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Watershed Impacts Report

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1 Introduction

This report describes analyses and results of a water quality assessment of surface water runoff to the Huntington Beach Wetlands (HBW). The objectives of the water quality assessment are:

- 1) Characterize the water quality of watershed contributions to the existing restored Talbert Marsh and to proposed restoration sites;
- 2) Describe water quality controls in the watershed and potential problems;
- 3) Suggest potential BMPs within the watershed or project area.

The water quality assessment was based on 1) a review of available water quality monitoring information and data, 2) a review of available documents and reports describing water quality controls and water quality issues in the watershed, 3) a field visit, 4) discussions with Geraldine Lucas of the City of Huntington Beach and Gary Gorman of the Huntington Beach Wetlands Conservancy, 5) development of a planning-level water quality model to estimate pollutant loads in stormwater runoff.

2 Project Area Description

2.1 Project Area

The HBW encompasses approximately 180 acres of restored and degraded saltmarsh, seasonal wetlands, and coastal dune habitat. The wetlands are distributed in four separate parcels, east of Pacific Coast Highway (PCH) between the Santa Ana River (SAR) and Beach Blvd (see Figure 1). A small fifth parcel north of Beach Blvd includes segregated natural and constructed wetlands for treatment of local runoff from neighboring residences.

The existing Talbert Marsh was restored in 1989 and included the construction of an ocean outlet to promote tidal circulation and aquatic habitat in the Marsh. The Huntington Beach Wetlands Conservancy has initiated work to develop conceptual plans for the restoration of the unrestored areas in the HBW and follow-up enhancement of the existing Talbert Marsh.

2.2 Watershed Area and Drainage Network

The tributary drainage area of the Talbert Marsh is approximately 8600 acres (13.5 square miles) and includes portions of the City of Huntington Beach and Fountain Valley (see Figure 1). Surface runoff is collected in three main improved flood control channels. The Talbert Channel drains the southern and central portions of the watershed and empties into the Talbert Marsh. The Fountain Valley Channel drains about 3.9 square miles and joins with the Talbert Channel fairly high up in the watershed. The Huntington Beach Channel drains about 4.3 square miles in the northern portion of the watershed and joins with the Talbert Channel near the outlet

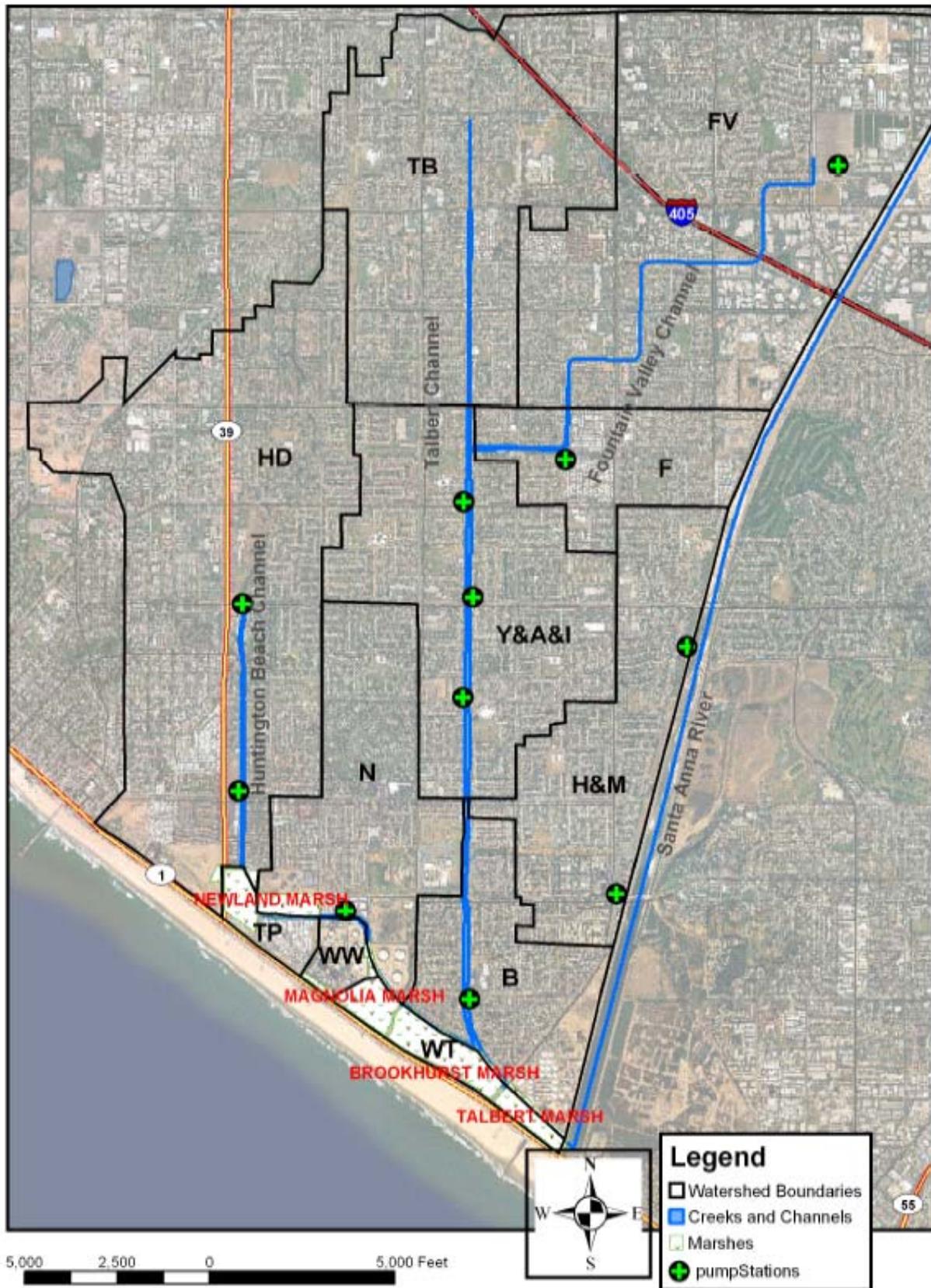


Figure 1: Huntington Beach Wetlands Project Site and Drainage Areas

The Talbert Channel Watershed has mild slopes with elevations ranging from sea level to about 130 ft. A storm drain network collects runoff by gravity drainage. Because of the mild slopes a system of pump stations has been constructed to convey runoff from the catch basins to the flood control channels. Figure 1 shows the location of the municipal stormwater pumping facilities and Table 1 lists the drainage area and receiving waters of the subcatchments shown in Figure 1.

Table 1: Huntington Beach Wetlands Subcatchments

Subcatchment Name and ID	Area (acres)	Drains to:
Fountain Valley and Talbert Channel Subcatchments		
FV – Fountain Valley	2070	Fountain Valley Channel
F – Flounders	455	Fountain Valley Channel
Y&A&I – Yorktown & Adams	1164	Talbert Channel
B – Banning	558	Talbert Channel
TB – Talbert	1440	Talbert Channel
Total	5687	
Huntington Channel Subcatchments		
HD – Huntington Drainage	2033	Huntington Channel
N – Newland	747	Huntington Channel
TP – Trailer Park	83	HB Wetlands & Huntington Channel
Total	2863	
Other Subcatchments		
WT – Marsh	134	HB Wetlands
WW – Power Generating Plant	68	Ocean
H&M – Hamilton & Merideth	788	SAR

The HBW project area is divided by developed areas in subcatchment WW and TP shown in Figure 1. Catchment TP includes a portion of the HBW, a mobile home park, and a commercial boat yard at the corner of PCH and Beach Blvd. Runoff from the mobile home park is pumped to the Huntington Beach Channel by two privately owned pumping facilities. A hydrologic assessment prepared by the Corp of Engineers indicates that there is also a private pumping facility at the Edison Tank Farm (COE, 1987), however, the current status of this facility is unknown.

Subcatchment WW primarily includes facilities associated with the AES power generating plant. The vast majority of runoff from this subcatchment is treated on-site and discharged to the ocean via a permitted offshore outfall (AES, 2001).

2.3 Land Use

Urban development dominates the Talbert Channel Watershed with little natural and open space areas remaining in the tributary drainage area. Land-use in the tributary area was estimated from aerial photographs using Graphical Information System (GIS) tools. Table 2 shows the estimated land-use percentages in the Huntington and Talbert Channel Watersheds. Residential

areas are by far the major land-use, using about 70 percent of the total watershed. Commercial, industrial and transportation related areas each use about seven percent of the watershed, and schools and open spaces such as parks each use about five percent of the watershed.

Table 2: Percent Land Use Distribution

Land Use	Tributary to the Huntington Channel & Newland Marsh	Tributary to the Talbert Marsh (Excludes Contributions from the Huntington Ch & Newland Marsh)	Total Drainage Area (Excludes Subcatchments WW and H&M)
Residential (Single & Multi-Family)	72.4%	66.0%	68.1%
Commercial	6.7%	6.4%	6.5%
Light Industrial	3.9%	9.1%	7.4%
Open (Parks and Vacant areas)	5.6%	4.6%	4.9%
Education (schools)	4.5%	4.7%	4.6%
Transportation (fwys and main arterials)	6.4%	6.8%	6.7%
Agriculture	0.0%	1.2%	0.8%
Channels	0.6%	1.2%	1.0%

2.4 Existing BMPs

Urban development in the Talbert Channel Watershed seems to be well established and generally older. The construction of many of the residential areas and commercial areas appear to have been completed during a period when site design BMPs, structural source control BMPs, and treatment BMPs were not required to the extent that they are now required by OC municipalities in order to comply with the recent the NPDES permit. New developments in the watershed are required to include these types of BMPs, as for example, the recently completed treatment wetlands along Beach Blvd across from the Newland Marsh, which will treat of dry and wet-weather flows from the adjacent residential development. In general, there appears to be few structural BMPs in the watershed for stormwater treatment.

The main regional BMPs in the watershed are the County and City diversions of dry-weather flows to the sanitary sewer system. These diversions were initiated in response to elevated levels of fecal indicator bacteria detected in the surf zone at the Huntington Beach. These BMPs, however, do not provide treatment of stormwater flows.

Source control BMPs are likely the major regional effort for controlling and reducing pollutants in stormwater flows. Local municipalities are required to implement a number of source control BMPs in order to comply with the NPDES permit for stormwater discharges to the flood control channels. Based on information in the 2002 Annual NPDES Progress Report, the following source control BMPs have been implemented in the City of Huntington Beach:

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- Trash and Debris Collection (clean-up program, special and bulky item pickup, public waste receptacles)
- Distribution of solid waste and recycling education materials (recycling videos for public service announcements)
- Drainage Facilities Maintenance (100% of catch basin in Huntington Beach were cleaned. Total debris removed was 387 tons)
- Catch Basin Stenciling (100% in Huntington Beach)
- Street Sweeping (3521 tons removed in Huntington Beach)
- Environmental Performance Reporting
- Household Hazardous Waste Collection Program
- Emergency Spill Response
- Fertilizer and Pesticide Management
- Public Information and Education
- Construction site inspections
- Detection and Elimination of Illegal and Illicit Connections

3 Regulatory Setting

The Huntington Beach Wetlands Restoration Project is subject to federal, state, and local water quality requirements administered and enforced by:

- The U.S. Environmental Protection Agency (USEPA),
- The California State Water Resources Control Board (SWRCB),
- The Santa Ana Regional Water Quality Control Board (RWQCB), and
- The County of Orange (OC)

A summary of surface water regulatory requirements follows.

3.1 Clean Water Act

The Federal Clean Water Act (CWA) is the principal federal statute governing water quality. The objective of the Clean Water Act is “to restore and maintain the chemical, physical, and biological integrity of the Nation's waters” (33 U.S.C 1251 et seq.). The CWA requires the States to adopt water quality standards for water bodies and have those standards approved by the USEPA. If states cannot propose acceptable standards to the USEPA, the USEPA is responsible for setting the standards. Water quality standards consist of designated beneficial uses for a particular water body (e.g. fishing, swimming, etc.), along with water quality criteria necessary to support those uses (40 CFR 131.36(i)).

Discharges of pollutants into waters of the United States are prohibited, unless the discharges are in accordance with the permitting program of the CWA, the National Pollutant Discharge Elimination System (NPDES) (33 USC 1342 (p)). In 1987, Congress amended the CWA to specifically require that stormwater discharges be included into the NPDES program. Under this amendment, stormwater runoff pollution must be controlled to the “maximum extent practicable”

(MEP). The NPDES permitting system is the primary enforcement mechanism requiring dischargers to meet water quality standards and applicable discharge limits. Authority to implement and administer the NPDES program in the State of California has been delegated to the State Water Resources Control Board and the Regional Water Quality Control Boards in accordance with the California Porter-Cologne Act of 1969 (see next section). However, the USEPA supervises state enforcement of the NPDES program and may bring a direct action where it believes that a state has failed to take action or where a state or local agency requests EPA involvement (33 U.S.C. 1342 (i)).

3.2 Beneficial Uses

Beneficial uses of inland waters in the flood control channels and estuaries in the project area are defined in the Santa Ana River (SAR) Basin Plan (RWQCB, 1995). However, the SAR Basin Plan does not specifically identify beneficial uses for the Talbert and Huntington Beach Channels or the Talbert Marsh. Therefore, beneficial uses in the project area are defined under the general category of “Tidal Prisms of Flood Channels Discharging to the Coastal or Bay Waters” found in Table 3-1 in the Basin Plan. The listed beneficial uses for these areas are:

- Water Contact Recreation (REC-1)
- Non-contact Water Recreation (REC-2)
- Commercial and Sportfishing (COMM)
- Wildlife Habitat (WILD)
- Marine Habitat (MAR)

When designated beneficial uses of a particular water body are compromised by water quality, Section 303(d) of the Clean Water Act requires the listing of the water body as “impaired.” The 2002 CWA Section 303(d) List of Water Quality Limited (Impaired) Segments was approved by the California State Water Resources Control Board on February 4, 2003 (SWRCB, 2003). There are no listings for the Huntington Beach and Talbert Channels or the Talbert Marsh. The 2002 303(d) list includes 5.8 miles of the Huntington Beach State Park as impaired by enterococci from unknown sources.

Once a water body has been designated as impaired, restrictions on the amount of impairing pollutants in the receiving waters must be developed. These discharge limits are called Total Maximum Daily Loads (TMDL). A TMDL is an estimate of the total daily load (mass) of pollutants from all sources (point, non-point, and natural sources) that a water body may receive without compromising designated beneficial uses (usually with a “margin of safety” included). Once established, the TMDL is allocated among current and future dischargers into the water body.

