEPA on March 11, 2009. The Machado Lake Nutrients TMDL was developed to address nutrient-related beneficial use impairments including the following Section 303(d) listings: eutrophication, algae, ammonia, and odor. The beneficial uses of Machado Lake include recreation, aquatic life, and water supply. In addition to nutrients, Machado Lake was also listed as impaired for OC Pesticides (chlordane, chem-A, DDT, Dieldrin), PCBs, and Trash. TMDLs have been developed to address these pollutants. The Regional Board has approved the Machado Lake Toxics TMDL (Toxics TMDL) on September 2, 2010, and is currently awaiting approval by the State Water Board and the USEPA. Note that the Toxics TMDL addresses chem-A compounds by directly addressing chlordane and Dieldrin. Further, Wilmington Drain, which contributes more than 80% of the flow to Machado Lake, was listed as impaired for metals (copper and lead) and bacteria. TMDLs specific to the Wilmington Drain have yet to be developed.

The Machado Lake Watershed and associated jurisdictions within the watershed are shown in **Figure 1**. The watershed has a total area of about 23 square miles. There are three unincorporated County areas within the watershed, accounting for about 8.4% (1.95 square miles) of the total area. For the purpose of this project, the unincorporated County areas are referred to as “County Islands”.

The Machado Lake Nutrients TMDL set concentration-based Waste Load Allocations (WLAs) for in-lake or end-of-pipe compliance options. At the same time, it provides for a mass-based compliance option, with the condition that the parties who choose this option develop an equivalent mass-based WLA and method of compliance with the WLA through a special study. The County has opted for the mass-based WLA alternative and, thus, conducted the associated special study for the unincorporated areas as defined in the Basin Plan Amendment (BPA) as Optional Study #3. Optional Study #3 states:

> “A work plan for permittees to assess compliance with TMDL WLAs on a mass basis for Total Nitrogen and Total Phosphorous. The work plan should detail testing methodologies, BMPs, and treatments to be implemented to attain and demonstrate a reduction of Total Nitrogen and phosphorous loading on a mass basis. A final report including the results shall be submitted to the Regional Board for Executive Officer approval.”

As presented in **Table 1**, the Nutrients TMDL WLAs for municipal separate storm sewer system (MS4) permittees are monthly average concentrations of 0.1 milligrams per liter (mg/L) for Total Phosphorous (TP) and 1 mg/L for Total Nitrogen (TN). Though the original intention of this special study was partly to establish a mass-based WLA for the County islands, the Regional Board Executive Officer latter decided to instead assign the required mass-based WLAs specific to the unincorporated County islands through a letter dated May 13, 2010. The Regional Board-assigned mass-based WLA is presented in **Table 2**.

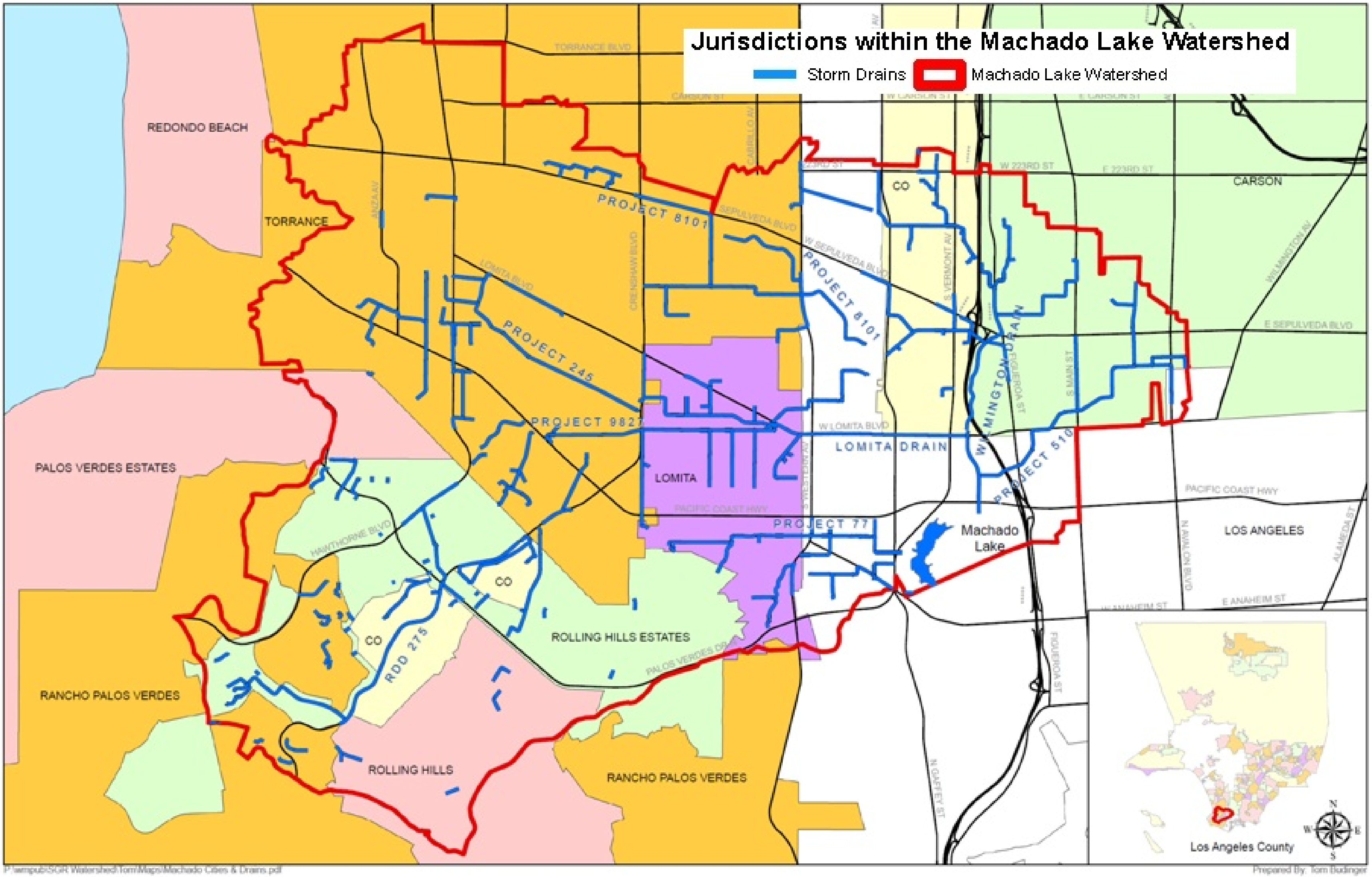

Figure 1: Machado Lake Sub-Watershed and Jurisdictions within the Watershed.

Table 1: Machado Lake Nutrients TMDL Targets and MS4 Allocations for Nitrogen and Phosphorous.

Parameter of Concern	Numeric Target		MS4 Allocation[1]	
	Concentration (mg/L)	Sample Type	Concentration (mg/L)	Sample Type
Total Nitrogen	1.0	monthly average	1.0	monthly average
Total Phosphorous	0.1	monthly average	0.1	monthly average
Ammonia-N	5.95	one-hour average	NA	
	2.13	30-day average		
Dissolved Oxygen	5.0	single sample	NA	
Chlorophyll a	0.02	monthly average	NA	

1 The numeric Nutrient Endpoint BATHTUB model was used in TMDL to establish the linkage between nutrient loading to Machado Lake and the desired water quality conditions, concluding that the allocations would address the 303d listings.

Table 2: Regional Board-Assigned Mass-Based WLAs for County Islands.

Parameter of Concern	WLA for County Islands	
	Interim WLA (kg)	Final WLA (kg)
Total Nitrogen	1739	710
Total Phosphorous	887	71

The Toxics TMDL numeric targets and WLAs for MS4 permittees are presented in **Table 3**. Unlike the Nutrients TMDL, Toxics TMDL WLAs are concentration-based, expressed as a fraction of suspended sediment loading by stormwater discharges. Compliance with the WLAs is 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.

Table 3: 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)	Application Type
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, Industrial Stormwater Permittees, and other non-stormwater NPDES Permittees.

The County submitted a Final Work Plan for the Machado Lake Nutrients TMDL Special Study for the Unincorporated Areas of Los Angeles County within the Machado Lake Watershed (Work Plan) on June 14, 2010 to the Regional Board. In accordance with the Work Plan, the County conducted this special study to characterize the ambient water quality conditions of the unincorporated County islands. Though the scope of the original Work Plan was limited to assessing nutrients only, the County expanded the scope to include additional constituents of concern in Machado Lake Watershed, including organics, metals, and bacteriological indicators.

1.2 STUDY OBJECTIVES

The main objectives of this Special Study include the following:

1. To characterize the water quality conditions in three unincorporated County islands within the Machado Lake watershed; and
2. To establish background data and information that is necessary for the development of TMDL monitoring and implementation plans for the County islands.

2. Study Approach

This study utilized a combination of water quality sampling and modeling to characterize flow and pollutant loading from the unincorporated County islands. The dry weather component of the study relied on monitoring and statistical analysis, while the wet weather component relied on the use of a physically-based model to simulate flow and water quality.