The 2002 303(d) list includes a priority ranking for development of TMDLs and proposed dates for TMDL completion. A low priority ranking is given for the impaired waters in the Huntington Beach State Park with no proposed TMDL completion data.

3.3 State Regulatory Programs

The California Porter-Cologne Water Quality Act of 1969 provides the State Water Resources Control Board with full authority over the state's rivers and their uses. The Act establishes nine regional water quality boards, which must prepare water quality plans (Basin Plans) for areas within their region, identify water quality objectives, and issue permits pursuant to the CWA (i.e. NPDES). The Huntington Beach Wetlands is in the jurisdiction of the Santa Ana Regional Water Quality Control Board (Region 8).

In accordance with the Porter-Cologne Act, the RWQCB has adopted the Water Quality Control Basin Plan for the Santa Ana River Basin (RWQCB, 1995). This document specifies the designated beneficial uses and water quality objectives (criteria) for surface and groundwater in the Regional Board's area of jurisdiction. Water quality criteria may be quantitative or narrative criteria for a range of water quality constituents in receiving waters. Specific criteria are provided for the larger water bodies within the region and general criteria or guidelines are provided for ocean waters, bays and estuaries, inland surface waters, and ground waters. In general, the narrative criteria require that degradation of water quality does not occur due to increases in pollutant loads that will impact the designated beneficial uses of a water body.

The General Construction Activities NPDES Permit, developed by the State Board and administered by the Regional Board, requires preparation of a Notice of Intent (NOI) for coverage of storm water discharges from construction sites. The General Construction Activities Permit relies on the implementation of Best Management Practices (BMPs). For each construction site that is one acre or greater, a NOI must be filed and a Storm Water Pollution Prevention Plan (SWPPP) must be prepared to incorporate BMPs prior to grading and implemented during construction. The primary objective of the SWPPP is to identify, construct, implement, and maintain BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction.

3.4 California Toxics Rule

The California Toxics Rule (CTR) is a federal regulation issued by the EPA providing water quality criteria for toxic constituents in waters with human health or aquatic life designated uses in the State of California (40 CFR 131.38). The CTR applies as ambient water quality criteria to all inland surface waters, enclosed bays, and estuaries of the State of California designated by existing and/or potential beneficial uses that would be compromised if the water quality criteria for aquatic species and human health were not met.

3.5 NPDES Permit

In January 2002, the Santa Ana RWQCB issued the third term permit (R8-2002-0010/NPDES No. CAS618030) to the County of Orange and 25 incorporated cities for stormwater discharges in Central and Northern Orange County (RWQCB, 2002). This permit regulates stormwater discharges in the Talbert Channel Watershed.

The NPDES permit details the programs and policies that must be implemented by the permittees to improve urban storm water quality and protect the beneficial uses of receiving waters of the region, including:

- Compliance and enforcement of discharge prohibitions and receiving water limitations (TMDLs)
- Survey of drainage facilities for illicit connections and discharges
- Programs to respond to accidental spills and leaks
- Public and business education outreach programs
- Municipal inspections of commercial, industrial, and construction activities
- New and significant redevelopment guidelines
- Water quality monitoring

To implement the requirements of the NPDES permit, the Co-permittees have developed a 2003 Drainage Area Management Plan (DAMP) that includes a New Development and Significant Redevelopment Program (OCRDMD, 2003). This New Development and Significant Redevelopment Program provides a framework and a process for following the NPDES permit requirements and incorporates watershed protection/stormwater quality management principles into the Co-permittees' General Plan process, environmental review process, and development permit approval process.

Local jurisdictions must adopt Local Implementation Plans (LIPs) that describe the process by which each Permittee will approve project-specific WQMPs as part of the development plan and entitlement approval process for discretionary projects, and prior to issuing permits for ministerial projects. The County of Orange and the Orange County Flood Control District LIP was adopted in July, 2003.

3.6 California Ocean Plan

The California Ocean Plan (COP) was created by the SWRCB to establish water quality objectives for California's ocean waters and to provide a basis for regulation of wastes discharged to coastal waters by point and non-point source discharges. Both the SWRCB and the RWQCB are responsible for implementing and interpreting the COP. The COP describes beneficial uses and water quality objectives for the open ocean waters - not forebays and estuaries such as those found in the Huntington Beach Wetlands. When an NPDES permit to discharge directly to the ocean is written, the water quality objectives of the COP become the

basis for establishing effluent criteria for the discharge. The COP does not apply to NPDES permitted discharges to the Huntington Beach and Talbert Channels.

4 Water Quality Data Search

The Talbert Channel Watershed has not been monitored as part of routine NPDES monitoring conducted by the County; however, the County has plans to monitor the Talbert Channel in the future (personal communication, Bruce Moore, County of Orange Resources Department). With the exception of extensive studies on fecal indicator bacteria (FIB) and quarterly monitoring of the pump station forebays, there appears to be little readily available water quality monitoring information in the Talbert Channel Watershed.

The water quality issue that has received the most attention in the Talbert Channel Watershed is high levels of FIB in dry and wet-weather discharges to the Talbert Marsh and near shore ocean waters. The Orange County Health Care Department routinely monitors levels of FIB in the surf zone. High levels of FIB were detected in the surf zone at Huntington State Beach in 1999, which resulted in extended beach closure during much of the summer. In response to these closures, the City of Huntington Beach and the County of Orange are now diverting all dry-weather discharges to the sanitary sewer system for treatment and disposal in the offshore ocean outfall. A number of studies were conducted to identify the sources of FIB in the surf zone, however, that have been no definitive conclusions linking any particular source with high FIB levels in the surf zone.

4.1 Dry Weather Monitoring Data

The City of Huntington Beach is currently conducting quarterly monitoring of water quality in the pump station forebays. Data from the most recent monitoring event (6/7/04) was provided by Geraldine Lucas, City of Huntington Beach, and are summarized in Table 3. There are no exceptionally high values for most of the monitored constituents. Moderately high levels of oil & grease at many of the pump stations, and benzene and MTBE detected at the Hamilton station are both suggestive of automobile related leakage or spills.

As a result of beach closures in 1999, there have been several studies examining the source of FIB in dry weather discharges. An extensive study was conducted by URS (2001) in which dry weather flows and standing pools in gutters and streets throughout Talbert Channel area were sampled and analyzed for FIB. Samples were collected in the cities of Huntington Beach, Costa Mesa, Fountain Valley, Santa Ana, and Newport Beach. The categories of nuisance flows that were sampled as part of this effort included:

- Residential irrigation overspray
- Car wash water
- Agricultural irrigation water

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- Restaurant washdown water
- Gutter flow
- Storm drain discharging directly into storm water conveyance channels
- Storm water conveyance channels
- Poned and pooled water on streets and in storm drain catch basins

Table 3: Results of Water Quality Monitoring of Pump Station Forebays, June 9, 2004

Constituent / Pump Station	Adam	Atlanta	Banning	Flounder	Hamilton	Indianapolis	Merideth	Newland	Yorktown
Ammonia (RL=0.5 mg/L)	0.84	1.26	1.75	1.05	2.1	0.91	0.77	3.01	1.05
BOD (RL=5 mg/L)	8	ND	ND	11	6	ND	10	6	8
Oil & Grease (RL=5 mg/L)	ND	11.3	13.2	ND	ND	15.3	14.8	9.9	9.7
TSS (RL variable: 2.7-15.6 mg/L)	2.8	19.3	9.8	5.6	30.6	5.2	8	6.2	10.7
Total Metals ¹ (RL = 0.05 mg/L, except 0.02 for cadmium)	ND	ND	ND	ND	ND	ND, except Zinc = 0.07	ND	ND	ND, except Zinc = 0.06
Organics (ug/L) ²	ND	ND	ND	ND	ND except, benzene = 13.2, MTBE = 1732	ND	ND	ND	ND
Chlorpyrifos (RL=1.2 ug/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazinon (RL = 2.4 ug/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND

RL = Report limit, ND = Not detected

¹ Cadmium, copper, lead, nickel, zinc (EPA 6010B)

² Volatile and extractable organics (EPA Methods 624 & 625)

Results from 238 water samples are summarized in Table 4. The URS report indicates that highest levels of FIB were generally found in dry weather water samples collected in residential, commercial, and industrial areas. Lowest levels were generally found in parks and agricultural areas.

The URS (2001) report also includes summary statistics of FIB in dry weather flows collected in flood control channels and the pump station forebays (see Table 5). These summary statistics indicate that FIB in the channels and forebays are generally smaller than levels detected in the curb and gutter study.

Table 4: Results of FIB Monitoring in Curb and Gutter Study (URS, 2001)

	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)	Enterococcus (MPN/100mL)
Minimum	5	2	5
Maximum	68000000	20000000	2800000
Average	1451151	179314	45028
Median	25000	1000	3000
Geometric Mean	22800	1289	2388

Results from all 283 water samples

Table 5: Results of FIB Monitoring in the Pump Station Forebays (URS, 2001)

Huntington Beach Storm Drain Pump Station	Mean 8 Month Concentration (cfu/100 ml)		
	Total Coliform	Fecal Coliform	Enterococcus
HB-Adams	71,146	13,922	2,627
Atlanta	54,142	6,557	2,260
Banning	39,659	1,283	1,008
Flounder	41,268	7,799	1,542
Hamilton	28,913	7,119	1,670
Indianapolis	47,995	12,552	2,383
Meredith	36,976	13,735	3,331
Newland	38,713	8,957	2,790
Yorktown	46,655	7,954	3,867

Source: URS (2001)

The available dry-weather water quality data in the Talbert Channel area were compared to regional dry-weather monitoring data to gain insight in the character, similarity, and general comparability of the Talbert Channel Watershed with other watersheds. Data were obtained from two dry-weather monitoring studies:

1. **IRWD R3 Study.** The Irvine Ranch Water District (IRWD) conducted a comprehensive study of water quality in dry weather discharges from residential areas, called the Residential Runoff Reduction (R3) Study (IRWD, 2003). Detailed flow and water quality data were collected from five predominantly residential watersheds in Orange County to evaluate the effectiveness of irrigation controllers and education BMPs.
2. **Ballona Creek Study.** A comprehensive study was recently completed to measure metals and bacteria levels in dry weather discharges in the Ballona Creek Watershed, a large, highly urbanized watershed in Los Angeles (Stein and Tiefenthaler, 2004).

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Monitoring data from the R3 and Ballona Creek studies are summarized in Table 6 and compared with data collected from the Talbert area watersheds. None of the available data from the Talbert Watershed appear to be vastly dissimilar to those from the R3 and Ballona Creek Study Watersheds. For several constituents, data from the Talbert Watershed appear to be comparable or smaller than data from R3 and Ballona Creek studies. Thus, these limited comparisons suggest that the Talbert Watershed is not atypical in terms of the types and magnitude of pollutants found in dry-weather runoff.

Table 6: Comparison of Regional and Local Dry Weather Monitoring Data

	R3 Study¹ Median (min, max)	Ballona Creek Study² Median (min, max)	Qualitative Comparison with Talbert Watershed Data
Ammonia (mg-N/L)	0.21 (.05, 6.9)	nd	Data from pump station forebays (Table 3) are slightly greater, but within the lower range of the R3 data
Total Nitrogen (mg-N/L)	3.9 (1.5, 20.4)	nd	No data available for comparison
Total Phosphorus (mg-P/L)	0.7 (0.1, 6.2)	nd	No data available for comparison
Dissolved Copper (ug/L)	11 (3, 390)	15 (2-129)	All total copper data from pump station forebays (Table 3) are below the reporting limit of 50 ug/L. Therefore, dissolved copper levels are not quantified, but are known to be less than 50 ug/L
Dissolved Lead (ug/L)	0.7 (0.1-81.7)	1.0 (0-25)	All total lead data from pump station forebays (Table 3) are below the reporting limit of 50 ug/L. Therefore, dissolved lead levels are not quantified, but are known to be less than 50 ug/L
Dissolved Zinc (ug/L)	53 (22-1070)	25 (1-1040)	All total zinc data from pump station forebays (Table 3) are below the reporting limit of 50 ug/L with the exception of 2 stations where values of 60 and 70 ug/L were detected. Dissolved zinc would be less than the detected total zinc levels. Therefore, the dissolved zinc levels are comparable to those observed in the R3 and Ballona Creek studies.
Fecal Coliform (MPN/100 mL)	6250 (23-300000)	nd	The median value from the curb and gutter study (Table 4) is smaller than the R3 results. Average values in the pump station forebays (Table 5) are comparable to the median value in the R3 study, however, median values of the forebay data would be expected to be much smaller. Therefore, data from the Talbert Watershed are generally smaller, but in the same order of magnitude, as data from the R3 study.

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	R3 Study¹ Median (min, max)	Ballona Creek Study² Median (min, max)	Qualitative Comparison with Talbert Watershed Data
E. Coli (MPN/100 mL)	nd	1850 (100-88000)	No data available for direct comparison. It is generally assumed that E. Coli constitutes about 80% of the fecal coliform bacteria. Thus, 80% of the fecal coliform results discussed above are comparable to the Ballona Crk monitoring results for E. Coli.
Enterococcus (MPN/100 mL)	nd	1400 (6-24000)	The median value from the curb and gutter study (Table 4) is slightly greater than the Ballona Crk results. Average values in the pump station forebays (Table 5) are comparable or slightly greater than the median value in the Ballona Crk study, however, median values of the forebay data would be expected to be much smaller. Data from the Talbert Watershed are generally comparable to data from the Ballona Crk study.
Total Coliform (MPN/100 mL)	nd	67000 (1800-200000)	The median value from the curb and gutter study (Table 4) and the average values in the pump station forebays (Table 5) are smaller than the median value in the Ballona Crk study. Data from the Talbert Watershed are generally smaller, but in the same order of magnitude, as the data from the Ballona Crk study.
Diazinon (ng/L)	480 (5-14500)	nd	All diazinon data from pump station forebays (Table 3) are below the reporting limit of 1200 ng/L, which is greater than the median value found in the R3 study. Therefore, diazinon levels are not quantified, but are known to be less than 1200 ng/L
Chlorpyrifos (ng/L)	18 (5, 781)	nd	All chlorpyrifos data from pump station forebays (Table 3) are below the reporting limit of 2400 ng/L, which is greater than the median value found in the R3 study. Therefore, chlorpyrifos levels are not quantified, but are known to be less than 2400 ng/L

nd = no data; ¹for pre-intervention (baseline) data; ²for storm drain monitoring data

4.2 Wet Weather Monitoring Data

Personnel in the OC Resources Department have indicated that there has been no routine wet weather monitoring in the Talbert Channel Watershed and that the County does not have any wet-weather monitoring data (personal communication, Bruce Moore & Lynette Lena, County of Orange Resources Department).

Some wet-weathering monitoring of FIB appears to have been conducted as part of a channel and forebay study described Reeves et al. (2004). It was reported that FIB concentrations measured in channel and forebays frequently increase following measurable rain, and that spikes in FIB loads were found to coincide with significant rain events. Increases in FIB loads were primarily related to increased runoff volumes, rather than increased concentrations. These results are consistent with local and national monitoring information (CWP 2000a). Reeves et al. (2004) were also able to fit FIB loading rates to a power function of volumetric flow rates.

4.3 Studies of Fecal Indicator Bacteria

There is considerable water quality information regarding fecal indicator bacteria (FIB) in the channels and beach areas. These studies were initiated in response to beach closures in the summer of 1999 due to high FIB levels in surf-zone monitoring. It was suspected that dry-weather urban runoff in the Talbert Channel Watershed was a primary source of the FIB. As a result, the City and County began diverting dry-weather flows in the Talbert Channel Watershed to the sanitary sewer system for treatment and offshore disposal.

There is evidence that runoff from the Talbert Channel and the SAR are, at least, a contributing factor to high FIB levels in surf zone monitoring. A Talbert Marsh Monitoring study (Grant et al., 2001) showed the enterococci (ENT) bacteria are flushed from the Marsh to the surf zone during ebb tides, and that the source of ENT appears to be urban runoff and possibly bird droppings in the Talbert Marsh. Kim et al. (2004) found that FIB released to the ocean from the Talbert Channel and the SAR during ebb tides are transported parallel to the shore line by wave driven surf zone currents and/or offshore tidal currents. A tidal zone mass budget analysis indicates that high FIB levels in surf zone monitoring could originate from the Talbert and SAR channel outlets.

Reeves et al. (2004) summarize the results of four years of bacterial monitoring in the Talbert Channel Watershed, including 1) monitoring of dry-weather runoff collected from curbs and gutters, channels, forebays, tidal channels, and at the ocean outlet, and 2) monitoring of wet-weather runoff at one channel and two forebay locations. Findings of the studies include:

- Concentrations of indicator bacteria in dry and wet-weather runoff exhibit a high degree of variability.
- Median concentrations of indicator bacteria in dry-weather runoff are extremely high, with greatest values in runoff from residential areas and lowest values found in runoff from parks and channels
- There is a systematic gradation of FIB levels in dry-weather runoff corresponding with salinity. Highest concentrations are in inland channels and forebays with the lowest salinity levels, intermediate levels are present in channels and forebays that have a mixture of runoff and ocean water, and lowest concentrations of FIB are at the ocean outlet.

- Median concentrations of indicator bacteria in wet-weather runoff are significantly higher than in dry-weather runoff. The vast majority of bacterial loads to the ocean are from wet-weather runoff, because of the substantial increase in runoff volumes.

Other possible sources of high levels of FIB in the surf zone that have been studied are offshore discharge of wastewater by Orange County Sanitation District (Noble et al., 2003; Boehm et al. 2002) and microbial transport in groundwater discharges to the ocean (Boehm et al. 2004). There does not appear to be direct evidence linking either of these sources with high levels of FIB in the surf zone.

4.4 Findings and Possible Implications of Water Quality Monitoring Data/Information

The following findings and possible implications on the HBWR project are based on the review of the available reports and water quality monitoring data:

- *Dry weather flows.* While dry weather discharges in the Talbert Channel Watershed are presently diverted to the sanitary sewer system, some dry weather discharges to the proposed marshes could occur if the pumps are off-line for maintenance or repair and/or may occur from private pumping facilities. The available monitoring information indicates that any dry weather flows to the proposed marshes would likely contain high concentrations of FIB. The FIB would be subject to die-off from UV light and salinity, as highest levels are typically recorded in the evening and early morning, and in the inland channels with low salinity levels. Based on available monitoring data, pollutant levels in dry weather discharges are not unusually high or atypical, which would suggest that any dry-weather flows to the restored marshes would not cause impacts on the aquatic and habitat functions of the marsh.
- *Wet weather flows.* Consistent with the existing conditions in the Talbert Marsh and with national, regional, and local monitoring data, wet weather flows to the restored HBW will contain high levels of FIB, far in excess of water quality standards. Storm flows to the ocean will likely contribute to elevated levels of FIB ocean waters, as is routinely detected in surf zone monitoring following storm events. There is essentially no local wet-weather monitoring information that could be used to evaluate how the water quality of stormwater might impact the restored HBW. Evaluation of the available dry-weather data suggests that watershed conditions are consistent with typical urban areas, which further suggests that the stormwater quality should be consistent with that of typical and neighboring urban areas.
- *Effects of the Marsh.* Restoration of HBW could possibly reduce levels of FIB reaching the ocean by increasing die-off during through increased retention periods in the Marsh. This was one option considered in the feasibility study conducted by URS (2001). Other studies suggest that droppings from birds attracted to the Marsh is potentially a significant source of FIB (Grant et al., 2001). Thus, a restored HBW could potentially increase internal sources of FIB.

5 Pollutant Loads Model Description & Assessment Approach

This section describes the methodology used to assess the water quality of stormwater runoff to the HBWR project sites.

5.1 Constituents of Concern

Potential water quality impacts were assessed by quantitatively and qualitatively evaluating the concentrations and loads of specific Constituents of Concern. The Constituents of Concern are those pollutants that are anticipated and commonly found in runoff from residential and urban land-uses.

Sediments (TSS). Excessive erosion, transport, and deposition of sediment in surface waters are a significant form of pollution resulting in major water quality problems. Excessive sediments can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, and reproduction. In addition, the sediment can transport other pollutants that are attached to the sediment particles including nutrients, trace metals, and hydrocarbons. A major source of sediment in urban areas such as the Talbert Channel Watershed is construction activity, including clearing and grading that results in exposed soils.

Nutrients (Phosphorous and Nitrogen). Nutrients are inorganic forms of nitrogen (nitrate, nitrite and ammonia) and phosphorus. Organic forms of nitrogen are associated with vegetative matter such as particulates from sticks and leaves. The Total Kjeldahl Nitrogen (TKN) is a measure of the organic nitrogen plus ammonia nitrogen. Total Nitrogen (TN) is a measure of all nitrogen present, including inorganic and particulate forms.

There are several sources of nutrients in urban areas, mainly fertilizers in runoff from lawns, pet wastes, failing septic systems, and atmospheric deposition from industry and automobile emissions. Nutrient over-enrichment is especially prevalent in agricultural areas where manure and fertilizer inputs to crops significantly contribute to nitrogen and phosphorus levels in streams and other receiving waters. Eutrophication due to excessive nutrient input can lead to changes in periphyton (algae), benthic, and fish communities; extreme eutrophication can cause hypoxia or anoxia, resulting in fish kills. Surface algal scum, water discoloration, and the release of toxins from sediment can also occur.

Trace Metals (Copper, Lead, and Zinc). The primary sources of trace metals in stormwater are typically commercially available metals used in transportation (e.g. automobiles), buildings, and infrastructure. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Metals are also found in fuels, adhesives, paints, and other coatings. Metals are of concern because of toxic effects on aquatic life. Copper, lead, and zinc are the most prevalent metals

found in urban runoff. Cadmium, copper, lead, and zinc may bioconcentrate within lower organisms, but do not biomagnify up the food chain. High metal concentrations can impair the beneficial uses of receiving waters.

Pathogens (Bacteria, Viruses, and Protozoa). Pathogens are viruses, bacteria, and protozoa that cause illness in humans. Identifying pathogens in water is difficult as the number of pathogens is exceedingly small requiring sampling and filtering large volumes of water. Traditionally water managers have relied on measuring “pathogen indicators” or fecal indicator bacteria (FIB) such as total and fecal coliform, as an indirect measure of the presence of pathogens. The presence of FIB implies the water body is potentially contaminated with human and/or animal waste, suggesting the potential presence of associated pathogenic organisms. While fecal coliform bacteria are generally fecal-specific in origin, there are some species within this family of bacteria that occur naturally in plants and soil. Therefore the USEPA now recommends the use of *E. coli* and enterococci as better indicators of health risk from water contact (USEPA, 2003). Although fecal coliform may be an imperfect indicator, the vast majority of States continue to use fecal coliform for recreational water quality standards. High level of FIB in the Talbert Channel and adjacent surf zone areas is a primary water quality issue in the Talbert Channel Watershed.

Petroleum Hydrocarbons and Oil & Grease. Petroleum hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs), can bioaccumulate in aquatic organisms from contaminated water, sediments, and food and are toxic to aquatic life at low concentrations. Some hydrocarbons can persist in sediments for long periods of time and result in adverse impacts on the diversity and abundance of benthic communities. Oil & grease are high molecular-weight organic compounds such as motor oil, cooking oil and fat, and waxes. Excessive oil & grease can result in a visible film on the water’s surface, which decreases the aesthetic value of the water body and can potentially cause nuisance odors. Oil & grease films can potentially coat birds and aquatic organisms resulting in adverse impacts. Hydrocarbons can be measured as total petroleum hydrocarbons (TPH), oil and grease, or as individual groups of hydrocarbons, such as PAHs.

There are a wide variety of potential sources stemming from applications in municipal, residential, commercial, industrial land-uses. The sources of hydrocarbons in urban areas include spillage of fuels and lubricants, discharge of domestic and industrial wastes, atmospheric deposition, and runoff. Runoff can be contaminated by leachate from asphalt roads, wearing of tires, and deposition from automobile exhaust. Also, do-it-yourself auto mechanics may dump used oil and other automobile-related fluids directly into storm drains.

Pesticides. Pesticides (including herbicides, insecticides and fungicides) are chemical compounds commonly used to control insects, rodents, plant diseases, and weeds. Excessive application of a pesticide may result in runoff containing toxic levels of its active component.

Common pesticides of concern are organophosphates, mainly diazinon and chlorpyrifos, both of which are currently being phased out by the USEPA for non-commercial applications. Diazinon and chlorpyrifos are used for structural pest control, nursery, agricultural, and landscape applications, as well as unreported residential applications. These compounds have been linked to toxicity in San Diego Creek and Upped Newport Bay, which has resulted in the development of TMDLs

Other pesticides of potential concern are legacy organochlorine pesticides such as DDT, chlordane, toxaphene, and dieldrin, which were banned in the 1970's because of toxicity concerns. These compounds tend to bioaccumulate and have considerable persistence in soils, sediment, and biota. They also sorb strongly to soil particles, thus these pollutants are directly associated with the sediment loads. Although these compounds were banned in the 1970 and 1980's they are potential present in older established urban areas.

Trash & Debris. Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape. The presence of trash & debris may have a significant impact on the recreational value of a water body and aquatic habitat. Trash & debris can also be harmful to wildlife such as nesting birds that may consume the debris or become entangled in the garbage.

5.2 Quantitative and Qualitative Evaluation

Two approaches were used to evaluate the water quality of watershed contributions to the Talbert Marsh:

1. A quantitative based assessment was used for pollutants that have a sufficient level of characterization and monitoring information. A planning-level water quality model was developed to estimate the volume and water quality of wet weather stormwater runoff from existing and proposed land uses in the project area. The water quality model is based on available local and regional information, as well as current scientific literature on urban water quality.
2. A qualitative assessment was undertaken for pollutants that have limited monitoring information and insufficient information for detailed modeling. Constituents in this category are generally more difficult and less frequently measured in stormwater monitoring programs, and/or commonly exhibit great variability in monitoring results. Consequently a reasonable level of confidence in statistical characterizations of monitoring data for these constituents is often not obtainable. Thus a qualitative assessment is warranted. This assessment is based on a subjective analysis of the general pollutant characteristics, the sources of the pollutant, and the type of the land-use in the watershed.

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Based on the availability of statistically significant monitoring information from Los Angeles County, the following pollutants/conditions were quantitatively evaluated:

- Total Suspended Solids (TSS)
- Total Phosphorus (TP)
- Nitrate
- Nitrite
- Ammonia
- TKN
- Total Nitrogen (TN)
- Total Lead
- Total and Dissolved Copper
- Total and Dissolved Zinc

The following constituents of concern and conditions were not modeled due to limited stormwater monitoring data. These constituents were assessed qualitatively:

- Coliform Bacteria
- Pesticides
- Oil & Grease and Hydrocarbons
- Trash & Debris

5.3 Water Quality Model Description

A water quality model was used to estimate pollutant loads and concentrations in stormwater discharge to the HBW. A detailed description of the water quality model and results is presented in Appendix A. The following summarizes major features of the model:

- Available rainfall data are used to estimate an average annual stormwater runoff volume from the land-uses in the project area. For example, residential areas are expected to generate a greater volume of runoff than would open areas for a similar size rainfall event. The rainfall data are analyzed in terms of long-term averages and average rainfall occurring during extended dry and wet periods.
- The water quality model estimates an average concentration of pollutants in runoff from storm events based on land-use in the project area. For example, residential areas may generate comparatively high levels of metals (from vehicles) and low levels of sediments, whereas the opposite may be true for open land-uses. The pollutant concentrations were estimated from regional land-use based monitoring information collected in Los Angeles County. These data are represented by statistical descriptions of the Event Mean Concentration (EMC) determined from the monitoring data.
- The water quality model estimates the average annual pollutant load in runoff from storm events. The pollutant load is the total mass (e.g. pounds) of pollutant in runoff during a given period of time (e.g. pounds per year). The pollutants loads are estimated for

average rainfall conditions, and for conditions that could occur during extended dry and wet periods.

- The water quality model generates an estimate of average annual runoff volumes, pollutant loads and concentrations based on available information. The model does not forecast stormwater characteristics for specific storms or monitoring periods. Actual runoff volumes, concentrations and loads are variable with expected values less than and greater than the estimated averages.

5.4 Comparison with Water Quality Standards

Narrative and numeric water quality objectives contained in the Santa Ana Region Basin Plan apply to the receiving waters of runoff in the Talbert Channel Watershed. Water quality criteria contained in the CTR provide concentrations that are not to be exceeded in the Talbert Channel receiving waters more than once in a three-year period.

For those constituents that are quantitatively evaluated, the results of the water quality model are compared with applicable numerical water quality standards. If the model results indicate that the watershed contributions exceed the water quality standards, then this would suggest that there is a potential for impairment of the aquatic health in the HBW from stormwater discharges.

6 Water Quality Assessment

6.1 Stormwater Runoff Volume

Table 7 shows the estimated average annual stormwater runoff volumes to the Newland and Talbert Marshes. It was assumed that watershed contributions to the Newland Marsh include only those areas that are tributary to the Huntington Channel, whereas watershed contributions to the Talbert Marsh include runoff from the entire drainage area.