2.1 DRY WEATHER APPROACH

As there are no physically-based models currently available to accurately characterize pollutant loading during dry weather, data were collected in the field. These data (flow and water quality) were then utilized to estimate the dry weather contribution pollutant loads from the County areas. The following section describes the details of the monitoring program, including the monitoring frequency, monitoring sites, constituents monitored and quality control approaches.

2.1.1 Monitoring Frequency

Water quality samples were collected during dry weather at each monitoring location bimonthly for six events, covering one full year, with the first sample collected in May 2010 and the last sample collected in March 2011. During the wet season, dry weather sampling events were scheduled to be seven days after measurable precipitation, or after flow rates have returned to base flow levels typical of the season, whichever period was shorter. As depicted in **Figure 2**, all sampling events took place during base flow conditions. Appendix A-1 provides additional details on the precipitation rates within the sampling area during the study period.

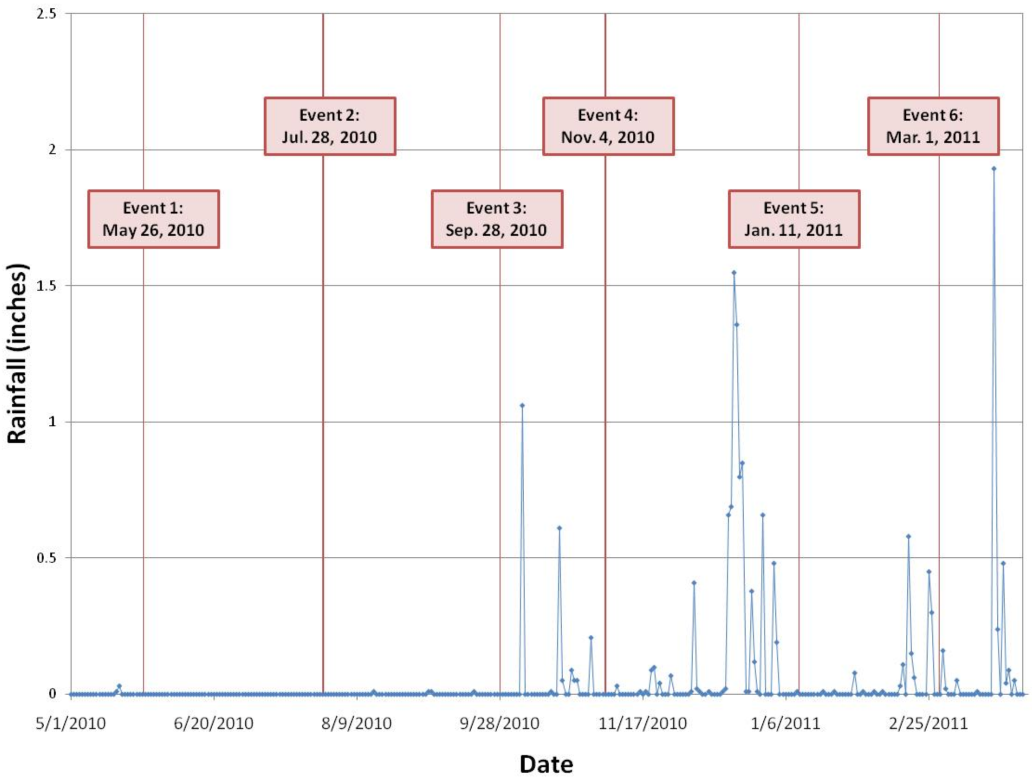

Figure 2: Precipitation Rates and Dates of Sampling within Southeast Torrance, California.

Reasonable efforts were made to ensure that each site was visited at various times on the sampling day to discount any potential bias from flow patterns throughout the day. To this end, site orders were randomized over the course of the study to the best extent possible, while certain sites were kept together for sampling efficiency and start times were made to fit staff and lab schedules.

Unlike the event-based water quality sampling, flow was measured on a continuous basis using pressure sensors installed at the monitoring sites throughout the study period.

2.1.2 Monitoring Sites

For this Special Study, the County Islands are numbered 1, 2, and 3 from west to east. The three County Islands are presented in **Figure 3**. The majority of the land use within the County area is residential (63%), which is the sum of single family residential (SFR), multi-family residential (MFR), and mobile homes. The next most prevalent land uses are open space at 15% and commercial at 6%.

The following factors were taken into consideration in identifying monitoring locations for dry weather:

- Major storm drains entering and leaving County jurisdictional boundaries
- Representativeness of the site in terms of land use and geographic extent
- Accessibility of the site

Based on the above factors, a total of six monitoring sites were selected for the Special Study. The detail descriptions of the selected monitoring sites are presented in **Table 4**.

The format for Site ID codes is #X_AAAA, where:

- *#* indicates the County Island in which the site is located.
- *X* identifies whether the site is an inlet (I) or outlet (O) site.
- *AAAA* indicates the cross street, where available, such as ACAD for Academy Drive

No monitoring sites were identified on County Island 2 because it does not appear to produce any runoff that leaves the County boundary during dry weather. This island is primarily composed of a botanic garden (South Coast Botanic Garden) and any dry weather runoff from garden was contained within a pond located in the middle of the garden. While no sampling took place, the botanic garden was visited during each monitoring event to confirm that runoff was not leaving the botanic garden during dry weather. Pictures of each monitoring site are provided in **Appendix A-2**. The monitoring site locations and associated land uses and drainage areas are shown in **Figures 4** and **5,** and summarized in **Table 5**.

Table 4: Monitoring Sites.

SiteID	County Island	Type	Nearest Intersection	Latitude	Longitude	Rationale
1O_ACAD	1	Island Outlet	Academy Dr./ Palos Verdes Dr.	33.7831	-118.3537	Representative of County Island outlet and potentially residential land use. This site will be used to characterize loading from the County Island and residential land uses.
1O_EAST	1	Island Outlet	Eastvale Rd./ Palos Verdes Dr.	33.7809	-118.3506	Representative of County Island outlet and residential land use. This site will be used to characterize loading from the County Island and residential land uses.
3I_NORMP	3	Island Inlet	Normandie Ave./ Pasatiempo Ln.	33.8058	-118.2989	Large drain into County Island. Associated Vermont/Sepulveda outlet drains large portion of County Island. This site will be used to characterize loading to the County Island and evaluate loadings to other portions of the County without an associated inlet site.
3I_ASHB	3	Island Inlet Proxy	Ashbridge Dr./ Pasatiempo Ln.	33.8082	-118.2954	Drains the combination of the two other small Island inlets to the associated Vermont/Sepulveda Island outlet. This site will be used to characterize loading to the County Island.
3O_VERSEP	3	Island Outlet	Vermont Ave./ Sepulveda Blvd.	33.8083	-118.2883	Drains large section of County Island. This site will be used to characterize loading from the County Island and evaluate loadings from other portions of the County without an associated outlet site.
3O_VAND	3	Island Outlet	Van Deene Ave./ 228th St.	33.8158	-118.2878	Drains large section of County Island. This site will be used to characterize loading from the County Island and evaluate loadings from other portions of the County without an associated outlet site.