Table 7: Estimated Average Annual Stormwater Runoff Volumes

	Average Annual Stormwater Runoff to the Newland Marsh (acre-ft)	Average Annual Stormwater Runoff to the Talbert Marsh (acre-ft)
Average Rainfall Conditions (11.3 inches)	1402	4312
Average Dry Period Conditions (9.1 inches)	1129	3473
Average Wet Period Conditions (14.1 inches)	1749	5381

6.2 TSS

Table 8 shows the estimated average TSS concentration and annual loads to the Newland and Talbert Marshes.

Table 8: Estimated Average Annual TSS Concentrations and Loads

	Watershed Contributions to the Newland Marsh	Watershed Contributions to the Talbert Marsh
Average annual TSS concentration (mg/L)	113	117
Average Annual TSS Load (tons/yr)		
Average rainfall conditions (11.3 inches)	215	686
Dry Period conditions (9.1 inches)	173	552
Wet Period conditions (14.1 inches)	269	868

There are no numeric objectives for TSS in enclosed Bays and estuaries or inland waters in the Basin Plan. The narrative objective states: enclosed bays and estuaries or inland waters "...shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses..." Similarly, a narrative objective for turbidity states: Enclosed bays and estuaries or inland waters "...shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses..." There are numeric standards for changes in turbidity from discharges to receiving waters, with the allowable changes based on the natural turbidity of the receiving waters.

The estimated TSS concentrations and loads in runoff to the HBW reflect the characteristically low levels generally found in runoff from residential and commercial land-uses. Because the watershed is mostly built-out, with few open areas, it is expected that TSS levels in stormwater contributions to the HBW will comply with the narrative objectives in the Basin Plan. This is also consistent with discussions with Gary Gorman who indicated that that they have not observed problems with sediments from stormwater flows and that the most of the sediments enter the Marsh from the ocean by tidal flushing (personal communication, Gary Gorman, HBW Conservancy).

6.3 Nutrients

The estimated average concentration and annual load of total phosphorus and total nitrogen in stormwater discharges to the Newland and Talbert Marshes is shown in Table 9 and Table 10, respectively.

Table 9: Estimated Average Annual Total Phosphorus Concentrations and Loads

	Watershed Contributions to the Newland Marsh	Watershed Contributions to the Talbert Marsh
Average annual TP concentration (mg/L)	0.37	0.37
Average Annual TP Load (lbs/yr)		
Average rainfall conditions (11.3 inches)	1411	4324
Dry Period conditions (9.1 inches)	1136	3482
Wet Period conditions (14.1 inches)	1761	5471

Table 10: Estimated Average Annual Total Nitrogen Concentrations and Loads

	Watershed Contributions to the Newland Marsh	Watershed Contributions to the Talbert Marsh
Average annual TN concentration (mg/L)	3.32	3.35
Average Annual TN Load (lbs/yr)		
Average rainfall conditions (11.3 inches)	12,800	40,000
Dry Period conditions (9.1 inches)	10,300	31,300
Wet Period conditions (14.1 inches)	15,900	49,300

There are no numeric water quality objectives for nutrients in enclosed bays and estuaries in the Basin Plan. A narrative objective for algae states: “Waste discharges shall not contribute to excessive algal growth in receiving waters.”

Nutrient loads in stormwater runoff could potentially promote algae growth in the HBW, but it is unknown whether the estimated loads would cause this effect. It appears that nutrient cycling dynamics and the effects on algae growth in California coastal salt marshes is a topic of ongoing study in the scientific literature. In one study, seasonal nutrient dynamics and macroalgal community responses in five estuaries in southern California were investigated to provide data that will assist in development of nutrient criteria for estuaries by local and regional water quality agencies (Kennison, et al., 2003). Results showed seasonal patterns for algal biomass but there was no significant relationship between water column NO₃ and total algal biomass. In another study Cohen and Fong (2003) used macroalgae as an indicator of terrestrial influences in southern California estuaries. Findings from the bioassay suggest that the rivers may not be the main sources of nutrients to the estuaries, even during the wet season. While these are not conclusive, they suggest that nutrient loads in stormwater flows to the HBW may not necessarily promote algae growth.

6.4 Metals

Table 11 and Table 12 show respectively the estimated average concentration and annual loads of copper, lead, and zinc in stormwater discharges to the Newland and Talbert Marshes.

Table 11: Estimated Average Metals Concentrations

	Average Annual Concentration in Watershed Contributions to the Newland Marsh (ug/L)	Average Annual Concentration in Watershed Contributions to the Talbert Marsh (ug/L)
Dissolved Copper	11.8	12.3
Total Copper	20.0	20.8
Total Lead	9.6	10.1
Dissolved Zinc	70	84
Total Zinc	117	132

Table 12: Estimated Average Annual Metals Loads

	Average Annual Load in Watershed Contributions to the Newland Marsh (lbs/yr)	Average Annual Load in Watershed Contributions to the Talbert Marsh (lbs/yr)
Average Rainfall Conditions (11.3 inches)		
Dissolved Copper	45	144
Total Copper	76	244
Total Lead	37	119
Dissolved Zinc	268	981
Total Zinc	445	1544

A narrative objective for toxic substances in the Basin Plan states: “all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.”

The CTR criteria are the applicable water quality objectives for protection of aquatic life. The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions were considered to be applicable for stormwater discharges because the duration of stormwater discharge is consistently less than four days. The freshwater CTR criteria are applicable to stormwater discharges to the flood control channels. However, the salt-water criteria are applicable in the estuarine receiving waters in the HBW, according to the CTR which states that “ for waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable criteria are the saltwater criteria...” During dry-weather conditions, water in the Talbert Marsh is primarily from tidal exchange because the majority of dry flows are diverted to the sanitary system. Groundwater flows to the marsh could reduce the salinity, but it is assumed that the salinity in the marsh is above 10 parts per thousand during dry-weather periods. Since stormwater flows generally occur for less than 2 weeks of the year, the 95% threshold is not exceeded, and therefore the saltwater CTR criteria were assumed to be applicable for the Talbert Marsh and the proposed marshes.

The freshwater CTR criteria are calculated on the basis of the hardness of the receiving waters. Lower hardness concentrations result in lower, more stringent CTR criteria. The saltwater CTR criteria are not hardness dependent. Due to the lack of stormwater monitoring data in the Talbert Channel Watershed, hardness values for stormwater discharges were estimated from available OC monitoring information. Stormwater monitoring data collected in the Costa Mesa Channel at Highland in 2001 indicates an average hardness of 257 mg/L in 62 samples (OCPFRD, 2001). Stormwater monitoring data collected the Santa Ana Delhi Channel indicates an average hardness of the 433 mg/L in 29 samples (OCPFRD, 2001). On the bases of this information average hardness in stormwater discharges to HBW was estimated at 250 mg/L.

The estimated concentrations and the acute CTR criteria are compared in Table 13. For the metal species considered in this analysis, the estimated average runoff concentrations are smaller than the acute freshwater CTR criteria calculated at a hardness of 250 mg/L. Similarly, the estimated average runoff concentrations are smaller than the acute saltwater CTR criteria, except for copper, which exceeds the saltwater standard. This exceedance is based on the comparison estimated copper concentrations in the ‘end-of-pipe’ stormwater discharges to the HB wetlands, without any consideration of mixing or tidal flushing that may occur in the estuarine waters, the temporal dynamics in the marsh, and adsorption to particulates. The direct comparison of the model estimates with the saltwater CTR criterion suggests that there could be a potential for copper levels in stormwater discharges to cause impairment of the aquatic health of the Marsh, however, for the reasons listed, it is unclear as to how much of the copper would be bioavailable.

Table 13: Comparison of Estimated Trace Metal Concentrations and CTR Criteria

	Estimated Average Dissolved Metal Concentration in Stormwater Discharges to the Talbert Marsh (ug/L)	Freshwater Acute CTR Criteria (hardness = 250 mg/L) (ug/L)	Saltwater Acute CTR Criteria (ug/L)
Copper (ug/L)	12	32	4.9
Lead (ug/L)	10 (total)	170	210
Zinc (ug/L)	84	250	90

6.5 Pathogens

Water Quality Objectives. Water quality objectives for fecal coliform bacteria in the Basin Plan objectives are based on the designated uses of the water body, which for the Talbert Marsh include REC-1 beneficial uses. The Basin Plan states: in waters designated for water contact recreation (REC-1), the fecal coliform concentration shall not exceed a log mean of 200/

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organisms per 100 mL (based on 5 or more samples/30 day period), nor shall more than 10 percent of total samples during any 30-day period exceed 400 organisms/100 mL.

Local surf zone monitoring indicates that elevated levels of FIB are routinely detected in the surf zone north and south of the SAR following storm events (Moffatt & Nichol, 2000). The source of these FIB are in part from stormwater runoff of the urban areas in the Talbert Channel Watershed. This is consistent with regional and nationwide monitoring data (CWP, 2000a) that indicate mean and median fecal coliform levels in urban stormwater generally ranging between 5,000-20,000 MPN/100 mL, which are well above the Basin Plan objectives. Studies by the CWP (2000a) also found that levels of fecal coliform in urban stormwater do not appear to be associated with the amount of impervious coverage. Factors that appear to affect bacteria levels in urban runoff are population density, age of the development, and percent of residential development. A comprehensive review of sources and pathways of fecal coliform in urban watersheds published by the Center of Watershed Protection (CWP, 2000a) resulted in four conclusions:

- It is “exceptionally difficult to maintain beneficial uses of water in the face of even low levels of watershed development, given the almost automatic violation of water quality standards during dry and wet weather flows.”
- Exceptionally efficient treatment processes (>99%) are needed to meet fecal coliform standards in urban stormwater, which is generally beyond the “maximum extent practicable” requirement in the NPDES permit
- Considerable monitoring is needed to isolate bacteria sources
- The relationship between bacterial indicators and public health is poorly understood, and fecal coliform bacteria are an imperfect indicator, but one with few alternatives.

Thus it is likely that elevated levels of FIB will continue to occur in stormwater runoff from the Talbert Watershed, and will be influent to the existing Talbert Marsh and proposed restored marshes.

Identified sources of FIB in the Talbert Channel Watershed are consistent with the general understanding of sources and pathways of FIB in urban watersheds. There are numerous natural and anthropogenic sources of pathogen indicators. Natural sources include birds and other wildlife. Local studies have identified birds in the Talbert Marsh as a possible significant source of FIB. Anthropogenic sources include domesticated animals and pets, and human sources that may be introduced via poorly functioning septic systems, cross-connections between sewer and storm drains, illicit connections to storm drains, and the direct utilization of outdoor areas for human waste disposal.

There does not appear to be any evidence of major leaks from the sanitary sewer system in the Talbert Channel Watershed. Therefore, the majority of FIB in stormwater runoff in the Talbert Channel Watershed is likely from non-human origins. Documented sources are dogs, cats, rats, raccoons, and birds. In particular dogs are thought to be the single greatest source of fecal coliform contamination due to their generally high density in residential settings and because

they have high bacterial densities in their feces compared with other urban wildlife (CWP, 2000a). This is indirectly supported by findings of higher coliform concentrations in runoff from residential lawns, driveways, and streets in comparison with runoff from rooftops and parking lots. In the Talbert Channel Watershed, dry-weather monitoring studies showed that highest levels of FIB were generally found in residential areas, which is consistent with the presumption that much of the FIB is from non-human origins, primarily pet waste. Source control measures that could help to reduce such sources include street sweeping, enforcement of pooper-scooper laws, public education campaigns, and availability of off-leash dog parks.

There does not appear to be any evidence that high levels of FIB entering the restored HBW would have any direct detrimental effects on the aquatic habitat in the Marsh. Conversely, the restored HBW could effect the levels of FIB reaching the surf zone. Fecal coliform bacteria do not generally thrive in the natural environment and most will gradually die-off over time (CWP, 2000b). Processes that contribute to die-off and removal in surface flows are exposure to sunlight (UV light), sedimentation process such as those that are promoted in detention basins and wetlands/marshes, and filtration processes which may occur in infiltration BMPs and wetlands/marshes. There is evidence of die-off in the Talbert Channels Watershed, with lowest levels found in the daytime due to exposure to sunlight, and reducing FIB gradients from upper to lower portions of the watershed due to retention and die-off in the flood control channels. Restoration of the HBW could potentially result in an enlarged estuarine system with longer retention times. This could potentially increase die-off occurring in the Marsh, however, it is not likely that any treatment occurring in the Marsh would reduce FIB levels below the Basin Plan objectives. It is also possible that any treatment occurring in the restored marshes could be offset to some extent by increased sources from birds, which have been suggested as a potential significant source of FIB.

6.6 Pesticides

The narrative objective for toxic substance in the Basin Plan states: “Toxic substances shall not be discharges at levels that will bioaccumulate in aquatic resources to levels waters which are harmful to human health.” A second objective states that “the concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses.” The CTR contains maximum levels for various of pesticides that are protective of beneficial uses.

The available data is limited with regards to pesticides. The dry weather monitoring data collected from the pump station forebays included analysis of a number of pesticides. No detectable levels of pesticides were reported in the reviewed data. These are no available wet-weather monitoring data for pesticides in the Talbert Channel Watershed.

Various state programs conduct toxicity monitoring throughout the state. These include the Inland Surface Waters Toxicity Testing Program, The Toxic Substances Monitoring Program, and the State Mussel Watch Program. Each of these programs has conducted monitoring at

various locations in OC, including the Anaheim Bay/Huntington Harbour, and locations in Newport Bay. Based on information in the Basin Plan, none of these programs has monitored or identified toxicity in the Talbert Channel Watershed.

Pesticide usage in the Talbert Channel Watershed is likely in residential areas and municipal landscape areas and parks for the control of insects, rodents, plant diseases, and weeds. Because of the fairly dense level of development in the watershed and the mixture of land-use types, excessive application of a pesticides and well as the possible presence of recently banned or legacy pesticides from previous applications could potential results in elevated levels of pesticides in stormwater runoff to the HBW. However, there is no direct evidence indicating that pesticides are present in dry- or wet-weather runoff to the Talbert Marsh and proposed Marsh restoration sites.

6.7 Oil & Grease and Hydrocarbons

Various forms of hydrocarbons (oil and grease) are a common constituents associated with urban runoff; however, these constituents are difficult to measure and are typically measured with grab samples, making it difficult to develop reliable EMCs for modeling.

Based on mixture of land-uses in the Talbert Channel Watershed, there are numerous potential sources of hydrocarbons and oil & grease. Industrial facilities, in particular the power plant and tank farm adjacent to the HBW, and some commercial facilities such as gas stations are a potential major source of hydrocarbons from accidental spills or leaks. Large facilities of this would typically have hazardous materials management and spill prevention programs, as well as emergency response procedures should a major spill occur.