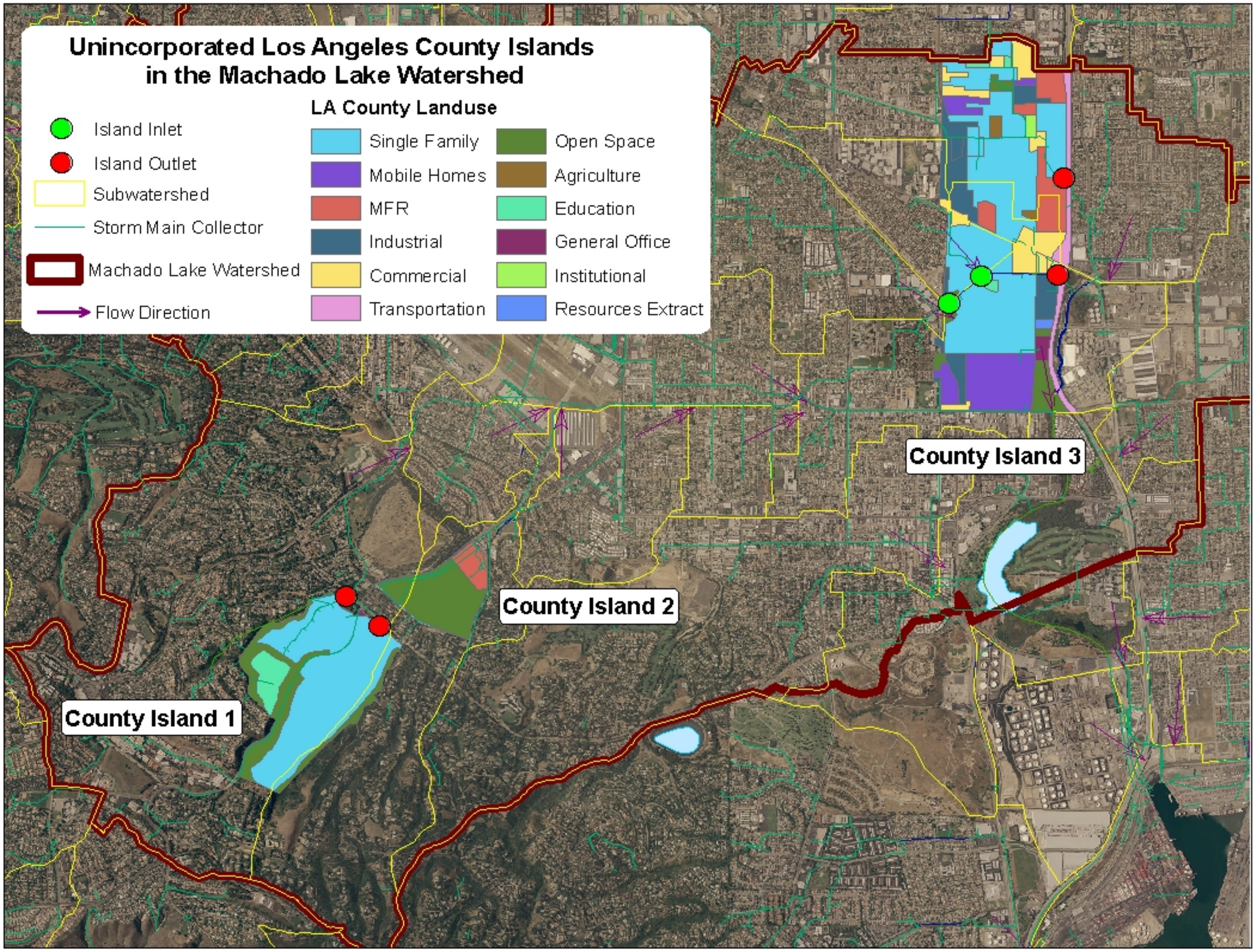

Figure 3: Overview of County Islands and Monitoring Sites.

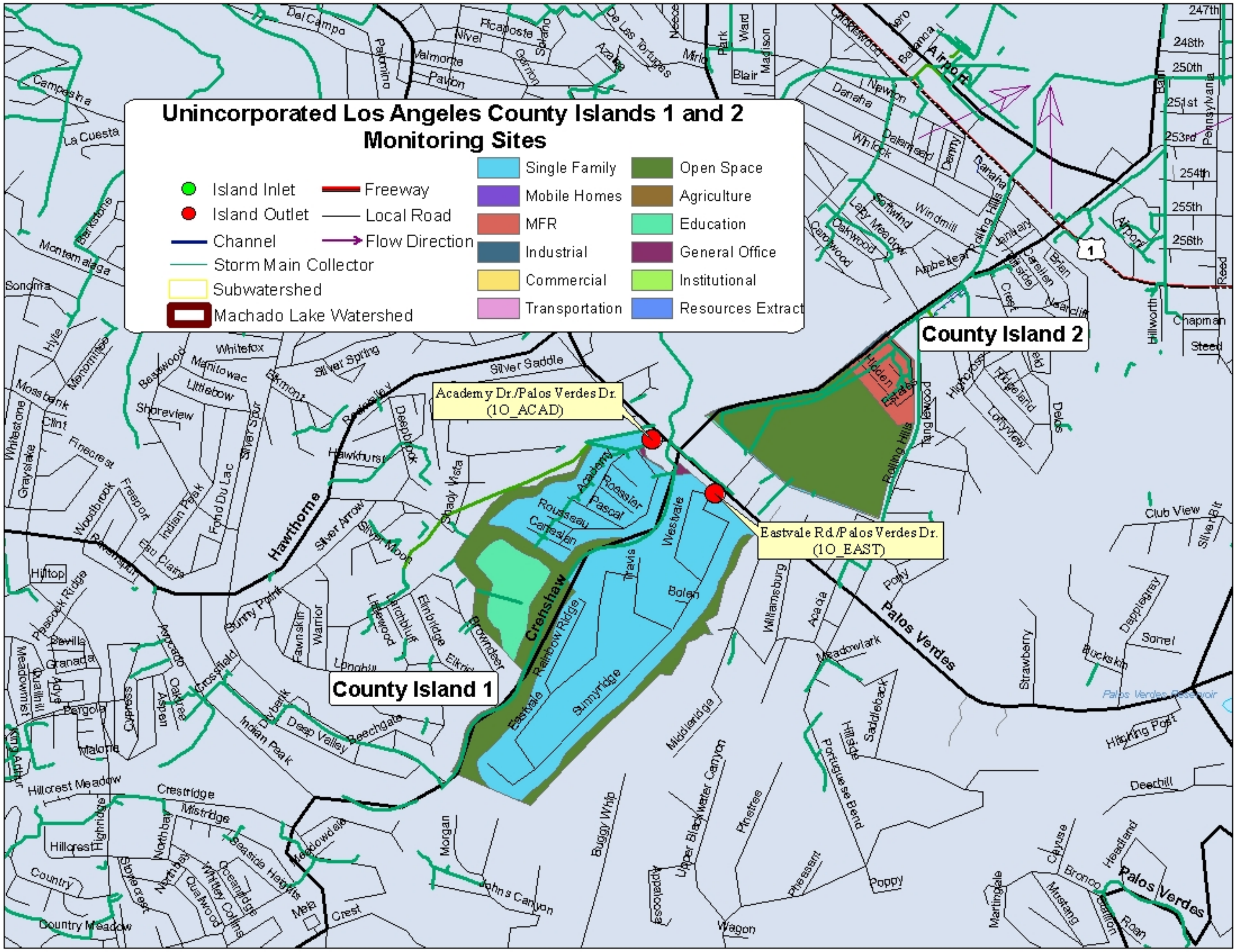

Figure 4: Monitoring Sites on County Islands 1 and 2.

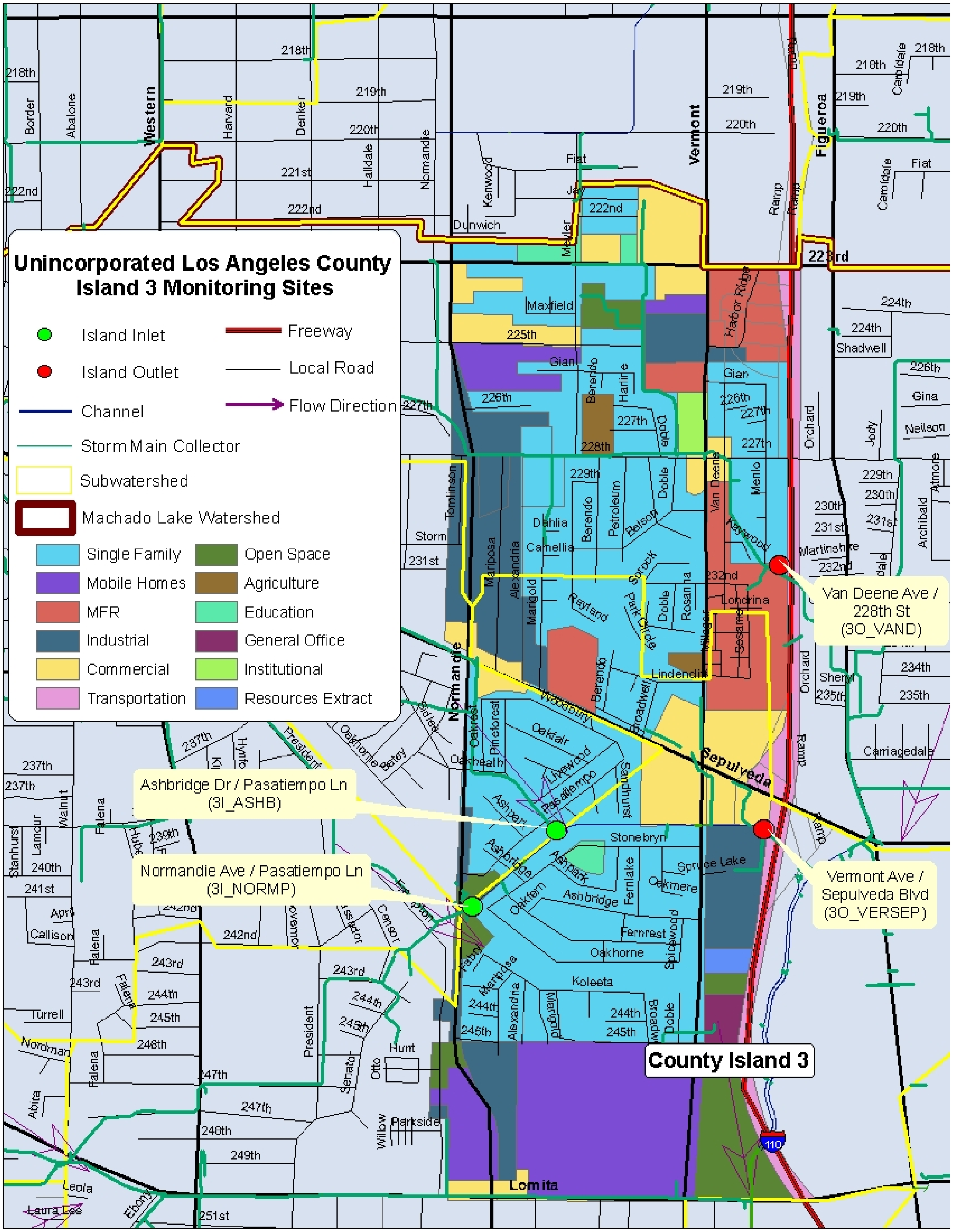

Figure 5: Monitoring Sites on County Island 3.