Excluding major accidental spills, which are infrequent and unpredictable, the major source of oil & grease and hydrocarbons in stormwater runoff in the Talbert Channel Watershed are from roadways, driveways, and parking areas. The primary source of oil & grease and hydrocarbons in streets and parking areas is from vehicle emissions and leaks. Do-it-yourself auto mechanics may dump used oil and other automobile-related fluids directly into storm drains.

Limited dry weather monitoring data showed moderately high levels of oil & grease at a majority of the pump stations, and data at one pump stations in the presence of gasoline constituents (benzene and MTBE). This is suggestive of fairly elevated levels of oil & grease and hydrocarbons related to automobile related leaks, spills, or dumping, which might be expected in a well-established and predominantly dense residential area. The available dry weather data are limited to one sampling event, and there are no wet-weather data to indicate levels in stormwater runoff.

A narrative objective in the Basin Plan states that “waste discharge shall not result in deposition of oil, grease, wax or other materials in concentrations which result in a visible film or in coating

objects in the water, or which cause a nuisance or adversely affect beneficial uses.” There is insufficient data to determine if pollutant levels in stormwater flows to the HBW would violate this objective. Based on limited dry weather monitoring data that showed moderately high levels of oil & grease, and the nature of the land-use in the watershed, there appears to be a potential for significant levels of oil & grease and/or various hydrocarbons in stormwater inputs to the HBW.

6.8 Trash & Debris

Trash & debris are not routinely monitored in stormwater runoff. There is no available monitoring information on which an assessment could be based. Moderate to large quantities of trash and debris are transported in the Huntington and Talbert Channels, and are deposited in the Talbert Marsh (personal communication, Gary Gorman, Huntington Beach Wetlands Conservancy).

A narrative objectives for floatable in the Basin Plan states “waste discharges shall not contain floating materials, including solids, liquids, foam or scum, which cause a nuisance or adversely affect beneficial.” Based on qualitative observations, trash & debris in the Talbert Marsh in aesthetically unpleasing, which could be interpreted as impacting the recreation beneficial uses.

In the absence of additional source or regional treatment BMPs, it is likely that current levels of trash & debris in stormwater flows will continue in the future and would be influent to the proposed restoration areas. Retrofit opportunities discussed in the next section could help to alleviate levels of trash & debris in the HBW. Another option could be in construct and maintain trash booms, similar to those employed in other locations in the County.

7 **BMP Retrofit Opportunities**

This section identifies and describes potential opportunities to implement treatment BMPs in the Talbert Channel Watershed to improve the water quality of dry and wet-weather flows to the HBW. The goal of these BMP retrofits are to maximize the benefits of the proposed wetland restoration project in terms of wildlife habitat, recreation, aesthetics, and general beneficial uses of the area. There are two general categories of BMP retrofits: 1) methods to reduce the amount of pollutants entering the main drainage channels; and 2) methods to manage and/or remove the pollutants that have entered the flood control channels.

Potential BMP retrofits to reduce the pollutants levels in the flood control channels include:

- ***Enhancement of the Bartlett Park Retention Basin.*** The Bartlett Park Retention Basin is located at the head of the Huntington Beach Channel and receives dry and wet-weather runoff from storm drains in the upper portion of the HD subcatchment (see Figure 1). Constructed wetlands built into the floor of the Bartlett Park Retention Basin could

potentially treat dry weather flows, and depending on the available storage, a separate extended detention riser outlet structure could potentially be added to provide treatment of runoff from small storms. Water quality treatment wetlands are one of the more effective treatment BMP options. They can provide excellent treatment of nutrients and FIB, and good treatment of metals and some organics. Wetlands within an extended detention basin would also be expected to enhance treatment of small storm runoff. Similar concepts have been proposed and implemented as part the NTS Master Plan for the San Diego Creek Watershed (IRWD, March 2003).

- **Catch Basin Inserts.** Catch basin inserts are screens or filters that can be installed in existing storm drains in the watershed. These systems are typically only effective for removing gross pollutants and oil and grease from stormwater runoff. Catch basin inserts are relatively inexpensive, simple to install, and easy to maintain. Proper maintenance, however, is critical to maintaining good treatment performance. Because of the large number of catch basins in the watershed, an alternative could be to target the installation of the inserts in areas where elevated pollutant loads would be expected, such as areas that are dominated by industrial or commercial land-uses.
- **Hydrodynamic Separators.** These are in-line structures that reduce, or manipulate, runoff velocities causing particulate matter and solids to settle in a collection chamber. The systems can also be designed to collect floatable trash, oils, and grease. These systems can be sized to treat up to 300 cfs. Thus, hydrodynamic separators could be installed in-line between the pump stations and channel outfalls, providing treatment for a major portion of the storm flows, including the first flush flows. They could also be situated in target storm drains. These systems are generally effective at removing gross solids, larger particulates, and pollutants that are associated with particulates such as metals and some organics. These systems would generally provide limited treatment of fine particulates, dissolved constituents, and FIB.

Potential BMPs to manage and/or remove the pollutants that have entered the flood control channels include:

- **Pretreatment Areas.** A portion of the restoration areas could be devoted to pretreatment of stormwater flows. The pretreatment areas could be sedimentation forebays or possibly constructed wetlands. These areas would need to be engineered to only receive storm flows, and would therefore be isolated from tides. Sedimentation areas would mainly target removal of gross solids and particulates, while constructed wetlands could provide effective treatment for particulates, dissolved constituents, and FIB. A disadvantage of this approach is that it would reduce the area available for salt marsh restoration.
- **Stormwater Bypass.** An alternative concept is to engineer tidal flushing of the restored marshes through controlled gates in the flood control channels. The gates would be designed to close when storm flows are conveyed in the channels. Thus, stormwater and the associated pollutants would be designed to bypass the restored marsh areas, thereby limiting any water quality impacts associated with stormwater discharges. The control

gates could be designed to close by mechanical float valves or computer controls that are activated by automatic or manual instructions.

8 References¹

- AES, July 2001. Storm Water Pollution Prevention Plan for AES Huntington Beach, LLC.
- Boehm, A.B., B.F. Sanders, C.D. Winant, 2002. Cross-Shelf transport at Huntington Beach. Implications for the fate of sewage discharged through an offshore ocean outfall, *Environ. Sci. Technol.*, 36, 1899-1906.
- Boehm, A.B., G.G. Shellenbarger, A. Paytan, 2004. Groundwater discharge: Potential association with fecal indicator bacteria in the surf zone, *Environ. Sci. Technol.*, 38, 3558-66.
- Cohen, R.A., P. Fong, 2003. Using macroalgae as an indicator of terrestrial influences in southern California estuaries, Abstract of presentation at the First Annual Meeting of the California Estuarine Research Society, obtained online at: <http://online.sfsu.edu/~caers/Abstracts.htm>
- County of Orange, October 1986. Orange County Hydrology Manual, prepared by the Orange County Environmental Management Agency
- County of Orange, 2002. Hydrologic Data Report, 2001-2002 Season, Volume XXXVII, Public Facilities and Resources Department.
- CWP, 2000a. Microbes and Urban Watersheds: Concentrations, Sources, & Pathways, Article 31 in *The Practice of Watershed Protection: Techniques for protecting our nation's streams, lakes, rivers, and estuaries*, (T.R. Schueler and H.K. Holland), available at www.cwp.org.
- CWP, 2000b. Microbes and Urban Watersheds: Ways to Kill 'Em, Article 67 in *The Practice of Watershed Protection: Techniques for protecting our nation's streams, lakes, rivers, and estuaries*, (T.R. Schueler and H.K. Holland), available at www.cwp.org.
- Grant, S.B., B.F. Sanders, A.B. Boehm, J.A. Redman, J.H. Kim, et al., 2001. Generation of enterococci bacteria in a coastal saltwater marsh and its impact on surf zone water quality, *Environ. Sci. Technol.*, 35(12).
- IRWD, March 2003. San Diego Creek Watershed Natural Treatment System Draft Master Plan, Irvine Ranch Water District, Irvine, California.
- IRWD, 2003. Residential Runoff Reduction (R3) Study, Draft Report, prepared by the Irvine Ranch Water District, Irvine, California.
- Kennison, R.L., K. Kamer, P. Fong, 2003. Nutrient and Macroalgal Dynamics in 5 Southern California Estuaries, Abstract of presentation at the First Annual Meeting of the California Estuarine Research Society, obtained online at: <http://online.sfsu.edu/~caers/Abstracts.htm>

¹ Includes citations in the Appendix

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- Kim, J.H., S.B. Grant, C.D. McGee, B.F. Sanders, J.L. Largier, 2004. Locating sources of surf zone pollution: A mass budget analysis of fecal indicator bacteria at Huntington Beach, California, *Environ. Sci. Technol.*, 38, 2626-36.
- Los Angeles County, 2000. Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, prepared by the Los Angeles County Department of Public Works.
- Moffatt & Nichol, 2000. Huntington Beach Water Quality Investigation Phase II: An Analysis of Ocean, Surf Zone, Watershed, Sediment and Groundwater Data Collected from June 1998 through September 2000.
- Noble, M., J. Xu, L. Rosenfeld, J. Largier, P. Hamilton, B. Jones, G. Robertson, 2003. Huntington Beach Shoreline Contamination Investigation, Phase III, USGS Open-File Report OF 03-0062, U.S. Geological Survey, Denver.
- Novotny, V. and H. Olem, 1994. Water Quality Prevention, Identification, and Management of Diffuse Pollution, Van Nostrand Reinhold, New York.
- OCFCD, 1999. Maps from the Master Plan of Flood Control and Drainage Facilities in Orange County, prepared by the Orange County Flood Control District, February 10, 1999.
- OCPFRD, 2001. NPDES Annual Progress Report, submitted to the Santa Ana Regional Water Quality Control Board, prepared by the Orange County Public Facilities and Resources Department.
- OCPFRD, 2003. Drainage Area Management Plan (DAMP). July 2003. A Cooperative Project of the County of Orange, the Cities of Orange County, and the Orange County Flood Control District.
- Reeves, R.L., S.B. Grant, R.D. Mrse, C.M. Oancea, B.F. Sanders, A.B. Boehm, 2004. Scaling and management of fecal indicator bacteria in runoff from a coastal urban watershed in southern California, *Environ. Sci. Technol.*, 38, 2637-48.
- RWQCB, 1995. Santa Ana Regional Water Quality Control Board, Water Quality Control Plan, Santa Ana River Basin (8).
- RWQCB, 2002. Orange County NPDES Permit (No. CAS618030), Order No. R8-2002-0010/NPDES, adopted January 18.
- Schueler, T. 1987. Controlling Urban Runoff, A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments.
- Stein, E. D. and L.L. Tiefenthaler, 2004. Characterization of Dry Weather Metals and Bacteria in Ballona Creek, Tech. Rep. 427, Southern California Coastal Water Research Project.
- USCOE, November 1987. Hydrologic Documentation for Feasibility Study, Santa Ana River Basin and Orange County, Interim 3 Talbert Valley Channels, Prepared by the U.S. Army Corps of Engineers, Los Angeles District.
- USEPA, 1989. Analysis of Storm Event Characteristics for Selected Gages throughout the United States.
- URS, May 2001. Engineering Services in Support of Investigating and Eliminating Bacteria in Urban Runoff Discharges to Huntington beach, prepared by URS, San Diego, CA

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VCFCD, July 2001. Ventura Countywide Stormwater Monitoring Program: 2000/01 Monitoring Status Report, Ventura County Flood Control Department

Water Quality Assessment for the Huntington Beach Wetlands

Appendix A - Water Quality Model Methodology and Results

A.1 Model Description

The model used to assess stormwater quality inputs to the Huntington Beach Wetlands Restoration Project is an empirical, volume-based, pollutant loads model. Empirical models of this type are commonly used to estimate pollutant loads and/or concentrations in stormwater runoff. This type of loadings model is generally applicable in the planning and evaluation stages of a project. If reliable estimates of the effluent quality resulting from installation of BMPs are available, the model can be used to evaluate the effectiveness of proposed BMPs.

The model methodology is adapted from an empirical method that has been referred to as the Simple Method (Schueler, 1987). The Simple Method is an empirical approach for estimating pollutant export from urban development sites. The model was developed to provide a simple yet effective method for predicting runoff volumes, pollutant loads, and resulting pollutant concentrations that result from development.

The pollutant loads model used in this work was developed in spreadsheet format and utilizes available stormwater monitoring and rainfall data, as well as a relationship for the prediction of runoff volumes. The model is capable of estimating changes in runoff volumes, pollutant loads, and resulting pollutant concentrations that may occur with changes in land-use and/or implementation of treatment BMPs. The model estimates stormwater runoff volumes, but does not simulate the hydraulics or hydrology of the site, which would be more appropriate for design stages and requires additional data and more sophisticated modeling. The model is capable of including the pollutant removal effects of structural BMPs, but does not account for the effectiveness of source control BMPs, as data are generally not available or inconclusive for the latter. Model calculations include only average annual results without an estimation of the potential variation in stormwater loads or concentrations.

The precision of the model results is heavily dependent on how well the runoff relationship and climatic and water quality data describe the actual site characteristics. Local and regional data are used to the fullest extent possible to minimize errors in model estimates, however, climatic and water quality data are subject to a high degree of variability that will add an element of uncertainty to the model results. An extensive model sensitivity analysis is beyond the scope of this document. The following is a qualitative description of the potential errors, variability, and

misinterpretations of the modeling approach and results. There are three major elements of the model that are subject to error and uncertainty:

- 1) **Rainfall Data.** Rainfall is subject to a high degree of seasonal and spatial variability. Spatial variability in rainfall within the watershed is not addressed in this application because of the generally flat topography within the Talbert watershed and generally small spatial difference in rainfall depth as indicated by the County isohyets (see Section A.3). A primary consideration in selection of the appropriate rainfall gauge was the proximity of the rain gauge to the watershed. It is expected that any potential errors in the model estimates stemming from use of inappropriate rainfall data or from spatial differences in rainfall are small in comparison to other sources of model uncertainty.

Seasonal variability in rainfall depths is greater than spatial differences in the Talbert watershed. The pollutant loads model uses an average annual rainfall depth to represent the rainfall volume in the watershed. Thus, model results should be interpreted as representing the pollutant loads generated by average rainfall conditions, and that seasonal differences in rainfall in any given year can result in actual pollutant loads that are less than or greater than the model estimates. Gauge selection was based to a large degree on the duration of the available rainfall records, with longer rainfall records providing a better estimate of average conditions. The number of missing records was also considered as this could also influence the average rainfall value.