Table 5: Monitoring Site Drainage Areas and Majority Land Use.

SiteID	Type	Drainage Area (acres)[1] County	Upstream of County	Total	% of Total Drainage Area Draining County Land	Majority County Land Use Drained[2]
1O_ACAD	Outlet	61	0	61	100%	Residential - 65% [SFR - 65%]
1O_EAST	Outlet	54	0	54	100%	Residential - 99% [SFR - 99%]
3I_NORMP[3]	Inlet	45	1,330	1,375	NA[4]	NA
3I_ASHB[3]	Inlet Proxy	48	197	244	NA[4]	NA
3O_VERSEP	Outlet	291	1,527	1,818	16%	Residential - 70% [SFR - 61% MFR - 5% Mobile Homes - 4%]
3O_VAND	Outlet	339	326	665	51%	Residential - 69% [SFR - 51% MFR - 14% Mobile Homes - 4%]

1. Determined using GIS layers of detailed basins and flow paths of the Wilmington Drain watershed provided by the County.
2. Determined using a GIS layer that was compiled with data from the year 2005.
3. Drains land upstream of County area, but complex drainage pattern causes small area of County land to drain to the site.
4. Not Applicable - Inlet sites are not intended to measure County inputs.

2.1.3 Monitored Parameters

Table 6, **Table 7**, and **Table 8** presents the water quality constituents monitored and the associated analytical methods, project method detection limits, and project reporting limits for each constituent. Constituents monitored include those for which Machado Lake and Wilmington Drain are listed as impaired. Data collected assisted in the understanding of pollutant loadings from the County areas and in identification of implementation actions needed for reducing those loadings.

Table 6: Nutrient TMDL Constituents, Analytical Methods, and Quantitation Limits.

Constituent Class	Constituent	Method	Detection Limit (mg/L)	Reporting Limit (mg/L)
Conventionals	Total Suspended Solids (TSS)	SM 2540D	0.5	1.0
	Total Dissolved Solids (TDS)	SM 2540C	1.0	10
Nutrients	Total Kjeldahl Nitrogen (TKN)	EPA 351.1	0.455	0.50
	Nitrate as Nitrogen (NO3-N)	EPA 300.0	0.01	0.10
	Nitrite as Nitrogen (NO2-N)	EPA 300.0	0.01	0.05
	Total Nitrogen[1]	calculation	NA	NA
	Ammonia as Nitrogen (NH3-N)	EPA 350.1	0.01	0.10
	Total Phosphorus	SM 4500-P E or F	0.02	0.1
	Dissolved Phosphorus	SM 4500-P E or F	0.02	0.1
	Total Orthophosphate (PO4-P)	SM 4500-P E or F	0.001	0.01

1. Total Nitrogen is the sum of TKN, NO3-N, and NO2-N.

Table 7: Additional Constituents, Analytical Methods, and Quantitation Limits.

Constituent Class	Constituent	Method	Analyzing Lab: Soil Control Lab	Analyzing Lab: Physis/ CRG	Detection Limit	Reporting Limit
Conventional	Hardness	SM 2340B	X		1 mg/L	10 mg/L
Metals	Total and Dissolved Copper	EPA 200.8	X		0.4 µg/L	0.8 µg/L
	Total and Dissolved Lead		X		0.1 µg/L	0.5 µg/L
Bacteria	*E. coli*	IDEXX Colilert		X	10 MPN/100 mL	10 MPN/100 mL
Organics	Organochlorine Pesticides[1,2]	EPA 625(m) / 8270C(m)		X	1 ng/L	5 ng/L
	PCBs[3]			X	10 ng/L	20 ng/L

1. Organochlorine Pesticides include aldrin, alpha-BHC, beta-BHC, gamma-BHC (Lindane), delta-BHC, chlordane-alpha, chlordane gamma, 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, toxaphene.
2. Chem A Pesticides: aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (HCH, including lindane), and toxaphene.
3. PCBs in water are measured as sum of seven Aroclors identified in the CTR (1016, 1221, 1232, 1242, 1248, 1254, and 1260).

Table 8: Project Reporting Limits for Field Measurements.

Parameter/Constituent	Range	Project RL[1]
Velocity/Flow[2]	-0.5 to +20 ft^3/s	NA
pH	0 – 14 pH units	NA
Temperature	-5 – 50 ^oC	NA
Dissolved oxygen	0 – 50 mg/L	0.5 mg/L
Turbidity	0 – 3000 NTU	0.2 NTU
Conductivity	0 – 10000 µmhos/cm	2.5 µmhos/cm

1 RL – Reporting Limit
2 For velocity/flow, range refers to velocities measured by a handheld flow meter. The lower limit for measuring flow is dependent upon the size of the specific pipe or channel.

2.1.4 Monitoring Method

While grab sampling method was employed for water quality monitoring on bimonthly basis, flow was measured on a continuous basis using sensors (called HOBO meters) installed at all of the monitoring sites. HOBO meters continuously record time, temperature, and pressure data, which then convert these readings to density and depth measurements. The field sampling crew downloaded data from the HOBO meters during each sampling event. Additionally, to help calibrate the HOBO meters, flow rate was measured at each site during each sampling visits.

2.1.5 Quality Assurance and Quality Control

Quality Assurance/Quality Control (QA/QC) measures were built into the Study[1] to assure data are credible. Field QA/QC for the Special Study included the following:

- Proper collection, handling, and preservation of samples
- Maintenance of a field log
- Field Blanks
- Field Duplicates

Laboratory QA/QC for the Special Study included the following:

- Use of the lowest available method detection limits (MDLs) for trace elements.
- Analysis of method blanks and laboratory duplicates.
- Use of matrix spikes (to test analytical accuracy) and matrix spike duplicates (to test analytical precision) (MS/MSD).
- Routine analysis of standard reference materials (SRMs) and method blanks.

To avoid any potential bias, the field duplicate and field blank site was rotated throughout the course of the Special Study, with consideration given to sample collection efficiency and likelihood of flow at each site.

[1] Additional information on QA/QC procedures followed during the Special Study is available in Appendix 2 of the Special Study Work Plan.

For QA/QC of the flow metering equipment the monitoring crew were required to review the installation during each field visit and confirm that the HOBO meters were measuring the correct water depth. At each site visit, the actual water depth was measured and compared to the depth recorded by the HOBO meters. Adjustments were made if corrections were warranted.

2.2 ANNUAL AVERAGE LOADING APPROACH

The recently developed Watershed Management Modeling System (WMMS) for the County of Los Angeles was used for the assessment of annual average water quality and flow conditions from County Islands. WMMS is a physically-based model that simulates both flow and water quality. The model is based on the Hydrologic Simulation Program-FORTRAN (HSPF) and Loading Simulation Program C++ (LSPC).

The WMMS model is a continuous simulation model and generates runoff characteristics based on rainfall, soil characteristics and infiltration rates, evapotranspiration, antecedent conditions, and land use-specific pollutant loading characteristics. Constituents simulated by the model include total nitrogen, total phosphorous, copper, lead, zinc, total suspended solids, and fecal coliform.

WMMS was regionally calibrated and validated using locally developed storm flow and water quality data. Meteorological data from 1997 to 2006 were used to calibrate the model. The model has been tested for small-scale land use and larger watersheds and has been used to support the development of implementation plans for various TMDLs in Los Angeles County.

The WMMS model was used to simulate the annual loadings of the various constituents of concern from unincorporated County Islands to Machado Lake. The Los Angeles County's sub-watershed GIS layer was used to divide the Machado Lake watershed into hydrologically connected sub-watersheds, and to calculate loading based on land use type and associated percentages of impervious cover. 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. Using existing meteorological data, hydraulic data, land use information, and monitoring data, each sub-watershed is calibrated to most accurately simulate the runoff and pollutant load.

3. Dry Weather Monitoring Data

3.1 WATER QUALITY DATA

All six monitoring sites were visited during each of the six sampling events. The dates and times of each sampling event are presented in **Table 9**. Times of the site visits and the location of field duplicate and blank site were intentionally varied to avoid sampling biases with consideration given to traffic safety and driving distance.

Table 9: Dates and Times of Sampling Events.

Site	Event 1: 5/26/2010	Event 2: 7/28/2010	Event 3: 9/28/2010	Event 4: 11/4/2010	Event 5: 1/11/2011	Event 6: 3/1/2011
1O_ACAD	10:10	16:40	12:30	8:15	13:15[1]	15:40
1O_EAST	10:30	16:00	11:50	8:45	12:30	14:40
3I_ASHB	14:20	11:30	14:45[1]	12:40	9:30	12:45
3I_NORMP	14:40	12:35[1]	16:00	13:15	8:45	11:30[1]
3O_VAND	15:25	10:00	9:30	13:50[1]	11:00	10:45
3O_VERSEP	12:25[1]	14:55	11:00	12:00	10:15	9:35

1. Site used for Field Duplicate and Field Blank

With the exception of 1O_EAST, flow was present and continuous at each site, allowing for the full suite of samples to be collected. During Event 3, flow was present then ceased at 1O_EAST, resulting in only a limited set of samples to be collected from the site. Flow was present and consistent at 1O_EAST during Event 6, resulting in a full collection of samples. A summary of the samples collected over the course of the study is presented as **Table 10**. During each event, it was also documented through photographs that no water was flowing out of the South Coast Botanic Garden spill way. Appendices B-1 and B-2 provides graphical representations of all non-organic parameters by site and by event, respectively.