Rainfall records also exhibit long-term trends in terms of extended dry and wet periods (see Section A.3). Average rainfall depths for dry and wet periods was calculated and used in the pollutant loads model to estimate a range in average pollutant loads.

- 2) **Runoff Calculation.** Runoff volumes are estimated with the Rational Formula, an empirical expression that is commonly used to estimate runoff in urban drainages less than one-square mile in size. Although the Rational formula is simple to apply, it is difficult to estimate the runoff coefficient, which is often expressed as a function of the percent of impervious cover in the watershed (see Section A.5). Model estimates of average annual runoff are subject to uncertainty stemming from inability to accurately estimate the runoff coefficient. It is expected, however, that use of the Rational Formula will tend to overestimate runoff volumes, and will therefore provide a conservative estimate of pollutant loads to the Huntington Beach Wetlands.
- 3) **Water Quality Estimation.** Characterization of the stormwater quality is likely to be the greatest source of uncertainty in the model estimates. Stormwater monitoring data typically have a high degree of variability, both within and between storm events. However, stormwater quality is often characterized by an event mean concentration (EMC), which is a volume-weighted average concentration that does not indicate the variability in stormwater data. Because of the lack of local stormwater monitoring information in the Talbert Channel Watershed, average concentrations of land-use based stormwater monitoring data collected in Los Angeles County were used to estimate stormwater quality in the Talbert Channel Watershed. Thus, uncertainty in pollutant load

estimates in the Talbert Channel Watershed occurs from general variability in the stormwater monitoring data, and from the use of regional monitoring information.

A.2 Modeling Steps

The following modeling methodology was used to estimate average annual pollutant loads in stormwater runoff to the Talbert Marsh and proposed marsh restoration sites.

- 1) Estimate the mean annual rainfall depth;
- 2) Determine catchment boundaries, area, and land-use;
- 3) Estimate runoff volumes using observed relationships between percent imperviousness and runoff coefficients;
- 4) Estimate runoff water quality based on observed statistical data from similar land-use types;
- 5) Estimate pollutant loads by multiplying the concentration in stormwater runoff by the predicted runoff volume;
- 6) Sum the flows and loads from individual sub-areas and calculate average catchment areas concentrations.

The following sections describe the application of these modeling steps.

A.3 Rainfall Analysis

The average rainfall in the Talbert Channel drainage area is about 11 to 12 inches per year, based on the countywide isohyetal map shown in Figure A-1. The map was obtained from the County of Orange Hydrology Data Report (2002). This figure shows that average rainfall depths generally increase along the coastline from north to south, as well as inland from west to east due to orographic effects. Therefore, slightly higher rainfall depths are expected on average in the southeast portion of the Talbert Channel Watershed and slightly smaller average rainfall depths are expected in the northwest corner of the watershed.

Hourly and daily rainfall data available from the County of Orange and National Climatic Data Center were evaluated for use in the water quality model. The location of the gauges and average rainfall measured at these gauges is shown in Figure A-1. There is also a rain gauge operated by the City of Huntington Beach within the watershed boundary at the Huntington Beach Fire Station, however, data from the gauge was not available for this study. The gauges considered for this study were evaluated in terms of distance and elevation in relation to the Talbert Watershed, the available period of record, and the amount of missing rainfall records. The need for storm statistics and event-based information was also considered in the gauge selection.

ISOHYETAL MAP - 40 YEAR MEAN
1963-2002
Lines of Equal Precipitation in Inches

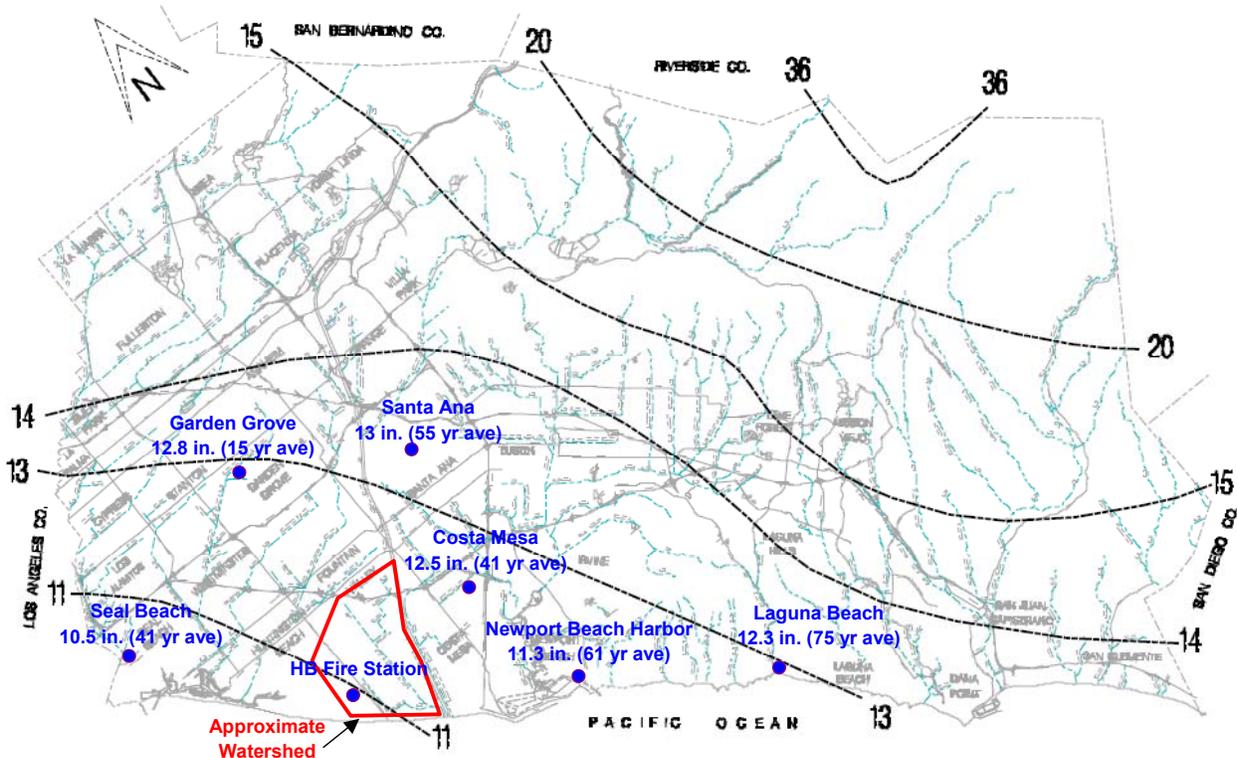


Figure A-1: County Isohyetal Map and Rain Gauges Considered for this Study

Available daily rainfall data collected at the Newport Beach Harbor rain gauge were selected for use in the water quality model. This gauge was selected because it is located near the coast and is reasonably close to the Talbert Watershed, there is a fairly long period of record with relatively few missing records, and average annual rainfall measured at the Newport Beach gauge is reasonably representative of the average rainfall in Talbert Watershed indicated by the County isohyets.

Hourly data at the Laguna Beach gauge would normally be preferable if event based information were needed (e.g. percent capture calculations for BMPs), however, such information was not needed for this study. Hourly data available at the Laguna Beach gauge could also be used to filter out small storms with rainfall total of less than 0.1 inches, which generally do not contribute to stormwater runoff volumes (USEPA, 1989). However, given that event based storm data was not needed, it was determined that the long-term daily data at the closer Newport Beach gauge was the most appropriate for this study.

The rainfall data exhibit trending periods of generally below average rainfall conditions (dry periods) and above average rainfall conditions (wet periods). Figure A-2 shows a plot of cumulative residuals (i.e. difference from the mean annual rainfall volume) for annual rainfall measured at the Newport Beach Gauge. The cumulative residual plot highlights dry periods, as indicated by decreasing trends of cumulative residuals, and wet period, as indicated by increasing trends. This plot shows a protracted dry period beginning in the mid 1940 and lasting through the mid 1970s. Several short-term wet and dry cycles have occurred since the mid 1970s.

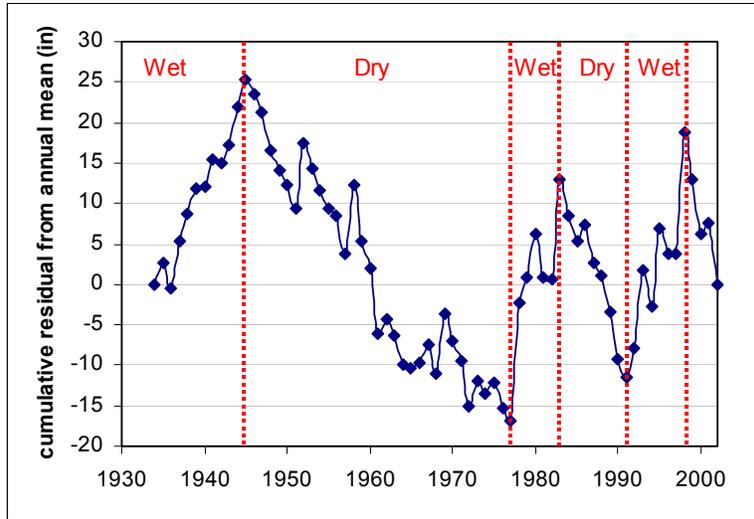


Figure A-2: Rainfall Wet and Dry Cycles (Newport Beach Gauge)

Annual rainfall statistics for the Newport Beach gauge are summarized in Table A-1. The average annual rainfall is 11.3 inches. Average annual rainfall during dry periods is about 9-inches, and about 14 inches during wet periods.

Table A-1: Average Annual Rainfall at the Newport Beach Harbor Station

	Average Rainfall Conditions	Average Dry Period Conditions	Average Wet Period Conditions
Number of Years of Data	68	39	29
Minimum annual rainfall (inches)	3.2	3.2	5.8
Maximum annual rainfall (inches)	26.2	19.7	26.2
Average annual rainfall (inches)	11.3	9.1	14.1

A.4 Subcatchment Delineation and Properties

The Talbert Channel Watershed was divided into 11 subcatchments on the basis of drainage area boundaries delineated in 1999 Orange County Storm Drain Maps (OCFCD, 1999). The subcatchment boundaries were superimposed on a 1999 aerial photograph using Graphical Information System (GIS) tools to compute the subcatchment areas. Figure A-3 shows the

subcatchment delineations, major channels, and pump stations. Subcatchment properties are listed in Table A-2 below.

Table A-2: Subcatchment Properties

Subcatchment Name and ID	Area (acres)	Drains to:	Percent Impervious Cover
B – Banning	558	Talbert Channel	55
F – Flounders	455	Fountain Valley Channel	54
FV – Fountain Valley	2070	Fountain Valley Channel	59
H&M – Hamilton & Merideth	788	SAR	
HD – Huntington Drainage	2033	Huntington Channel	52
N – Newland	747	Huntington Channel	50
TB – Talbert	1440	Talbert Channel	48
TP – Trailer Park	83	Huntington Channel	54
WT – Marsh	134	Talbert Channel/Marsh	29
WW – Power Plant	68	Ocean	
Y&A&I – Yorktown & Adams	1164	Talbert Channel	51
Total	9541		

Land-use in the subcatchments was estimated from the 1999 aerial photograph. Land-use was divided into nine general categories listed in Table A-3, which were superimposed on the aerial photograph based on visual observation and judgment. The location of schools, parks, and some commercial areas were determined from street maps. The resolution of the photograph was not sufficient to distinguish between detached single-family residential (SFR) housing and multi-family residential housing. Because the vast majority of residential areas in the watershed are SFR, all residential areas were grouped in this category. Figure A-4 shows the estimated land-use distribution, and Table A-3 lists the land-use breakdown determined by GIS for subcatchments that are tributary to the Talbert Channel (WW and H&M are not included because they are not tributary to the Talbert Marsh).

Table A-3: Land-Use Acreage for Subcatchments Tributary to the Talbert Channel

Land Use Category	B	F	FV	HD	N	T&B	TP	Y&A&I	WT
Residential	372	333	1141	1584	442	1116		880	
Mobile Home Park							45		
Commercial		12	210	188		60	1	91	
Light Industrial	86	54	389	22	88				
Education (schools)	12	23	69	45	83	97		73	
Transportation (fwys & arterials)	34	27	152	135	44	97	5	74	13
Vacant (Parks & open areas)	29	1	41	50	83	65	30	22	108
Channels	24	4	1	8	7	6	2	23	12
Agriculture (row crops)			69						
Total	558	455	2070	2033	747	1440	83	1164	134