Table 10: Event Numbers in which Samples were collected

Site	Conventionals[1]	Nutrients[2]	Organics[3]	Metals[4]	Bacteria[5]	Field[6] Measurements	Reason not Sampled
1O_ACAD	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	NA
1O_EAST	3[7], 6	3[7], 6	6	6	6	6	No Flow
3I_NORMP	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	NA
3I_ASHB	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	NA
3O_VERSEP	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	NA
3O_VAND	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	1 - 6	NA

1. Conventionals: Total suspended solids, total dissolved solids, and hardness
2. Nutrients: Total Kjeldahl Nitrogen (TKN), Nitrate as Nitrogen (NO3-N), Nitrite as Nitrogen (NO2-N), Ammonia as Nitrogen (NH3-N), Total Phosphorous, Dissolved Phosphorous, Total Ortho-phosphate (PO4)
3. Organics: Organochlorine Pesticides include aldrin, alpha-BHC, beta-BHC, gamma-BHC (Lindane), delta-BHC, chlordane-alpha, chlordane gamma, 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, toxaphene. Chem A Pesticides: aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (HCH, including lindane), and toxaphene. PCBs in water are measured as sum of seven Aroclors identified in the CTR (1016, 1221, 1232, 1242, 1248, 1254, and 1260).
4. Metals: Total and dissolved copper and lead
5. Bacteria: *E. coli*
6. Field Measurements: Flow, pH, temperature, dissolved oxygen, turbidity, and electrical conductivity
7. Because the flow ceased during sample collection, only the Nutrients constituents and Total Dissolved Solids were analyzed from the sample collected at 1O_EAST during Event 3.

3.2 FLOW DATA

As noted previously, continuous flow measurement was conducted for one year using HOBO meters installed at each of the monitoring sites. A list of the HOBO meter data collected over the course of the Study is summarized in **Table 11**. Additional information about the collection and analysis of the HOBO meters can be found in Appendix C.

Table 11: Time Spans from which HOBO Meter Data were collected.

Sites	July 7, 2010 – July 28, 2010	July 28, 2010 – August 25, 2010	August 25, 2010 – September 28, 2010	September 28, 2010 – November 4, 2010	November 4, 2010 – January 11, 2011	January 11, 2011 – March 1, 2011	Reason if Data Not Available
1O_ACAD	X	X	X	X	X	X	NA
1O_EAST	X	X	X	X	X	X	NA
3I_NORMP	X	X	X	X	X	X	NA
3I_ASHB	X	X		X	X	X	Downloading Error
3O_VERSEP	X	X	X	X	X	X	NA
3O_VAND	X	X	X	X	X	X	NA

3.3 QA/QC REVIEW OF DATA

Overall, no data points were rejected from the sample set as a result of QA/QC, nor were any changes to the sampling protocol considered as a result of the QA/QC qualifications. A summary of the QA/QC qualifications recorded over the course of the Study is provided in **Table 12**. Additional information about the QA/QC review of the samples can be found in Appendix D.

Table 12: Summary of QA/QC Qualifications.

Constituent	Event Number	Number of Data Points Qualified	Program Qualifier	Reason for Qualification
Total Suspended Solids (TSS)	1	5	FD RPD	Field Duplicate RPD above limit
	2	5	FD RPD	Field Duplicate RPD above limit
	6	6	FD RPD	Field Duplicate RPD above limit
Total Dissolved Solids (TDS)	NA	0	None	
Hardness	NA	0	None	
Total Kjeldahl Nitrogen (TKN)	2	5	FD RPD	Field Duplicate RPD above limit
Nitrate as Nitrogen (NO3-N)	NA	0	None	
Nitrite as Nitrogen (NO2-N)	NA	0	None	
Ammonia as Nitrogen (NH3-N)	NA	0	None	
Total Phosphorous	NA	0	None	
Dissolved Phosphorous	NA	0	None	
Total Ortho-phosphate (PO4)	1	5	FD RPD	Field Duplicate RPD above limit
Organochlorine Pesticides	2	1	MS>UL	Matrix Spike Recovery above limit
	4	10	MS <LL EST MS/MSD	Matrix Spike and Duplicate below the recovery limit, Matrix Spike and Duplicate RPD above limit
PCBs	5	10	MS/MSD RPD	Qualified as estimated due to MS/MSD RPD being outside of standards
Total Copper	NA	0	None	
Dissolved Copper	NA	0	None	
Total Lead	6	1	U	Field and method blank above detection limit

Continued

Table 12: Continued

Constituent	Event Number	Number of Data Points Qualified	Program Qualifier	Reason for Qualification
Dissolved Lead	4	5	FD RPD	Field Duplicate RPD above limit
	6	6	U (4); FD RPD (6)	Field and method blank above detection limit; field duplicate exceeded RPD
E. coli	1	5	FD RPD	Field Duplicate RPD above limit
	2	5	FD RPD	Field Duplicate RPD above limit
	3	5	FD RPD	Field Duplicate RPD above limit

Notes: EST MS/MSD - Qualifier indicating the percent difference in recovery between the matrix and matrix spike exceeded the control limit.
FD-RPD - Flagged data should be noted as possibly imprecise measurements because duplicate samples did not return results sufficiently consistent with the original sample.
MS < LL – Qualifier indicating the matrix spike and/or matrix spike duplicate recovery was less than the control limit.
MS > UL – Qualifier indicating the matrix spike percent recovery exceeded the upper limit.
U - Flagged data should be treated as the upper limit of the estimated quantity because blank samples recorded results above the detection limit.

4. Pollutant Load Estimation

4.1 DRY WEATHER LOAD

4.1.1 Flow Calculations

HOBO meters data were compiled together into one time series of depth data for each site. Depth readings were scaled to the field measurements of depth recorded during each sampling event, and then scaled to the field measurements of flow during each sampling event. Appendix E-1 provides additional details on the calculations of flow from HOBO meter depth readings, while Appendix E-2 provides non-exceedance percentile (Quantile-Quantile or Q-Q) plots of flow data from each site. Appendix E-3 provides time series graphs of flow data from each site.

The data sets were then reviewed to determine which flow readings constituted dry weather events and which constituted wet weather events. It was determined that the dry weather flows in County Island 3 sites corresponded to measured flows up to the 92nd percentile, while dry weather flows in County Island 1 corresponded to measured flows up to the 99th percentile. This dry weather threshold difference is a result of the difference in the degree of urbanization between the islands. As County Island 3 is more urbanized with a higher level of impervious area than County Island 1, it takes a smaller storm to result in wet-weather runoff in Island 3 than in Island 1.

An example of the analysis conducted to establish the dry weather threshold is presented in **Figure 6**. The analysis provided a set of flow data that was statistically significant and site-specific.

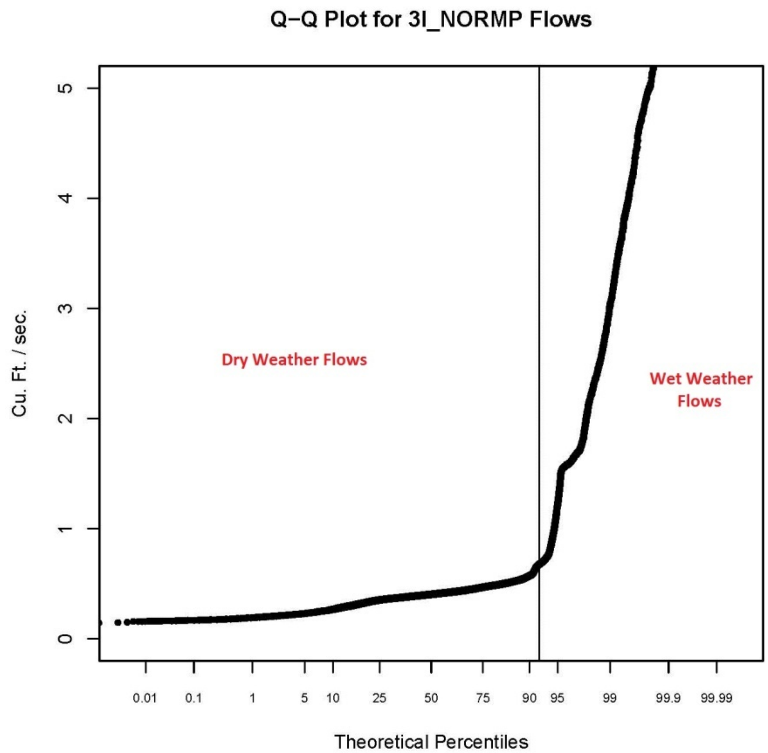

Figure 6: Flow Rates at Site 3I_NORMP.