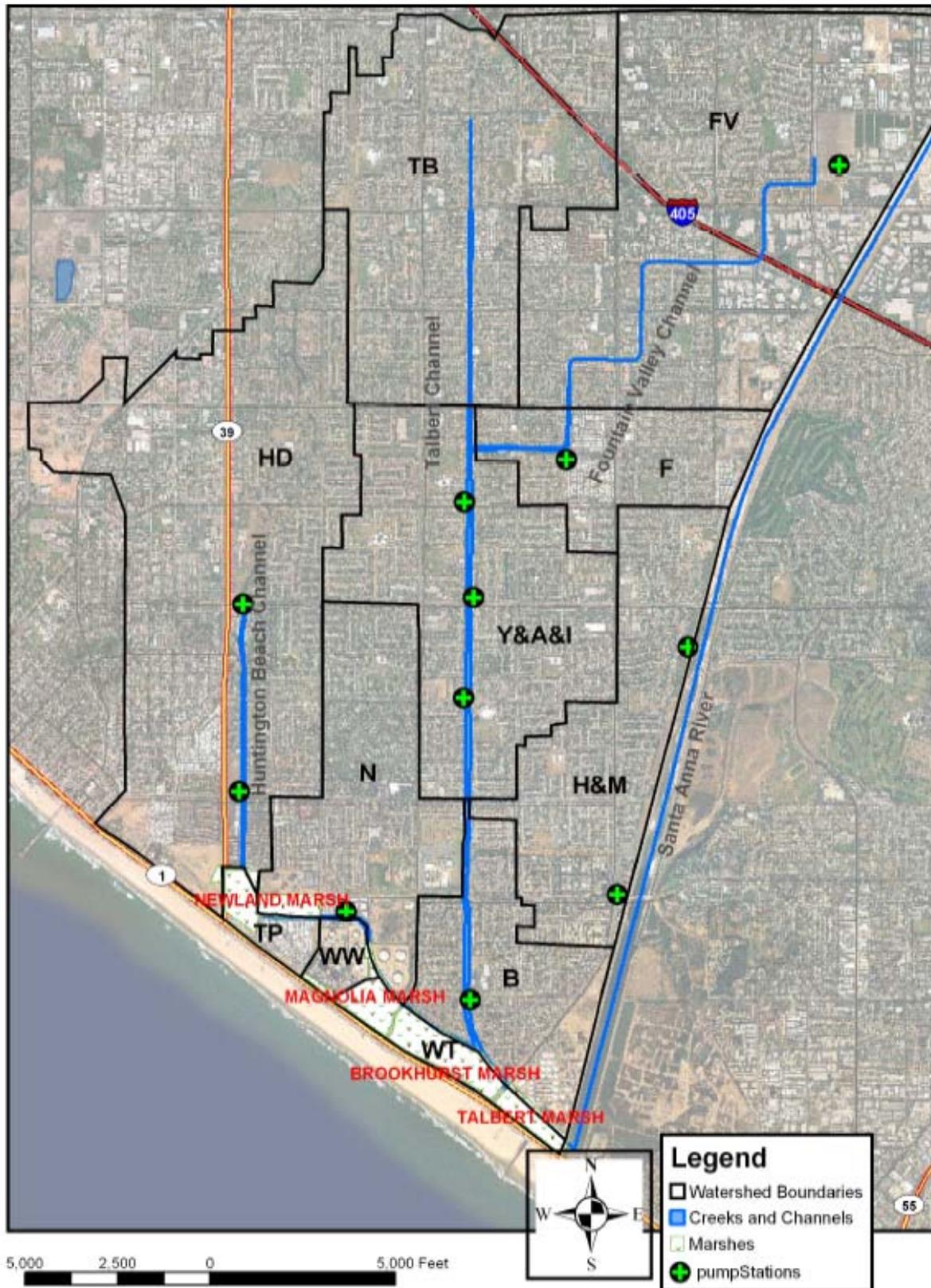


Figure A-3: Subcatchment Delineation in the Talbert Channel Watershed

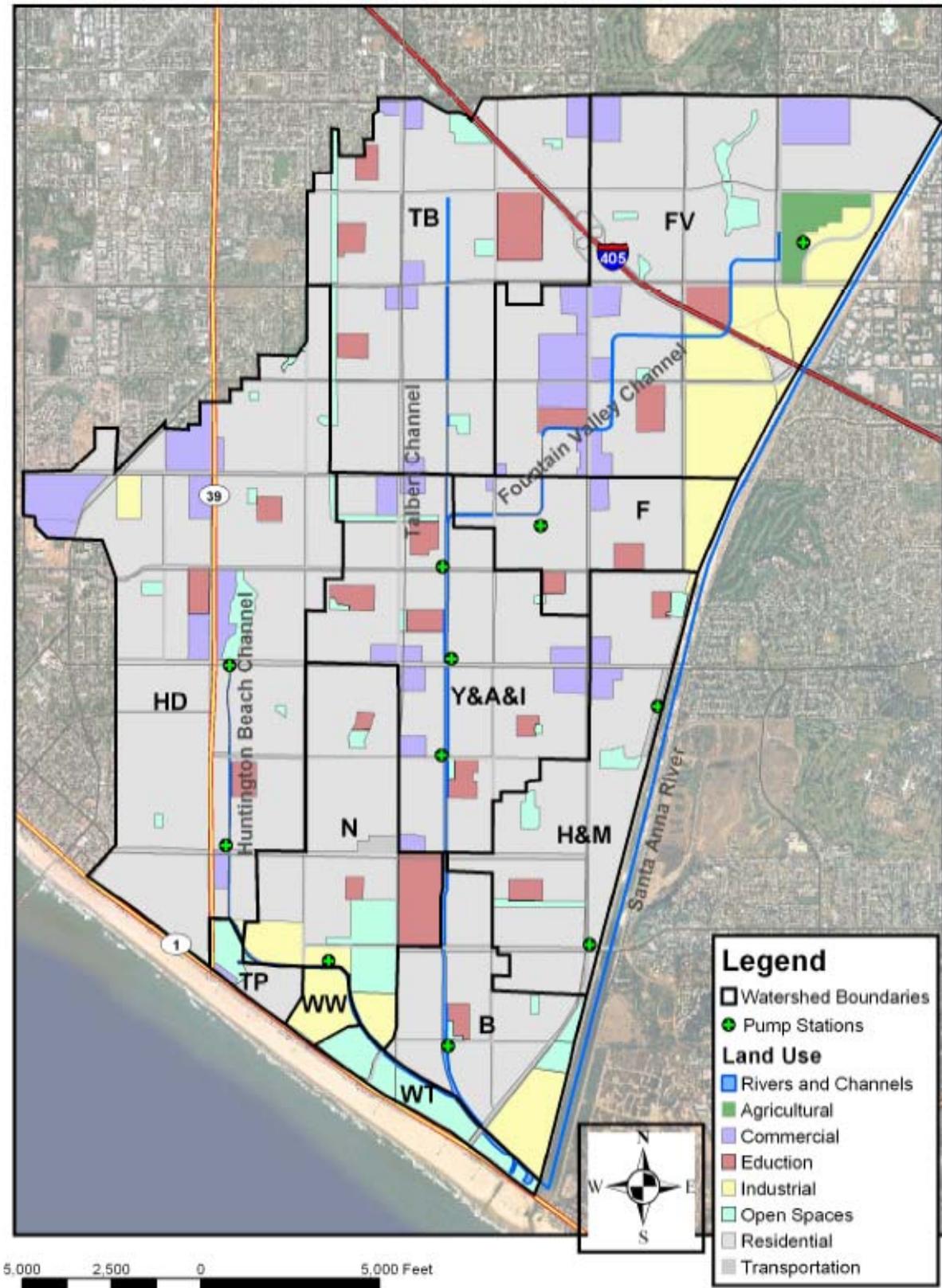


Figure A-4: Estimated Land-Use Distribution

The amount of impervious cover greatly influences the amount runoff. The percentage of impervious cover was determined for each land-use category based on values given in the Orange County Hydrology Manual (County of Orange, 1986). Table A-4 lists the impervious fractions for each land-use. An average impervious fraction for each subcatchment was calculated as an area-weighted average. The subcatchment percent impervious covers given in Table A-2 range between 48-59 percent, which is within the range of 40-65 percent used by the Corps of Engineers in their hydrologic studies (USCOE, 1987)

Table A-4: Impervious Cover Fractions by Land-Use

Land-Use ¹	Range-Percent ¹	Recommended Value ¹	Used in Pollutant Load Model
Single Family Residential (5-7 dwelling per acre)	35-55	50	45 ²
Mobile Home Park	60-85	75	75
Commercial, Downtown Business or Industrial	80-100	90 ³	90 ³
Schools	30-50	40	40
Transportation			90 ⁴
Public Parks	10-25	15	15
Channels			90 ⁴
Natural or Agriculture	0-0	0	0

¹ From Figure C-4 in the Orange County Hydrology Manual (OCHM).

² Used mid-point of recommended range. Applied to all residential land-use.

³ Used for commercial and light industrial land-uses.

⁴ No value listed in the OCHM. Assumed value

A.5 Runoff Estimation

Runoff volumes are calculated using the Rational Equation (Novotny and Olem, 1994):

$$Q = Rv \times I \times A$$

where:

Q = runoff (volume or flow rate)

I = rainfall (depth or intensity)

A = drainage area

Rv = mean annual runoff coefficient

The runoff coefficient is a unit-less value that is a function of the imperviousness of the watershed. The runoff coefficient was calculated with the following expression based on the Simple Method (Schueler, 1987):

$$Rv = 0.9 \times (\text{impervious fraction}) + 0.05$$

Mean annual runoff volumes were calculated utilizing the above method, the catchment information described in Section A.4, and the mean annual rainfall given in Section A.3. The

estimated mean annual runoff volumes in the Talbert Channel Subcatchments are shown in Table A-5. The estimated total mean annual runoff volume based on a long-term average annual rainfall of 11.3 inches is approximately 4300 acre-ft. The estimated mean annual runoff volume during average dry and wet-period conditions is approximately 3400 and 5300 acre-ft, respectively. Recall that these estimates represent long-term average runoff volumes, and as discussed previously, rainfall variability in any given year can result in runoff volumes that are less than or greater than values in Table A-5.

Table A-5: Estimated Mean Annual Runoff Volumes

Subcatchment	Average Rainfall Conditions (11.3 inches per year) (Acre-ft)	Average Dry Period Conditions (9.1 inches per year) (Acre-ft)	Average Wet Period Conditions (14.1 inches per year) (Acre-ft)
B	286	231	357
F	231	186	288
FV	1134	913	1414
HD	991	798	1237
N	349	281	435
TB	658	530	821
TP	62	50	77
Y&A&I	562	453	701
WT	39	32	49
Total	4312	3473	5381

A.6 Estimates of Stormwater Water Quality

The concentrations of stormwater runoff and resulting pollutant loads can be difficult to quantify. Many factors can affect stormwater quality including: source concentrations, topography, soil type, and rainfall characteristics. Moreover, these factors can be highly variable, both spatially and temporally.

A primary factor influencing stormwater quality is the land use type within a watershed, which has been shown to significantly affect the types and concentrations of pollutants found in the runoff. Several studies have been conducted to characterize runoff quality as a function of land use. The Nationwide Urban Runoff Program (NURP) Final Report (USEPA, 1983) provides estimates of average or event mean concentrations (EMCs) for priority pollutants based on the predominant land use of the watershed. However, NURP is a national dataset that did not include sites in Southern California (Fresno was the closest site).

Recent and more regional land-use based stormwater quality monitoring data was collected through the LA County Stormwater Monitoring Program. This program was initiated with the goal of providing technical data and information to support effective watershed stormwater

quality management programs in Los Angeles County. Specific objectives of this project included monitoring and assessing pollutant concentrations from specific land uses and watershed areas. In order to achieve this objective, the County undertook an extensive stormwater sampling project that included 7 land use stations and 5 mass emission stations, which were tested for 82 water quality parameters. These data are presented in two published reports: *Los Angeles County 1998-1999 Stormwater Monitoring Report, 1999* and *Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, 2000*.

The land-use based monitoring conducted by Los Angeles County did not include agricultural areas. The EMCs for row crops were estimated by available monitoring data collected by the Ventura County Flood Control District (VCFCD, 2000). For NPDES compliance, the VCFCD monitors stormwater runoff from a 350-acre watershed in Oxnard, Ventura County at a location known as Wood Road at Revolon Slough Station (A-1). The drainage area is primarily row crops, including strawberries that incorporate plastic mulch as part of the farming technique. The watershed contains a small number of farm residences and ancillary farm facilities for equipment maintenance and storage. Sprinklers are used to irrigate crops for plant establishment, but once the plants are established the farmers switch to drip irrigation. Plastic cover is required during certain life stages of strawberries.

For this modeling effort, stormwater quality was estimated with the recent EMC data collected by Los Angeles County (LA County, 2000) and by the Ventura County Flood Control District (VDFD, 2001) for agricultural area. These data were used because the monitored land uses are representative of those in the Talbert Valley Watershed, and because similar land-use based monitoring information is not available for locations in Orange County. All of the land uses stations available through monitoring conducted by LA County are listed in Table A-6 with a brief description of the site and the years monitoring data have been collected. All sites except stations S26 and S27 were used to represent land uses in the Talbert Channel Watershed.

The monitoring data collected by LA County were summarized in terms of descriptive statistics (e.g. mean and standard deviation) for each monitored pollutant at each land use monitoring station. In the data analysis conducted by Los Angeles County the censored data were handled by using a common procedure whereby half the laboratory detection limit was substituted for results that were reported below the laboratory detection limit. In an effort to derive more robust estimates of event mean concentrations (EMCs), the raw monitoring data was obtained from the Los Angeles Department of Public Works. A maximum likelihood estimator method was used to analyze the monitoring data. This method ranks the log-transformed data above the detection limit and extrapolates to estimate probable values of data points below the detection limit. These estimated values were then combined with the laboratory data above the detection limit. The arithmetic means for the EMCs that were estimated from the lognormal statistics are presented in Table A-7 and Table A-8.

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Table A-6: Los Angeles County Land Use Monitoring Stations

Station Name	Station No.	Modeled Land Use	Site Description	Years Monitoring Conducted
Santa Monica Pier	S08	Commercial	The monitoring site is located near intersection of Appian Way and Moss Avenue in Santa Monica. The storm drain discharges below the Santa Monica Pier. Drainage area is approximately 81 acres. The Santa Monica Mall and Third St. Promenade dominate the watershed with remaining land uses consisting of office buildings, small shops, restaurants, hotels and high-density apartments.	1996-1999
Sawpit Creek	S11	Open Space & Parks	Located in Los Angeles River watershed in City of Monrovia. The monitoring station is Sawpit Creek, downstream of Monrovia Creek. Sawpit Creek is a natural watercourse at this location. Drainage area is approximately 3300 acres.	1996-2000
Project 620	S18	Single Family Residential	Located in the Los Angeles River watershed in the City of Glendale. The monitoring station is at the intersection of Glenwood Road and Cleveland Avenue. Land use is predominantly high-density, single-family residential. Drainage area is approximately 120 acres.	1996-2000
Dominguez Channel	S23	Freeway	Located within the Dominguez Channel/Los Angeles Harbor watershed in Lennox, near LAX. The monitoring station is near the intersection of 116 th Street and Isis Avenue. Land use is predominantly transportation and includes areas of LAX and Interstate 105.	1996-2000
Project 1202	S24	Industrial	Located in the Dominguez Channel / Los Angeles Harbor Watershed in the City of Carson. The monitoring station is near the intersection of Wilmington Avenue and 220th Street. The overall watershed land use is predominantly industrial.	1996-2000
Project 474	S25	Education	Located in Los Angeles River watershed in the Northridge section of the City of Los Angeles. The monitoring station is located along Lindley Avenue, one block south of Nordoff Street. The station monitors runoff from the California State University of Northridge. Drainage area is approximately 262 acres.	1997-2000
Project 404	S26	Multi-Family Residential	Located in Los Angeles River watershed in City of Arcadia. The monitoring station is located along Duarte Road, between Holly Ave and La Cadena Ave. Drainage area is approximately 214 acres.	1997-2000
Project 156	S27	Mixed residential	Located within the Los Angeles Watershed in the City of Glendale. The station is located along Wilson Avenue, near the intersection of Concord Street and Wilson Avenue. The land use of the drainage area is classified as mixed residential.	1997-2000

Source: Los Angeles County 1999-2000 Draft Stormwater Monitoring Report (Los Angeles County, 2000)

Table A-7: Nutrient EMC Values for Nutrients used in the Pollutant Loads Model

Land Use	Total Phosphorus (mg/L)	Nitrate-N (mg/L)	Nitrite-N (mg/L)	Ammonia-N (mg/L)	TKN (mg/L)	Total Nitrogen (mg/L) ³
Transportation	0.29	0.29	0.05	0.14	1.05	1.40
Light Industrial	0.31	0.59	0.07	0.37	2.28	2.94
Education	0.30	0.58	0.09	0.27	1.59	2.26
Residential	0.41	0.77	0.09	0.50	2.99	3.86
Commercial	0.40	0.56	0.15	1.26	3.11	2.82
Vacant	0.12	1.16	0.03	0.09	0.98	2.16
Crops ¹	2.7	12.3	0.57 ²	2.05	8.07	21.0

1 – Data from Ventura County; all other stormwater monitoring data obtained from Los Angeles County

2 – Nitrite was not monitored by Ventura County. The same ratio of nitrite to ammonia as open space was used to estimate the concentrations for crops.