4.1.2 Water Quality Analysis

The entire set of water quality sampling data was reviewed to identify if site location or the timing of events were significant factors in determining the concentrations observed. The data set was reviewed by constituent, and as necessary, fraction (e.g. total and dissolved phosphorous). An analysis of variance determined that neither site nor event were consistently significant factors in the concentrations of all parameters measured during the course of the study. Because no consistent pattern of differences across constituents (e.g. all parameters greater at 1O_ACAD compared to other sites) or groups of constituents (e.g. all nutrients greater at 1O_ACAD compared to other sites) arose through the analysis of location and event date, it follows that measurement of each constituent can be considered as part of a statistical distribution applicable for all County islands. The conclusion of the analysis is that the distribution of constituent concentration would not be dependent upon location within the watershed, season, or date of sampling. Appendix F provides details on the analysis of variance performed on the data set.

An analysis of variance was not performed on any of the measured toxic constituents as the majority of analyses for each parameter resulted in non-detect. Most detected concentrations were observed at the island inlet site of 3I_ASHB but not at the corresponding island outlet of 3O_VERSEP, indicating that the detected toxic pollutants were originating from outside of County Islands and that they were getting entrapped with County islands. The results of the toxic constituent sampling during the dry weather study are summarized in **Table 13**. Due to the high number of non-detects, dry weather toxics loading was considered to be insignificant.

Table 13: Dry Weather Special Study Toxics Samples.

Constituent	Number of non-detects[1]	Percent non-detects	Detected values in ng/L (Event and Site)
2,4-DDD	31	100	None
2,4-DDE	31	100	None
2,4-DDT	30	97	20.9 (Event 2 at 3I_ASHB)
4,4-DDD	30	97	11.4 (Event 2 at 3I_ASHB)
4,4-DDE	28	90	9.1 (Event 2 at 3I_ASHB) 3.4 (Event 5 at 1O_ACAD) 3.3 (Event 5 at 3I_ASHB)
4,4-DDT	31	100	None
Chlordane-alpha	28	90	24.4 (Event 2 at 3I_ASHB) 1.63 (Event 4 at 1O_ACAD) 3.5 (Event 5 at 3O_VAND)
Chlordane-gamma	29	94	9.13 (Event 2 at 3I_ASHB) 4.5 (Event 5 at 3O_VAND)
Dieldrin	31	100	None
Total PCBs	31	100	None

1 Total number of samples = 31

The analysis determined that the concentration of nutrients, metals, and total suspended solids did not exhibit consistent pattern between monitoring sites or monitoring events. Statistical modeling of these parameters, which are central to the study objectives, were confidently represented as one sub-watershed-wide distribution.

The determination of site and event date differences as statistically insignificant to constituent concentration is an important conclusion that impacts modeling decisions of the dry weather samples and future sampling, and monitoring plans, which are discussed later in this document.

Though no consistent overarching relationship between site and event was identified for the constituents monitored in the study, several specific instances of possible relationships were identified. Additional information on differences between water quality constituent distributions is provided in Appendix F. These possible relationships should be considered when developing future monitoring plans, as additional data may provide additional evidence as to whether sites or dates provide unique differences to the resulting water quality of the dry weather loading to Machado Lake. However, there was no clear statistical evidence to conclude any of the relationships exist. The following are the identified constituents that may have special relationships:

- The distribution for several nitrogen parameters at 1O_ACAD are potentially different than the overall distributions. It is possible that this is the result of landscaping activity performed at areas upstream of the site, such as the nearby school.
- The distribution for total and dissolved phosphorous and dissolved copper during Event 2 is potentially different than the overall distributions for said parameters. As this event took place in late July, it is possible that this is the result of residual from

firework activity from earlier in the month impacting water quality. Similarly, this may also be the result of late season fertilizer applications or landscaping activities.

- The distribution for total lead at 3O_VAND is potentially different than the overall distribution. As houses in the area are of older construction, antiquated piping may contribute to increased concentrations of lead to the site via over irrigation of landscape.
- The distribution for hardness at each site is potentially different than an overall distribution. It is uncertain what activities within each watershed may contribute to any potential differences between each site. Hardness is likely a factor influenced by groundwater seeping into storm channels or the water supply from the urban areas adding to the dry weather flow. The presence of unique site-specific distributions for hardness would run counter to the distribution for total dissolved solids, which identified no relationship between site or event and concentration. The observed differences may be reflective of the specific domestic water supply in each area.

As described in Appendix F, the analysis results are deduced from a small sample size, and no statistically significant pattern across several constituents or groups of constituents was identified. Statistical variation is anticipated for environmental data, and it is not yet conclusive that the resulting differences described above are the result of unique features of the site or sampling date, or natural variation. Additional sampling can assist in the determination of the nature of these deviations.

4.1.3 Creation of Statistical Distributions

Following the conclusion that water quality constituent data would be considered as one distribution across the year of study and across the sub-watershed, parameters defining each constituent's distribution were calculated. Organics were not considered for analysis because of the preponderance of non-detect results. For constituents with several non-detect values in their distribution, a regression on order statistics (ROS) was performed. The ROS produced a lognormal distribution for the associated parameters with consideration given to the uncertainty surrounding non-detect values. Results of the ROS are presented in Appendix G-1.For the remainder of the water quality constituents, a frequency distribution was created for each parameter. Fitness tests were then performed to see if the statistical parameters (i.e. mean and standard deviation) for a normal or lognormal distribution produced a more optimal fit. The results of the frequency distributions are presented in Appendix G-2.

All constituents except dissolved copper were found to be better fit as a lognormal distribution. Dissolved copper was found to be best represented by a normal distribution, which theoretically may result in a negative concentration. Any simulated dissolved copper concentration that was generated was reassigned a random number from a uniform distribution spanning 0 mg/L to the constituent's detection level of 0.084 mg/L, simulating a non-detect concentration. Nitrate was observed to be better represented as two separate distributions the first from the 0^{th} to 10^{th} percentile and second from the 10^{th} to 100^{th} percentile. As no other distributions were observed to accurately reflect the concentration distribution and no site or event parameters appeared to impact the lower and higher concentrations, this was identified as the most reasonable method. For each water quality constituent, the parameters and distribution type used for the simulated water quality constituent distributions are listed in **Table 14**.

Table 14: Distributions and Statistical Parameters Used for Water Quality Constituent Distribution Simulation.

Water Quality Constituent	Units	Distribution type	Mean	Standard Deviation
Total Suspended Solids (TSS)	mg/L	Lognormal	2.0	1.2
Total Dissolved Solids (TDS)	mg/L	Lognormal	7.0	0.65
Hardness	mg/L	Lognormal	5.9	0.73
Total Kjeldahl Nitrogen (TKN)	mg/L	Lognormal	0.24	0.82
Nitrate as Nitrogen (NO3-N)	mg/L	0-10 % Lognormal 10-100% Lognormal	-3.6 0.53	0.40 1.0
Nitrite as Nitrogen (NO2-N)	mg/L	Lognormal	-4.1	1.6
Ammonia as Nitrogen (NH3-N)	mg/L	Lognormal	-2.4	1.2
Total Phosphorous	mg/L	Lognormal	-1.3	0.88
Dissolved Phosphorous	mg/L	Lognormal	-1.9	1.3
Total Ortho-phosphate (PO4)	mg/L	Lognormal	-1.8	1.0
Total Copper	µg/L	Lognormal	2.2	0.62
Dissolved Copper	µg/L	Normal[1]	7.6	4.2
Total Lead	µg/L	Lognormal	-0.40	1.0
Dissolved Lead	µg/L	Lognormal	-1.8	1.0
E. Coli	MPN/100 mL	Lognormal	5.0	2.8

1. Any resulting negative concentrations converted to a value at or below the MDL.

The resulting distributions (simulated by the generation of 1000 random data points within the distribution) were then compared to the distribution of actual samples to affirm appropriateness of fit. **Figure 7** presents a simulated concentration of Total Nitrogen generated by the estimated distribution and a comparison to the measured concentrations during the study. As both the simulated and actual data fit the same straight line along the Q-Q plot, the distribution can be qualified as accurate. All simulated and actual distributions of water quality constituents are presented in Appendix G-3.

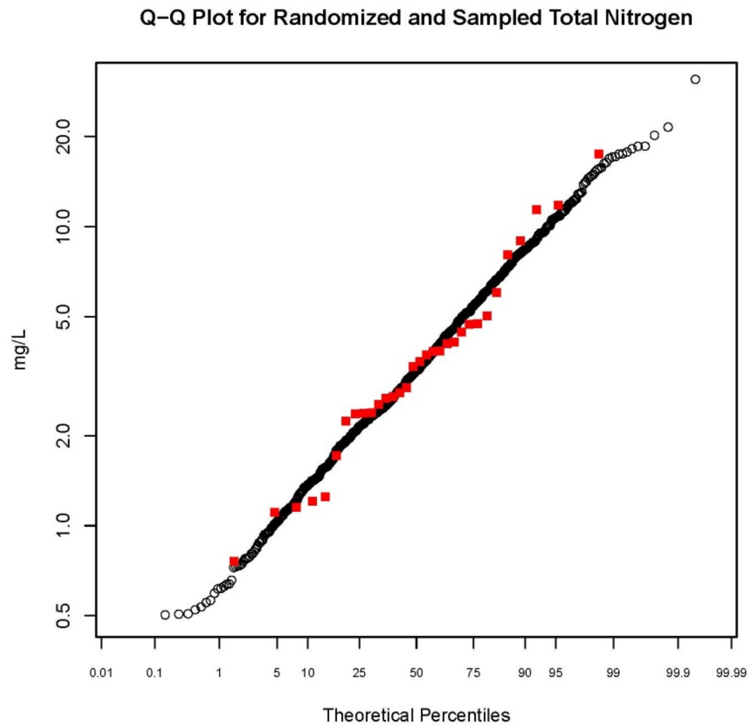

Figure 7: Simulated and Actual Concentrations of Total Nitrogen.