3 – Total Nitrogen was not monitored by LA County. Computed as the sum of Nitrate + Nitrite Nitrogen and TKN.

Table A-8: EMC Values for TSS and Metals used in the Pollutant Loads Model

Land Use	TSS (mg/L)	Dissolved Copper (ug/L)	Total Copper (ug/L)	Total Lead (ug/L)	Dissolved Zinc (ug/L)	Total Zinc (ug/L)
Transportation	39.4	24.3	33.9	3.5	129	173
Light Industrial	177.8	17.1	27.8	18.2	267	335
Education	93.6	9.9	15.7	2.9	66.5	96.7
Residential	127.5	9.5	15.7	8.8	30.5	73.2
Commercial	67.6	14.5	34.8	20.8	157	239
Vacant	224	2.5 ¹	8.8	3.2	25 ²	21.9
Crops ¹	1397	29.0	133	49.1	37.6	332

1 – Only 1 of 41 samples was above the detection limit (5 ug/L). The EMC was set to half the detection, 2.5 ug/L.

2 – Only 2 of 52 samples were above the detection limit (50 ug/L). The EMC was set to half the detection, 25 ug/L.

Comparison with Local Stormwater Monitoring Data

The land-use based stormwater monitoring data collected in LA County was compared to local stormwater monitoring data to gauge the appropriateness and applicability to the Talbert Channel Watershed conditions. The Orange County Public Facilities and Resources Department (OCPFRD) has developed Site Event Mean Concentrations (EMCs) using stormwater monitoring data collected between 1991-2002 (OCPFRD, 2001). Site EMC data were obtained from four five OCPFRD monitoring stations described below:

- ***East Garden Grove Wintersburg at Gothard.*** OC Station No. EGWC05. This station captures runoff from 20.8 square mile watershed that drains portions of Anaheim, Fountain Valley, Garden Grove, Huntington Beach, Orange, Santa Ana, and

Westminster. The watershed is immediately north of the Talbert watershed. The land-use in the watershed appears to be similar to that in the Talbert Watershed in that it is predominantly established residential with a mixture of commercial and light industrial, parks, and schools.

- ***Westminster Channel at Hazard Downstream of Beach Blvd.*** OC Station No. WMCC04. A 6.7 square mile watershed that drains portions of Garden Grove and Westminster. The watershed is located to the north of the Talbert Channel Watershed. Qualitatively, the land-use appears to be similar to that in the Talbert Channel Watershed, with established residential areas, the 22 fwy, and perhaps slightly more commercial areas.
- ***Anaheim Barber City Channel Downstream of US Gov. Railroad Bridge at Rancho Road.*** OC Station No. ABCC03. A 14.9 square mile watershed that drains portions of Anaheim, Garden Grove, Huntington Beach, Stanton and Westminster. The watershed is located to the north and west of the Talbert Channel Watershed. Based on qualitative observations the land-use appears to be somewhat comparable to that in the Talbert Channel Watershed, with a mixture of commercial, industrial, transportation and residential areas.
- ***Santa Ana Delhi Channel, Upstream of Irvine Ave.*** OC Station No. SADF01 A 17.6 square mile watershed that drains portions of Costa Mesa, Irvine, Newport Beach, and Santa Ana. It is located to the northeast of the Talbert Channel Watershed on the south side of the SAR. Based on qualitative observations, the land-use is mixed, with residential areas and considerable areas of commercial, light industrial, and transportation land-uses, including the OC airport.
- ***Oso Creek at Crown Valley Parkway.*** OC Station No. OSOL03. A 14.0 square mile watershed that drains portions of Laguna Hills, Laguna Niguel, and Mission Viejo. Located south of Talbert Channel Watershed towards the southern end of OC. Based on qualitatively observations land-use is predominately residential, but generally is newer and less dense than residential areas in the Talbert Channel Watershed. The watershed also includes commercial, transportation, and open space land-uses.

Table A-9 compares the average in-channel pollutant concentrations for selected sites with the average concentrations from the LA County land-use based monitoring. In making these comparisons it is important to keep in mind that OC EMC results represent a flow-weighted average of the in-stream monitoring data, which reflects runoff from a mixture of land-uses. It is also important to bear in mind that stormwater monitoring data typically have a high degree of variability.

The comparisons for TSS in Table A-9 indicate that OC EMCs from watersheds north of the Santa Ana River (SAR) are generally comparable with the LA County monitoring data for a mixture of predominantly high-density residential and other land-use. High TSS values detected at the Santa Ana Delhi and Oso Creek stations may reflect larger amounts of open space areas than are found in the built-out watersheds north of the SAR.

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In contrast to TSS, comparisons for nitrate and total phosphorus (TP) in Table A-9 shows that the OC EMCs are greater than LA County monitoring results for all monitored land-uses. It is not clear why nitrate levels are considerably higher in OC, but could possibly reflect higher levels of fertilization of landscaped areas. Higher levels of TP detected in the OC EMCs could reflect regional differences in geology, as soils in OC are generally naturally rich in phosphorus. The comparisons in Table A-9 suggest that use of the LA County Monitoring data in the pollutant loads model may result in an underestimation of nitrate and TP loads to the Talbert Marsh.

The comparison for total metals in Table A-9 show mixed results. The comparison for total metals show that OC EMCs from the East Garden Grove Wintersburg (immediately adjacent to the Talbert Channel Watershed) and Oso Creek Stations are generally comparable to LA County results for a mixture of high-density residential and commercial land-uses. Higher levels of total copper and total lead found at the other OC stations may reflect greater levels of commercial, light industrial and transportation land-uses in these watersheds. While these comparisons are by no means comprehensive, the comparisons suggest that the LA County monitoring data are reasonable surrogates for local conditions.

Table A-9: Comparison of Stormwater Monitoring Information from Los Angeles and Orange Counties

Location	Sampling Period	TSS (mg/L)	Nitrate-N (mg/L)	TP (mg/L)	Total Copper (ug/L)	Total Lead (ug/L)	Total Zinc (ug/L)
East Garden Grove Wintersburg	23 events: 1991-1998	108	4.7	1.4	30.3	21.0	113.2
Westminster Channel	23 events: 1992-1999	177	7.1	1.6	47.9	28.3	170
Anaheim Barber City Channel	22 events: 1993-2000	75	6.7	1.3	41.0	18.9	179.1
Santa Ana Delhi Channel	34 events: 1992-2002	220	7.5	2.1	41.4	33.2	185.1
Oso Creek	17 events: 1992-1999	450	4.7	2.8	23.7	6.9	87.6
LA County Monitoring							
High Density Single Family Res.		128	0.8	0.4	15.7	8.8	73
Multi-Family Residential		40	1.4	0.2	11.1	3.3	97
Mixed Residential		73	0.6	0.3	13.5	5.2	134
Commercial	1996-2000	67	0.6	0.4	34.8	20.8	239
Light Industrial		178	0.6	0.3	27.8	18.2	335
Transportation		40	0.3	0.3	33.9	3.5	173
Vacant		224	1.2	0.1	8.8	3.2	22

A.7 Pollutant Loads and Concentrations without Treatment

The water quality model estimates the average annual pollutant loads in runoff from storm events. The pollutant load is the total mass (e.g. pounds) of pollutant in runoff during a given period of time. The pollutant load was calculated by multiplying the estimated mean annual runoff volume and the estimated pollutant concentration (EMC) using the following equation:

$$\begin{array}{ccccccc}
 \text{Flow} & & \text{EMC} & & \text{Conversion Factor} & & \text{Load} \\
 \left(\frac{ft^3}{year} \right) & \times & \left(\frac{mg}{L} \right) & \times & \left(6.2428 \times 10^{-5} \frac{lbs}{ft^3} \right) & = & \left(\frac{lbs}{year} \right)
 \end{array}$$

Annual loads were calculated for all modeled pollutants from all land-uses within each modeled subcatchment in the Talbert Channel Watershed. The total load in any given subcatchment is sum of the loads from all land-uses with the subcatchment. The estimated loads from all modeled subcatchments are presented in Table A-10 for average rainfall conditions, as well as, average dry and wet period conditions.

An estimate of the average pollutant concentration in stormwater discharges from the modeled catchments was calculated from the estimated loads and runoff volumes, using the expression:

$$\begin{array}{ccccccc}
 \text{Concentration} & & \text{Total Load} & & \text{Total Runoff} & & \text{Conversion Factor} \\
 \frac{mg}{L} & = & \left[\frac{\sum lbs}{year} \div \frac{\sum ft^3}{year} \right] & \times & \frac{6.2428 \times 10^{-5} lbs/ft^3}{mg/L}
 \end{array}$$

The estimated average stormwater pollutant concentration for all modeled catchments is presented in Table A-11 for the proposed project conditions without treatment BMPs.

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Table A-10: Estimated Average Annual Pollutant Loads in Stormwater Discharges

Pollutant\Subcatchment	B	F	FV	HD	N	TB	TP	Y&A&I	WT	Total
<i>Average Rainfall Conditions</i>										
TSS (tons)	49	39	195	147	61	100	7	81	7	686
TP (lbs/yr)	269	232	1136	1039	332	681	40	576	18	4324
Nitrate-N (lbs/yr)	508	420	2059	1834	641	1239	87	1024	76	7887
Nitrite-N (lbs/yr)	61	55	284	259	77	163	9	143	3	1054
Ammonia-N (lbs/yr)	307	287	1644	1517	371	877	47	813	11	5874
TKN (lbs/yr)	1896	1627	7922	7348	2279	4727	285	4044	106	30234
TN (lbs/yr)	2396	2089	10263	9417	2979	6114	377	5144	152	38929
Diss. Copper (lbs/yr)	9	8	43	32	12	21	1	17	1	144
Total Copper (lbs/yr)	15	13	75	56	19	34	2	30	1	244
Total Lead (lbs/yr)	8	6	39	27	9	15	1	14	0	119
Diss. Zinc (lbs/yr)	75	57	390	177	87	96	5	89	5	981
Total Zinc (lbs/yr)	110	88	562	307	129	174	9	159	6	1544
<i>Average Dry Period Conditions</i>										
TSS (tons)	40	31	157	118	49	81	6	65	6	552
TP (lbs/yr)	217	187	915	837	267	548	32	464	15	3482
Nitrate-N (lbs/yr)	409	338	1658	1477	516	998	70	825	61	6351
Nitrite-N (lbs/yr)	49	44	229	209	62	131	7	115	3	849
Ammonia-N (lbs/yr)	247	231	1324	1222	299	706	38	655	9	4730
TKN (lbs/yr)	1527	1310	6380	5917	1836	3807	230	3257	86	24348
TN (lbs/yr)	1929	1682	8265	7584	2399	4923	303	4142	122	31350
Diss. Copper (lbs/yr)	8	6	35	26	9	17	1	14	1	116
Total Copper (lbs/yr)	12	10	60	45	15	27	2	24	1	196
Total Lead (lbs/yr)	6	5	31	22	7	12	1	11	0	96
Diss. Zinc (lbs/yr)	60	46	314	142	70	77	4	72	4	790
Total Zinc (lbs/yr)	89	70	453	247	104	140	7	128	5	1243
<i>Average Wet Period Conditions</i>										
TSS (tons)	62	49	246	186	77	127	9	103	9	868
TP (lbs/yr)	341	293	1438	1315	420	862	51	729	23	5471
Nitrate-N (lbs/yr)	642	531	2606	2320	812	1568	110	1296	96	9981
Nitrite-N (lbs/yr)	78	69	359	328	97	206	12	181	4	1334
Ammonia-N (lbs/yr)	388	363	2080	1920	470	1110	60	1029	14	7434
TKN (lbs/yr)	2399	2059	10025	9299	2884	5982	361	5117	135	38261
TN (lbs/yr)	3032	2643	12988	11917	3769	7737	477	6510	192	49264
Diss. Copper (lbs/yr)	12	10	55	41	15	26	1	22	1	182
Total Copper (lbs/yr)	19	16	94	71	23	43	2	38	2	309
Total Lead (lbs/yr)	10	8	49	34	11	19	1	18	0	150
Diss. Zinc (lbs/yr)	95	73	494	223	110	121	6	113	6	1241
Total Zinc (lbs/yr)	139	111	711	388	164	220	11	201	8	1953

Table A-11: Estimated Average Pollutant Concentrations in Stormwater Discharges

Pollutant/Subcatchment	B	F	FV	HD	N	TB	TP	Y&A&I	WT	Total
TSS (mg/L)	126	124	126	109	128	112	87	106	129	117
TP (mg/L)	0.35	0.37	0.37	0.39	0.35	0.38	0.24	0.38	0.17	0.37
Nitrate-N (mg/L)	0.65	0.67	0.67	0.68	0.68	0.69	0.52	0.67	0.71	0.67
Nitrite-N (mg/L)	0.08	0.09	0.09	0.10	0.08	0.09	0.05	0.09	0.03	0.09
Ammonia-N (mg/L)	0.39	0.46	0.53	0.56	0.39	0.49	0.28	0.53	0.11	0.50
TKN (mg/L)	2.43	2.59	2.57	2.73	2.40	2.64	1.71	2.65	1.00	2.58
TN (mg/L)	3.08	3.32	3.33	3.49	3.14	3.42	2.25	3.37	1.42	3.32
Diss. Copper (ug/L)	12.0	12.4	14.0	11.9	12.2	11.5	6.7	11.4	7.7	12.3
Total Copper (ug/L)	19.2	20.3	24.2	20.7	19.5	19.1	11.2	19.6	13.4	20.8
Total Lead (ug/L)	9.8	10.2	12.5	10.0	9.2	8.5	5.1	9.2	2.5	10.1
Diss. Zinc (ug/L)	96	91	127	65	92	53	27	58	47	84
Total Zinc (ug/L)	141	139	182	114	136	97	52	104	57	132