The study results could not be used to directly create an average dry weather loading of organic constituents because a significant majority of concentrations were non-detect. Of the chlorinated organics, only DDT compounds and chlordane were detected sporadically (about 6% of the time). Other organic compounds were not detected during the study. All measurements of PCBs and Dieldrin for each event and each site were found to be non-detect. Loading calculations for the toxics constituents were not performed as the resulting estimates of loading would be better estimated from the TSS loading and multipliers representing toxics associated with the suspended sediments.

4.1.4 Loading Estimations

Mass loadings were calculated with the appropriate estimation of dry weather flow rates and an appropriate distribution of dry weather concentrations for constituents of concern. The dry weather concentrations were developed by sampling from the developed distributions as a Monte Carlo simulation of the conditions. The flow and concentration data sets were used to calculate the loading rates per site.

Following the generation of the loading rates per site, the loading from each site was then scaled to represent the percentage of unique site drainage area that is owned by the County. The decision to scale based upon land area is consistent with the Regional Board's decision to designate the County's waste load allocation based upon its percentage of land ownership within the Machado Lake sub-watershed. These six separate loading rates were then summed together. The result is a representation of the loading rate from County-owned land that drains to the monitored sites. To apply the loading rate to all County Islands, not just those lands covered by the monitoring area, another scaling factor accounting for the differences in monitored and unmonitored land area is applied to the loading rate of the summed sites. The area of County Island 2 is not included in the scaling factor, as it was observed during the study that no discharges to Machado Lake from the area take place during dry weather. In other words, the dry weather loading from County Island 2 is zero for all constituents. The results of the analysis produce a representation of the dry weather loading rate from all County Islands.

To ensure the randomized data presented an appropriately average representation of loading, the process was run as a Monte Carlo simulation. The simulation ran for 1000 recursions and the overall median value was selected to most adequately represent the mass-based loading estimate from County Islands. **Figure 8** presents a plot of the simulation for Total Nitrogen and the determination of the median value (corresponding to the 50th percentile).

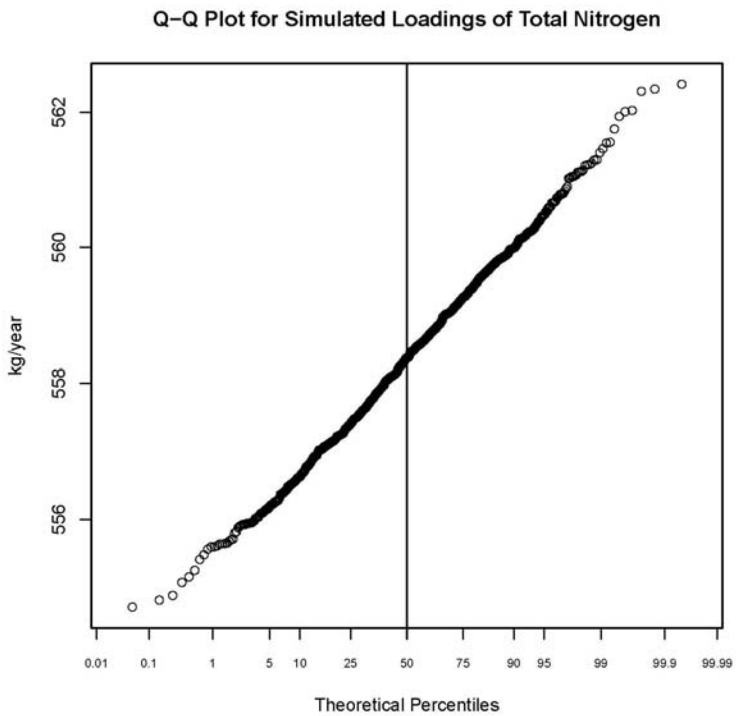

Figure 8: Estimated Mass Loading of Total Nitrogen from all County Islands in the Machado Lake Watershed.

Mass-based loading estimates from County Islands to Machado Lake in kilograms per year (kg/year) are presented in **Table 15**. Appendix H-1 presents details of the calculations entered into the Monte Carlo simulation and the derivations of the land area scaling calculations applied to site loading rates. Appendix H-2 presents the results of the Monte Carlo simulations and the derivations of the median value of each constituent's mass-based loading estimate.

Table 15: Annual Mass-Based County Land Dry Weather Loading Estimates of Water Quality Constituents

Water Quality Constituent	Units	Mass-Based Loading Estimate
Total Suspended Solids (TSS)	kg/yr	2,000
Total Dissolved Solids (TDS)	kg/yr	169,000
Hardness	kg/yr	62,100
Total Nitrogen	kg/yr	558
Total Kjeldahl Nitrogen (TKN)	kg/yr	230
Nitrate as Nitrogen (NO3-N)	kg/yr	317
Nitrite as Nitrogen (NO2-N)	kg/yr	8.40
Ammonia as Nitrogen (NH3-N)	kg/yr	22.0
Total Phosphorous	kg/yr	54.7
Dissolved Phosphorous	kg/yr	45.0
Total Ortho-phosphate (PO4)	kg/yr	33.8
Total Copper	kg/yr	1.35
Dissolved Copper	kg/yr	0.986
Total Lead	kg/yr	0.147
Dissolved Lead	kg/yr	0.0353
E. Coli	MPN/yr	$1.02 \cdot 10^{13}$

4.2 ANNUAL AVERAGE LOAD

The County's WMMS model was used to generate annual loading rates for metals, total suspended solids, and nutrients. The results of the WMMS simulation for the current condition are presented in Appendix I-1. The loadings represent the average of the simulated time frame (1997 through 2006) reflecting the various levels of precipitation received and the watershed responses.

The WMMS generated annual average loadings for each County Island are presented in **Table 16**. The data used in the model represent general observations in the Los Angeles Region, and not specific monitoring from the unincorporated areas of this study. Monitoring conducted as per the TMDL requirements will be used to evaluate the performance of the WMMS in the Machado Lake watershed, and refinements to the model performed as appropriate.

Table 16: Watershed Management Modeling System Annual Average Loads from Each County Island.

County Island	Area (acre)	TSS (kg/yr)	TN (kg/yr)	TP (kg/yr)
1	334.91	2,990	271	200
2	106.26	1,070	37.5	24.3
3	813.09	34,300	1,060	888
Total	1,254.26	38,400	1,370	1,110

The WMMS uses a multiplier on the total suspended solids loading to estimate the toxics loading. The fractions of OC pesticides and PCBs are estimated from a 2010 Machado Lake Sediment Characterization Report (SCR) after review of several regional studies examining toxics in sediment. The values determined in the SCR are used because the study is one of the most complete with a large sample size from across a broad and representative range of 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. However, it is also acknowledged that as legacy pollutants, OC pesticide and PCB concentrations found in the bed sediment do not necessarily reflect concentrations being discharged to the lake by MS4s today. The concentration values from the study were used as worst-case estimates of OC pesticides and PCBs loadings from County Islands. Further details on these fractional estimates are provided in Appendix I-2. These estimates need to be verified or revised in the future based on data to be collected from the County Islands. A summary of the estimated annual loadings of various constituents from County Islands is presented in **Table 17**.

Table 17: Annual Average Loading of Constituents of Concern from Unincorporated County Island within the Machado Lake Watershed.

Constituent	Annual Loading
Total Nitrogen (kg/yr)	1,370
Total Phosphorous (kg/yr)	1,110
Total Suspended Solids (kg/yr)	38,400
Chlordane (g/yr)	0.768
Total DDT (g/yr)	0.223
Dieldrin (g/yr)	0.188
DDE (all congeners) (g/yr)	0.196
PCBs (g/yr)	2.23
Copper (kg/yr)	16.3
Lead (kg/yr)	14.8
E. coli (MPN/100ml)	—[1]

1. Bacteria not modeled with the WMMS.

5. Discussion of Results

5.1 ANNUAL AND DRY WEATHER LOADING

A summary of the annual and dry weather loadings for all constituents of concern is presented in **Table 18**. As described in previous sections of this report, the dry weather loading is estimated using monitored data and statistical modeling, while the annual loading is estimated using the County WMMS model.

Table 18: Estimated Annual Loading Rates to Machado Lake from Unincorporated County Islands

Constituent	Annual Loading	Dry Weather Loading	Loading from Dry Weather (%)
Total Nitrogen (kg/yr)	1,370	558	41%
Total Phosphorous (kg/yr)	1,110	54.7	5.0%
Total Suspended Solids (kg/yr)	38,400	2,000	5.2%
Chlordane (g/yr)	0.768	—[1]	—[1]
Total DDT (g/yr)	0.223	—[1]	—[1]
Dieldrin (g/yr)	0.188	—[1]	—[1]
DDE (all congeners) (g/yr)	0.196	—[1]	—[1]
PCBs (g/yr)	2.23	—[1]	—[1]
Copper (kg/yr)	16.3	1.35	8.3%
Lead (kg/yr)	14.8	0.147	0.99%
E. coli (MPN/100ml)	—[2]	$1.02 \cdot 10^{13}$	—[2]

1. Insufficient detected data to make loading estimate from measured dry weather samples. Using fractions, the toxics load would be 5.2% of the annual load.
2. Bacteria not modeled with the WMMS.

As indicated, the estimated percentages of toxics, metals, nutrients, and bacteria loading coming from dry weather events is relatively negligible, with the exception of Total Nitrogen. Dry weather loadings do represent a significant fraction of the final WLAs of Total Nitrogen.

5.2 RELATION TO SUBSEQUENT STUDIES

The information gathered from this special study were used to provide guidance on developing subsequent plans related to Machado Lake TMDLs. How the study has impacted the plan of action for future work is described below.

5.2.1 Implementation Plan

As defined in the Work Plan, the Implementation Plan will identify BMPs and treatments to be implemented to demonstrate a reduction of pollutant loading on a mass basis which will result in attainment of the mass-based WLAs. Three potential scenarios would dictate the implementation process:

Scenario 1: Dry weather loading is insignificant compared to the overall load, and therefore loading reductions are focused on wet weather loadings that lead to exceedances of the mass-based WLAs. In this instance, WMMS will be utilized to identify and optimize combinations of wet weather BMPs for inclusion in the Implementation Plan that will result in attainment of the mass-based WLA.

Scenario 2: Dry weather loading and wet weather loading both exceed the mass-based WLAs. The WMMS will be utilized to identify and optimize combinations of wet weather BMPs associated with varying degrees of load reductions. The effectiveness of the wet weather BMPs on reducing dry weather loading will be evaluated, and an optimized combination of BMPs that reduce loadings in both dry and wet weather to attain the mass-based WLAs will be included in the Implementation Plan.

Scenario 3: The combination of dry weather loading and wet weather loading exceed the mass-based WLAs. The WMMS will be utilized to identify and optimize combinations of wet weather BMPs associated with varying degrees of load reductions. Similar to Scenario 2, the effectiveness of the wet weather BMPs on reducing dry weather loading will be evaluated, and an optimized combination of BMPs that reduce loadings in both dry and wet weather to attain the mass-based WLA will be included in the Implementation Plan.

For all parameters of concern, dry weather loading is less than half of the annual load and for most the parameters of concern dry weather loading is 5% or less of the annual load. However, reductions to dry weather loadings provide capacity for wet weather loading, aiding efforts to comply with the final annual mass-based waste load allocations, due to the low levels of the final allocations. Therefore, the Implementation Plan should follow the plan described in Scenario 3. As Total Phosphorous and Total Suspended Solids (and therefore Toxics) dry weather loadings are less significant to the annual load than Total Nitrogen's dry weather loadings, evaluations of dry weather loading reductions could be pursued less aggressively for these constituents.

5.2.2 Monitoring and Reporting Program

The dry weather data collected during the special study concluded that each distribution of water quality constituent was of the same for each County Island and year-round. The study results imply it is not necessary to routinely sample every site over all County Islands during a sampling event. It is instead recommended that one or two of the six sites be sampled on a rotating basis for future sampling events. Due to consistently negligible flows at site 1O_EAST, it is recommended not to sample for water quality at this site during dry weather in the future.

For the interest of nitrogen loading, additional sampling for 1O_ACAD may help to confirm or reject the hypothesis that Total Nitrogen and nitrogen-related constituents discharging from the site are part of a distribution unique to the site. Additional research regarding landscaping activities and practices within the drainage area may also independently verify the hypothesis.

For phosphorous loading, additional sampling during the months of June through August may help to confirm or reject the hypothesis that Total Phosphorous and phosphorous-related constituents discharging during this time period are part of a distribution unique from the remainder of the year, which was found to be a potential concern but not confirmed by the results from Event 2 of the study.

For lead loading, additional sampling at 3O_VAND may help to confirm or reject the hypothesis that total lead concentrations discharging from the site are elevated and part of a distribution unique to the site. Additional research regarding water distribution pipelines, industrial activity history, or current resident watering practices within the drainage area may also independently verify the hypothesis.

As toxics concentrations were predominantly non-detect during the special study, future sampling will be limited to wet weather events. Additional review of fractional relationships between suspended sediment and toxic constituents based on wet weather data is recommended to accurately represent toxic loadings to Machado Lake from County Islands.

5.3 POLLUTANT REDUCTION ASSESSMENT

Table 19 presents the level of reduction needed to attain the Nutrients TMDL waste load allocations.

Table 19: Summary of Loading Reduction Needed for Nutrient TMDL.

Parameter	Total Nitrogen (kg/yr)	Total Phosphorous (kg/yr)
Dry Weather Mass Based Loading Estimate	558	54.7
Annual Mass Based Loading Estimate	1,370	1,110
Interim WLA	1739	887
Final WLA	710	71
Reduction needed to achieve Interim WLA	None	223
% reduction needed to achieve Interim WLA	0%	20.1%
Reduction needed to achieve Final WLA	660	1,039
% reduction needed to achieve Final WLA	48.2%	93.6%

The current loading from the County meets the Interim WLA for Total Nitrogen, while about 20 percent reduction is needed to attain the corresponding Interim WLA for Total Phosphorus. Moreover, it requires about 50 percent and 94 percent reduction for Total Nitrogen and Total Phosphorus, respectively, to attain the Final WLAs. While a majority of the nitrogen reductions would need to occur from the wet weather, significant reductions in the dry weather would be advisable. Similarly, a majority of phosphorus reductions need to come from wet weather loadings, as dry weather loadings comprise only about 5 percent of County's annual Total Phosphorous loadings.

The County's current loading reduction needed for the Toxics TMDL is presented in **Table 20**. Based on the estimated toxics loadings, about 84 percent reduction of total suspended solids loadings may be needed to achieve a mass-based WLA for the toxic pollutants. The majority of these reductions would need to come from wet weather loadings, as dry weather loadings comprise only about 5 percent of County's annual toxics loadings.

Given that dry weather toxics measurements were predominantly non-detect, further investigation into wet weather toxics loading in the Machado Lake sub-watershed is needed. Determination of a fractional relationship between suspended sediment and the constituents of

DDD congeners, DDT congeners, and Total PCBs is also needed for determination of the County's compliance with the WLAs of the Toxics TMDL.

Table 20: Summary of loading reduction needed for the Toxics TMDL.

Compliance Category	Total Suspended Solids (kg/yr)	Chlordane (g/yr)	Total DDT (g/yr)	Dieldrin (g/yr)	DDE (all congeners) (g/yr)	PCBs (g/yr)
Annual Mass Based Loading Estimate[1]	38,400	0.768	0.223	0.188	0.196	2.23
Dry Weather Mass Based Loading Estimate	2,000	—[2]	—[2]	—[2]	—[2]	—[2]
Waste Load Allocation[3]	NA[4]	0.124	0.199	0.0729	0.121	2.30
Reduction needed to Achieve WLA		0.644	0.0240	0.115	0.0750	None
Associated Reduction in TSS loading needed to achieve WLA[1]		32,200 kg TSS/yr	4,140 kg TSS/yr	23,500 kg TSS/yr	14,700 kg TSS/yr	None
% Reduction in TSS loading needed to achieve WLA	NA[4]	83.9%	10.8%	61.2%	38.3%	None

1. Based on sediment fractions determined from 2010 Machado Lake Sediment Characterization Report.
2. High percentage of non detected data precluded estimation of dry weather loading.
3. Toxics TMDL does not establish mass-based waste load allocations. Listed values are for planning purposes only.
4. Not Applicable. Sediment is not a named parameter in established or scheduled TMDLs. Sediment does not have a WLA.

6. References

California Regional Water Quality Control Board, Los Angeles Region, “Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Eutrophic, Algae, Ammonia, and Odors (Nutrient) for Machado Lake”, Resolution R08-006, May 1, 2008.

California Regional Water Quality Control Board, Los Angeles Region, “Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Pesticides and PCBs for Machado Lake”, Resolution R08-010, September 2, 2010.

Camp, Dresser, and McKee, in association with Parsons Corporation (CDM 2010), “Sediment Characterization Report: Machado Lake Ecosystem Rehabilitation Project and Wilmington Drain Multi-Use Project”, April 22, 2010.

Larry Walker Associates, “Quantification of Organochlorine Pesticide and PCB Fractions in Sediments Loaded to Machado Lake”, August 1, 2011.

Weather Underground, History for Weather Station KCATORRA18, Available: http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KCATORRA18, Accessed July 2011.